

Sudan University of Science and Technology

College of Graduate Studies

**Evaluation of Deep Veins Thrombosis in Lower Limbs
Fractures using Ultrasonography**

تقويم جلطة الأوردة العميقة في كسور الأطراف السفلي باستخدام التصوير بالموجات فوق
الصوتية

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

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2018

الاستهلال

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قال الله تعالى :

﴿لَا يُكَلِّفُ اللَّهُ نَفْسًا إِلَّا وُسْعَهَا لَهَا مَا كَسَبَتْ وَعَلَيْهَا مَا اكْتَسَبَتْ رَبَّنَا لَا تُؤَاخِذْنَا إِنْ نَسِينَا أَوْ
أَخْطَأْنَا رَبَّنَا وَلَا تَحْمِلْ عَلَيْنَا إِصْرًا كَمَا حَمَلْتَهُ عَلَى الَّذِينَ مِنْ قَبْلِنَا رَبَّنَا وَلَا تُحَمِّلْنَا مَا لَا طَاقَةَ
لَنَا بِهِ وَاعْفُ عَنَّا وَاعْفِرْ لَنَا وَارْحَمْنَا أَنْتَ مَوْلَانَا فَانصُرْنَا عَلَى الْقَوْمِ الْكَافِرِينَ﴾

سورة البقرة

الآية : 286

صدق الله العظيم

Dedication

This work is dedicated to
my parents who influenced my life
to my sisters and brother

Acknowledgement

I thank almighty God for giving me the strength, courage and determination in conducting this study, despite all difficulties.

I would like to thank gratefully my supervisor

Dr. Ahmed Mostafa Abukonna

Phrases may not cover what I mean to show, but a word must be penned to those who helped me and guided me through the way and to those who intended to help me accomplish this work, it's because of their patience and splendid character I reached this far.

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List of Abbreviations

Abbreviation	Full meaning
A.T.V	Anterior Tibial Vein
C.F.V	Common Femoral Vein
DVT	Deep Vein Thrombosis
F.V	Femoral Vein
S V T	Superficial venous thrombosis
Lt	Left
Pop.V	Poplotial Vein
P.T.V	Posterior Tibial Vein
Rt	Right
VTE	Veins thromboembolism

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Abstract

Deep vein thrombosis (DVT) is the third cardiovascular disease most frequent in the world. DVT can go away naturally, but the most serious complication is when a thrombosis dislodge and travels to lungs to become a life-threatening pulmonary embolism.

This was descriptive cross sectional study conducted in AL-Ribat University Hospital (RUH), in the period from february 2017 to uolio 2018. The aim of this study is to assess Deep Vein Thrombosis after trauma by using doppler ultrasound.

The problem of this study is the most serious complication is when a thrombosis dislodge and travels to lungs to become a life-threatening pulmonary embolism. This study was done among 50 Sudanese patients came to department to exclude DVT (50 patients with DVT). The study was include variables divided as gender, age, location of DVT (which veins), characteristics of DVT (visualization, vessel compressibility, surface characteristics, texture, vessel size,), types of DVT.

The study found acute DVT (80%) is more incident than chronic DVT (20%), proximal (FV) 36% is more prevalent than distal (POP.V) DVT 7%. The important acquired risk factors include prolong immobilization of the leg and trauma, the most appearance of DVT is hypoechoic, irregular surface, size of vein is larger than the normal size, the vessel semi compress, the blood flow not seen if totally obstructed, .

finally the most differential diagnosis of DVT is enlarged inguinal lymph node.

الخلاصة

الجلطة الدموية هي ثالث امراض القلب و الاوعية الدموية شيوعا فى العالم ,يمكن ان تختفى طبيعيا لكن من اخطر مضاعفاتها الجلطة التى تنفصل و تنتقل للرئة لتصبح مهددة للحياه وهى الجلطة الرئوية .

هذه الدراسه وصفية مقطعية أجريت فى الفتره من فبراير 2016 يوليو 2017 من مستشفى الرباط الوطني . الهدف من هذه الدراسه تقييم الجلطه بعد الحوادث (الكسور) باستخدام الموجات فوق الصوتيه للاورده والشرايين , تمثلت مشكلة البحث فى ان اخطر مضاعفات الجلطه الدمويه تكون حينما تنفصل وتنتقل الى الرئة فتصبح جلطة رئوية مهددة للحياة.

أجريت هذه الدراسه على خمسين مريض سوداني اتوا الى قسم الموجات فوق الصوتيه لاستبعاد الاصابه بالجلطه الدمويه (خمسين مريض بالجلطه الدمويه .هذه الدراسة تحتوى على متغيرات قسمت الى : النوع ,العمر ,موقع الجلطة الدمويه (اي وريد) , الجانب المصاب ,صفات الجلطة الدمويه(الرؤية ,انضغاطية الوريد,صفات السطح ,القوام,حجم الوريد ,اوردة تأمينيه غير رئيسيه),نوع الجلطة الدمويه .

الدراسة وجدت ان الجلطة الدمويه الحادة اكثر حدوثا من الجلطة الدمويه المزمنة ,الادنى (الاقرب للقلب)الوريد الفخديساند اكثر من الاقصى (البعيد من القلب)الوريد المأبضى . من اهم العوامل المكتسبة هى عدم الحركه لمدة طويله والحوادث .اغلب ظهور للجلطة الدمويه هى انها سهله التمييز ,,سطح غير منتظم , حجم الوريد اكبر من الحجم الطبيعى ,الوريد شبه انضغاطي ,مجرى الدم لا يرى اذا وجد انسداد تام معه .و اخيرا اكثر التشخيص متباين للجلطه الدمويه هو تضخم الغدد الليمفيه الأربية .

Chapter One

Introduction

1.1 Introduction:

Deep vein thrombosis (DVT) means a blood clot (thrombus) in the deep venous system of the leg. DVT is not dangerous in itself. The situation becomes life-threatening when a piece of the blood clot breaks off (embolus), travels downstream through the heart into the pulmonary circulation system, and becomes lodged in the lung which could be life threatening. Hence early diagnosis and treatment of a deep venous thrombosis (DVT) is essential to prevent this catastrophe (Kapoor et al., 2016).

DVT predominantly occurs in the legs and may have no symptoms, although it may also occur in other veins (upper extremities, liver, cerebral sinus, retina, mesenteric), albeit far more frequently. When symptoms are present, the non-specific signs include pain, swelling, redness, warmth 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 lungs to become a life-threatening pulmonary embolism (Lu et al., 2007).

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 health care costs of DVT (Waheed and Hotwagner, 2018).

Previous studies have attempted to identify patient risk factors and comorbidities that warrant prophylaxis. Jameson et al. studied the National Health Service hospital database and suggested ankle fracture fixation in patients over 50 as being

a risk factor for VTE(Jameson et.,2011). After studying the American College of Surgeons (ACS) National Trauma Data Bank (NTDB), Knudson et al., proposed risk factors for VTE, including lower extremity fracture with an Abbreviated Injury Score (AIS) over 3 (i.e. femur fracture or open tibia fracture)(18).Shibuya et al. performed an analysis of the NTDB and showed the incidence of DVT and PE in isolated foot and ankle fractures to be 0.28% and 0.21% (Shibuya et .,2012).

Diagnosing Deep vein thrombosis (DVT) on clinical signs and symptoms alone is not accurate. Veins duplex ultrasonography has become the routine initial evaluation of DVT. This study was designed to evaluate DVT in patients with limb bone fractures.

1.2 Problems of the study:

Deep vein thrombosis (DVT) is the almost asymptomatic and difficult to diagnose clinically (signs and symptoms alone is not accurate)-if suspected, the most serious complication is when a thrombosis dislodge and travels to lungs to become a life-threatening pulmonary embolism.

1.3 Objectives of the Study:

1.3.1 General Objectives:

to evaluate Deep Vein Thrombosis in lower limb fracture using ultrasound

1.3.2 Specific Objectives:

1-To identify the site of DVT

2-Cross tabulation of D V T to the ultrasound characteristic of DVT(visualization, vessel compressibility, echogenicity,

surface characteristics, texture, vessel size, audible Doppler signal quality, collateral circulation.

1.4 Overview of the study:

This study was containing five chapter that introduction include the literature review, and problem of the study, general and specific objectives, chapter two contained background and literature review. Chapter three includes material and method, place and time of the study. Chapter four includes result and finally chapter five to discussion and conclusion of this study and references.

Chapter Two

Literature review and theoretical background

2.1 Anatomy For Venous Duplex Imaging:

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. There are numerous interconnections between the deep and superficial veins via perforating veins(Uhl and GILLOT,2007).

2.1.1 Lower Extremity Deep Veins:

The major deep veins are paired analogues of the corresponding arteries. Originating in the foot, the plantar veins unite to become the deep plantar arch which later forms the paired posterior tibial veins. Along with the paired anterior tibial and peroneal veins, the posterior tibial veins join to form the single popliteal vein(Uhl and Gillot,2007).

The posterior tibial and peroneal veins are usually paired and are associated with their respective arteries, which frequently lie in between the paired veins. The paired veins join into common trunks in the upper calf before forming the below knee popliteal vein. The soleal veins are deep venous sinuses and veins of the soleus muscle that drain into the popliteal vein. They are an important part of the calf muscle pump mechanism. The gastrocnemius veins drain the medial and lateral sides of the gastrocnemius muscle and are usually larger in the medial side. The main trunk of the gastrocnemius vein drains into the popliteal vein below the level of the saphenopopliteal junction. The anterior tibial vein is paired and associated with the anterior tibial artery; it drains to the popliteal vein(Hnatek and Hnatkova,2010).

