

## 7. Lower limb venous duplex assessment

### a) General

Where possible, patients are assessed whilst standing, the majority of weight on the contralateral limb. The ipsilateral limb should be non-weight bearing to avoid muscular contraction of the veins. The knee should be slightly flexed and the foot turned outwards.<sup>12</sup> For assessment of the popliteal and calf veins, the patient may sit on the edge of the bed placing their foot in the CVS's lap, alternatively their feet may be placed on a raised stool. The thigh should slope downwards avoiding compression from the bed; the knee should be flexed with the calf muscles as relaxed as possible.<sup>2</sup>

A mid frequency linear array transducer should be used (12-3 MHz linear array) to image the proximal leg and calf veins.<sup>1</sup> A lower frequency curvilinear array transducer (5-1 MHz curvilinear array) should be used if it is necessary to image the iliac veins and inferior vena cava (IVC).<sup>1</sup> An appropriate venous default setting should be selected on the machine to ensure that low venous flow can be detected<sup>1,3</sup>.

On calf augmentation all veins should fill from wall-to-wall with uniform blue colour. If the vein does not fill wall-to-wall, thrombus may be present. Investigation using different steering angles, lower colour PRF and wall filter settings should be utilised to optimise colourfilling.<sup>3</sup> On release of the calf there should be no or very slight (<0.5s) retrograde flow, which indicates no significant reflux disease.<sup>4</sup> Vein patency or obstruction should also be confirmed by ultrasound compression.<sup>1</sup>

### b) Deep Venous Thrombosis Assessment (12-3MHz linear array)

The transducer is placed in the groin in transverse plane and the common femoral vein (CFV) is identified medial to the common femoral artery.<sup>3</sup>

The Doppler sample volume is placed in the CFV, corrected to a 60 degree angle and steered to align parallel with common femoral vein flow. The sample volume gate should span the full diameter of the lumen.<sup>1,8</sup> Venous flow should be phasic with respiration. The patient is asked to perform a Valsalva manoeuvre, i.e. a cough. If a cough does not produce a satisfactory response, a full Valsalva manoeuvre should be performed.<sup>1,6</sup> Ask the patient to take a breath in and hold it, then to increase the pressure in their thorax. This is achieved by asking the patient to 'bear down' – pretending to go to toilet.<sup>1,4</sup> This should result in a temporary reversal of venous flow and indicate patency of proximal veins. With a proximal obstruction, flow in the CFV will be continuous and aphasie with respiration, with poor or no response to Valsalva manoeuvre.<sup>1</sup> If this occurs then the CVS should scan the iliac veins and IVC to assess whether there is a proximal DVT and/or a mass causing external compression of the vein.<sup>1,5,6</sup>

Following completion of the Valsalva manoeuvre, the common femoral vein should be compressed using external transducer pressure, to confirm patency.<sup>1</sup> Assessment of competency (using colour/spectral Doppler) and patency (using compression) of all other deep proximal veins should be performed as follows. The distal CFV bifurcates into two deep veins. The deeper vein is the profunda femoris vein, the more superficial vein is the superficial femoral vein (SFV). The profunda femoris origin should be assessed whilst the SFV should be

assessed along its length, adopting an increasingly antero-medial approach.<sup>2,5</sup> The popliteal vein is located within the popliteal fossa – care should be taken to scan as proximally as possible to overlap with the distal SFV.<sup>1</sup>

Manual compression of the deep veins should be repeated at regular intervals (2-3cm); failure to fully compress the veins may indicate the presence of thrombus.<sup>2</sup> The echogenicity of the thrombus indicates its age.<sup>11</sup> Thrombus becomes increasingly echogenic over time, as it becomes more organised.<sup>1</sup> In time, the vessel may begin to re-canalise – old residual thrombus can be seen to produce a scarred appearance, with multiple channels of flow seen.<sup>1</sup> Slow or partial re-canalisation can result in deep venous insufficiency.<sup>1</sup> Competency is assessed by calf augmentation using both colour and spectral Doppler - on release of the calf there should be no or very slight (<0.5sec) retrograde flow, which indicates no significant reflux.<sup>4</sup>

Deep calf veins should be assessed using manual compression, colourflow and spectral Doppler to assess competency. The transducer is placed into the popliteal fossa and the popliteal vein is identified lateral to the mid line. Up to eight gastrocnemius veins may be visualised in the proximal calf, within the gastrocnemius muscle.<sup>2</sup> The soleal veins are imbedded in the soleus muscle and are often less easily identified. Several soleal veins may be present which may have connections with other deep calf veins – often the posterior tibial or peroneal veins. Soleal veins are identified more distally than the gastrocnemius veins.<sup>2</sup> If gastrocnemius or soleal veins appear particularly dilated, they should be assessed for competency using colour/spectral Doppler.

