The differential diagnosis of deep vein thrombosis to consider when applying for a Doppler ultrasound of the lower limbs

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Authors: R. E. Correa Soto¹, D. S. Palomino Posé², K. Müller Campos³, J. M. Fernandez García-Hierro⁴, A. Casas Martín¹, A. Blázquez Saéz¹; ¹Salamanca/ES, ²Barcelona/ES, ³Santiago/CL, ⁴Carbajosa de la Sagrada/ES

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Learning objectives

• To describe the characteristics of ultrasound and Doppler ultrasound images of the various entities which suggest the clinical diagnosis of deep vein thrombosis.

• To review lower limb anatomy and to classify into regions, in order to get a sequential schematic examination.
Background

INTRODUCTION

Deep vein thrombosis (DVT) has an annual incidence in general population of 1-2/1000 habitants. Although this entity has an effective treatment, 1-8 % of patient will develop a pulmonary thromboembolism, 40 % a post-phlebitis or post-thrombotic syndrome and 4 % chronic thromboembolic high pulmonary pressure.

Clinical DVT signs and symptoms are not always reliable. If we used only clinical signs to reach the DVT diagnosis, 42 % of patients would receive an unnecessary anticoagulant treatment. Doppler ultrasound (US) is the best initial test to reach the DVT diagnosis due to its high sensibility (95%) and specificity (100%), specially for proximal lower limb.

Venous compression ultrasononography is currently the imaging test of choice for the diagnosis of DVT. The lack of compressibility of a given vein segment is the diagnostic criteria, while adding color-Doppler allows more accurate identification of the thrombosed vein segment. The detection of proximal vein thrombosis (from common femoral to popliteal vein) with ultrasound shows a sensitivity of 97%, while for calf veins is reduced to 73%. Considering that in symptomatic patients only 20-30% will extend the proximal territory and only 1-2% of patients with negative ultrasound presented thrombosis after a serial study is not advisable nor is cost-effective realization serial ultrasounds.

Studies over the past 30 years have found that seven out of ten patients might have a different cause of DVT pain, edema, mass, or redness in the legs.

The key to making an accurate diagnosis is to recognize the characteristics of various diseases in ultrasound images.

It has been described as more anatomical approach useful strategy to characterize the spectrum of pathological conditions observed in patients with symptoms simulating DVT. This approach divides the lower limb in four regions: groin, thigh, popliteal, and leg. The groin is the region between the inguinal ligament and a horizontal line at the level of the intersection of the sartorius and adductor longus; the inguinal region extends about 10 cm below the inguinal ligament. Thigh extending from this line to the Hunter channel, which is the upper limit of the popliteal region. The lower limit of the popliteal region and the upper limit of the leg is approximately 10 cm from the popliteal crease, and the leg region extends to the ankle.
Each deep vein is accompanied by an artery traveling in close proximity to it.

The external iliac vein becomes common femoral vein when reaching the inguinal ligament. The common femoral vein positioned medial and slightly deeper than the artery just below the groin. The first branch that arises from the common femoral vein is the great saphenous vein coursing medial and superficial to the fascia of the thigh and leg towards the foot. At a distance of 1 to 2 cm, there is a branch of the common femoral vein leading to the superficial and deep femoral femoral veins. Deep femoral vein drains the muscles of the thighs and it is located more laterally and deeper than the superficial femoral vein. When the US is performed from above, the deep femoral vein is located in the upper portion of the deep femoral artery. The superficial femoral vein is the vein in charge to the deep draining of the lower thigh and calf; it courses medial to the deep femoral vein. Superficial femoral vein is placed deep and posterior to the femoral artery when scanning from the anterior thigh. Both the artery and the vein are introduced into the adductor channel traversing the fascia in the lower third of the thigh. When leaving the adductor channel, the vein remains deeply located over the corresponding popliteal artery. Since typically the popliteal vein is scanned from the back leg region, it will be closer to the transducer than the artery.

The small saphenous vein usually arises from the popliteal vein in the middle of the knee or more cranial to it, and runs back and then laterally along the leg; usually ends immediately in front of the lateral malleolus. The popliteal vein can often be followed by US until the proximal calf, at that point it is divided into anterior tibial vein and tibio-peroneal trunk. It is at this level where the veins are duplicated. Before this, the superficial femoral vein is doubled over at least a short length in the 15 to 20% of patients, while the popliteal vein can do the same by up to 35% of patients. When they are duplicated, the segments of the superficial femoral vein join back into a canal after passing through the thigh during a variable distance. The duplication of the popliteal vein tend to follow as duplicated separate segments. The anterior tibial veins can be identified as they emerge and cross the interosseous membrane in its top and in its course down the leg; then they cross the ankle as dorsal foot veins. The tibiofibular trunk is difficult to visualize in the upper third of the calf. The posterior tibial veins can be visualized as they migrate more superficially in the middle third of the calf and they are placed behind the medial malleolus. The fibular veins are located behind the fibula.
Fig. 1: Anatomy of deep venous system of the lower extremity.
Findings and procedure details

DIFFERENTIAL DIAGNOSIS ACCORDING TO ANATOMICAL REGIONS

INGUINAL REGION

Lymphatic System

Lymphadenopathy. - The most common lymph nodes in the inguinal region are inflammatory, and neoplastic lymph nodes are less common. Most common neoplastic lymphadenopathy are lymphomas, followed by genital squamous cell carcinomas and melanomas. If the ratio of measures length / cross is less than 2 and echogenic hilum lacks, the positive predictive value for malignancy is 93% with a specificity of 97%.

