**Introduction**

This protocol was prepared by the Senior Vascular Physiologist. The SVT guidelines were used in conjunction with our current lab practices.

A lower limb deep venous duplex scan is performed to assess the deep and superficial venous system of the lower limbs to determine the presence or absence of thrombus.

**Common Indications**

1. Pain
2. Swelling
3. Tenderness
4. Known pulmonary embolism (PE).

**Limitations**

1. Casts, dressings, open wounds which will limit visualisation
2. Obesity
3. Limited mobility i.e., unable to stand unaided
4. Patients with severe oedema and lower limb swelling
5. Patients with reduced cognitive function who are unable to follow instruction
6. Patient discomfort
7. Bowel gas may hamper visualisation of the abdominal veins

**Patient Referral**

The referral should include details of the presenting symptoms.

**Patient Preparation**

No preparation is required. The examination should be fully explained to the patient and consent obtained. Patient name and date of birth must be confirmed. Relevant medical history should be taken prior to the examination. Such as:

* Presence of risk factors eg previous DVT, recent major surgery, active cancer, family history of DVT, oral contraceptive pill or hormone replacement therapy
* Nature of patients symptoms, i.e., specific area of pain
* Results of other relevant diagnostics

The Vascular Physiologist should complete a limited visual examination of varicosities, ulceration and skin discolouration prior to conducting the ultrasound examination.

**Examination**

The examination may be unilateral or bilateral depending on clinical symptoms and consultant referral. The examination is performed in the supine position. The patient will be asked to remove lower limb clothing and wear a disposable gown which will maintain patient dignity at all times.

1. Patient is examined in the supine position with the leg externally rotated and the knee slightly flexed.
2. Apply ultrasound gel to the correct linear array transducer and select the Venous programme on the Ultrasound machine
3. There will be constant adjustment of the different functions on the control panel throughout the exam to ensure optimal imaging eg., depth, focus, gain, TGC, sample volume size, colour box, colour scale etc.
4. In the transverse plane in B-mode begin at the groin and locate the Common Femoral Vein (CFV) and Common Femoral Artery (CFA).
5. Rotate the transducer into the longitudinal plane and assess the CFV for patency. Using Colour Doppler demonstrate normal or abnormal colour filling.
6. Using Spectral Doppler observe if phasic spontaneous flow is present, without angle correction. If continuous or abnormal flow is demonstrated within the CFV this may be due to iliac vein obstruction which will also require investigation (Refer to bullet numbers 27-44).
7. Instruct the patient to take a deep breath and hold it in. Normal venous haemodynamics with respiration demonstrate that flow should cease on the Doppler spectrum and return only on exhale. Freeze the image and save it.
8. Once the Vascular Physiologist is satisfied the CFV is patent only then should he/she compress the vein. Note: Never compress a thrombosed CFV. Rotate the transducer into transverse plane, select the dual image function and save an image of the CFV uncompressed and then save an image of the compressed CFV.
9. In the transverse plane in B Mode slide the transducer down the leg and locate both the Profunda Femoris vein and the Superficial femoral vein (SFV).
10. Rotate the transducer into the longitudinal plane and assess the PFV for patency. Using Colour Doppler demonstrate normal or abnormal colour filling.
11. Using Spectral Doppler observe if phasic spontaneous flow is present, without angle correction. Instruct the patient to take a deep breath and hold it in. Flow should cease on the Doppler spectrum and return only on exhale. Freeze the image and save it.
12. In B Mode move the transducer laterally and assess the SFV for patency.
13. Using Colour Doppler demonstrate normal or abnormal colour filling.
14. Using Spectral Doppler observe if phasic spontaneous flow is present, without angle correction. Instruct the patient to take a deep breath and hold it in. Flow should cease on the Doppler spectrum and return only on exhale. Freeze the image and save it.
15. Steps 12-14 should be repeated in the upper thigh, mid thigh, lower thigh.
16. Rotate the transducer into the transverse plane, select the dual image function and save an image of the SFV uncompressed and then save an image of the compressed SFV.
17. The SFV should be compressed in 1 cm intervals from the groin to the lower thigh to definitely out-rule thrombus. Care should be taken when compressing the vein or assessing for echolucent acute thrombus, to ensure the thrombus is not dislodged.
18. In B Mode place the transducer in the transverse position above the popliteal fossa (posterior lower thigh). Identify the Popliteal vein lying superficial to the Popliteal artery.
19. Rotate the transducer into the longitudinal plane and assess the Popliteal vein for patency. Using Colour Doppler demonstrate normal or abnormal colour filling.
20. Using Spectral Doppler observe if phasic spontaneous flow is present, without angle correction.
21. Rotate the transducer into the transverse plane, select the dual image function and save an image of the popliteal vein uncompressed and then save an image of the compressed popliteal vein.
22. Slide the transducer below the popliteal crease in longitudinal. Assess the below knee popliteal vein for patency. Using Colour Doppler demonstrate normal or abnormal colour filling.
23. Using Spectral Doppler compress the deep veins of the calf (anterior tibial veins, posterior tibial veins and peroneal veins) one after the other and demonstrate augmentation on the Doppler Spectrum.
24. Rotate the transducer into transverse plane, select the dual image function and save an image of the below knee popliteal vein uncompressed and then save an image of the compressed popliteal vein.
25. Examine the deep calf veins and assess them for normal colour filling, phasic signals and compressibility.
26. The Soleal, Gastrocnemius veins and any prominent superficial varicosities should also be examined for thrombus.