The popliteal vein accompanies the popliteal artery. The popliteal vein originates from the confluence of the anterior tibial veins with the posterior and peroneal veins (tibial-peroneal trunk). A duplicated popliteal vein occurs in approximately 30% to 35% of the population. The popliteal vein lies superficial to the artery.

In the lower popliteal fossa, the popliteal vein lies medial to the artery. The vein passes to the lateral side of the artery as it ascends through the popliteal space.

The aboveknee popliteal vein runs through the adductor canal and becomes the superficial femoral vein in the lower medial aspect of the thigh(Hnatek and Hnatkova,2010).

The name is misleading as it is not a superficial vein but part of the deep venous system. The superficial femoral vein runs toward the groin, where the profundafemoris vein, also known as the deep femoral vein, joins to form the common femoral vein. This junction lies below the level of the saphenofemoral junction and common femoral artery bifurcation(Hoballah et al .,2002).

The common femoral vein lies medial to the artery, becoming the external iliac vein above the inguinal ligament. The external iliac vein runs deep and is joined by the internal iliac vein, which drains blood from the pelvis, forming the common iliac vein. The left common iliac vein runs underneath the right common iliac artery to drain into the vena cava which lies to the right of the aorta(Cavezzi et al.,2007).

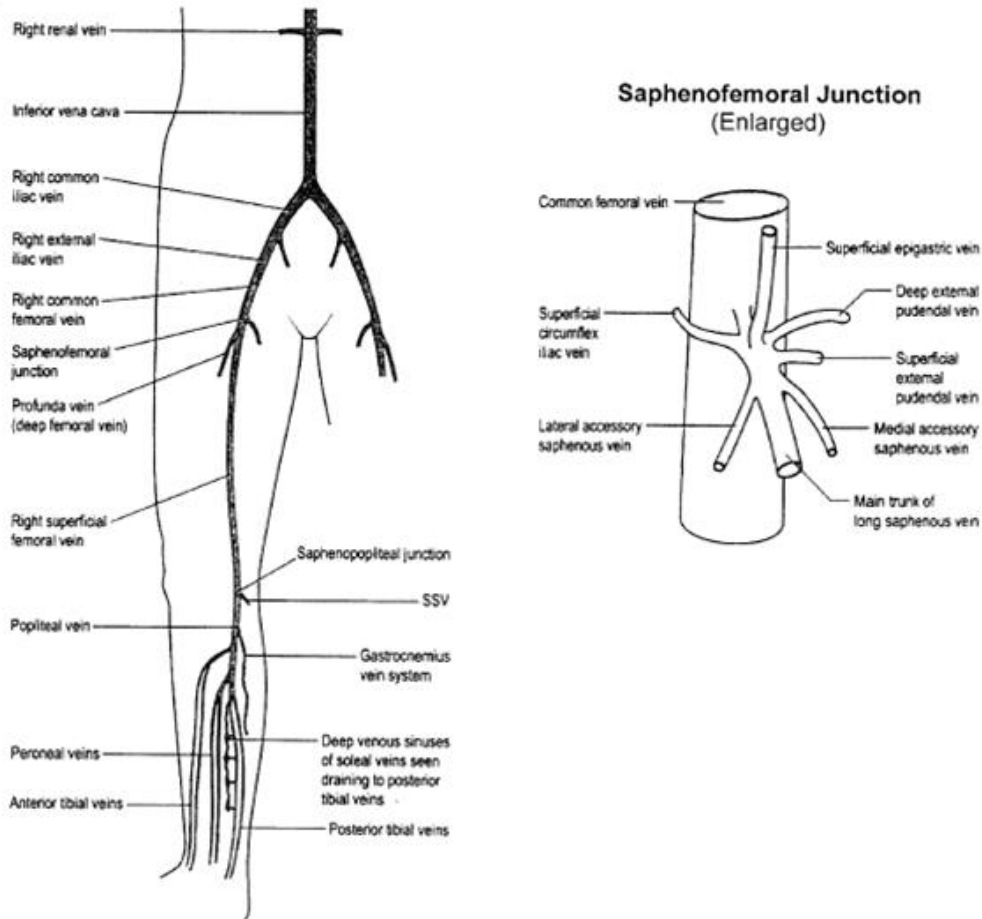


Figure 2-1 Deep Veins of Pelvis and lower Extremity) (Sandra 2012)

2.1.2 Superficial Veins:

The two principal veins comprising the superficial venous system include the greater (or long) and lesser (or short) saphenous veins. The greater saphenous vein arises lateral and anterior to the medial malleolus and courses up the medial aspect of the calf and thigh to anastomose with the common femoral vein at the saphenofemoral junction. As many as six additional veins drain into the saphenofemoral junction, any of which may be the source of recurrent varicose veins. Also, accessory saphenous veins may be present in some patients along the thigh or calf. These veins, when present, empty into the greater saphenous vein.

The lesser saphenous vein arises posterior to the lateral malleolus and runs up the posterior aspect of the calf to terminate at the popliteal vein.

Numerous tributaries drain into the saphenous veins, one of the more important tributaries being the posterior arch vein, which is of major importance in the formation or genesis of venous stasis ulcers(Cavezzi et al 2007).

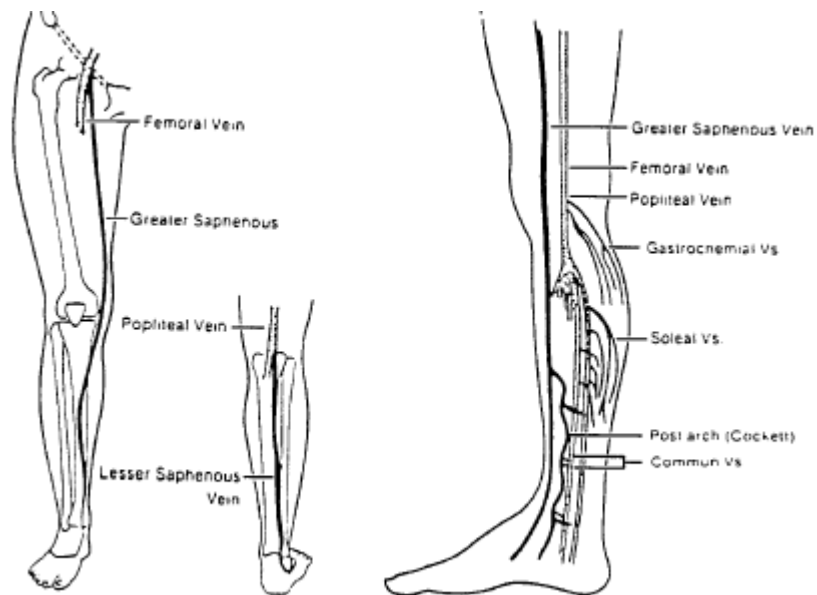


Figure (2-2): The **perforating veins** connect the superficial and deep venous systems. Perforating veins penetrate the deep fascia and contain valves that permit unidirectional blood flow from the superficial to the deep veins. (Sandra 2012)

2.2 Physiology of the venous system:

The deep venous drainage system of the lower limb is located beneath the deep fascia of the lower limb. As a general rule, the deep veins accompany and share the name of the major arteries in the lower limb. Often, the artery and vein are located within the same vascular sheath – so that the arterial pulsations aid the venous return(Ricci et al.,2014).

The main venous structure of the foot is the dorsal venous arch, which mostly drains into the superficial veins. Some veins from the arch penetrate deep into the

leg, forming the anterior tibial vein. On the plantar aspect of the foot, medial and lateral plantar veins arise. These veins combine to form the posterior tibial and fibular veins. The posterior tibial vein accompanies the posterior tibial artery, entering the leg posteriorly to the medial malleolus. On the posterior surface of the knee, the anterior tibial, posterior tibial and fibular veins unite to form the popliteal vein. The popliteal vein enters the thigh via the adductor canal (Grant, 2006).

Once the popliteal vein has entered the thigh, it is known as the femoral vein. It is situated anteriorly, accompanying the femoral artery. The deep vein of the thigh (profunda femoris vein) is the other main venous structure in the thigh. Via perforating veins, it drains blood from the thigh muscles. It then empties into the distal section of the femoral vein (Grant, 2006).

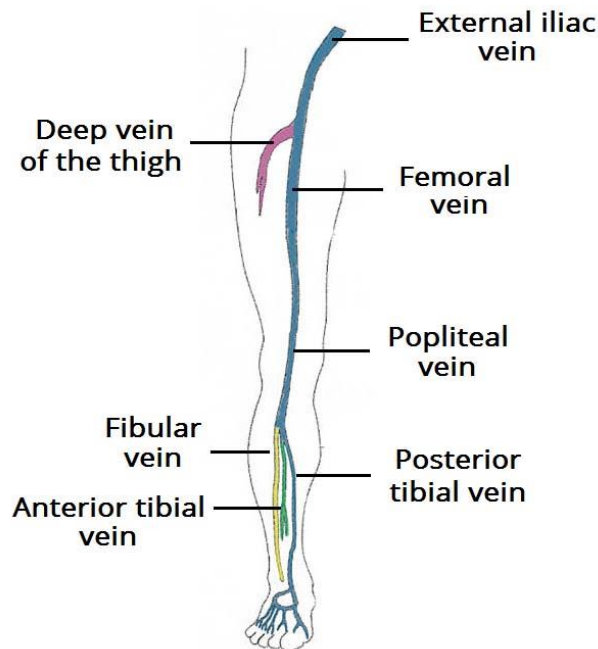


Figure (2-3) Overview of the deep veins of the lower limb (SHAH 2015)

The femoral vein leaves the thigh by running underneath the inguinal ligament, at which point it is known as the external iliac vein. The gluteal region is drained by inferior and superior gluteal veins. These empty into the internal iliac vein. The superficial veins of the lower limb run in the subcutaneous tissue (Ricci et al., 2014).

