WINFOCUS

Ultrasound Enhanced Critical Management

Deep Vein Thrombosis

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Deep Vein Thrombosis Introduction

Deep Vein Thrombosis

- Thrombosis in the deep veins, esp in the lower limbs
- 0.1% annual incidence in white population*
- Frequent DDx to be ruled out in Emergency care settings

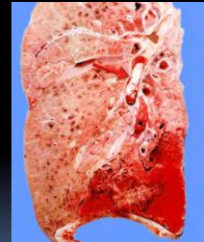
*White RH. The epidemiology of venous thromboembolism. Ciruclation 2003; 107 (supp 1): I-4-I-8.

Deep Vein Thrombosis

- If missed, may lead to fatal PE or chronic venous insufficiency
- Clinical signs are neither sensitive nor specific
- [50% DVT missed, 30% misdiagnosed as DVT]

Kakkar V. Circulation 1975; 51:8-19.

Hillner B et al. Arch Intern Med 1992; 52:165-75

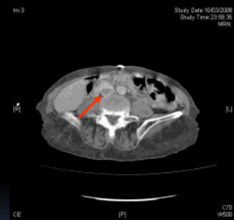


Deep Vein Thrombosis

- Gold standard=contrast venography
- Rarely performed because:
  - Invasive, expensive
  - Time consuming not 24 hourly a/v in most institutions
  - Complications: anaphylaxis, inducing DVT, extra-vasation of contrast
  - Non-diagnostic: around 1%

Modern Imaging Modality

- CT venography/MR venography
  - High sensitivity
  - Expensive
  - Required contrast media [CT]
  - Not always available
  - Not for unstable patients
  - Calf vein not always included
  - Can readily identify thrombosis in IVC and iliac veins



A clot is seen in the IVC in Contrast venography

Compression USG

- Compression USG
  - Advocated for >20 years
  - Now recognized as the primary diagnostic modality + clinical probability + D-dimer for lower limb DVT
  - Noninvasive
  - Cheap, repeatable
  - Portable at bedside [esp unstable patient]
  - Lack of Complications [no contrast is used]

Compression USG

- However, formal ultrasound study usually not 24-hourly a/v in Department of Diagnostic Radiology
- OR even not accessible to ED patients
- Emergency Physicians/Intensivists have to perform bedside USG to rule out/rule in DVT.

Deep Vein Thrombosis In Lower Limbs

Anatomy of LL venous system

•Most believe only proximal DVT needs treatment.

•But 20% of calf DVT may propagate to the more proximal veins†.

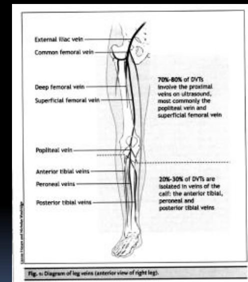


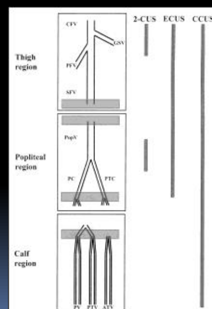
Fig. 1: Diagram of leg veins (anterior view of right leg).

† Pezzullo JA, Perkins AB, Cronan JJ: symptomatic DVT: Dx with limited compression USG. Radiology 1996; 196:67-70

Scarvelis D, PS Wells. Dx and Tx of DVT. Canad Med Ass L. 2006; 175(9): 1087-92.

USG Protocols

- 2-point compression USG [2CUS]
  - Scan only the groin and popliteal fossa
  - i.e. CFV and proximal SFV, and PoPV
- Extended compression USG [ECUS]
  - From groin to thigh then to popliteal fossa
  - i.e. CFV, SFV, PoPV till trifurcation
- Complete compression USG [CCUS]
  - From groin to calf, every cm
  - i.e. CFV to paired calf veins



USG Protocols

- CCUS
  - Time consuming
    - 37 mins for CCUS Vs 5.5 mins for targeted scan +
  - Difficult to identify the calf veins
  - Normal variants occur
  - 3 month failure rate=0.3-0.5%*.

+Poppiti R et al. J Vasc Surg. 1995; 22: 553-57.
*Elias et al. Thromb Haemost 2003; 89: 221-227.
Schellong et al. Thromb Haemost 2003; 89: 228-234

USG Protocols

- 2CUS/ECUS
  - Easy & fast to perform- iliofemoral & popliteal regions are superficial
  - Repeat if 1st USG –ve in high risk case
  - EP are competent in performing 2-CUS+
    - Kappa=0.9, 98% agreement with vascular sonorgraphers
    - Median time=3 min 28 sec
  - 3-month failure rate was 0.7 to 2%*

