Evaluation of deep vein thrombosis of the lower limbs using ultrasound

A Thesis Submitted for Partial Fulfillment of the Requirement of the M. Sc. Degree in Medical Diagnostic Ultrasound

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قال تعالى:

وَعَلَّمَ آدَمَ الأَسْمَاءِ كُلَّهَا ثُمَّ عَرَضَهُمْ عَلَى الْمَلاَئِكَةِ فَقَالَ أَنبِئُونِي بِأَسْمَاءِ هَـؤُلاءِ إِنْ كُنتُمْ صَادِقِينَ َقَالُواْ سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّاً مَا عَلَّمْتَنَا إِنَّكَ أَنتَ صَدِيقُ اللَّهِ العَظِيمُ

صدق الله العظيم
سورة البقرة (31-32)
Dedication

I Dedicate This Effort to:
My Mother Om ballena
My Grand mother…. 
To My Sisters Rania and Rawia
To Any One who Ever Taught Me
Acknowledgement

I Am Greatly Indebted To My Supervisor Dr. Elsir Ali Saied, For His Advice, True Guidance, Great Help and Constrictive Criticism.

I Would Like To Thanks The Staff Of Ultrasound In The Fedail Hospital, Algwoda Hospital, Police And Omdurman Hospital For Their Help.

My Appreciation To Each Person Who Help, Encourage And Support Me To Perform And Process This Study.
Abstract:

Deep venous thrombosis (DVT) of lower limbs is one of the most common cause for the majority of deaths caused by pulmonary embolism. Many medical and surgical disorders are complicated by DVT. Most venous thrombi are clinically silent. Gray scale and color Doppler imaging is needed for early diagnosis of DVT to prevent complications and sequelae of DVT.

The objectives of the following study were to evaluate the role of Doppler as an imaging modality in diagnosing DVT of lower limbs, to study the spectrum of findings on Doppler ultrasound in patients with DVT.

Retrospective descriptive analysis of 100 patients of DVT diagnosed on Doppler. The study found that nearly 74% of the patients were males and 26% were females with majority belonging to fifth decade (26%). 98 (98%) cases showed unilateral while 2 (%2) cases of male showed bilateral lower limb involvement. In our study, predominant distribution of thrombus was found to be in above knee region with (30%) patients having thrombus in the left common femoral vein. Left Popliteal vein was involved in (21%) patients, right Popliteal vein was involved in (16%) patients, right common femoral vein (15%)

Subacute stage was seen in 53 cases (53%), acute stage in 30 cases (30%) while chronic stage in 17 cases (17%).

(75%) patients had isolated vein involvement, whereas 25 cases (25%) had multiple veins involvement.

The study found that Color Doppler is useful in diagnosing DVT in symptomatic and at risk patients and provides a non-invasive method of investigation. It is also helpful in evaluating the site, extent and stage of thrombus.
 المستخلص الدراسة:
- تعتبر جلطات أوردة الأطراف السفلية من أكثر أسباب الوفيات التي تسببها الجلطات الرئوية وأغلب هذه الجلطات لا تظهر أعراض لذلك تستخدم الموجات فوق الصوتية الملونة والعادية للشرايين والاوردة في التشخيص المبكر لتجنب حدوث المضاعفات.
- وكان الهدف من هذه الدراسة هو تقييم دور الموجات فوق الصوتية الملونة كوسيلة لتشخيص هذه الجلطات وتحليل نتائجها.

لقد اجريت هذه الدراسة على 100 مريض تم تشخيصهم بالأصابات بجلط في الأوردة العميقه للأطراف السفلى وكانت نتائج الدراسة كالاتي:
حوالي 74% ذكور و 26% أناث.
98% من الجلطات كانت في طرف سفلي واحد. 2% من الجلطات في الطرفين وكانت في الذكور. الغالبيه العظمى من الجلطات كانت في اوردة الجزء الاعلي من الركبة. حوالي 30% من المرضى حدثت الجلطه في الوريد الرئيسي للخذ اليسار وحوالي 21% في LtPOPV و 15% في RtPOPV.

حوالي 53% من الحالات كانت في المرحلة تحت الحادة و30% من الحالات في المرحلة الحادة و17% في المرحلة المزمنه. 75% من الحالات في مرحلة واحدة و 25% كانت في أكثر من وريد.

وقد وجدت هذه الدراسة ان استخدام الموجات فوق الصوتية الملونة مفيدة في تشخيص جلطات أوردة الاطراف السفلية في المرضى الذين لايعانون من اعراض والأشخاص الذين لديهم عامل خطر لحدوث تلك الجلطات وكذلك توفر طريقة غير جراحية للتشخيص أيضاً نبضه في تقييم موقع وامتداد ومرحلة الجلطه.
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1-1: introduction:

Venous thromboembolism (VTE) is a significant, but relatively under diagnosed health problem. The threat of deep venous thrombosis (DVT) and pulmonary embolism (PE) is a daily concern in intensive care unit (ICU), hospitalized and bedridden patients. Early diagnosis of DVT is mandatory to prevent unnecessary deaths from PE.\(^{(1)}\)

The incidence of DVT varies in different parts of the world for reasons that are not yet completely understood. Though, some of the recent studies published from other Asian countries have shown that DVT is not a rarity in Asian patients as was thought earlier. The incidence of DVT in the general population has been estimated to be 80-100/1,00,000 annually in the western societies, 75/1,00,000 in South-Asia. In Sudan, the incidence of DVT is not well highlighted and literature survey shows scanty works in this field.\(^{(1)}\)

Most of the literature available in Sudan is from the orthopedic departments, overall incidence of DVT in the general population is unknown.

Risk of new postoperative DVT rises from 26% to 68%, respectively. In patients on bed rest in a general medical ward, the rate of DVT is 10% but in an ICU it is 29%. of DVT in the general population is largely unknown.\(^{(1)}\)

VTE is the third most common cardiovascular illness after acute coronary syndrome and stroke. PE is the third most common cause of hospital related death and the most common preventable cause of hospital related death. Most hospitalized patients have at least 1 or more risk factors for VTE (Wells score).\(^{(1)}\)

A proximal lower-extremity DVT (defined as occurring in the popliteal vein and above) is linked to an estimated 50% risk of PE if not treated, while approximately 20-25% of calf vein thrombi propagate (in the absence of treatment) to involve the popliteal vein or above. PE occurs in between 15% and 32% of cases following DVT in a lower extremity. The majority of patients die because of a failure in
diagnosis rather than inadequate therapy. In fact, the mortality rate for PE without treatment is approximately 30%.\(^{(1)}\)

Many medical and surgical disorders are complicated by DVT. The common signs of DVT are pain and swelling of affected lower limbs. It may in turn cause structural damage to the valves of deep veins resulting into post phlebitic syndrome. Exaggeration of the normal process of hemostasis may be considered as a functional cause for development of a thrombus within a vein.\(^{(1)}\)

The patients after a major surgery, trauma and prolonged immobilization such as in acute myocardial infarction, congestive cardiac failure, stroke and postoperative convalescence form a major group of patients at high risk for DVT. Neoplasm’s, pregnancy, oral contraceptive pills and hypercoaguable states are a few other risk factors to mention.\(^{(1)}\)

DVT occurs along a continuum with propagation, extension and progression. 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 the third 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).\(^{(1)}\)