There are two major superficial veins – the great saphenous vein, and the small saphenous vein. The great saphenous vein is formed by the dorsal venous arch of the foot, and the dorsal vein of the great toe. It ascends up the medial side of the leg, passing anteriorly to the medial malleolus at the ankle, and posteriorly to the medial condyle at the knee. As the vein moves up the leg, it receives tributaries from other small superficial veins. The great saphenous vein terminates by draining into the femoral vein immediately inferior to the inguinal ligament. Surgically, the great saphenous vein can be harvested and used as a vessel in coronary artery bypasses (Ricci et al., 2014).

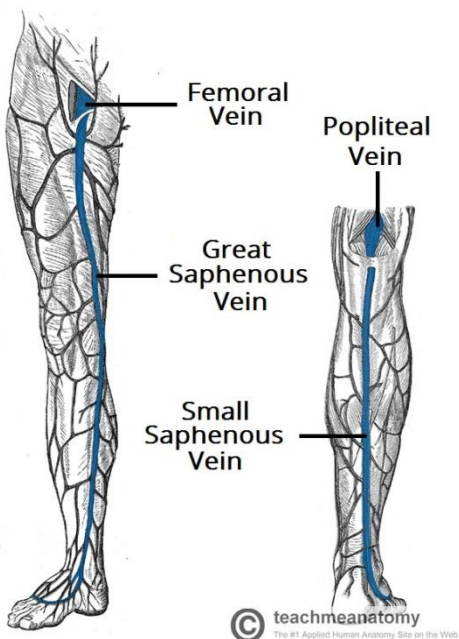


Figure (2-4) the two major superficial veins of the lower limb (SHAH 2015)

The small saphenous vein is formed by the dorsal venous arch of the foot, and the dorsal vein of the little toe. It moves up the posterior side of the leg, passing posteriorly to the lateral malleolus, along the lateral border of the calcaneal tendon. It moves between the two heads of the gastrocnemius muscle and empties into the popliteal vein in the popliteal fossa(Hnatek and Hnatkova,2010).

2.3 Pathology of the venous system:

Acute venous disease (which is usually unilateral) may be asymptomatic, but generally results in tenderness over the affected vein which is red and warm to the touch, and patients will often be able to direct you to the site. Along with the tenderness, edema is often present and should be measured with a measuring tape and compared to the identical site on the normal leg. These measurements should of course be documented depending on the level of venous obstruction; prominent superficial veins may be evident(Guch and Chernukha,1997).

Patients may also present with pulmonary symptoms including severe chest pain, shortness of breath, sweating, fever, and cough, sometimes with hemoptysis. These symptoms should alert the examiner to the possibility of pulmonary embolus, however many patients with PE are totally silent in terms of symptoms(Arnoldussen et al ,2012).

Predisposing risk factors for DVT includes age, co-existing malignant tumors, dehydration, history of recent surgery (especially abdominal and orthopedic) or trauma, history of previous DVT or pulmonary emboli, obesity, patients with cardiac disease resulting in low flowstates (i.e. congestive heart failure) ,pregnancy (due to compression of the pelvic veins by the gravid uterus, and venous dilatation due to hormonal stimulation) . Previous episode of DVT, prolonged immobilization with the legs in a dependent position while traveling and use of the birth control pill(Waheed and Hotwagner,2018).

The most common risk factor for the development of deep vein thrombosis is a previous episode of DVT. After reviewing the list of predisposing risk factors above, you should also notice that many of the factors listed above have a common ground in that they result in venous stasis. For instance, pregnant women (especially in their postpartum state) and people who are post-op (or post-trauma) are at greater risk for developing DVT because of venous stasis (Waheed and Hotwagner,2018).

Any process that results in injury to the venous intimal endothelium similarly puts the patient at risk for developing DVT. Examples of this sort of injury include indwelling catheters, trauma and inflammatory processes involving the veins. Finally, use of the birth control pill as well as some malignant tumors may result in hypercoagulability which may lead to venous thrombosis.(Waheed and Hotwagner,2018).

2.3.1 Mechanisms of Disease

It is thought that the majority of lower extremity thrombi originate in the soleal sinuses of the calf. In about 20% of cases, venous thrombi spread to the popliteal and femoral vein, occasionally involving the common femoral vein. Venous thrombi may also arise from the region of the valve cusp of the deep veins of the leg(Stephenson and Liem,2015).

Thrombi are caused by the platelet aggregation or "clumping" that result from the slow or absent motion of blood within the soleal sinuses or at the sinus that is located just cephalic and surrounding the valve cusps. This absence of blood flow is called venous stasis. In fact, the pathogenesis of venous thrombosis requires three factors to be present. These three factors are known as Virchow's triad and include stasis of blood, increased blood coagulability (hypercoagulopathy),vascular wall damage to the conditions are right for thrombus formation, the evaluation of venous thrombosis includes several stages. As noted above, thrombus usually

begins as a non-obstructing "collection of platelets" at the base of a venous valve. The 20% that proliferate further may enter the popliteal and femoral venous segments, often leading to a painful, obstructive process. Those that don't completely obstruct the vein segment often attach to the vessel wall and become "free floating". After three to seven days these thrombi are less likely to detach and embolize. After a few days, the totally obstructing thrombus begins to lyse, taking on a heterogeneous appearance on ultrasound. In the meantime, collaterals typically develop, shunting blood from the deep to the superficial venous systems by way of perforators (Bokshanet al.,2018).

2.3.2 Signs and Symptoms of DVT

The single most reliable symptom of DVT is acute unilateral lower extremity edema. Patients suffering from proximal deep thrombophlebitis (i.e. popliteal, femoral or iliac segments) may have a palpable hard cord over the involved vein as well as dilated superficial collateral veins. Thrombosis of any of these single deep veins will result in swelling of the calf (Badgett et al.,2000).

DVT of the calf veins is more difficult (and many believe less important) to diagnose clinically because three main paired veins drain the calf and thrombosis of one of them does not completely obstruct venous return. Consequently, the swelling, discoloration and dilated superficial veins that we see with proximal DVT may not be evident (Waheed and Hotwagner,2018).

Patients with calf DVT complain of pain while standing and walking that is relieved by elevating the legs while resting. Recall that this sort of pain is never seen with arterial disease. Deep vein tenderness is evident when these patients are examined and some patients with DVT have calf pain with dorsiflexion of the foot when the knee is extended. This symptom is known as Homan's sign and you should be aware of it for your exam even though it is unreliable, as many other disorders can result in the same type of pain without the presence of DVT.

Statistically, there is a 2:1 incidence of DVT on the left side (Waheed and Hotwagner,2018).

2.3.3 Signs and Symptoms of SVT

Superficial venous thrombosis (SVT) is usually easily palpated as a linear cord associated with pain, tenderness, redness and warmth of the affected part. The presence of SVT does not necessarily indicate that DVT is also present and in fact it seldom is. SVT does not result in P.E. or chronic venous insufficiency even when it is recurrent. Superficial venous thrombosis is usually treated with a combination of bed rest, warm compresses and anti-inflammatory drugs, including aspirin(Nagler et al., 2018).

2.3.4 Treatment and Prevention of DVT:

More than 50% of patients cannot be accurately diagnosed as having a DVT by clinical examination alone. Therefore, non-invasive testing plays an important role in patient management. Non-invasive tests in combination may be diagnostic in 90- 95% of cases. It is gratifying to report that today, duplex venous scanning has become the examination of choice for the investigation of suspected lower extremity DVT,when doubt remains, a few institutions may perform a contrast venogram to diagnose DVT, especially below the knee(Mioc et al., 2018).

The importance of making the diagnosis of DVT cannot be overestimated. A missed DVT may result in death from pulmonary embolus (PE), and treating the patient with anti-coagulants before demonstrating an intravascular thrombus puts the patient at risk for a serious hemorrhage. Fortunately, we are getting better all the time in terms of making the diagnosis by non-invasive means and this can only be good news for the referring physician and the patient. Let's look at the current methods of treating and possibly preventing DVT(Knudson et al., 2004).

The treatment of acute DVT varies from center to center, but usually includes a regiment of anticoagulants including heparinization for a period of five to ten days,

followed by Coumadin for a period of three to six months. Although quite uncommon today, in patients where treatment with anticoagulants is contraindicated, some centers introduce a "filter" into the inferior vena cava to intercept life threatening emboli. Finally, some centers are introducing thrombolytic agents to lyse the clot under real-time ultrasound guidance!

Patients at high risk for developing DVT may utilize several preventive measures ranging from simple aspirin therapy to compression stockings, and intermittent pneumatic compression of the lower extremity veins (Mioc et al., 2018).

2.3.5 Venous insufficiency:

Approximately 60% of patients presenting with venous insufficiency report a previous history of DVT. The remainder often suffers from some defect in a venous valve's function, whether acquired (i.e. during pregnancy) or congenital. Patients suffering from chronic venous insufficiency presents with symptoms ranging from ankle edema and dilated superficial veins (varicosities), to skin changes above ankle level. They also complain of aching legs when standing and walking that is relieved by rest with elevation of the affected part. Elevation aids in the drainage of blood from the legs and reduction in the high interstitial pressure present when the patient is erect (Shortell, 2012).