+Blaivas M et al. Acad Emerg Med 2000 7(2): 120-126
*Ginsberg JS. N Eng J Med 1996; 335:1816-1828
*Cogo A et al. Thromb Hemost 1995; 73:1098

Hardware preparation

- High frequency linear transducer
- 5-10MHz
- Mainly B mode imaging
- Colour flow / Pulse wave Doppler application optional
- Adequate transonic Gel
- Adjust TGC and Depth when scanning mid-thigh level [veins go deeper]

Image Acquisition

- Patient in supine position with slightly externally rotation and flexion of hip
- Transverse scan
- Start just below the inguinal ligament

Image Acquisition

- Identify the Common Femoral Vein [CFV] in cross section
- It comes close with the Common Femoral Artery [CFA].
- Apply firm and direct pressure to assess the compressibility of the CFV
- Then go distal 1cm by 1cm to assess the sapheno-femoral junction

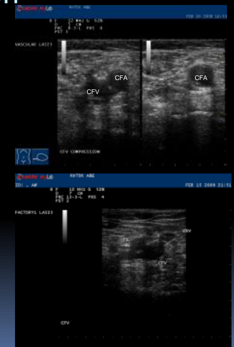
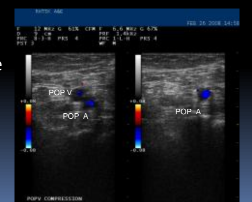


Image Acquisition

- Further distal movement of probe to notice splitting of CFV into Superficial Femoral Vein [SFV] and Deep Femoral Vein [DFV].
- SFV is actually part of the deep vein system!
- SFV goes medial and deep into muscle layer and turns posteriorly into the popliteal fossa in the adductor canal.
- Need to use bimannual technique to compress the SFV at this point.

Image Acquisition

- Put the transducer to the Popliteal fossa behind the knee to assess the Popliteal vein [PopV]
- PoPV is above the popliteal artery at this point.
- Assess the compressibility at least on the proximal 2cm of the vein and just distal to the trifurcation



Compressibility

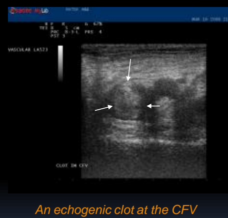
- Apply firm and direct pressure in transverse scan
- Probe must be perpendicular to the vein.
- Normal compressibility
  - Complete collapse of the vein as shown in the ultrasound monitor.
  - Adequate pressure=Pressure just enough to deform the correspondent arteries

Compressibility

- Pitfalls
  - Pressure at wrong angles and vectors
  - Difficult areas: adductor canal
    - → need both hands
  - Longitudinal scans
    - →slip away from the vein!
    - → better avoid it

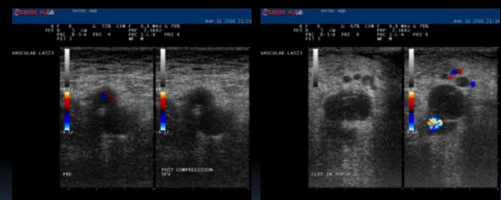
DVT features

- Acute DVT:
  - Fresh clots may not be visible, depending on the echogenicity.
  - Only complete compressibility →rule out DVT
  - Avoid excessive compression to prevent dislodgement of the clot →risk of PE!



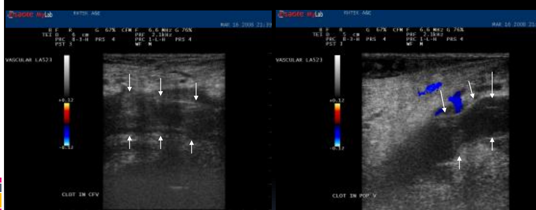
An echogenic clot at the CFV

DVT features



Left SFV and Pop V failed to compress ie. DVT +ve. Also absence of colour flow doppler in these 2 viens

DVT features



Dilated left CFV and Pop V with echogenic intramural clots

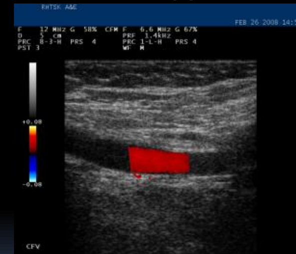
DVT features

- Chronic DVT:
  - Clots begin to organize within 5-10 days.
  - Aging thrombi recannulize centrally and blood flow can be possible
  - Complete compression is still not possible but near-complete collapse occur!
  - Appears as thickened venous wall
  - Longitudinal scan with colour flow doppler can help.

Doppler Assessment

- Not an essential examination for identifying DVT
- But provide more info about the blood flow within the vessels ie. Venous obstruction
- Help to differentiate artery from vein
- Colour flow doppler shows flow defect in thrombosed veins.
- Pulse wave doppler shows absence of normal phasic changes and loss of augmentation.