Thus to prevent the complications and sequela of early and appropriate treatment instillation, there is a need of an objective technique to supplement and confirm the clinical diagnosis of DVT.\(^{(1)}\)

The diagnosis and treatment of DVT has irrevocably been altered after the introduction of Doppler ultrasound technique. The principle used is that the venous flow pattern of the vein gets distorted due to thrombotic obstruction which is readily detected by the Doppler instrument.\(^{(1)}\)
Doppler USG can be used in pregnant women, permits multiple views in various positions of leg and it is safe, painless and inexpensive. It is also non-invasive technique and can be repeatedly used, performed rapidly in the clinic, at patient’s bedside or even at home and the results are available immediately. The test is useful in high risk patients as a screening modality to ensure early diagnosis and treatment. The duplex scan can diagnose many thrombi at a stage when no major changes have occurred in the venous hemodynamic and the patient is asymptomatic or minimally symptomatic.\(^{(1)}\)

1-2 Background studies:

Taylor Kenneth (Doppler ultrasound for evaluation of venous pathology) 1995 has mentioned that definitive diagnosis of DVT relies on visualization of intraluminal thrombus. Duplex and color Doppler imaging demonstrate several advantage in the evaluation of venous system, first the examination is non invasive, without exposure to contrast media or radiation. This technique provides both physiologic and anatomic information during scan. The test excels to contrast venography with sensitivity and specificities ranging from 89% to 100%.

Lewis-BD et al (diagnosis of acute deep venous thrombosis of the lower extremity prospective evaluation of color Doppler flow imaging versus venography) September 1994 their study showed that color Doppler flow imaging is complementary to compression ultrasonography in evaluation of suspected acute DVT and may be help full in evaluation of suspected DVT in patients with previous or chronic DVT. CD in 97 of 103 cases had sensitivity of 95%, specificity of 99% positive and negative predictive values of 95% and 99% respectively and accuracy of 98% in detection of acute DVT and was also helpful in differentiation of chronic form acute DVT.\(^{(6)}\)

Miselli et al. (Ultrasonography in diagnosis of deep venous thrombosis of the leg) October 1990 they showed that Doppler ultrasound proved to be valid alternative
to contrast venography in diagnosis of proximal DVT of lower limbs. The venographic results were in substantial agreement with ultrasound findings with 99% to 100% sensitivity and specificity respectively. Ultrasound also allowed the detection of condition mimicking DVT such as muscular rupture, hematoma, popliteal cyst or compressive tumors.\(^{(6)}\)

Blavis et al (lower extremity Doppler for deep venous thrombosis) February 2000 in their study they showed that emergency physicians can perform L.E duplex ultrasound examination accurately and quickly clinical diagnosis of lower extremity DVT requires confirmation by an imaging before committing the patient to anticoagulation therapy. Their studies have shown that demonstrating compressibility of leg veins under color duplex ultrasonography is accurate for ruling out DVT when performed by experienced.\(^{(8)}\)

In 2006 Dr Balaji Patel Kola(role of color duplex sonography as a diagnostic modality in suspected lower deep vein thrombosis), Rajiv Gandhi University of health and science show in his study an early and accurate diagnosis of DVT is not only essential to prevent mortality but also to avoid complication related to unnecessary anticoagulation therapy. The study also showed that color duplex sonography is ideal investigative method which is simple, cost effective and non invasive. and he found that DVT is highest incidence in male 58% and in age group of 30-60years 78%, and most common symptom are pain heaviness in limbs 80%, and common sign is pedal edema 74% and most common site of DVT in the popleatal 76%.\(^{(6)}\)
1-3: Problem of the study:
DVT of the lower limbs is one of the most common cause for the majority of deaths caused by pulmonary embolism, many medical and surgical disorders are complicated by DVT.
Most venous thrombi are clinical silent, gray scale and CD imaging is needed for early diagnosis of DVT to prevent complications and sequelae of DVT.

1-4: general objective:
To evaluate the role of Doppler as an imaging modality in diagnosing DVT of lower limbs, to study the spectrum of findings on Doppler ultrasound inpatients with DVT. in Khartoum state.

1-5: Specific objectives:
- To determine site of DVT.
- To determine size of thrombos.
- To determine the most risk factor that causes the (DVT) among Sudanese.
2-1: Anatomy of the veins of lower limbs:

Veins have walls made of three principal layers. Each layer is called a coat or tunic. The outer layer (tunica externa or adventitia) consists of strong connective tissue which acts as a specular reflector (a broad, smooth echogenic interface). The middle layer (tunica media) consists of smooth muscle and elastic fibers. The muscle contractions propel the blood along the vessel; whereas, the elastic fibers enable vessel expansion due to surges in blood pressure. The inner layer (tunica intima) consists primarily of epithelial tissue which acts as a smooth lining so blood will encounter the least possible resistance to blood flow. Venous blood flow is improved by the massaging action of adjacent skeletal muscle contractions. In this manner, blood is said to be "milked" along the vessel toward the heart.\(^{(3)}\)

The caliber of veins varies with the respiratory phase. In most patients the caliber is minimal at end-inspiration without breath holding and maximal at end-expiration. The Valsalva maneuver produces a more variable response. Distention may be greater when the patient holds his breath after a deep inspiration.\(^{(3)}\)

The lower limb venous system can be divided into the deep and superficial veins, located in two main compartments. The deep compartment contains all the deep veins and is bounded by the muscular fascia. The superficial veins lie in the superficial compartment and are bounded deeply by the muscular fascia and superficially by the dermis the muscular fascial layer is usually visible on an ultrasound image.\(^{(2)}\)
Figure (2.1): Diagram of the deep and superficial vein Compartments. The main trunk of the saphenous vein lies in the saphenous compartment (SC), located within the Superficial compartment. \(^{2}\)

Figure (2.2)(A,B): The main trunks of the superficial veins are shown in cross section. A: The long saphenous vein (V) lies in the superficial compartment, bounded by the deep muscular fascia (upward arrows) and the saphenous fascia (downward arrows). B: The short saphenous vein (V) is also bounded by the deep fascia (upward arrows) and saphenous fascia (downward arrows). The medial gastrocnemius muscle (MG) and lateral gastrocnemius muscle (LG) are shown on this image of the right leg. \(^{2}\)
The superficial (epifascial) venous drainage system consists of two subsystems, that of the great saphenous vein and that of the small saphenous vein, which receive the larger arch veins and side branches. The great saphenous vein extends from the back of the foot to the medial malleolus and takes a medial course through the lower and upper leg to about 2–3 cm below the inguinal ligament, where it opens into the popliteal vein. There is variation in the tributaries to the great saphenous vein in the lower leg but these are mainly the following: the posterior arch vein, which is connected to the major deep veins, in particular the posterior tibial vein, through the perforating veins (Cockett I, II and III); the great saphenous branch from the back of the foot; and the anterior tributary vein. In the thigh, connections to the deep venous system are established by Dodd’s perforators. Just before its junction with the common femoral vein, the great saphenous vein receives tributary veins of the upper leg and lateral branches that establish collateral connections to the abdominal (epigastric) veins and become important as collaterals in pelvic vein thrombosis.\(^3\)

The small saphenous vein drains the lower leg and arises at the lateral dorsum of the foot, coursing behind the lateral malleolus to the posterior side of the lower leg, where it ascends between the heads of the gastrocnemius and pierces the fascia to open into the popliteal vein above the knee joint cleft. The gastrocnemius veins enter the small saphenous vein shortly before its opening or enter the popliteal vein directly. The femoropopliteal vein passes from the small saphenous vein (just before it opens into the popliteal vein) as a collateral to the deep veins of the upper leg.\(^3\)

Both the great and small saphenous veins have valves. In comparison to the deep veins, the superficial veins have thicker walls with a thin muscular layer. The lumen varies with the intravenous pressure and can be compressed by external
structures. There is wide variation in the course of individual veins and the connections they form.