The anterior tibial veins may be seen as the first deep communication with the popliteal vein. Distal to this junction the tibio-peroneal trunk veins divide to form the posterior tibial and peroneal veins.<sup>1,12</sup> It is sometimes easier to trace the deep calf veins from the ankle proximally. Placing the transducer posterior to the medial malleolus, both posterior tibial veins can be visualised adjacent to the posterior tibial artery.<sup>2</sup> If the probe is angled slightly posteriorly the peroneal artery and veins should be visualised deep to the posterior tibial vessels.<sup>2</sup> Placing the transducer on the anterior aspect of the ankle, the anterior tibial artery and veins can be visualised and traced.<sup>14</sup> Placing your thumb and first finger on the antero-medial or antero-lateral aspects of the ankle and applying pressure can augment flow in posterior tibial, anterior tibial and peroneal veins in order to assess competency.<sup>1,2</sup>

When a DVT scan is requested the LSV, SSV and their junctions with the deep venous system should be assessed for superficial thrombophlebitis and obvious signs of incompetence.<sup>1,2,11</sup> If the LSV is incompetent within 0.5cm of the SFJ, it is assumed that the SFJ is slightly incompetent even if no reflux is seen in the CFV.

Differential diagnoses of clinical DVT include (but are not limited to): Bakers cysts, superficial oedema, cellulitis, lymphoedema, thrombophlebitis, popliteal arterial aneurysms and superficial venous incompetence. If you identify an abnormal lesion during the course of your scan, note site, dimensions and descriptive information.

## **Rescan Policy**

In some situations it is difficult to be certain that a vein is patent along its length. In such cases we state that we are “unable to fully exclude a DVT”. The scan is equivocal and upon the clinicians discretion usually requires a rescan 6-8 days later to check for DVT progression.<sup>2</sup> Local protocols differ slightly as below:

**Oldham/NM:** The patient is brought back to have a further scan following an equivocal result. The equivocal vein and up to the popliteal vein is rescanned assessing for progression of the potential DVT.

**South Manchester/Bury/Stepping Hill:** The patient is brought back to have a further scan following an equivocal result. The symptomatic leg is fully rescanned from the CFV to ankle.

**Bolton/Blackpool/Arrowe Park/NC:** The patient is brought back to have a further scan following an equivocal result. The symptomatic leg is rescanned from the CFV to popliteal vein only, assessing for progression of the potential DVT in line with NICE guidelines

## **SM – Additional information**

### **Beacon Pathway patients:**

*Negative DVT* – Prepare IVS report, give report the patient in an envelope AND fax report to Beacon office using pre-set fax number, patient can go home.

*Positive below the knee (distal to popliteal)* - Prepare IVS report, give report the patient in an envelope AND fax report to Beacon office using pre-set fax number, patient can go home.

*Positive DVT knee level and above* – Prepare IVS report, fax report to Beacon office using pre-set fax number, discuss with patient that they have to attend AMRU for clinical follow up and treatment.

## **North Cheshire – Additional Information**

IVS staff are required to verbally give the patient their result to facilitate the patients' progression through the DVT pathway. This is confined to a confirmation of whether the result is POSITIVE, NEGATIVE or EQUIVOCAL and does not require the vascular scientist to engage the patient in any further discussion about the result, further testing or prophylactic treatment (i.e. heparin injections). The appropriate letter should be given to the patient for their information following the scan as outlined below:

For inpatients, put a copy of the report into the patient notes & scan a copy to CRIS. No letter needed.

For A&E/GP/outpatient referrals:

If **negative** result, give a copy of the appropriate DVT negative letter (available in the scan room) to the patient. Scan a copy of the report to CRIS. No further action is needed.

If **positive** – send patient to the DVT clinic in Ambulatory Care Unit – Ground Floor (located near GP out of hours). Patient is to sign a copy of DVT positive letter (available in scan room) which can be scanned into CRIS documents. Patient to then take copy of letter to DVT clinic.