In basic terms, these problems present because of the patient's inability to clear blood from the lower extremity venous system, especially in the calf. Also a result in blood pools in the lower extremity, causing distension of the veins, often making the valves malfunction. Valve incompetence at the calf level is particularly significant because the calf muscle pump, which is activated with any lower extremity movement, may in fact pump blood in a retrograde manner through the incompetent calf valves, resulting in ambulatory venous hypertension and its consequences, the venous stasis syndrome discussed below. Eventually, the high interstitial pressures result in edema at the ankle level or higher. Longstanding

deep venous insufficiency may eventually cause the perforating veins to become incompetent, resulting in increased pressure in the superficial venous system with varicose vein development often the end result (Shortell, 2012).

2.3.6 Thrombophlebitis

Superficial thrombophlebitis is an inflammatory process that involves the superficial veins. The superficial vein may become partially or fully thrombosed. Typically, the area around the phlebitis is reddened, tender and hot, and the superficial vein may be swollen and hard. Phlebitis is normally treated with analgesia and anti-inflammatory drugs, but superficial vein stripping may be required, especially if there is a thrombus tip extending to the saphenofemoral junction or saphenopopliteal junction (Mohan, 2005).

2.3.7 Hematoma

Hematomas are accumulations of blood within the tissues that can clot to form a solid swelling. They can be caused by external trauma, or other mechanisms such as muscle tears, can be extremely painful and can lead to limb swelling, especially in the calf. Blood in the hematoma may also track extensively along the fascial planes. The sonographic appearance of a hematoma is of a reasonably well defined anechoic area in the soft tissues or muscles. Hematomas can be very variable in size and shape. It is sometimes impossible to image the veins in the immediate vicinity, owing to the size of the hematoma or the pain the patient experiences. The hematoma may also compress the deep veins in the local vicinity (Topol and Califf, 2007).

2.3.8 Lymphedema

Lymphedema is described as the accumulation of excessive lymph fluid with associated swelling of the subcutaneous tissues. This is due to obstruction, destruction, or hypoplasia of lymph vessels. This disorder may be primary or secondary. Primary lymphedema may present at any time in life and is more

common in women. It is usually unilateral and painless, and patients present with swelling of the foot and lower leg. It seems to get worse with warm weather, pregnancy, before menstruation, and after a prolonged period of dependency.

Secondary lymphedema is often the result of infection or malignant disease of the pelvis or groin (Topol and Califf, 2007).

The swelling of both types of lymphedema is treated by elevation and compression of some sort (either support hose or pneumatic). Diuretics may be used as necessary, and if the lymphedema is caused by infection, antibiotics are a necessary part of patient management. Lymphedema may be differentiated from edema caused by DW by the fact that the latter is characterized by swelling in the ankles and legs, but not in the feet (Bonow et al., 2011).

2.3.9 Cellulitis

Cellulitis is a bacterial infection of the skin and tissues beneath the skin. Cellulitis is an infection that also involves the skin deep layers; the dermis and subcutaneous tissue. It produces diffuse swelling in the lower limb, often associated with pain, tenderness and redness. There is usually evidence of edema in the region of swelling. A duplex examination can confirm patency of the deep veins. In addition, there may be hyperemic flow in the veins and arteries of the limb due to the infection (Camm et al., 2009).

2.3.10 Edema

Patients can develop edema in the calf due to infection, leg ulceration, local trauma, or as a result of significant venous insufficiency. This is characterized as fluid or edema in the superficial tissues. The ultrasound appearance of edema demonstrates tissue playing by numerous interstitial channels. Patients with congestive heart failure often develop edema in the legs due to the increased pressure in the venous system and the right side of the heart. Another characteristic of congestive heart failure is the pulsatile flow pattern that is often observed in the

proximal deep veins, which can be mistaken for arterial flow. Careful attention to the color display will confirm the direction of flow (Camm et al., 2009).

Baker's cysts

Baker's cysts are bursal dilations that normally originate on the medial side of the knee between the medial head of the gastrocnemius muscle and semimembranosus tendons. A bursa is essentially a small sac of synovial fluid that prevents friction between a bone joint or tendon. The bursa can extend out of this region and into the tissue planes in the upper calf, causing swelling, pain and discomfort. Such bursae are caused by a number of conditions, including arthritis and trauma to the knee. Baker's cysts are caused when excess joint fluid is pushed into one of the small sac of tissue behind the knee. When this sac fills with fluid and bulges out, the excess fluid is usually caused by conditions such as rheumatoid arthritis or osteoarthritis that irritate the knee (Chopra et al., 2013).

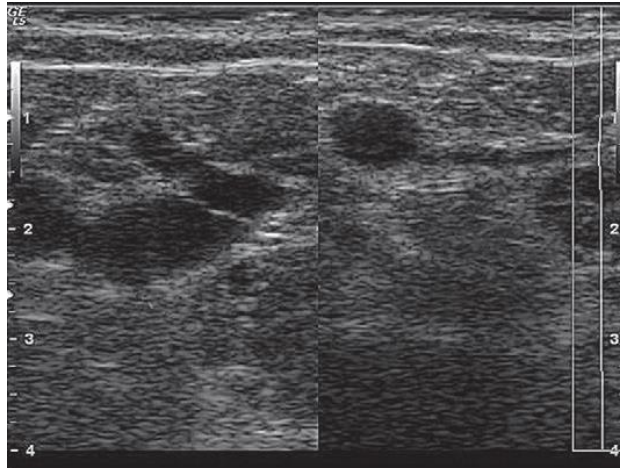
2.3.11 Enlarged lymph nodes

Enlargement of the lymph nodes can cause limb swelling due to reduction in lymphatic drainage. Enlargement occurs as a result of pathologic conditions, including infection or malignancy. The main sites for enlargement are at the groin or axilla, and the nodes can become so large that they compress the adjacent vein. Enlarged nodes may be tender, and localized redness and heat (erythema) may be present. They can also be clinically misdiagnosed as femoral artery aneurysms if the pulsation of the artery is amplified to the skin surface by the enlarged node.

Enlarged lymph nodes are imaged as oval or spherical masses that are found in groups. They are mainly hypoechoic in appearance but may contain stronger echoes within the center of the node and can be mistaken for a thrombosed vein. Color flow Doppler usually demonstrates blood flow in larger nodes, especially if infection is present (Topol and Califf, 2007)

2.3.12 Other pathologic lesions:

Other pathologic conditions that can clinically mimic DVT are abscesses, arteriovenous fistulas, muscle tears and hyperperfusion syndrome following arterial bypass surgery for lower limb ischemia.



Figur (2-2) Normal common femoral vein (*CFV*) with (*left*) and without compression (*right*) at the level of the greater saphenous vein (*GSV*). *CFA*, Common femoral artery (Rumack.Carol.M et 2016)

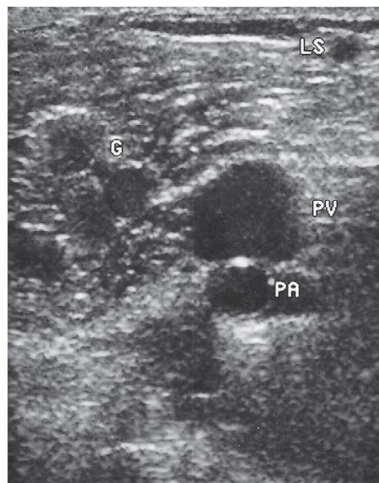


Figure (2-6) Transverse view at the popliteal fossa without transducer pressure. The popliteal vein (*PV*) lies superficial to the popliteal artery (*PA*). The lesser saphenous (*LS*) vein lies just below the skin line. A set of paired gastrocnemius (*G*)

veins are located on either side of the accompanying artery(36). (Rumack.Carol.M et 2016)

2.4 Lower Extremity Deep venous Doppler Examination Technique

Like so many other venous exams, the head on the bed should be elevated, resulting in a degree of venous pooling in the lower legs. After removing the patient's stockings, the legs should be slightly flexed and externally rotated to prevent the possibility of venous compression behind the knee. In addition, it is important that the patient be warm as cold temperatures may result in a low flow state and loss of an audible Doppler signal (Zamorano et al., 2015).

The posterior tibial vein is examined first, from its position adjacent to the posterior tibial artery just posterior to the medial malleolus. The posterior tibial signal may normally be inaudible in the bedridden patient (i.e. no spontaneity) or because of the peripheral vasoconstriction that occurs with cold temperatures. When this occurs, the posterior or tibial vein can usually be identified by compressing the foot, effectively augmenting flow at the level of the Doppler probe. Once the posterior tibial vein is identified, the calf should be manually compressed to test for valve competence (Pellerito and Polak, 2012).

Always be careful not to cause excessive pain in an already tender limb. When the compression is released, augmentation of the signal should occur as venous flow increases secondary to the backup caused by proximal compression.

Greater Saphenous Vein The greater saphenous vein of the superficial venous system is examined next, starting at the ankle, just superior and anterior to the medial malleolus. The rationale for examining this superficial vein (when you're looking for deep venous thrombosis) is that when obstruction of the deep calf veins is present, there is often increased flow in the superficial system. The same compression maneuvers described above are again performed with the saphenous vein, taking care not to obstruct this superficial vein with unnecessary probe

pressure. Saphenous vein should be assessed at the ankle, as well as above and below the knee. Incompetent perforators below the knee may be assessed by using a tourniquet (Lohman et al., 2013).

The common femoral vein is next on the list to be examined. Once again, the common femoral vein is identified by palpating and locating the common femoral artery and then by angling the Doppler probe medially. After assessing this vein for spontaneity, the presence of phasic respiratory change is documented. Next, augmentation of venous flow is identified by first manually compressing the calf and then the thigh (recall that augmentation immediately following the release of thigh compression is due to increased venous flow following the rapid escape of blood in the leg below the point of compression). Finally, valvular competence can be assessed by having the patient perform a Valsalva maneuver (Stephenson and Liem, 2015).