The perforating veins are transfascial veins that drain blood from the superficial venous system into the major deep veins. About 150 such short veins exist between the superficial and deep venous systems, among which the Cockett groups I-III, the Sherman vein, and the Boyd vein are of clinical importance in the lower leg, the Dodd group in the upper leg and the May perforator between the small saphenous vein and deep lower leg veins. Under normal conditions, valves ensure blood flow from the superficial to the deep venous system while the blood is propelled toward the heart by muscular contraction with compression of the deep veins. This mechanism prevents backward flow into the superficial vein.\(^{(3)}\)

![Medial superficial and perforating veins of the lower limb](image)

Figure (2.3) Medial superficial and perforating veins of the lower limb\(^{(6)}\)
2-1-1: Deep veins system:

1-Deep veins of the leg include:
   a-Anterior tibial veins
   b-Posterior tibial veins
   c-Peroneal veins

2-Venous sinusoids in the calf:
   a-Gastrocnemius veins
   b-Soleal veins

3-Popliteal vein

4-Femoral vein
   a-Deep femoral
   b-Common femoral vein

5-Iliac vein
   a-External iliac vein
   b-Internal iliac vein

There can be considerable anatomic variation in the deep veins of the leg, particularly duplication variants. Since these variations are common, they pose a significant consideration in the sonographic diagnosis of deep vein thrombosis. (5)
(a)Calf Veins:
The deep veins in the calf arise in the dorsal venous rete (foot), course up the leg through the soleus and gastrocnemius muscles and empty into the popliteal vein behind the knee. A set of paired tibial veins accompanies each of the three runoff arteries: anterior tibial, posterior tibial, and peroneal. The anterior tibial veins are formed by the cephalad continuation of the veins that accompany the dorsalis pedis artery. They pass between the tibia and fibula through a large opening anterior to the interosseous membrane. They join with the tibioperoneal trunk vein to form the popliteal vein behind the knee. The posterior tibial veins are formed by the internal and external plantar veins of the foot and course cephalad with the posterior tibial artery along the medial aspect of the tibia. In the lower popliteal space they join with the peroneal veins to form a
short trunk (tibioperoneal trunk vein). This trunk in turn joins with the anterior tibial veins to form the popliteal vein. (5)

Veins that drain the major calf muscles, also referred to generically as sural veins, join the deep calf veins in the popliteal fossa. There is considerable anatomic variation in venous drainage from the calf muscles. In fact, most of these veins are not named. Generally, smaller veins draining muscle mass coalesce to form the soleal and gastrocnemius intramuscular venous plexi. There are between 2 and 12 draining veins in each gastrocnemius muscle head which, in turn, empty into a medial or lateral gastrocnemius vein. In the great majority (87%) of cases, the main gastrocnemius veins drain into a gastrocnemius trunk that then empties into the popliteal vein. Alternatively, the medial and lateral gastrocnemius veins can drain individually into the popliteal vein. (5)

The soleal veins drain the soleus muscle which is a broad flat muscle located anterior the gastrocnemius muscles. Like the gastrocnemius veins, the irregularly arranged plexus veins deep within the muscle drain into one or several main trunks. These short extramuscular trunks can terminate in a number of ways: a single common trunk may drain into the posterior tibial or peroneal veins or; the terminal branches may create an anastomosis with the posterior tibial or peroneal veins via multiple intramuscular communications at different levels throughout the leg. (5)

inferior vena cava (IVC). The external iliac vein receives several large tributaries that follow their adjacent arteries: the inferior epigastric vein, the deep iliac circumflex vein, and the superficial external pudendal vein all described above as superficial veins of the leg. (5)

(b): Popliteal Vein (PV):  
The popliteal vein is formed by the junction of the anterior and posterior tibial veins at the lower border of the popliteus muscle. It receives tributaries
corresponding to the branches of the popliteal artery, and it also receives the small saphenous vein. It ascends through the popliteal fossa to the adductor canal where it becomes the femoral vein.

In the lower part of its course, the popliteal vein runs medial to the popliteal artery. As it courses cephalad between the heads of the gastrocnemius muscles, it rises superficial to the artery and exits the popliteal space along its lateral margin. There are between two and four valves in the popliteal vein. While the popliteal vein is single most of the time (56%), duplication anomalies are be found.\(^{(5)}\)

**Figure (2.5):** Posterior superficial and perforating veins of the leg. \(^{(3)}\)

**Figure (2.6):** Color doppler ultrasound image longitudinal view of normal popliteal vein and artery\(^{(9)}\)
(c): Femoral vein (FV):
Anatomic nomenclature for this vascular structure can be confusing since it is frequently referred to as the superficial femoral vein (SFV) but it is, in fact, a deep vein. To obviate this confusion, the SFV is now simply called the femoral vein. Beginning in the distal, medial thigh just above the medial condyle of the femur, the popliteal vein exits the adductor (Hunter’s) canal as the femoral vein. It courses up thigh medially and slightly posteriorly to the femoral artery. Just below the level of the inguinal ligament (≈ 4cm), it is joined by the deep femoral vein to form the common femoral vein (CFV). The CFV passes, together with the femoral artery and nerve, beneath the inguinal ligament to enter the pelvis as the external iliac vein. Along its course in the thigh, the femoral vein accommodates perforator veins arising from the GSV which joins it near its termination in the groin. The FV usually contains 2-5 valves. It may be single (62%) or duplicated. Duplication of the distal segment is more common with sequential fusing to form a single vein in mid thigh (31%). Complete duplication of the entire vein occurs about 3% of the time. (5)

(d): Deep Femoral Vein (DFV):
The deep femoral vein (profunda femoris v.) receives numerous muscular tributaries from the upper leg. It courses along the profunda femoris artery and joins the superficial vein to form the common femoral vein (CFV) in the groin. It receives the medial and lateral femoral circumflex veins. (5)
Figure (2.7): color Doppler ultrasound image (longitudinal view) shows communication of SFV and DFV and origin of CFV and femoral artery. (9)

(e): Iliac Veins:
The external iliac vein begins as the femoral veins terminate at the level of the inguinal ligament. As it courses into the pelvis, it is joined by the internal iliac vein (hypogastric v.) to form the common iliac vein (CIV) at the level of the sacro-iliac joint. The common iliac veins on each side unite to form the inferior vena cava (IVC). (5)

Figure(2.8): shows common iliac vein and internal and external iliac veins (5)
The external iliac vein receives several large tributaries that follow their adjacent arteries: the inferior epigastric vein, the deep iliac circumflex vein, and the
superficial external pudenda vein all described above as superficial veins of the leg.\(^5\)

On the right side, the CIV initially lies medial to the iliac artery but, as it courses cephalad, it gradually inclines behind it. On the left side, the CIV passes posterior to the internal iliac artery on its way to the IVC. This subtle anatomic distinction between the two sides can impact venous outflow from the leg. The compression of the vein by the artery or adjacent pathology can reduce venous flow volume resulting in mild to severe venous congestion with attendant sequelae such as deep vein thrombosis. This configuration also contributes to the increased incidence of varicoceles in the left hemiscrotum.\(^5\)

