Imaging lower limb deep venous thrombosis

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Introduction

A patient presenting with possible deep vein thrombosis (DVT) is one of the most common scenarios that clinicians face on a daily basis. Incidence is estimated to be approximately 1 in 1,000. Due to the potentially fatal consequences of not appropriately diagnosing and treating DVT – specifically pulmonary embolism – the importance of prompt and accurate investigation is the cornerstone to good patient management. Imaging, including specifically compression ultrasonography and contrast venography, can play a role in the diagnosis and increasingly the management of DVT.

Indications for imaging

Pre-test probability, as estimated using the Wells Score, is calculated based on several risk factors.

- Paralysis, paresis or recent orthopaedic casting of a lower extremity (1 point)
- Recently bedridden for longer than three days or major surgery within the past four weeks (1 point)
- Swelling of an entire leg (1 point)
- Localised tenderness in the deep vein system (1 point)
- Calf swelling 3cm greater than the other leg, measured 10cm below the tibial tuberosity (1 point)
- Pitting oedema greater in the symptomatic leg (1 point)
- Collateral non-varicose superficial veins (1 point)
- Active cancer or cancer treated within six months (1 point)
- Alternative diagnosis more likely than DVT (e.g., Baker’s cyst, cellulitis, muscle damage, post phlebitis syndrome, inguinal lymphadenopathy, external venous compression (-2 points)).

A score of zero or fewer points indicates an unlikely probability of DVT, a score of 1-2 indicates moderate probability and 3-8 indicates high probability. A Modified Well Score is calculated if a patient has a previously documented DVT. A history of DVT is added as one extra point. In these cases a DVT is considered ‘likely’ if the score is 2 or greater and ‘unlikely’ if the score is 1 or less.

D-Dimer. A degradation product of cross linked fibrin, D-dimer is an indicator of clot breakdown. It is incredibly sensitive for the measurement of clot breakdown, but is non-specific for DVT. It is generally only considered to be useful in combination with a Wells Score. Indications for imaging are based on an algorithm using combined results of the Wells score and D-dimer test.

- For patients with an ‘unlikely’ Wells Score and a negative D-dimer, DVT can be effectively ruled out.
- If the D-dimer is positive, compression ultrasound is indicated.
- For patients with a ‘likely’ Wells Score, compression ultrasound is indicated in all cases to rule out DVT. In the scenario where the Wells score is likely with a positive D-dimer but a negative ultrasound, repeat ultrasound is indicated in seven days’ time.

Compression ultrasound

Compression ultrasound is considered the first line imaging modality for the diagnosis of DVT based on ease of availability, cost and patient tolerance. Ultrasound is performed with the patient in both supine and prone positions, in order to examine the entire venous system of the leg. Features of diagnosis include:

- abnormal compressibility of vein
- abnormal Doppler flow
- the presence of an echogenic band
- Abnormal change in diameter during Valsalva manoeuvre.

Ultrasound has been found to be 100% sensitive and 99% specific for proximal vein thrombosis when performed by a trained clinician. However, ultrasound can be limited due to the anatomical limitations of scanning the iliac vein and the portion of the femoral vein within the adductor canal. If the initial scan is negative in a patient who is considered to be likely to have a DVT or the clinician cannot adequately view the veins, a follow-up scan is indicated within seven days or alternatively a different imaging modality.

Other imaging modalities

Contrast venography. Although well recognised to be definitive imaging for the diagnosis of DVT, contrast lower limb venography is rarely indicated as an initial investigation due to poor patient tolerance, contraindications (e.g., impaired renal function) and limited availability. Non-invasive testing has been established as nearly equivalent in terms of diagnostic accuracy, however venography is still considered to be clinically useful when non-invasive imaging is not feasible, equivocal or discordant with strong clinical suspicion. CT or MR venography is particularly useful where more central venous thrombosis is suspected and the use of ultrasound is limited.

Impedance plethysmography is a non-invasive test that is completed by inflating a cuff around the thigh while change in blood volume at the calf is measured by impedance as determined by electrodes wrapped around it. In reality it is infrequently used and often considered to be impractical for reasons as basic as the lack of equipment and trained staff.

Follow-up imaging

NICE recommends a repeat proximal leg ultrasound in 6-8 days for all patients with a positive D-dimer and a negative initial proximal vein ultrasound scan. Otherwise there is no specifically indicated repeat scanning for DVTs that have been confirmed and treated.
When to image for cancer

An unprovoked DVT can be an initial presentation of cancer. NICE recommends that all patients with a confirmed unprovoked DVT who are not already known to have cancer be further worked up by an extensive history and physical examination, a chest x-ray, blood tests (FBC, serum calcium and LFTs) as well as urine analysis. Further investigations (including CT CAP) can be indicated based on history and examination and the findings of initial investigations.12

May-Thurner syndrome and the role of interventional radiology

Also known as iliac vein compression syndrome, anatomical compression of the left iliac vein between the right iliac artery and the underlying vertebral body is an additional cause of unprovoked lower limb DVT. Due to the local anatomy surrounding the left upper iliac vein, the use of ultrasound is often limited in these cases. As such, contrast venography and interventional radiological procedures are often indicated in both the investigation and management of suspected cases. Confirmed cases of acute iliac vein with potentially limb threatening thrombosis, can be more definitively managed by pharmaco-mechanical techniques such as catheter-directed thrombolysis (CDT), venous angioplasty and/or intravascular stenting.13-14

Randomised controlled trials including The CaVenT Study15 (completed) and The ATTRACT Study 16 (final results awaited), are suggestive that interventional therapies appear promising for limb salvage and reduction of the long term sequelae such as post thrombotic syndrome. There is also an increasing practice and weight of evidence to suggest the benefit of central venous recanalisation and stenting in the chronic situation, also with patients being worked up using CT and/or MR venography and intravascular ultrasound.

Conclusion

Prompt and reliable investigation of suspected DVT is paramount to good patient care, particularly given the potentially fatal consequences. Imaging, coupled with a probability score and a D-dimer measurement, is essential to accurate diagnosis and patient management. Advanced interventional radiology techniques are gaining prominence, particularly in the iliofemoral DVT setting.

References

1, Tovey C, Wyatt S. Diagnosis, investigation and management of deep vein thrombosis. BMJ 2003;326(7400):1180-84.
6, Scarvelis D, Wells P S. Diagnosis and treatment of deep-vein thrombosis. CMAJ 2006;175:1087.
Figure 1A-C
Axial power Doppler ultrasound. (A) Left common iliac artery (orange) and expanded left common iliac vein with hyperechoic thrombus. (B) Ultrasound longitudinal view showing expanded common femoral vein containing hyperechoic thrombus. (C) Ultrasound showing expanded left common femoral vein containing hyperechoic thrombus.

Figure 2A-B
Case: A 55-year-old woman with left leg DVT. Venogram demonstrates stenosis of distal left external iliac vein with filling of collaterals passing medially. (A) Axial TRU FISP MRI. (B) Venogram.
Figure 3A and B
(A) occluded IVC coronal 1 (red arrows) and occluded left renal vein (red triangle). (B) Stenotic infrahepatic IVC coronal (red arrow).

Figure 4A and B
May-Thurner syndrome. (A) Axial CT. Red arrow showing iliac vein confluence or distal IVC. Blue arrow shows right common iliac artery compressing left common iliac vein (green arrow). (B) Venogram. Red arrow shows indentation of left common iliac vein by right common iliac artery (with collateral drainage).