When the examination of the common femoral vein is complete, continue with the femoral vein at its position on the anteromedial aspect of the thigh by assessing its qualities of flow. The femoral vein's signal may be difficult to separate from the superficial femoral arteries because they normally overlie one another. Also remember to examine the femoral vein at several other locations, including the area of the adductor canal. (Guch and Chernukha, 1997).

The popliteal vein should be the last vein examined as this part of the test is best performed with the patient prone with his/her feet elevated on a pillow (effectively bending the knee and reducing any compression that may occur at the popliteal fossa). The popliteal vein is also assessed for venous signal quality in the same manner as the other deep veins (Pellerito and Polak, 2012).

Normal individuals demonstrate a lower extremity venous Doppler signal that is spontaneous and phasic with respiration, showing a decrease in venous flow velocity with inspiration and an increase in expiration. Signals that are

continuous rather than phasic with respiration suggest proximal venous obstruction and are characteristic of collateral flow (Zamorano et al., 2015).

Compression of the vein distal to the Doppler probe as well as release of compression proximal to the probe should result in augmentation of the venous signal in the normal patient. When venous thrombus is present, augmentation may be diminished, or entirely absent. Gentle compression of the patient's abdomen will have the same effect as a Valsalva maneuver. Recall that this response to respiration is opposite in the upper extremity. Next, the presence of competent venous valves prevents retrograde flow in the veins when proximal compression is applied. Valvular incompetency results in the audible demonstration of retrograde flow on the distal side of the valve when compression of the vein is performed proximally (a Valsalva maneuver may give the same result) (Guch and Chernukha, 1997).

Patients with chronic venous insufficiency usually demonstrate valvular incompetency on Doppler evaluation. Doppler is also useful in differentiating between primary and secondary varicose veins, recall that primary varicose veins demonstrate incompetency of the superficial venous system but a normal deep venous evaluation. When secondary varicose veins are present the deep veins will be incompetent and/or obstructed and incompetent perforators are also usually present. Finally, inflammatory processes involving the lower limb may result in high pitched venous Doppler signals secondary to relatively increase through the area of inflammation (Stephenson and Liem, 2015).

2.5 Previous studies:

Nadia Ali (2013) stu

02 died (300) Saudi patients; 121 male (40.3%) and 179 female (59.7%). Acute DVT is more incident than chronic DVT, proximal (FV) is more prevalent than

distal (POP.V) DVT. The incidence of DVT is strongly prevalent with old age. Female patients have higher prevalence of acquired DVT than male patients. In-patients had higher prevalence of DVT than out-patients. the left limbs have higher prevalence of DVT than right limbs. The important acquired risk factors include major surgery and trauma. The sensitivity of CDI is (91.3%), specificity is (97.2%) versus D Dimer Test with sensitivity is (95.3%), specificity is (83.3%) (Ali, 2013)

Khaladkar et al conducted study 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. 78 patients of DVT diagnosed on Doppler. The results of the study showed that 74% of the patients were males and 26% were females with majority belonging to fifth decade (26%). 75 (96.1%) cases showed unilateral while 3 (3.9%) cases showed bilateral lower limb involvement. In the study, predominant distribution of thrombus was found to be in above knee region with 69/78 (88.5%) patients having thrombus in the superficial femoral vein. Popliteal vein was involved in 54/78 (69.2%) patients. Complete thrombosis was observed in 54/78 (69%) cases, while partial thrombosis was observed in 24/78 (31%) cases. Subacute stage was seen in 42 cases (53.8%), acute stage in 23 cases (29.5%) while chronic stage in 13 cases (16.7%). 71 cases (91%) had multiple contiguous segmental involvements, whereas 7 cases (9%) had isolated vein involvement. The study concluded 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(Khaladkar et al., 2014).

A study to determine the prevalence of DVT and its complication was done from September 2011 to June 2013 in 125 patients with lower limb trauma in Dhiraj General Hospital Piparia by (Shah et al., 2015). In this study a series of 125

patients, 107 were male and 18 female (M: F=5.9:1). Out of them 6 patients were DVT positive (4.8%). Amongst them 3(2.4%) had proximal DVT and 3(2.4%) had distal DVT. Only 1 had pulmonary embolism. Out of 47 patients with periacetabular fractures, 4 (8.51%) developed DVT and Out of 8 patients with floating knee injury, 2 (25%) developed DVT. Combination of risk factors rather than a single risk factor had played important role for development of DVT in our study. Conclusion: Prevalence of DVT is low in Indian population thereby avoiding the need for chemoprophylaxis in all patients. However based on fracture geometry and co morbid conditions chemoprophylaxis may be justified in few individuals (Shah et al., 2015).

A study conducted by (Adam et al., 2018) to evaluate the role of duplex ultrasound (DUS) in the evaluation of deep venous blood flow in fractured lower extremities to rule out DVT prior to orthopedic surgery. In this prospective study a total of 58 patients (42 males and 16 females; mean age of 51.5 ± 19.5 years) with fractured lower extremities were thoroughly evaluated prior to surgery with respect to medical history, fracture pattern, associated injuries, comorbid conditions, and venous duplex ultrasound (VDUS) findings. Each affected limb was assessed for the presence of DVT using a Sonoline G 60S ultrasound unit. The analysis was performed with the Statistical Package for the Social Sciences (SPSS) version 20. DVT was found in 36 (62.1%) patients with single closed fractures, 9 (15.5%) patients with single opened fractures, 10 (17.2%) patients with multiple closed fractures, and in 3 (5.2%) patients with multiple opened fractures. Sensitivity and specificity of the findings of compressibility and phasicity for DVT detection in patients with fractured lower extremities were 81.25% and 87.50% and 100% and 100% respectively. In addition, the absence of compressibility and phasicity had positive predictive value of 100% and 100% and negative predictive value of 93.75% and 95.65% respectively. The study concluded that Sonography of DVs in

the brightness mode (B-mode) with compression maneuvers should be the first-line imaging modality for suspected DVT in patients with fractured lower extremities(Adam et al., 2018).

Chapter Three

Materials and Methods

3.1 Study design:

This was a Cross-Sectional study where the samples were selected randomly.

3.2 Duration and area of the study:

The study was conducted from February 2016 to June 2018 in the Al-Ribat hospital teaching.

3.3 sample volume :

The study conducted in 50 Sudanese patients referred to AL-Ribat University Hospital (RUH) in the period of study with DVT after trauma. Any Arterial Disease or normal duplex scan was excluded

3.4Data collecting:

The data will be collect by :

Data collecting sheet , Observation and Personal interview.

3.5 Data analysis:

Analysis of data will be by using SPSS.

3.6 Data storage:

All data collecting during the study will be stored in:
personal computer.

data collecting sheet and U\S images.

3,7 Ethical concideration:

no patient details will be published.

Permission of both patients and U\S Department should be taken to use the data.

3.8 Variables:

The study variables divided were gender, age, location of DVT (which veins), affected Side, Causes, types of DVT, characteristics of DVT (visualization, vessel compressibility, echogenicity, surface characteristics texture, vessel size, audible Doppler signal quality and collateral circulation).

3.9 Machine used:

Color duplex ultrasound machine (SEMEINS SONOLINE G60S) is capable of B-mode imaging, pulsed wave duplex scanning, color Doppler flow imaging and power Doppler imaging.

The choice of transducer for evaluating the lower extremity veins depends on the patient's habitus and the depth of the vessel to be studied. The examination is preferentially performed with a high-resolution (7 to 10 MHz) Linear array transducer.

3.10 Technique used:

US scanning was conducted with the patient in the supine position with the head raised from 15 to 30 degrees and the examination table tilted by 5 to 10 degrees (reverse Trendelenburg tilt). The investigated leg was outwardly rotated at the hip with the knee slightly. In the short axis, starting at common femoral vein (CFV) and advancing into the distal external iliac vein (EIV), the transducer was moved moderately inferiorly to completely scan CFV and superficial femoral vein (SFV) throughout the thigh and to scan popliteal vein (POPV) from a posterior approach throughout the popliteal fossa. From a posteromedial access in the lower extremity, posterior tibial veins (PTVs) were evaluated. Probe compression was applied at 1 to 2 cm intervals for all vein sections, with each section evaluated for complete compressibility and for the presence of any intraluminal echoes suggestive of thrombus. Longitudinal inspections were applied to assure the

presence of intraluminal echoes seen on short axis imaging and to obtain Doppler spectral waveforms of venous hemodynamics in CFV, SFV, POPV, and PTVs. These Doppler waveforms were studied for the presence of spontaneous flow, respiratory phasicity, and augmented flow in response to manual distal limb compression.