**2-1-2: Venous valves:**

Bicuspid venous valves are important structures assisting unidirectional flow in the normal venous system. The GSV usually has at least 6 valves (range, 4-25), with a constant valve present within 2 to 3 cm of the SFJ in 85% of cases, and the SSV has a median of 7 to 10 valves (range,4-13). There are valves in the deep veins of the lower limb, but the common femoral or external iliac vein has only one valve in about 63% of cases. In 37%, there is no valve in the common femoral or external iliac veins. The internal iliac vein has a valve in 10%; its tributaries have valves in 9%.\(^6\)

![Figure (2.9): Sonographic demonstration of normal venous valves cusps and sinus\(^8\)](image)
2-2: Physiology:

2-2-1: Introduction:

The circulatory system is responsible for circulating (moving) blood throughout the body. The heart and the blood vessels are the most important parts of the circulatory system. The heart is a central organ in the circulatory system. With each beat it forces blood into the blood vessels which transport or carry oxygen and nutrients to all of the tissues and organs (the arteries) of the body and then blood returns back to the heart through the veins. (1)

There are three different types of blood vessels which play different roles within the circulatory system. The two main blood vessels are the arteries and the veins. The arteries carry the blood loaded with oxygen and nutrients away from the heart and the veins return the “used” blood, which has had the oxygen and nutrients removed, back to the heart. The lymphatic vessels are the third component. Briefly, they act as a “clean-up” system to pick up fluid, protein, and other debris left behind by the veins. They filter and clean the fluid before returning it to the heart (1).

2-2-2: Physiology/Hemodynamic:

In normal circulation, the oxygenated blood leaves the left side of the heart through very large arteries. It flows through smaller and smaller arteries and even smaller arterioles and capillaries until it reaches the tissues and organs where the blood vessels are very small usually requiring a microscope to see them. This is called the “capillary bed”. This is where the end of the arterial system connects to the beginning of the venous system. The blood vessels in the “capillary bed” are very tiny, thin walled vessels. This allows for easy release of oxygen and nutrients (sugars, fats, etc.) into the tissue. Blood must then return through the veins to the right side of the heart where it can enter the lungs and pick up more oxygen. The venous system has deep and superficial veins. The deep veins are the major veins
which return the blood. These lie within the muscles of the arms and legs. The superficial veins collect blood from the skin and are intended to take blood through the communicating veins back into the deep system. This is assisted by a series of one-way valves. (1)

The regulation of blood flow through the blood vessels and to the tissues is under fairly complex control of the brain and nervous system as well as local chemicals which may be released by the tissues. Through out the course of the blood vessels there is a complex network of nerves that help regulate the flow through the arteries and veins. This allows tissues to have more blood flow when they are active or exercising and less flow when they are quiet or relaxed. For example, the blood vessels within the skin play a major role in maintaining body temperature. When it is cold they constrict or shut down and move blood away from the skin to the center of the body to preserve heat and when it is hot, they shunt more blood towards the skin to increase heat loss. (6)

Local injury or trauma causes release of chemicals which may create either increased or decreased flow. Increased flow may be seen as localized swelling such as in the case of a burn or an ankle sprain. (6)

The veins are fairly thin walled and are able to change their shape depending on the volume or amount of blood within the vein. The volume of blood is proportional or related to the pressure in the veins. When the amount of blood (or pressure) in the vein is low, the veins are flat like an empty balloon. As the volume (or pressure) increases, the vein expands, similar to an inflated balloon. If the pressures are elevated in the venous system and the veins are too full this may cause leaking into the tissues which is reflected as swelling or edema.

To normally circulate blood through the body there are 4 requirements:
(1) A pump – the heart
(2) A pressure difference or areas of high pressure and areas of low pressure
(3) A “venous pump” – the muscles

(4) A normal vein with intact valves

(1) The heart serves as the main pump in the circulatory system. Blood moves through the arterial system propelled by the force of the heart. Even at the level of the ankle the arterial blood pressure can be recorded with a blood pressure cuff. When the heart is not pumping well, as in heart failure, this will frequently cause swelling.\(^1\)

(2) A pressure difference exists between the legs and the right side of the heart where blood returns to as it goes through the body. At the end of the capillary bed and moving into the venous system there is very little pressure in the veins and at the level of the heart there is even less venous pressure. This pressure difference helps move blood back to the heart. When you lay flat the blood can flow from the higher pressure in the legs to the lower pressure at the heart fairly easily. If there are higher pressures on the right side of the heart, from heart disease or lung disease, the normal pressure difference between the legs and the heart is changed and this may cause swelling.\(^1\)

(3) A “venous pump” - normal venous return requires a “pump”, similar to the heart, to return blood from the legs to the heart. There are two muscular “pumps” in the legs. The main pump of the legs, responsible for generating most of the venous return (blood pushed back toward the heart), is the calf muscle. In the foot there is a network of veins which serve as a minor or secondary pump to “prime” the calf muscle pump of the legs. With each step the foot and calf muscles contract (squeeze) and forces blood up through the venous system against gravity on the way back to the right side of the heart. Loss of the normal calf muscle pump because of not walking normally (shuffling) or loss of normal ankle movement in a cast or splint or after a stroke will result in swelling of the leg because of a decrease in venous return. Some adults as they age their gait may change and they
can develop a “shuffling” gait – this may cause swelling because of loss of the calf muscle pump.\(^6\)

(4) A normal vein with intact valves is required to control “one-way” flow in the veins. A normal vein with intact valves is also required for normal venous return. When the calf muscle pump contracts it lifts a column of blood up against gravity through the venous system. The venous valves act like steps on a ladder – supporting the column of blood until it reaches the right side of the heart and the pressure difference can pull the blood back to the heart.\(^1\)

Normal vein is clean on the inside like a soda straw. If there has been injury from a blood clot and the inside of the vein is scarred or rough this will inhibit normal venous return. If the valves are not working properly, either because of prior injury or because they have worn out (are incompetent), they will not support the column of blood and cause more pressure in the veins this is called reflux. The weight of the blood pushing down in the veins causes increased pressure and can push fluid out of the veins into the tissues. This is one cause of swelling or edema, a main symptom of abnormal venous function. \(^1\)

If any of the above mechanisms of venous return are impaired for a short time – swelling or leaking of fluid into the tissues may be noted. This is commonly noted after a long flight or with short-term immobilization. When these mechanisms are chronically impaired and pressures are chronically or persistently elevated we can begin to see the effects reflected in the skin and tissues of the legs as long-standing swelling, darkening and thickening of the skin, and occasionally even ulceration or wound formation. \(^1\)
2-3: Pathology:

2-3-1: DVT:

Deep vein thrombosis (DVT) is a blood clots forming in the deep veins often of the leg, pelvic or abdomen but can also occur in the arm veins. is a serious healthcare problem. A among patients with DVT, one third of them are diagnosed due to a blood clot traveling in the blood vessels to the lung, causing shortness of breath and chest pain. This is called a pulmonary embolus (PE). The long-term effects of (DVT), called post-thrombotic syndrome (PTS), affects about 500,000 patients with skin ulcers and millions more with discoloration and other skin changes in the legs. Because of the clot’s ability to travel to the lungs, the effects of post-thrombotic syndrome, and the risk of recurrent (DVT), it is important to prevent (DVT) from ever forming (prevention). In order to prevent (DVT) and (PE) some knowledge of who is at risk is needed. (1)