Colour Flow Doppler

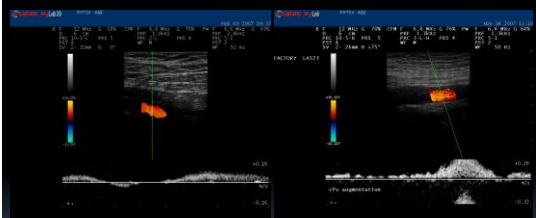


Normal and complete fill-up of the colour map in the Common Femoral Vein→ No DVT was found

Colour Flow Doppler

Absence of flow in the CFV and SFV with echogenic clots

Pulse-wave Doppler



Normal phasic changes and augmentation in the Common Femoral Vein

Sensitivity and Specificity

- However, compression only USG not 100% sensitive and specific.
- Sensitivity falls when scanning calf veins: 30-70%†

†Birdwell, Raskob GE, Whitsett TL, et al. The clinical validity of normal compression USG in outpatients suspected of having DVT. Ann Intern Med 1998; 128:1-7.

Lensing AW, Prandoni P, Brandjes D et al. Detection of DVT by real time B mode USG. N Engl J med 1989; 320: 342-5.

Kearon C, Ginsberg JS, Hirsh J. The role of venous UGS in the Dx of suspected DVT and PE. Ann Intern Med 1998; 129:1044-9.

Sensitivity and Specificity

- A recent Meta-analysis by Goodacre et al
  - 100 studies comparing all USG techniques Vs venography
  - Sensitivity: 94.2% for proximal DVT and 63.5% for distal DVT
  - Specificity: 93.8% overall
  - With duplex:
    - sensitivity 96% for proximal DVT and 71% for calf DVT
    - Specificity 94% overall

Goodacre S et al Health Technol Assess 2006; 10:168, iii-iv.

EP performed Venous Scan

- Burnside et al. did a systemic review of emergency physician-performed USG for LL DVT
  - 6 studies identified
  - Criterion standard: Vascular sonorgrapher/radiologist performed USG.
  - Pooled data analysis yielded overall sensitivitiy of 95% [CI=0.87-0.99] and specificity of 96% [CI=0.87-0.99].

Burnside et al Acad Emerg Med 2008; 15:6, 493-498.

Pitfalls

- Anatomical variation e.g. Double pop veins.
  - 32.5% have multiple SFV†
  - 42% have more than 1 POP veins in popliteal fossa; 5% true duplications †
- Technical aspect [Doppler may help]
  - Groin Lymph Nodes: mistaken as a thrombosed vein
  - Mistaken an artery as a vein with incompressibility

†Quinlan DJ, AAlikhan R, Gishen P Sidhu PS. Variations in Lower limb venous anatomy: implications for USG diagnosis of DVT. Rdaiology 2003; 228:443-448.

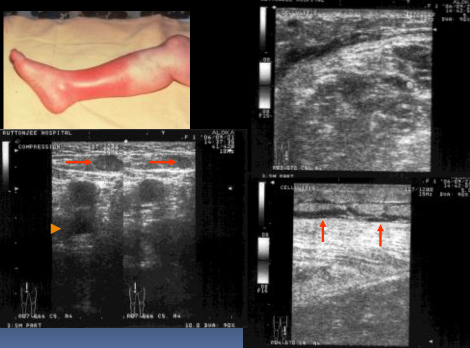
Limitation of USG

- Acute on chronic DVT
  - Not accurate to differentiate old/new clots
  - Need venography
- Physical obstacles
  - POP/Cast insitu
  - Surgical emphysema/open laceration wound
  - Iliac viens/IVC: relies on doppler flow assessment because compression is impossible

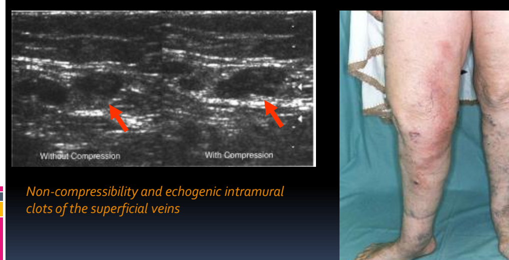
Common DDx

- Cellulitis/subcutaneous abscess
- Superficial thrombophlebitis
- Calf muscle tear: medical head of gastronemicus
- Ruptured Baker's cyst

Cellulitis

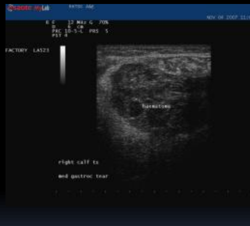


Superficial thrombophlebitis



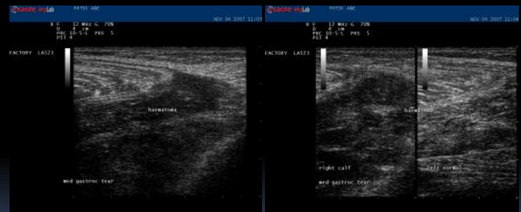
Non-compressibility and echogenic intramural clots of the superficial veins