Lymphangitis. - Inflammation of the lymph vessels is known as lymphangitis, this may be primary or secondary. They are presented as lymphadenopathy and tubular dilations of superficial veins, showing no flow Doppler ultrasound.

Vascular conditions

They are hematomas and pseudoaneurysms secondary to catheterization of the common femoral artery and, less frequently, resulting from a surgical trauma. Those are the most common vascular lesions mimicking DVT.

Pseudoaneurysms are usually observed in obese patients, who required thick caliber catheters, antiplatelet and anticoagulation treatment after the procedure. If grayscale images do not reveal a good definition of the pseudoaneurysm within a hematoma, it will proceed with color Doppler ultrasound, which can be clearly show the two-way flow appearing as a sign of "yin yang". Dimensions of the neck should be measured to determine treatment with compression therapy or to administer an injection of thrombin.

Conditions related to fat

Femoral hernias, lipomas, liposarcoma, and lipomatosis.

Femoral Hernia. - Femoral hernias, especially incarcerated produce a painful, bluish tumor, mimicking DVT. Femoral hernias account for 4.7% of all groin hernias and they are more common in older women.

A hernia ultrasound will look different depending on the content held; if there is intestine inside, a hernia usually appears hypoechoic and may exhibit peristalsis. If there is
mesenteric fat in, the hernia occurs echogenic and it will have a similar appearance to the subcutaneous fat. The use of the Valsalva maneuver and to examine the patient in supine and standing position are essential for the diagnosis of a hernia and to rule out DVT. The loss of peristalsis and lack of blood flow to the mucosa can help determine if the hernia is incarcerated.

Lipomas. - They are the most common fatty tumors in the subcutaneous tissue. They are usually asymptomatic, but when they are large they can compress the vein or nerve and present similar symptoms to DVT.

With US it is seen as an echogenic mass, usually with well-defined edges and a similar subcutaneous fat texture. The Valsalva maneuver and color Doppler can help identify the vein when compressed.

**THIGH REGION**

**Traumatic muscle injury**

Trauma is the most common cause of muscle injuries in both the thigh and leg. Muscle injuries are subdivided into bruises, sprains, tears and lacerations. Usually they are related to sport, but they can also be the result of normal daily activities.

Muscle injuries, tears and lacerations often mimic DVT. The findings of ultrasound imaging of muscle contusions vary depending on time and severity of trauma. The muscular edema can be seen in focal lesions and minor trauma, but the bruises result from severe trauma. Hematomas change over time, ranging from anechoic to echogenic within 24 hours. Then in the next 2-3 days, hypoechoic to anechoic converted; thereafter, increased echogenicity can be seen.

Thigh Traumatic injuries most often endanger the adductor group. The adductor longus muscle is more often injured, especially in the pubic miotendinous union.

**Soft Tissue Tumors**

These tumors arise from mesenchymal cells. Represent 1% of all tumors. Almost 50% of tumors of soft tissues occur in the extremities. US is used to help confirm the presence of a suspicious lesion to distinguish a local mass of an edema, to differentiate cystic masses of solid masses, and for guiding percutaneous biopsies. The initial manifestation of a sarcoma can simulate a DVT.

Deep fibromatosis
It is also called aggressive fibromatosis and desmoid tumor. In 70% of cases of profound extraabdominal fibromatosis, the limbs are involved. Desmoid tumors are aggressive metastatic lesions with a high rate of local recurrence. They infiltrate the adjacent soft tissue, neurovascular invasion is common and bone involvement is occasionally seen. The peak incidence occurs between 25 and 35 years old. In patients under 30, desmoid tumors may exhibit more aggressive behavior and they have a recurrence rate of up to 87%. In US images, desmoid tumors appear as a hypoechoic soft tissue injury, well defined and not homogeneous.

Chronic exertional compartment syndrome

It is classified as acute or chronic, depending on how it manifests. The acute compartment syndrome is always associated with trauma and therefore is not a differential diagnosis of DVT. In chronic compartment syndrome appears recurrent pain and it is due to increased muscle mass associated with exercise. In the compartment syndrome, fascial compartment can not expand to accommodate well enough the change in the volume generated by an increase in blood flow, so that an elevated tissue pressure and pain occurs.