DVT is acute abnormal clotting in deep veins hindering normal flow of venous blood. This may take place when at least one of the three following occurs; venous stasis, vessel wall injury and/or hypercoagulability, known as Virchow’s triad since 1856. The initial thrombus formation usually takes place in the paired calf veins, and if not recognized and treated may result in continuous clotting and more proximal extension of the clot. When attending medical help, 85% have developed proximal DVT affecting the popliteal or more proximal veins thrombotic material may embolize and finally lodge in the pulmonary arterial circulation causing pulmonary embolism (PE) in up to 50 % of patients with proximal DVT. (7)

DVT of the lower limb may cause substantial acute and chronic morbidity, and even death in cases of severe PE. (7)
2-3-2: Risk factor of DVT:
(a): Age, Gender and Race
Age, gender, and race may potentially influence the risk of venous thromboembolism (VTE). Among these, age has most consistently been associated with increased VTE risk. As age increases, so does the risk. This increase in risk appears to be related to several age related factors, including decreased mobility, an increased number of other major risk factors such as cancer, age related changes in the blood’s tendency to clot, and changes in the veins themselves. Gender differences are less clear, with the existing studies differing on whether gender influences risk or not. The lack of consistent data makes it unlikely that there are major gender differences in the incidence of DVT. However, the risk in women is higher during childbearing years, whereas between the ages of 45 and 60 the risk may be higher in men.
Race has a variable affect on incidence of thromboembolism. There is evidence to suggest that the occurrence of post-operative DVT is less in Asian, Arab, Hispanic, and African populations than among those of European descent. This difference is probably due to genetic factors associated with VTE. (1)
(b): Surgery:
The increased risk of DVT or PE associated with surgery is due to decreased ability to move after surgery, and changes in the levels of certain clotting factors in the blood that occur after major surgery. The degree of risk also varies with the age of the patient, the length of the operation, the type of operation, and the presence of other DVT risk factors. Without treatment, DVT can occur in about 25% of patients undergoing general surgery, and can be up to 50% in patients undergoing hip or knee surgery. This risk can be greatly decreased with the appropriate use of sequential compression devices on the legs and/or doses of blood thinners before and after surgery. (1)
(c): **Trauma:**
A person who has had a significant trauma (in a car crash, for example) is at great risk for DVT and PE. These patients are generally unable to move for long periods of time due to their injuries. Often they are severely ill and are unable to have blood thinners due to their injuries.\(^1\)

(d): **Immobilization or travel:**
Bed rest or other immobilization is also associated with an increased risk of VTE. This has to do with blood “pooling” in the veins for long periods of time, a condition called “stasis”. Stasis of blood in the veins is the reason that people on long air flights or long drives are thought to have increased risk of VTE. This risk can mostly be erased by occasionally moving about during the travel and using knee-high elastic compression stockings. Older age, obesity, previous history of VTE, use of oral contraceptives and underlying blood clotting disorder increase the risk of travel-related clots.\(^1\)

(e): **Malignancy**
Malignancy (cancer) carries a significant risk for VTE. Up to 30% of patients with cancer can develop a DVT. While any cancer can increase the risk of DVT, leukemias and lymphomas have a particular risk, as do lung and gastrointestinal cancers. The risk of DVT is highest early after the diagnosis of cancer and cancer can sometimes be diagnosed in patients who present with a DVT for initially unknown reasons.\(^1\)

(f): **Primary blood clotting disorders:**
There are several known genetic conditions that alter the presence or amount of clotting factors in the blood. These conditions often are associated with an increased risk of DVT or PE, but usually cause a problem only when another risk factor is also present. These existing genetic conditions include antithrombin III (AT III) deficiency, protein C deficiency, protein S deficiency, Factor V Leiden
mutation, anti-phospholipid antibody syndrome, prothrombin 20210A gene mutation, hyperhomocysteinemia, alterations in plasmin generation and increase in factors II, VIII, IX or XI. The amount that each of these conditions affects DVT risk varies with the condition and with whether the patient has either one or two genes coding for the defect. (1)

(g): Oral contraceptives and hormonal therapy

Estrogen (female hormone) replacement, either in oral contraceptives (birth control) or in hormone replacement therapy, has been associated with an increased risk of VTE. The higher the estrogen amount, the higher the risk. Although it is less clear, progestin components in some contraceptives may also be related to an increased risk of VTE. The risk for VTE in women who take oral contraceptives is greater in women over 40, and in smokers.

In general, oral contraceptives are discouraged in smoking women over 40, or in women with one of the genetic clotting disorders. (1) Although, the doses of estrogen used for post-menopausal replacement are about 1/6 of those used for contraception, there is a 2-4 fold increase in the risk of VTE in women who use them. However, the risk of replacement therapy must be kept in perspective, as it causes only about 2 new cases of VTE per 10,000 women per year. (1)

(h): Pregnancy:

There is an increased risk of DVT and PE in pregnancy, primarily due to a combination of changes in the blood clotting factors and compression of the pelvic veins by the fetus. There is also a risk of VTE after delivery. Once a mother has had a DVT during pregnancy, she is at increased risk for a recurrent DVT during subsequent pregnancies. (1)
2-3-3: Signs and symptoms of DVT:
One of the most feared complications of DVT is pulmonary embolus. PE occurs in about 10-25% DVT’s. Although sometimes the only symptoms of DVT experienced by a patient are those of a PE, most PEs may be asymptomatic. The symptoms of PE include a sudden onset of chest pain, shortness of breath (breathing very fast) and increased heart rate. Sometimes a person with a PE will pass out from the PE. Other less common signs are pain with breathing, dizziness and anxiety. Most of these symptoms are very vague, and could be due to a number of different conditions. Therefore, other tests are needed to find a PE. A person who experiences a sudden onset of these symptoms should be evaluated immediately. (1)

2-3-4: Varicose veins:
Varicose veins are twisted, enlarged veins near the surface of the skin. They are most common in the legs and ankles. They usually aren't serious, but they can sometimes lead to other problems. Varicose veins are caused by weakened valves and veins in the legs. Normally, one-way valves in the veins keep blood flowing from the legs up toward the heart. When these valves do not work as they should, blood collects in the legs, and pressure builds up. The veins become weak, large, and twisted.
Varicose veins often run in families. Aging also increases the risk. Being overweight or pregnant or having a job where you must stand for long periods of time increases pressure on leg veins. This can lead to varicose veins. (10)
Varicose veins look dark blue, swollen, and twisted under the skin. Some people do not have any symptoms. Mild symptoms may include:
- Heaviness, burning, aching, tiredness, or pain in your legs. Symptoms may be worse after you stand or sit for long periods of time.
- Swelling in your feet and ankles.
- Itching over the vein.
- More serious symptoms include:
- Leg swelling.
- Swelling and calf pain after sit or stand for long periods of time.
- Skin changes, such as:
  - Color changes.
  - Dry, thinned skin.
  - Inflammation.
  - Scaling.
- Open sores, or you may bleed after a minor injury.
- Varicose veins are common and usually aren't a sign of a serious problem. But in some cases, varicose veins can be a sign of a blockage in the deeper veins called deep vein thrombosis.\(^{(10)}\)