If **equivocal** – Patient is to sign a copy of DVT two-part scan letter (available in scan room) which should be scanned into CRIS documents. Patient can go home - no further action is needed. General ultrasound admin staff will arrange a follow-up appointment.

For pregnant patients referred for ?PE – patient is to return to DVT clinic regardless of result.

### **Stepping Hill – Additional Information**

DVT referrals can be accepted from HASU (ED or A10) or the rapid access stroke clinics to aid patient flow through the ward/clinic. The patients are sent back to the ward/clinic with the result and the ward/clinician is informed of an equivocal result so that the patient can be brought back in a week for a rescans. The ward or clinician in clinic should arrange this and send us a repeat referral.

#### **c) Varicose Vein Assessment**

A full DVT scan is performed, as per the above protocol. Evidence of deep venous insufficiency and previous DVT should be clearly noted in the report. The superficial system should be assessed as below:

#### **Long Saphenous Vein**

Moving distally along the common femoral vein, the long saphenous vein (LSV) will appear as a superficial medial branch. Assessment of competency at the level of the sapheno-femoral junction (SFJ) should be performed by calf augmentation using colour/spectral Doppler.<sup>1</sup> If the LSV is incompetent within 0.5cm of the SFJ, it is assumed that the SFJ is slightly incompetent, even if no reflux is seen in the CFV. The (LSV) should be traced along its length in longitudinal and transverse planes, as isolated segments of incompetence may be identified. Any incompetent branches/perforators should be noted.<sup>2</sup>

#### **Short Saphenous Vein**

The short saphenous vein (SSV) is identified in the upper calf and traced distally to ensure that it remains within the fascia into the lower calf. The SSV is checked for competency and patency and then traced proximal to its junction with the popliteal vein.<sup>10</sup> Any incompetent branches/perforators should be noted.<sup>2</sup> In the presence of SSV incompetence, the popliteal vein must be viewed proximal and distal to the sapheno-popliteal junction (SPJ) to determine whether the junction is incompetent.<sup>1</sup> In some cases an SPJ may not be identified and/or the SSV may communicate with the vein of Giacomini which lies just beneath the fascia and extends into the proximal posterior thigh and may connect to the LSV.<sup>12</sup>

If the SPJ is incompetent, then its location needs to be recorded – the distance measured proximal to the knee crease and lateral/medial to the mid line.<sup>2,5</sup>

The distance of any incompetent perforators from the medial malleolus should be noted and marked if the patient is undergoing superficial venous surgery.<sup>2</sup>

Table: Grading of incompetence.<sup>1</sup>

<b>Grade</b>	<b>Reflux Duration</b>
Normal	<0.5 seconds
Slightly Incompetent	0.5 – 1.0 seconds
Incompetent	>1.0 seconds

#### **Primary Varicose Vein Protocol**

The Vascular Consultant will review patient referral letters and specifically request the limited protocol outlined below.<sup>13</sup>

The protocol should be used in conjunction with the Section 5 'Lower limb venous duplex assessment' from 'Protocols for non-invasive and minimally invasive assessments' for explanation of patient positioning probe, colourflow and Doppler settings.<sup>2</sup>

1. Assess common femoral vein for patency and competency.<sup>1</sup>
2. Comment of absence or presence of sapheno-femoral junction (SFJ) and its competency.<sup>2</sup>
3. Comment on absence or presence of long saphenous vein (LSV) and its competency.<sup>13</sup>
4. Comment on the absence or presence of anterior or posterior veins which form junctions to the LSV within 3cm of the SFJ, measure the distance of the junction to the SFJ, and comment on the competency of the vein.<sup>2,13</sup>
5. If an incompetent thigh vein is identified but the SFJ is absent, the position the vein reforms should be identified and measured and any incompetent thigh perforators identified and measured.<sup>17</sup>
6. Assess popliteal vein for patency and competency.<sup>2,13</sup>
7. Comment of absence or presence of sapheno-popliteal junction (SPJ) and its competency.<sup>1</sup>
8. Comment on absence or presence of short saphenous vein (SSV) and its competency.<sup>2,13</sup>
9. Incompetent thigh veins and SSV should be assessed for suitability for EVLT or VNUS as per full EVLT protocol (see copy below).
10. All other deep veins do not need assessment unless there is evidence of thrombus in the common femoral or popliteal veins.<sup>14</sup>
11. Calf perforators do not need to be assessed or measured.<sup>2,13</sup>

Patient will be reviewed by the Vascular Consultant and if necessary referred for full Venous duplex protocol.