Chapter Four

Results

Table (4.1) frequency distribution of age group

	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	16	83	46.06	18.117

Table (4.2) gender distribution

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Male	35	70.0	70.0	70.0
Valid Female	15	30.0	30.0	100.0
Total	50	100.0	100.0	

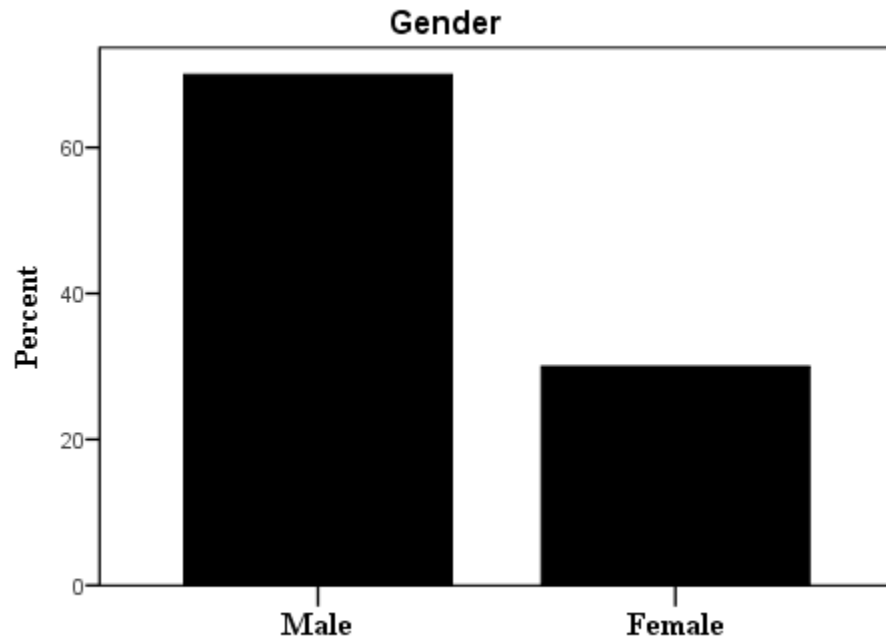


Figure (4. 2) shows gender distribution

Table (4.3) frequency distribution of thrombus location

	Frequency	Percent	Valid Percent	Cumulative Percent
Femoral Vein	36	72.0	72.0	72.0
C.F.V	7	14.0	14.0	86.0
Popliteal Vein	7	14.0	14.0	100.0
Total	50	100.0	100.0	

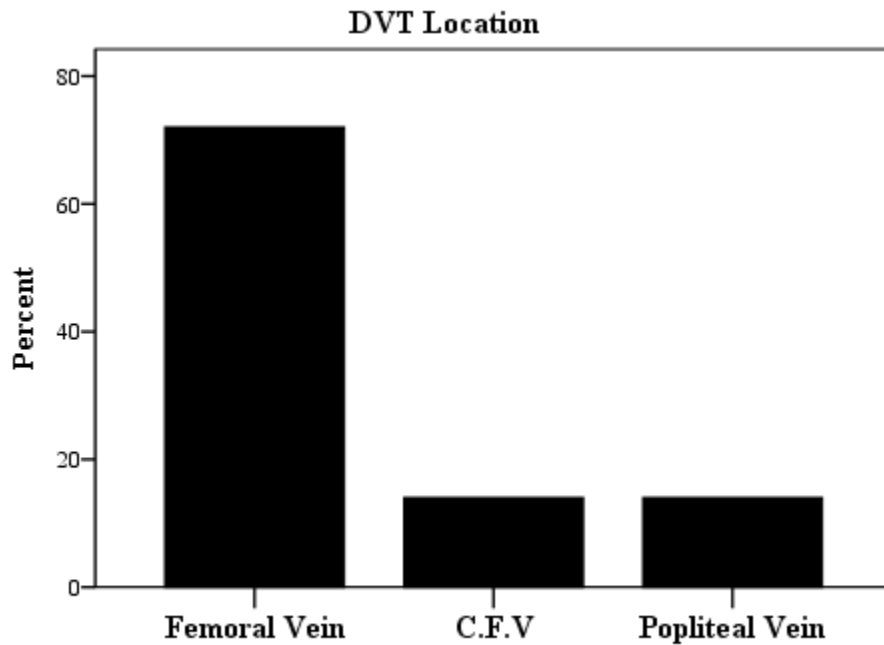


Figure (4. 3) shows frequency distribution of thrombus location

Table (4.4) frequency distribution of type of DVT

	Frequency	Percent	Valid Percent	Cumulative Percent
Acute	40	80.0	80.0	80.0
Chronic	10	20.0	20.0	100.0
Total	50	100.0	100.0	

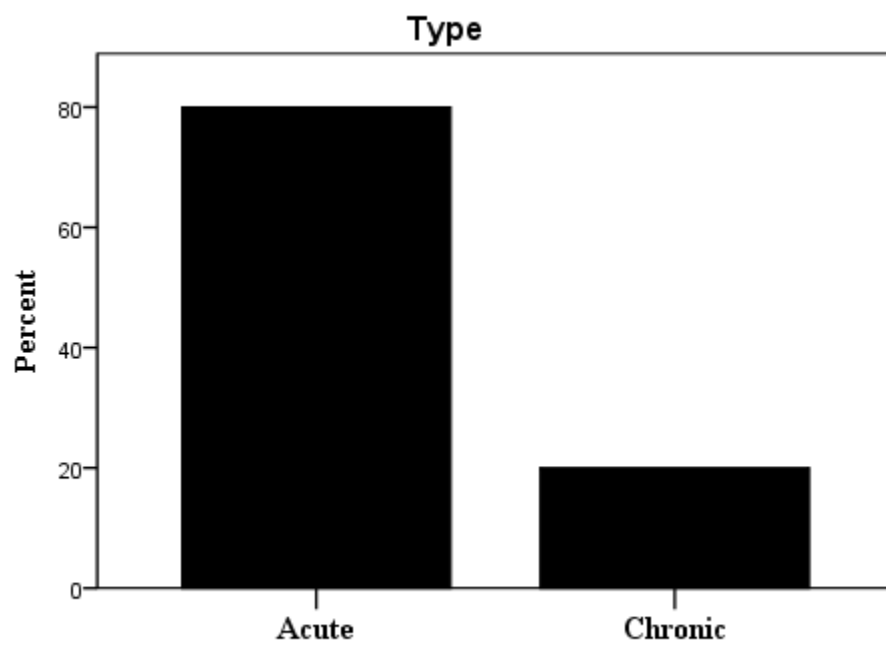


Figure (4.4) shows frequency distribution of type of DVT

Table (4.5) frequency distribution of Fracture Site

	Frequency	Percent	Valid Percent	Cumulative Percent
Femur	39	78.0	78.0	78.0
Leg	8	16.0	16.0	94.0
Knee	3	6.0	6.0	100.0
Total	50	100.0	100.0	

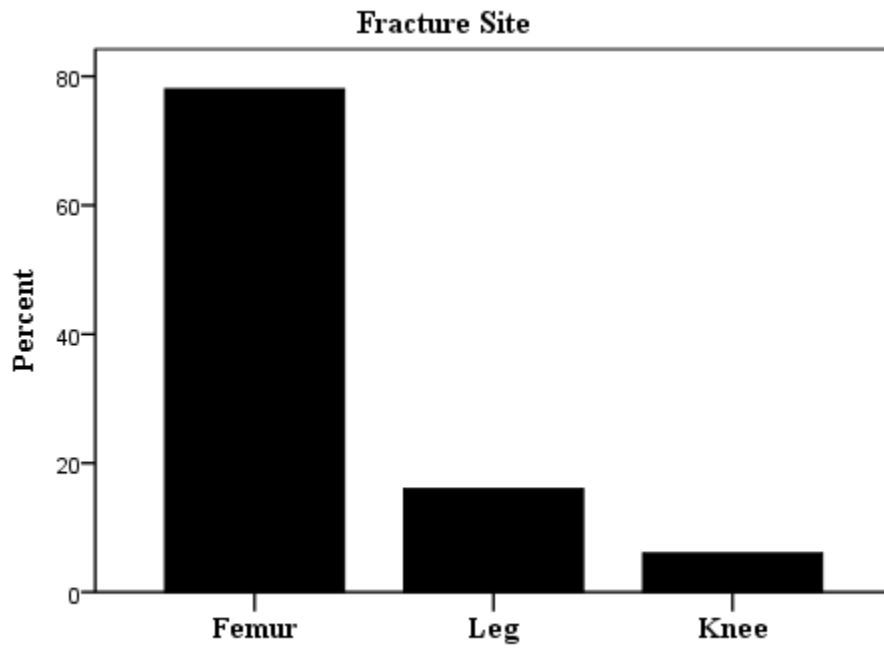


Figure (4.5) shows frequency distribution of Fracture Site

Table (4.6) frequency distribution of compressibility of vessel

	Frequency	Percent	Valid Percent	Cumulative Percent
Semi compressible	29	58.0	58.0	58.0
Non Compressible	21	42.0	42.0	100.0
Total	50	100.0	100.0	

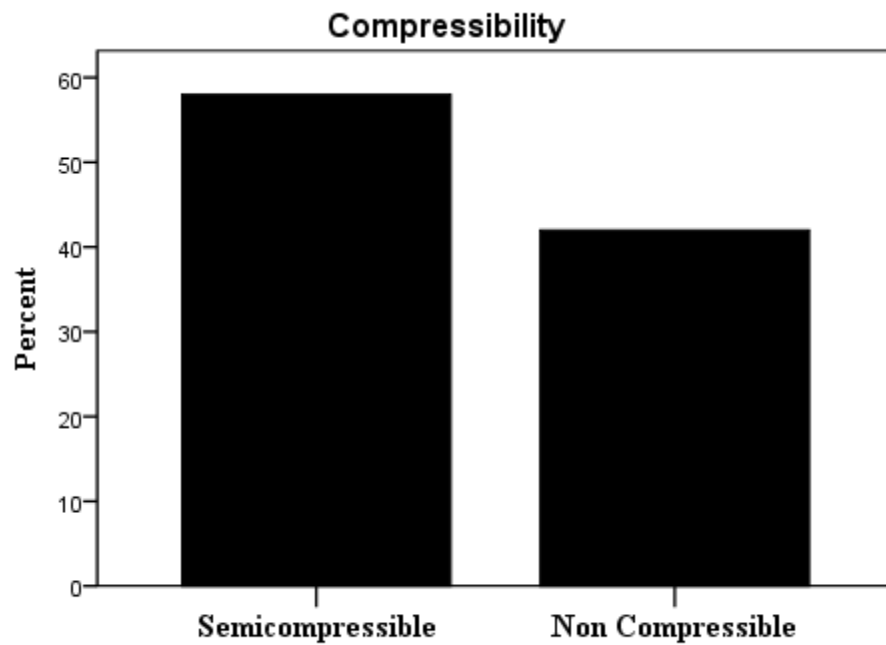


Figure (4.6) shows frequency distribution of compressibility of vessel

Table (4.7) frequency distribution of surface characteristics of DVT

	Frequency	Percent	Valid Percent	Cumulative Percent
Smooth	23	46.0	46.0	46.0
Irregular	27	54.0	54.0	100.0
Total	50	100.0	100.0	