Normal Veins have leaflet valves to prevent blood from flowing backwards (retrograde flow or reflux). Leg muscles pump the veins to return blood to the heart (the skeletal-muscle pump), against the effects of gravity. When veins become varicose, the leaflets of the valves no longer meet properly, and the valves do not work (valvular incompetence). This allows blood to flow backwards and they enlarge even more. Varicose veins are most common in the superficial veins of the legs.\(^{(12)}\)
Figure (2.10): normal flow in normal vein and abnormal flow in varicose vein\textsuperscript{(13)}

Figure (2.11): Color Doppler image show the reflux (change in color) in the GSV.\textsuperscript{(13)}

**2-4: Ultrasound evaluation of DVT:**

Over the past 2 decades venous ultrasonography (US) has become the standard primary imaging technique for the initial evaluation of patients for whom there is clinical suspicion of deep venous thrombosis (DVT) of the lower extremity veins.
It has replaced the venogram and other diagnostic studies such as impedance plethysmography, various radionuclide studies, and conventional CT because of its noninvasive nature, the ease with which it can be performed in skilled hands, and its proven efficacy. Compression US first was described as a means of diagnosing DVT in 1986 by Raghavendra and colleague and was introduced into clinical practice in 1987 by Cronan and colleagues from the United States and A ppleman and colleagues from the Netherland (8)

The use of Doppler ultrasound to evaluate blood flow within the body is steadily expanding. Peripheral vascular Doppler investigation of the carotid arteries and the deep veins of the legs are well established procedures. (4)

Duplex scanning (Doppler and B mode) is considered to be the method of choice for the imaging of (DVT), with venography reserved for technically incomplete or difficult duplex examinations. Duplex scanning can be used for serial investigations to monitor the progression and outcome of thrombosis. In addition, duplex scanning can be useful for assessing the long-term damage to veins and valve function as a result of chronic post-thrombotic syndrome. This can lead to the development of lower limb venous hypertension and possible leg ulceration. (2)

Color duplex ultrasonography has evolved as a noninvasive test that can be repeated any time, sonography is increasingly replacing conventional diagnostic modalities that cause more discomfort to the patient.

The combination of gray-scale sonographic information for evaluating topographic relationships and morphologic features of vessels with the qualitative and quantitative data obtained with the Doppler technique enables fine diagnostic differentiation of vascular disorders. In particular, the hemodynamic Doppler information is a useful supplement to the findings obtained with radiologic modalities. Being noninvasive and easy to perform any time, duplex sonography precedes more invasive, stressful, and expensive diagnostic tests in the step by-
step diagnostic workup of patients with vascular disease. It provides crucial information for optimal therapy and will replace invasive modalities such as angiography and venography. (3)

Pulsed and color Doppler (PD, CD) studies add significant information for the diagnosis and characterization of the clot. (CD) quickly determines whether the clot is occlusive or non occlusive. It can readily characterize a hematoma, lymph node, Baker's cyst or differentiate between a vascular and nonvascular mass. (4)
3-1: Methodology:

3-1-1: study design:
A retrospective descriptive cross section study.

3-1-2: Study area:
The study was conducted in fedail hospital, National Ribat hospital and Algoda hospital.

3-1-3: Study duration:
The study was conducted between January 2015–June 2015.

3-1-4: Study population
Sudanese patients of DVT diagnosed on Venous Doppler in Khartoum state.

3-1-5: Sample size:
100 patients with lower extremities veins thrombosis with different ages and genders.

3-1-6: Study variables:
Different ages, gender.

3-1-7: Inclusion criteria:
All patients with lower extremities veins thrombosis diagnosed on B-mode and color Doppler.

3-1-8: Exclusion criteria:
All patients with other lower extremities pathologies or DVT patient’s who under treatment.

3-1-9: Tools of data collection:
-Primary data was collected from data collection sheets and Doppler ultrasound examinations.
-Secondary data was collected from books and internet.
3-1-10: **Data analysis:**
- Analysis of cases of DVT was done in terms of age and sex wise distribution, symptoms and signs, predisposing conditions, anatomic distribution and stage of involvement of thrombus.
- The data was analyzed by software programs, EXCEL and statistical program (SPSS).

3-1-11: **Data presentation:**
- The data was presented in tables and figures

3-2: **Instrumentation**
Ultrasound machine SEMINS model 1003322 serial No 49043 linear probe, ultrasound machine CHAISON ,linear probe and MINDARY model DC-N3 serial No 6D-36000676 linear probe, ultrasound gel.

3-3: **Technique:**
All patients was scan by Doppler ultrasound machine high frequency linear transducer from upper thigh till foot with longitudinal scans and transverse scans to exam the iliac vein common femoral vein, saphenous vein, popliteal vein, posterior tibial vein, anterior tibial vein and dorsal rete.

3-4: **Examination protocol:**
(a): **Iliac vein:**
The patient lie supine, with low frequency convex probe the external iliac vein is identified at the groin and is fallowed up by the transducer lateral to the rectus muscle. And the pressure applied by the transducer to better visualization of this region. It then divided into internal and an external iliac vein in the iliac fossa the confluence is not always identified.

(b): **Femoral segment:**
Change to higher frequency and return to the groin region. The patient is supine with hip slightly externally rotated. Visualize common femoral vein with
longitudinal plane and differentiate between the vein and artery by the color Doppler.

The SFJ was evaluated by spectral analysis and to check for spontaneous, phasic flow, normal valsava response and augmentation with calf compression. Proceed distally along the femoral vein to junction of superficial and deep femoral vein. And then return to the CFV level and begin transverse examination with color Doppler.

(c): Popliteal vein:

Patient lies prone with feet elevated by using a billow. The knee flexed slightly 10-15 degree to avoid collapse of the vein. Begin with longitudinal view of the superficial femoral vein the distal part of adductor canal continue distally till it bifurcates into peroneal and tibial vein at the inferior end of the popliteal fossa. And then exam in the transverse plane.
4. RESULTS

In the fifth decade [Table 1]. Out of the 100 patients showing evidence for DVT, male predominance was found that constituted 74 % of the cases [Table 2]. Edema (61%), pain and edema (17%), previous history of DVT (11%), pain (8%) were the presenting symptoms while 3% patients presented with PE [Table 5]. It was found that prolonged hospitalization/immobilization were the most common predisposing factor, followed by postoperative cause and trauma. However no predisposing condition was found in the majority of the patients [Table 6]. Bilateral lower limb DVT was observed in 2 cases (2%), unilateral lower limb involvement was seen in 98 (98%) cases, thus showing predominant unilateral lower limb involvement.

The number of Left lower limb involvement was seen in 65 (65%) cases, right lower limb involvement was seen in 35 (35%) cases. The left common femoral vein predominance was noted in our study (30%).