Myositis

It is a common cause of muscle edema secondary to autoimmune diseases, infections, vasculitis, and trauma. Bacterial myositis, often becomes an acute abscess, subacute or chronic.

In the early stages of myositis it is seen diffusely increased echogenicity of the affected muscle fibers and that is associated with an increase in the diameter of the muscle group. In most cases, the natural history of infection leads to the formation of an abscess with central necrosis.

POPLITEAL REGION

Baker's cysts

They are the most common cystic lesions seen around the knee. The gastrocnemius and medial semimembranosus bursa communicate with the knee joint by more than 50% of patients older than 50 years. Baker’s cysts are usually secondary to degenerative changes in the knee, but may result from the meniscal tear; pigmented villonodular synovitis; chronic infectious processes and inflammatory arthritis, especially rheumatoid
arthritic. A distinctive feature of rheumatoid arthritis is the synovial hypertrophy, which may affect the joint surface and the walls of the cyst.

Asymptomatic popliteal cysts are considered an incidental finding. Symptoms usually are due to growth or cyst rupture. The dissection of the muscles causing pain and edema, symptoms that mimic DVT.

**Popliteal artery aneurysms**

They are the most common type of peripheral artery aneurysms. They are expansions of the popliteal artery of 7 mm or more. They may be bilateral in 50% - 70% of patients and are associated with aneurysms in other locations in 30% -50% of patients. Almost 45% of the popliteal artery aneurysms are asymptomatic at diagnosis, but they may be symptomatic when they break, embolize, or they can produce DVT secondary to compression of the popliteal vein.

**LOWER LEG**

**Tennis leg**

It is a common injury typically seen in middle-aged patients. It is caused by hyperextension of the knee and forced dorsiflexion of the ankle. Clinically, it is characterized by a sudden calf pain that patients describe as a "pop". During the next 24 hours, edema and pain ensue, symptoms that simulate DVT.

**Soft Tissue Neoplasms**

The prevalence soft tissue neoplasms in the leg is age dependent. The most common benign tumors are lipomas, fibrous histiocytoma, nodular fasciitis, neurogenic tumors, schwannomas and neurofibromas. The most important lesions are malignant sarcomas, most of which appear as a painless mass, unless compress the neurovascular structures. Neurogenic tumors also emulate some DVT.

Ultrasounds are used to determine the size and nature of an injury to the soft tissues (solid or cystic) and to help exclude DVT as a diagnosis.

**Miscellaneous**
The most common are venous congestion (eg, heart and kidney failure and fluid overload) and cellulite. US findings include swelling of the subcutaneous tissue, which appears as an area of increased echogenicity with hypoechoic bands, caused by a buildup of fluid.

Less common, but can also simulate a TVP it is bruising resulting from anticoagulation, panniculitis, erythema nodosum, insect bites, lymphangitis, and foreign bodies.
**Fig. 2:** Inflammatory adenopathy in the right inguinal region (arrow).

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Fig. 3: Malignant pathologic adenopathy in inguinal region (arrow).

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Fig. 4: Malignant pathologic adenopathy in inguinal region (arrow).

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Fig. 5: Groin hematoma (arrow) secondary to catheterization of right femoral artery (arrow).

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Fig. 6: Groin hematoma (arrow) secondary to catheterization of right femoral artery (arrow).

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**Fig. 7:** Pseudoaneurysm in right common femoral artery.

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Fig. 8: Pseudoaneurysm in right common femoral artery.

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Fig. 9: Right inguinal hernia (arrow).

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Fig. 10: Hematoma in the left thigh quadriceps muscle (arrow).

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Fig. 11: Melanoma metastases in right thigh (arrow).

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Fig. 12: Edema thigh subcutaneous tissue (arrow).

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Fig. 13: Thigh subcutaneous abscess (arrow).

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Fig. 14: Baker's cyst.

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**Fig. 15:** Baker cyst complicated (arrow).

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**Fig. 16:** Achilles tendinopathy.

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**Fig. 17:** Achilles tendinopathy.

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Fig. 18: Ruptured Achilles tendon (arrow).
Fig. 19: Ruptured Achilles tendon (arrow).
**Fig. 20:** Hematoma in extensor digitorum longus muscle of the foot (arrow).

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**Fig. 21:** Cellulite leg.

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**Fig. 22:** Schwannoma right leg.

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Fig. 23: Schwannoma right leg.

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Fig. 24: Thrombophlebitis superficial venous system of leg (arrow).

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Fig. 25: Thrombophlebitis superficial venous system of leg (arrow).

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Conclusion

- Most patients evaluated by US do not present DVT. Other alternative diagnoses are common in patients who show similar symptoms of DVT.

- The rule out DVT may have therapeutic implications, especially in relation to anticoagulation treatment, and possible complications.

- An anatomical approach may be useful to focus on the most common pathology, depending on the region that the patient indicates as the most painful.
References