**Abdominal and iliac fossa deep veins**

1. Apply gel to the low frequency curvilinear probe and select the venous programme on the Ultrasound Machine.
2. In the transverse plane in B-mode begin at the inguinal crease and locate the Common Femoral Vein (CFV) and Common Femoral Artery (CFA).
3. Rotate the transducer into the longitudinal plane and assess the CFV for patency. Using Colour Doppler demonstrate normal or abnormal colour filling.
4. Using Spectral Doppler observe if phasic spontaneous flow is present, without angle correction.
5. In Longitudinal B Mode slide the transducer above the Inguinal crease and identify the External iliac vein (EIV). Using Colour Doppler and Spectral Doppler demonstrate normal or abnormal colour filling. Document if phasic spontaneous flow is present, without angle correction.
6. In Transverse using Colour Doppler and Spectral Doppler demonstrate normal or abnormal colour filling of the EIV.
7. If thrombus is identified measure the length of the thrombus with the callipers and document the anatomical location ie. proximal mid or distal EIV. Document if occlusive, non-occlusive, chronic or acute. Assess if the vein demonstrates compression by the iliac artery or some other source of compression such as an abdominal mass.
8. In Transverse B Mode locate the confluence of the EIV and the internal iliac vein.
9. Rotate the transducer into longitudinal plane and assess the Common Iliac Vein for the presence or absence of thrombus.
10. Using Colour Doppler demonstrate normal or abnormal colour filling.
11. Using Spectral Doppler observe if phasic spontaneous flow is present, without angle correction.
12. If thrombus is identified measure the length of the thrombus with the callipers and document the anatomical location ie. proximal mid or distal CIV. Document if occlusive, non-occlusive, chronic or acute. Assess if the thrombus extends into the Inferior Vena Cava.
13. If bowel gas is limiting visualisation of the IVC in the lower abdomen, place the probe in the transverse position below the Xiphoid process in the midline of the abdomen. The IVC is the vessel directly adjacent to the liver demonstrated in close proximity to the proximal abdominal aorta.
14. Using Colour Doppler demonstrate normal or abnormal colour filling.
15. Rotate the transducer into the longitudinal plane and assess the IVC for the presence or absence of thrombus.
16. Using Colour Doppler demonstrate normal or abnormal colour filling.
17. Using Spectral Doppler observe if phasic spontaneous flow is present, without angle correction.
18. Slide the transducer towards the umbilicus and assess the IVC for patency. If thrombus is identified within the IVC document the upper extent of the thrombus.

**Interpretation**:

If the CFV demonstrates a continuous venous signal the contralateral CFV should automatically be assessed for spontaneous phasic flow.

If thrombus is identified within the deep system, anatomical landmarks can be used to identify where the thrombus begins and the upper extent of the thrombus. If the upper extent of the thrombus cannot be visualised due to limitations as a result of bowel gas for example this must be documented in the report and alternative imaging recommended. B Mode can be used to evaluate if thrombus is acute or chronic from its echogenicity, attachment and vein dilation. Free floating thrombus tails exhibit a side to side waving motion within the lumen of the vessel.

The IVC will collapse anytime the pressure within the IVC drops below the pressure outside the IVC (intra-abdominal pressure). The pressure within the IVC is determined by the blood volume, cardiac function and intrathoracic pressure. During inspiration, intrathoracic pressure drops which increases venous return from the IVC into the heart, lowering the pressure in the abdominal IVC and the IVC collapses.

**Reporting**

The report is a recording and interpretation of observations made during the assessment. It should be written by the Vascular Physiologist who performed the exam**.**

The Non-Invasive Vascular Unit has a standardised reporting system for each examination so that all Vascular Physiologists and clinicians alike can understand the report.

The report should include:

* Patient name, Medical Record Number, Date of examination, examination type, Vascular Physiologists initials.
* The presence/absence of phasic flow in the CFV
* Any abnormal venous flow such as a saw toothed waveform which may be indicative of cardiac congestive heart failure or some central aetiology.
* Which veins have been assessed, their patency or presence of thrombus
* Where thrombus is identified, the anatomical location, length, extent, degree of patency and if the thrombus is acute or chronic
* Any anatomical variations
* Any limitations encountered during the examination
* Recommendations for further imaging in the event of a limited examination
* Any incidental findings for example such as enlarged lymph nodes, Baker’s cysts, abscesses, cysts, interstitial fluid, lipomas and arteriovenous malformations
* An appropriate amount of annotated images that represent the entire ultrasound examination in accordance with department protocol