Gastrocnemius tear



Transverse scan of the right medial gastrocnemius muscle tear with formation of haematoma

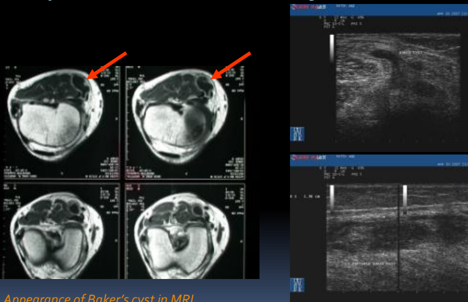
Gastrocnemius tear



Tear of right medial gastrocnemius muscle with formation of hypechoic collection of fluid between gastrocnemius and soleus muscles

Normal gastrocnemius for comparison

Ruptured Baker's cyst



Appearance of Baker's cyst in MRI

USG appearance of Baker's cyst with sign of rupture and dissection into the calf

Deep Vein Thrombosis In Upper Limbs

Upper Limb DVT

- Less common than lower limb DVT
- More common in patients with iv lines and malignancy
  - Presence of a central venous catheter (72%)
  - Infection (28%)
  - Extra-thoracic malignancy (22%)
  - Thoracic malignancy (21%)
  - Renal failure (21%)
  - Prior LL DVT (18%)

Marinella MA, Kathula SK, Markert RJ. Heart Lung. 2000 Mar-Apr;29(2):113-7. Spectrum of upper-extremity deep venous thrombosis in a community teaching hospital.

Clinical Features

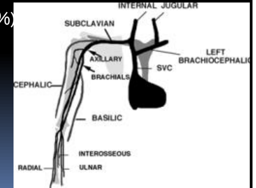
- Predisposing factors:
  - iv lines, Malignancy
- Arm swelling, pain, heaviness
- Dilated subcutaneous veins
- Upper limb cyanosis
- *Can be asymptomatic*

→ Again clinical features are not specific!

Upper limb venous system

Common Site of UL DVT

- Mainly Subclavian and/or Axillary Veins
- Usually multiple site involvement
  - Subclavian vein (18-69%)
  - Axillary vein (5-42%)
  - Internal jugular vein (8-29%)
  - Brachial vein (4-13%)



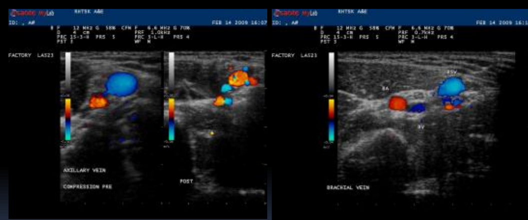
Scanning Protocol

- Patient is placed supine and place the arm on bed.
- Linear Transducer 5-7MHz
- Start proximally from IJV, SV, AV, to BVs.
- Compression Scan [same as LL scan] from Basilic and brachial veins to axillary veins.
- Colour Doppler to assess the Subcalvian and Internal Jugular Veins

Diagnostic Criteria

- Same as LL Scan
- Incomplete compressibility
- Presence of clots
- Loss of normal pulsatile flow pattern in the IJV and SV
- Valsalva manoeuvre: widening of veins and reduction in flow
- Sniff test: narrowing of vein and increase in flow
- But flow abnormalities are only suggestive of thrombosis → need venography

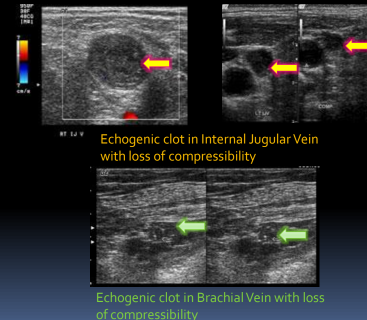
Normal Scan



Normal Compressibility of Axillary Vein

Normal Brachial Veins

Abnormal Scan



Echogenic clot in Internal Jugular Vein with loss of compressibility

Echogenic clot in Brachial Vein with loss of compressibility

Sensitivity and Specificity

- Limited number of published reports on Sn and Sp of USG Vs Contrast Venography
- Reported Sensitivity=78-100%
- Reported Specificity=82-100%

Baarslag HJ et al. *European Radiology* 2004 14:1263-74.

Diagnostic Pitfalls

- USG not sensitive for DVT involving proximal Subcalvian viens and Innominate viens.
  →need other modality of imaging
- Presence of collaterals →mistaken as a normal vein, causing false –ve result.
- Other DDx: Superficial vein thrombosis

Any Questions?

THANK YOU