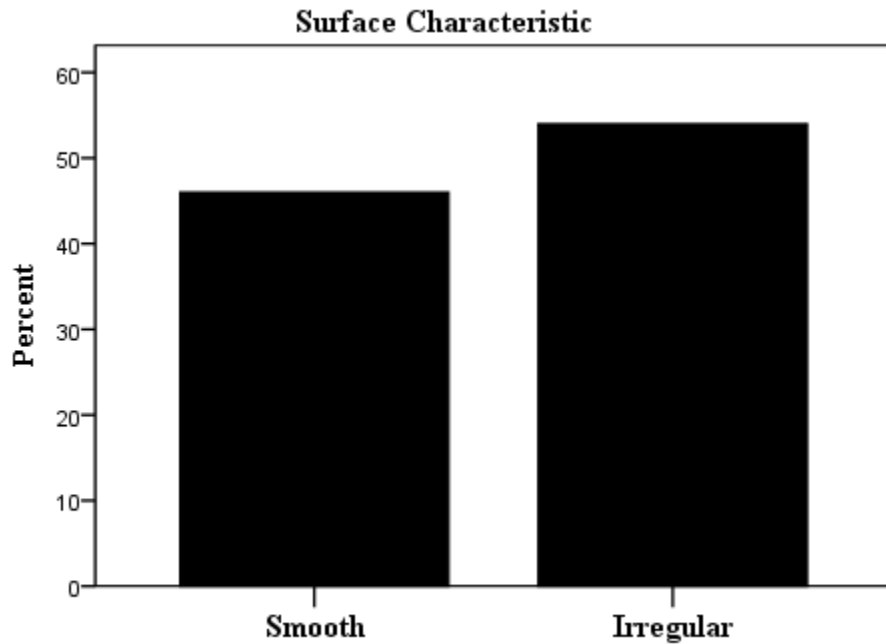


Figure (4.7) shows frequency distribution of surface characteristics of DVT

Table (4.8) frequency distribution of vessel size

	Frequency	Percent	Valid Percent	Cumulative Percent
Larger than Normal	35	70.0	70.0	70.0
Smaller Than Normal	15	30.0	30.0	100.0
Total	50	100.0	100.0	

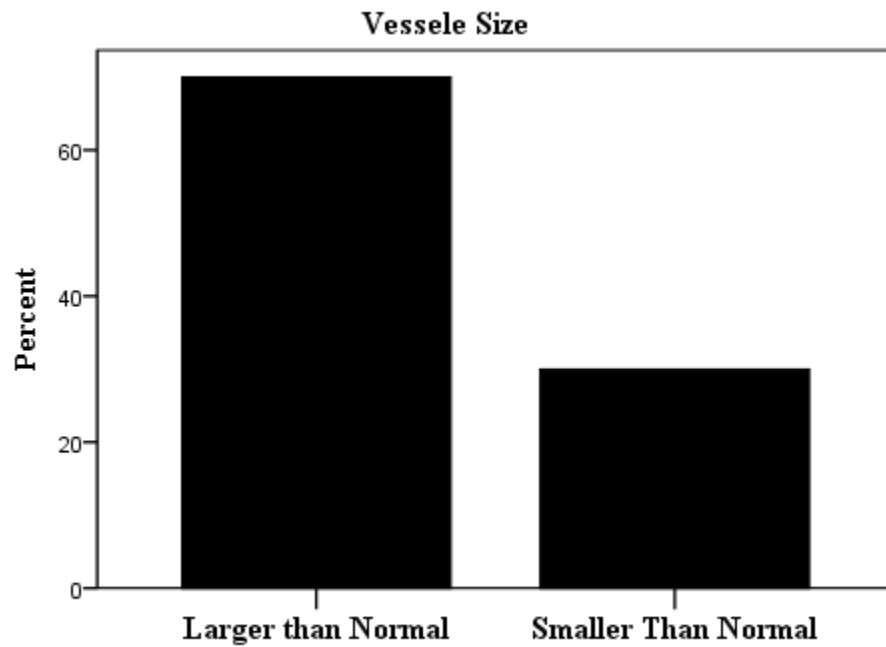


Figure (4.8) shows frequency distribution of vessel size

Table (4.9) frequency distribution of blood flow

	Frequency	Percent	Valid Percent	Cumulative Percent
Recanalization	28	56.0	56.0	56.0
Not seen	22	44.0	44.0	100.0
Total	50	100.0	100.0	

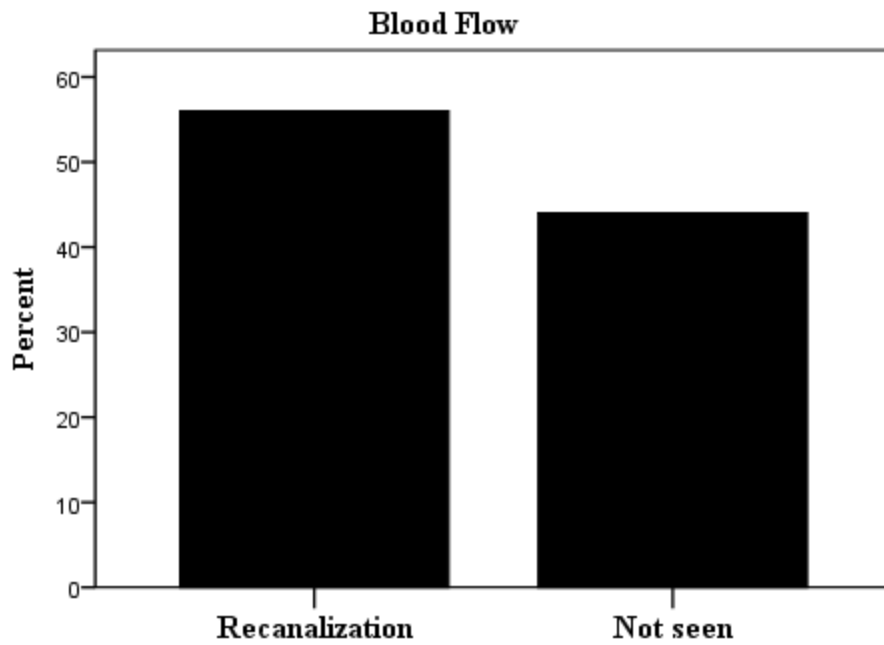


Figure (4.9) shows frequency distribution of blood flow

Chapter Five

Discussion, Conclusion and Recommendation

5.1 Discussion

Out of 50 patients 35 patients are male 35 males (70%) and 15 females (30%) with the Male: Female ratio 2:1 in accordance with male predominance seen in trauma series. This result was in line with the previous studies (Shah et al., 2015)(Adam et al., 2018).

Concerning thrombus location , Femoral Vein was found in 36(72%),common Femoral Vein 7 (14%), Popliteal Vein was found in 7(14%), the result agreed with study done by(Shah et al., 2015) they found that predominantly distribution of thrombus was found to be in above knee region with (65.63%), while only 34.38% of them had DVT below knee.Also agree withstudy done by (Ali, 2013)they found "site of DVT is proximal DVT(Femoral Vein 220(80.3%) andPopliteal Vein 54(19.7%) .

regarding the fracture distribution in this study, 39 (78%)patients were having femur fractures followed byfractures in the leg8 (16%) and around knee 3 (6%). In available literature, few studies are involving onlyspecific types of fracture of lower limb. (Sharma et al., 2002)reported19.6% DVT rate in 112 hip fracture patients; (Bhan et al., 2004)had 0%DVT with mechanical prophylaxis in 15 lower limb fractures and10 spinal injuries; (Sen et al., 2011)showed that 28.6% of patients hadDVT in 56 pelvi-acetabular fracture patients. So reported incidenceamong patients with lower limb trauma and commonest fracture associated with this is hipfracture.

The study showed that the types of DVT, Acute 40(80%), Chronic 10(20%). This result was in line with the study conducted by (Ali, 2013) which stated that acute DVT(74.5%) is more incident than chronic DVT(25.5%).

Recanalization is a complex process that involves thrombus organization and neovascularization as well as fibrinolysis, and the factors that favor complete thrombus resolution in some patients but not others remain poorly defined. In this study, recanalization was seen in 28 (56%) patients, this result was similar to (Meissner et al., 2002) study where the recanalization was detected in (60%) of patient with lower limb fracture.