Left Popliteal vein was involved in 21% of the patients Right Popliteal vein was involved in 16% of the patients [Table 7].
Table (4.1): Frequency distribution of patients according to age

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![Graph showing frequency distribution according to age](image)

**Fig. (4.1):** Distribution according to Age
### Table (4.2): Frequency distribution of patients according to gender

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</tr>
<tr>
<td>Females</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100%</td>
</tr>
</tbody>
</table>

![Pie chart showing gender distribution](chart.png)

**Fig. (4.2):** distribution according to gender
Table (4.3): Frequency distribution of the patients according to residence

<table>
<thead>
<tr>
<th>Residence</th>
<th>Frequency</th>
<th>male</th>
<th>female</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khartoum</td>
<td>55</td>
<td>45</td>
<td>10</td>
<td>55</td>
</tr>
<tr>
<td>Omdurman</td>
<td>27</td>
<td>20</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Khartoum North</td>
<td>18</td>
<td>9</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>74</td>
<td>26</td>
<td>100%</td>
</tr>
</tbody>
</table>

Fig. (4.3): distribution according to Residence
Table (4.4): Frequency distribution of the patients according to occupation

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Frequency</th>
<th>male</th>
<th>female</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have occupation</td>
<td>63</td>
<td>50</td>
<td>13</td>
<td>63</td>
</tr>
<tr>
<td>No occupation</td>
<td>37</td>
<td>24</td>
<td>13</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>74</td>
<td>26</td>
<td>100%</td>
</tr>
</tbody>
</table>

Fig. (4.4): distribution according to occupation
Table (4.5): Frequency distribution of the patients according to sign of DVT

<table>
<thead>
<tr>
<th>Signs and symptoms</th>
<th>Frequency</th>
<th>male</th>
<th>female</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edema</td>
<td>61</td>
<td>47</td>
<td>14</td>
<td>61</td>
</tr>
<tr>
<td>pain and Edema</td>
<td>17</td>
<td>12</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Previous history of DVT</td>
<td>11</td>
<td>8</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Pain</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

Fig. (4.5): distribution according to sign of DVT
Table (4.6): Frequency distribution of the patients according to risk factor of DVT

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Frequency</th>
<th>male</th>
<th>female</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolonged hospitalization</td>
<td>32</td>
<td>22</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>Postoperative cases</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>History of Trauma</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Long term Oral contraceptive users</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Non known predisposing factors</td>
<td>48</td>
<td>41</td>
<td>7</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>74</td>
<td>26</td>
<td>100%</td>
</tr>
</tbody>
</table>

Fig. (4.6): distribution according to Risk factor of DVT
Table (4.7): Frequency distribution of the patients according to location of thrombus

<table>
<thead>
<tr>
<th>Location</th>
<th>Frequency</th>
<th>male</th>
<th>female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lt.CFV</td>
<td>30</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Lt.popliteal vein</td>
<td>21</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Rt. popliteal vein</td>
<td>16</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Rt.CFV</td>
<td>15</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Lt.SFV</td>
<td>9</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Rt.SFV</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Fig. (4.7): distribution according to Location of thrombus
Table (4.8): Frequency distribution of the patients according to degree of extension

<table>
<thead>
<tr>
<th>Degree</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension</td>
<td>25</td>
<td>25%</td>
</tr>
<tr>
<td>No extension</td>
<td>75</td>
<td>75%</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100%</td>
</tr>
</tbody>
</table>

Fig. (4.8): Distribution according to degree of extension
<table>
<thead>
<tr>
<th>Location</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFV</td>
<td>12</td>
<td>12%</td>
</tr>
<tr>
<td>SFV</td>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>CFV+EIV</td>
<td>8</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**Table (4.9):** Frequency distribution of the patients according to location of extension

**Fig. (4.9):** Distribution according to location of extension
5-1: Discussion:
The varied signs and symptoms that are associated with DVT make the diagnosis of DVT difficult and challenging. Furthermore, the thrombi may be asymptomatic making it exceedingly difficult to diagnose on clinical presentation. For proper management of the patients with DVT, the nature, location and the extent of the thrombus is necessary to know.
The study included assessment of spectrum of findings of DVT by using gray scale and color Doppler USG. All the major deep veins and superficial veins of the lower limb were examined in all patients along with the external iliac, common iliac and IVC in indicated cases.
Retrospective descriptive analysis of 100 patients of DVT diagnosed on Doppler was done.
Duplex USG has high sensitivity and specificity for detecting DVT in symptomatic patients. In cases of isolated calf vein thrombosis, serial Doppler study (once weekly for 2 weeks) is suggested for propagation of thrombus into the proximal veins (popliteal vein or above).
The age group of patients with DVT ranged from 30 to 90 years in our study. The majority of the patients belonged to the fourth decade. In the study conducted by Hill et al. they had found that mean age of patients shown to have DVT was in sixth decade. In our study, 74% of the patients were males and 26% were females. Thus males dominated the study group. This correlates well with the study conducted by Hill et al. which had higher incidence of DVT among males.
The majority of the patients in our study had edema as the most common presenting symptom which constituted 61% of all the patients, followed by pain and edema (17%), previous history of DVT (11%), pain (8%) and PE (3%). This correlates well with the study conducted by Glover and Bendick and Eze et al. in which 25 patients with unilateral leg swelling were found to have DVT.
In their study, only 5% of patients were found to have DVT in absence of leg swelling. This is well explained by the normal venous physiology that when major venous channels get occluded, there is resultant increase in venous pressure and volume which manifests into edema. This also correlates with the study conducted by Langsfeld et al. who found edema as the most common sign in patients diagnosed with DVT. The three patients (3%) that presented with PE were retrospectively diagnosed to have DVT. Duplex USG should be done between 7th and 14th day in bedridden and ICU patients and following surgery for early diagnosis of DVT. Follow up Doppler should be done for detecting propagation of thrombus in cases of calf vein thrombosis.

Out of the 100 cases showing evidence for thrombosis, the most common predisposing condition was prolonged hospitalization in 32 cases (32%), followed by 10 (10%) postoperative cases, 7 (7%) patients had history of trauma and 3 (3%) females were long term oral contraceptive users. 48 patients (48%) however had no known predisposing condition. Heit et al. had concluded in their study that hospital or nursing home confinement, surgery, trauma, malignant neoplasm, chemotherapy are independent and important risk factors for VTE.

98 (98%) cases showed unilateral lower limb involvement, whereas 2 (2%) cases showed bilateral lower limbs involvement. No case with unilateral symptom had bilateral involvement. Also no case with bilateral symptoms had unilateral involvement in our study. This correlated well with the study conducted by Sheiman and Mc Ardle in 1995 who in their study indicated a low incidence of thrombosis in contralateral extremity.

The commonest involvement was found to be of the left lower limb. 65 cases (65%) showed left lower limb involvement as compared to 35 cases (33%) showing right
lower limb involvement. 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.

The present study localized thrombus predominantly in the thigh or popliteal region as compared to the isolated calf DVT in 4 limbs. This correlated well with the study conducted by Markel et al who concluded that proximal limb involvement was more common pattern of involvement as compared to the isolated calf DVT.

The predominant stage of DVT in the cases showing evidence for thrombosis was that of the subacute stage seen in 53 cases (53%) as compared to the acute stage of involvement seen in 30 cases (30%) and chronic stage seen in 17 cases (17%) in our study. These findings corroborate well with study conducted by Hill et al who found that the positivity rate for acute DVT was 17.4%.