### **Endovenous Laser Treatment/ VNUS protocol**

The inclusion criteria are as follows:

1. The LSV needs to follow a relatively straight course; it will be difficult to pass the laser up a tortuous vein. If the LSV leaves the fascia or becomes tortuous state the distance from the medial malleolus and also comment on general position.
2. It needs to be checked whether the LSV is bifid – both veins can be treated providing they are of suitable diameter.
3. The vein diameter (AP) needs to be measured at the junction, mid-thigh, knee level and the minimum diameter stated. If the LSV dilates make another diameter measurement and its distance from medial malleolus.
4. Need to ensure LSV is widely patent – no evidence of recent/old thrombo-phlebitis.
5. Any incompetent branches close to the SFJ need to be measured. If there is an incompetent branch less than 1-1.5cm from the SFJ then the patient will not be suitable for EVLT. Other major branches should also be identified.
6. Redo LSV's can be retreated with the laser if they are of a suitable diameter so provide measurements as above. State whether there is an intact/reformed SFJ or not.
7. As with all superficial venous procedures the whole deep venous system needs to be competent and patent (Except for simple varicose vein assessments, where the patency and competency of the CFV and popliteal vein only need to be checked).

8. Incompetent thigh accessory veins can be treated with EVLT/VNUS. Minimum and maximum diameters of these veins must be recorded, and if they exit the fascia, the approximate treatable length should be measured (from the SFJ to point at which they leave the fascia).

#### **d) Venous marking**

The patient should be asked to point out the major varicose veins or where they feel discomfort.<sup>14</sup> Under direction of the patient any obvious varicosities should be traced to their junctions with the major venous branches and marked. Any perforators should be marked. The sapheno-femoral and sapheno-popliteal junctions should be marked if incompetent.<sup>15</sup>

When marking the SPJ or perforators prior to surgery you need to ensure the mark is directly above the structure of interest.<sup>2,15</sup> In the longitudinal section, move the leading edge of the probe so the structure is just off the screen and mark either side of the leading edge.<sup>1</sup> In TS, again move the leading edge so the structure is just off the screen and mark the skin on the upper edge of the probe.<sup>1,15</sup> This should result in three marks on the skin surface and where the imaginary lines bisect marks the structure. Extend the dots towards the bisecting point but do not join up as the permanent ink has been known to tattoo the skin during surgery. The final mark should resemble an upside 'T' without a connecting section.<sup>2,15</sup>

#### **e) Long (LSV) and short saphenous vein (SSV) mapping, 12-3MHz probe**

In some cases of lower limb bypass surgery the saphenous veins are used as the conduits. Surgery that uses an autogenous vein can be greatly aided by a detailed preoperative venous assessment.<sup>2,15</sup> Patient is assessed, when possible, in a standing position or sitting to facilitate maximum filling of veins.<sup>1</sup> The LSV or SSV are identified, (outlined above in "venous duplex assessment") and traced along their length in L.S. and T.S. to confirm patency and compression should be used to exclude thrombus/incompetency.<sup>14</sup>

In transverse section – A.P. diameters are measured in the proximal, mid and distal thigh for the LSV, and proximal, mid and distal calf for the LSV and SSV. In transverse section the probe is moved so the vein is just off the edge of the screen (ensuring probe is perpendicular to vessel) and marks are made along its length using the indelible pen to map out the vein.<sup>1,2,16</sup> The course of the vein is marked on leg, allowing improved use of veins and better planning of the specific surgical approach. It minimises the dissection and reduces the frequency of wound complications.<sup>15</sup>

To be suitable as a bypass the vein has to be greater than 0.30cm and not varicose, thrombosed or tortuous.<sup>2,15</sup>

A full length review of the LSV will be produced with the tributaries marked and specific measurements recorded;

**Vessel Inner Diameter** (These will be recorded at 6 specific points)

Proximal Thigh, Mid-Thigh, Distal Thigh, Proximal Calf, Mid Calf, Distal Calf

**Varicosities/Tributaries** (including perforators)

The location and number of tributaries and possible varicosities will be marked and recorded.

### **Intramural Thrombus**

The presence and location of any intramural thrombus will be noted.

### **Total usable length**

The total usable length will be recorded based on a diameter greater than 0.3 cm and is measured from the sapheno-femoral junction.

### **Depth from skin surface**

The depth from the skin surface will be marked.

## **REFERENCES**

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