In conclusion, we evaluated the role of DUS in the detection of deep venous blood flow in fractured lower extremities prior to orthopedic surgery. The incidence of DVT after orthopedic trauma was high and appears to be associated with fractures of the peri-acetabular area, femur, knee joint, tibia, and fibula. VDUS with gray-scale imaging with compression maneuvers should be the first-line imaging modality for suspected lower extremity DVT. Loss of phasicity and compressibility in a venous segment, often with accompanying Doppler abnormalities, indicates DVT with a high degree of accuracy, and no additional examination is required to initiate manage

5.2 Conclusion:

- The study found that DVT occurs more common in male, the most important risk factor include prolong immobilization of the leg and trauma , the incident of Acute was more than chronic D V T. is more incident than chronic DVT and prevalent of D V T in is F V more than POP V .

The most appearance of DVT is easy to identify, irregular surface, size of vein is larger than the normal size, the vessel semi compress, the blood flow not seen if totally obstruction

5.3- Recommendations:

Further studies should be done evaluate D V T with more sample volume and more duration .

1-Due to the prevalence of DVT with hospitalized patients we recommend anticoagulant (heparin) after surgery or trauma (fractures) and prolong immobilization.

2-The patients must be mobilized after trauma if possible.

3-Increase awareness about DVT workshops, seminars, symposiums and educational brochures about mortality and risk factors of DVT for both patients and medical staff.

4-As the Doppler ultrasound is operator depended skilled and well-practiced operator are needed to perform this technique.

5-Ultrasound machine should be available in hospitals and clinics.

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Appendices

Appendix (A)U|S images

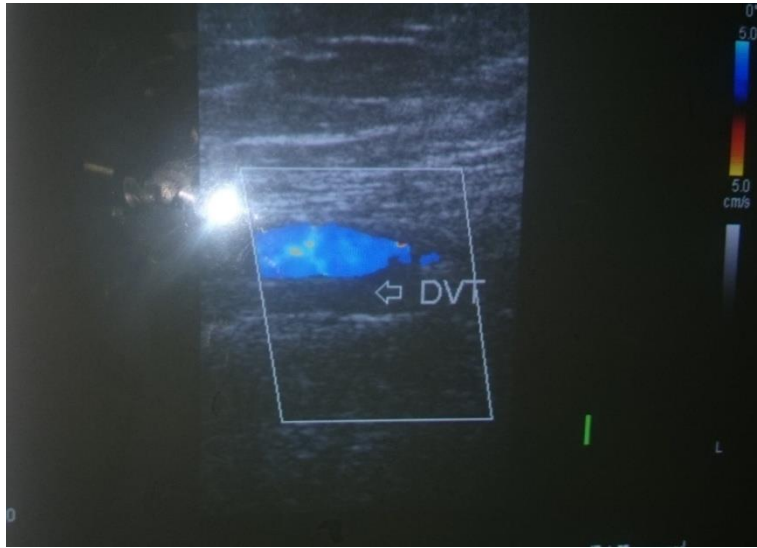


Image (1): Sagittal U/S image plan show acute DVT in left Femoral vein for female in 57years age .

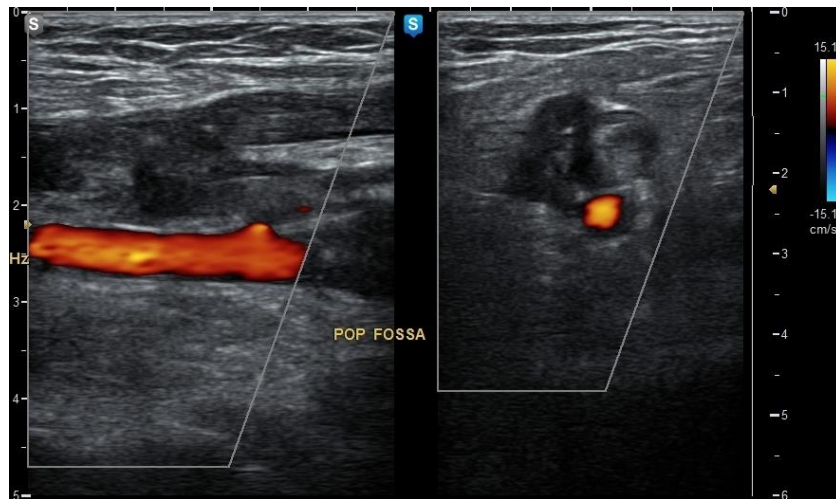


Image (2): Sagittal and transverse U/S image plans show acute DVT in right Popliteal vein for male in 24years age .

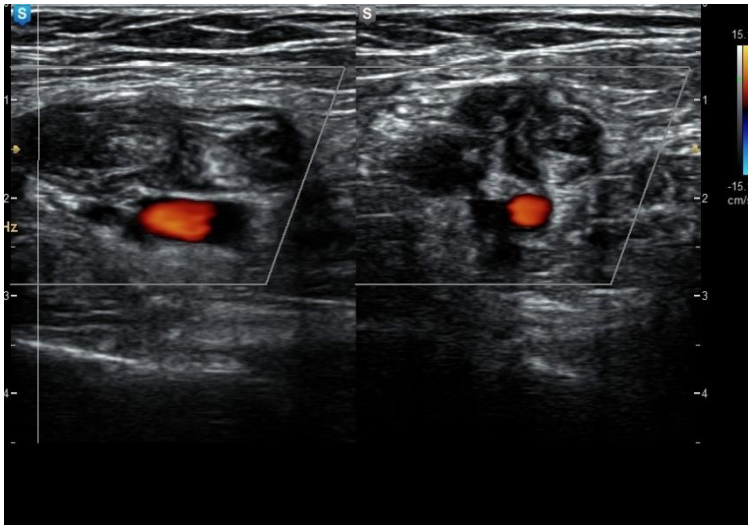


Image (3): Sagittal and transverse U/S image plans show acute DVT in right Femoral vein for male in 34years age

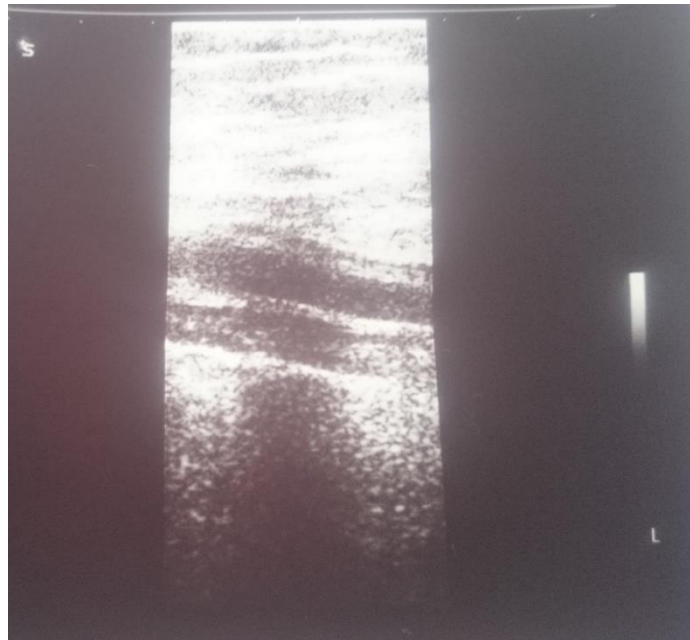


Image (4): Sagittal U/S image plans show chronic DVT in left Femoral vein for female in 47 years age

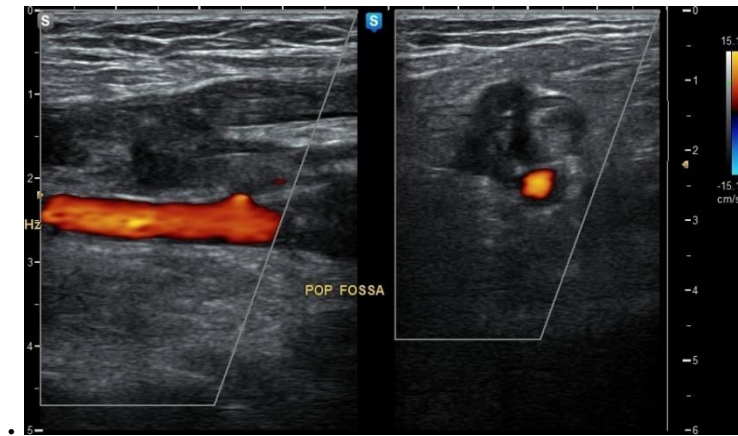


Figure (2)

Sagittal and transverse U/S image plans show acute DVT in right Popliteal vein for male in 24 years age.

Appendix (B)

Data collection sheet

***Gender:**

1/Male

2/ Female

***Age :**

***Location of DVT(which veins):**

1/ C.F.V

2/ F.V

3/ POP.V

4/P.T.V or A.T.V or peroneal V

*** Affected Side :**

1/Rt

2/ Lt

3/both

*** Causes:**

1/age

2/ co-existing malignant tumors

3/dehydration.

4/ trauma .

5/ history of previous DVT or pulmonary emboli .

6/obesity

7/ cardiac disease .

8/ pregnancy .

9/previous episode of DVT

10/prolonged immobilization with the legs . 11 / history of recent surgery 12/ HTN

13/ DM

Type of DVT:

1/ Acute

2/Chronic

***Characteristics of DVT:**

-Vessel Compressibility :

1/The vessel cannot be completely compressed.

2/The vessel can be semi compressed.

-Echogenicity:

1/ Hypochoic

2/Hyperechoic

-Surface Characteristics:

1/ Smooth

2/irregular

-Vessel Size :

1/ larger than normal.

2/ smaller than normal.

-Blood Flow :

1/ Not seen if totally obstructed

2/ recanalization.

-Audible Doppler signal quality :

1/ Doppler signal not evident.

2/Doppler signal often heard and may be normal.

-Collateral Circulation: 1/ Not evident

2/Often evident

location of pathology :

1-ankle.

2-leg

3-knee

4-femur.