In our study, out of the 100 cases involved, 25 cases (25%) had multiple contiguous segmental involvement of the veins. Whereas 75 cases (75%) had isolated vein involvement.
Conclusion:
The study found that nearly 74% of the patients were males and 26% were females with majority belonging to fifth decade (26%). 98 (98%) cases showed unilateral while 2 (%2) cases of male showed bilateral lower limb involvement. In our study, predominant distribution of thrombus was found to be in above knee region with (30%) patients having thrombus in the left common femoral vein. Left Popliteal vein was involved in (21%) patients, right Popliteal vein was involved in 16/100 (16%) patients, right common femoral vein (15%)
Subacute stage was seen in 53 cases (53%), acute stage in 30 cases (30%) while chronic stage in 17 cases (17%).
(75%) patients had isolated vein involvement, where as 25 cases (25%) had multiple veins involvement.
The study found that Color Doppler is useful in diagnosing DVT in symptomatic and at risk patients and provides a non-invasive method of investigation. It is also helpful in evaluating the site, extent and stage of thrombus.
5-3: Recommendations:

Doppler ultrasound is very effective method to diagnosis of deep vein thrombosis but the effectiveness depend on the sonologist and ultrasound equipment for this I recommended that:

- Doppler US should be done for every patient complaining of swelling, pain and hotness so as to decrease the incidence of pulmonary embolism which is fatal condition.
- The Doppler ultrasound should be done by skilled examiner which have knowledge about anatomy physiology and pathology and should be very familiar with ultrasound machine to make the examination very easy and effective and the usage of high resolution ultrasound machine to produce high image quality.
- Ultrasound machine with Doppler to be available in each emergency department.
- Increase the training of sonologist and their knowledge by SME.
- All admitted patients for prolonged time at hospital should take aheparin medications.
- Increase the population awareness about disease causes, sign and symptom and role of Doppler ultrasound in diagnosis and they should be came to hospital when any symptoms are appear.
References:
4- Devin Dean. Abdominal Ultrasound (module4). The burwin institute of diagnostic medical ultrasound; Lunenburg, Canada: 2005. page No
5- Professional ultrasound services. Lower extremity venous anatomy. - Professional ultrasound services; San Francisco: 2006. Page (3-9).
7- Tone Ronny Enden. towards improvement in deep vein thrombosis; studies on diagnostic MRI, thrombolytic therapy and quality of life (PhD thesis): university of Oslo; Oslo: 2009
8- http://www.bing.com/search?q=Diagnosis+for+Venous+Doppler&first=11&FORM=PERE 5-6-2014 11:10am
11- ultrasound of veins of lower limbs from
13- varicose veins Doppler images from
   http://www.bing.com/images/search?q=doppler+evaluation+of+varicose+vein
   &FORM=HDRSC2#view=detail&id=D9F0CE6E09479B3EF6B6505960B0120C9654350F&selectedIndex
### Appendix I

#### Data sheet

<table>
<thead>
<tr>
<th>No</th>
<th>Sex</th>
<th>Age in years</th>
<th>Signs and symptoms</th>
<th>Predisposing conditions</th>
<th>Veins involved</th>
<th>Stage of involvement</th>
<th>Pattern of involvement</th>
</tr>
</thead>
</table>

**Signs and symptoms:** Includes edema, pain, previous of DVT and pulmonary embolism.

**Predisposing conditions:** Includes prolonged hospitalization, postoperative, history of trauma and long term oral contraceptive users.

**Stage of involvement:** Of acute, subacute or chronic.

**Pattern of involvement:** Of the isolate, multiple contagious or multiple non contagious.

**Veins involve:**

- CFC=Common femoral vein
- SFV= Superficial femoral
- PV= Poplitel vein
- PTV= Posterior tibial vein
- ATV= Anterior tibial vein
- CIV= Common iliac vein
- EIV= External iliac vein
- SVS= Superficial venous system
- PER= Peroneal vein
Appendix II: Ultrasound image from the sample of the study.

Image (1): 34 years old male presented with pain and swelling of foot color Doppler US transverse view shows anterior tibial artery but the vein is not seen.

Image (2): 56 years old male presented with pain and swelling of LT foot color Doppler US image shows anterior tibial artery the anterior tibial vein is not seen.
Image (3): 45 years old male HIV patient presented by pain and tenderness of both legs color Doppler US transverse view shows RT popliteal vein thrombus (T).

Image (4): 32 years old male presented by pain and swelling of left leg color Doppler transverse view showed left common femoral vein thrombus (T)
Image (5): 35 years old female presented with pain and swelling of RT leg color Doppler US transverse view shows popliteal vein thrombus (T)

Image (6): 60 years old male presented with pain and swelling of LT leg color Doppler US longitudinal view shows thrombus in LT CFV.
image (7): 45 years old female presented with pain and swelling of both legs color Doppler US longitudinal view shows LT popliteal vein thrombus (T)

Image (8): 30 years old female presented with pain and swelling of LT leg color Doppler US image transverse view shows EIV thrombus (T)
Image (9): 50 years old female presented by swelling of LT leg she has a history of uterine carcinoma color Doppler US longitudinal view shows LT CFV thrombus (T)

Image (10): 40 years old male presented by swelling of RT popliteal vein color Doppler US longitudinal view shows RT popliteal vein thrombus (T) partially occluded the vein.
Image (11): 62 years old male presented with pain and swelling, fever he has a history of DVT 3 years ago color Doppler US image transverse view shows LT CFV thrombus (T)

Image (12): 43 years old female presented with pain and heaviness in the lower limbs color Doppler US longitudinal view shows LT femoral vein thrombus (T)
Image (13): 45 years old male presented by swelling and heaviness of lower limbs color Doppler US transverse view shows LT CFV thrombus (T)

Image (14): 38 years old male presented by pain and swelling of RT leg, he has + moses sign color Doppler US transverse view shows anterior tibial vein thrombus (T)
Image (15): 33 years old female presented with pain and swelling redness of lower limbs color Doppler US transverse view shows LT popliteal vein thrombus (T)

Image (16): 40 years old male presented with pain and swelling of RT leg color Doppler US transverse view RT femoral vein thrombus (T)
Image (17): 42 years old male presented with pain and tenderness of lower limbs color Doppler US longitudinal view shows LT popliteal vein thrombus (T)

Image (18): 28 years old male presented with pain and tenderness color Doppler US longitudinal view shows RT femoral vein thrombus (T)
Image (19): 43 years old female presented by pain and swelling of RT leg color Doppler US transverse image shows RT popliteal vein thrombus (T)

Image (20): 33 years old male presented by pain and swelling of LT foot color Doppler US transverse image shows LT posterior tibial artery LT posterior tibial vein not seen
Image (21): 30 years old male presented by pain and swelling of LT leg color Doppler US longitudinal view shows LT peroneal vein thrombus (T)

Image (22): 50 years old female presented with pain and heaviness of lower limbs color Doppler US image longitudinal view shows LT popliteal vein thrombus of lower segment (T)
Image (23): 45 years old female presented by pain and swelling of LT leg color Doppler US transverse view shows LT popliteal vein thrombus (T)

Image (24): 35 years old male presented by pain and swelling of RT leg color Doppler US longitudinal view shows popliteal vein thrombus (T) partially occluded the vein.
Image (25): 35 years old male presented by pain and swelling color Doppler US transverse view of RT leg shows RT popliteal vein thrombus (T) partially occluded the vein

Image (26): 35 years old female presented by swelling of LT leg color Doppler US transverse view shows LT popliteal vein thrombus (T)
Image (27): 45 years old male presented by pain and swelling of legs color Doppler US transverse image shows femoral vein thrombus (T)

Image (28): 33 years old male presented with pain and swelling of left leg color Doppler ultrasound Images transverse view showed DVT of common femoral vein (T) partially occluded to the vein
32 years male with HIV presented with pain swelling of both legs. Color Doppler longitudinal view showed that thrombosis in left common iliac vein (T).

40 years old male presented by pain and heaviness of lower limbs. Color Doppler transverse view showed the thrombosis of right popliteal vein (T).