



CL1.6

6. Lower limb arterial duplex/graft surveillance/angioplasty(stent) surveillance –

a) Thigh arteries

Probe types – 12-3 MHz linear array^{2,4,6}.

Measurements – velocities in centimetres per second, diameter (anterior-posterior AP, medial-lateral ML) in centimetres, length of disease in centimetres^{1,2}.

Patient lies supine^{1,7}. Due to the intimate nature of the scan, a chaperone should be offered²⁵.

The common femoral artery is visualised in the groin and followed proximal to the inguinal ligament^{1,2}.

The common femoral artery is then traced distally to the bifurcation and the profunda femoris and superficial femoral arteries are identified. The superficial femoral is traced along its length and through the adductor canal, visualisation is improved by flexing the leg at the knee to a 45 degree angle and turning the knee outwards^{1,2,7}.

Peak velocity readings and waveform shape and quality are recorded in the common femoral, at the profunda origin and at the superficial femoral origin, and at the proximal, mid and distal SFA^{2,8}.

If an area of stenosis is identified a peak velocity reading is taken immediately proximal, within and immediately distal to the diseased section. The colourflow and Doppler assessments are used to decide whether the disease is a stenosis or complete occlusion. The disease length and the distance from the medial malleolus is recorded. Any collateral vessels are noted. It should be stated whether the disease appears acute or chronic. It should be made clear in the report whether the distal superficial femoral reforms a disease free segment above the knee^{7,8}.

If there is a significant stenosis present, measure the maximum PSV through the stenosis (V2) and the PSV just proximal to the stenosis as a "normal" reference velocity (V1), to enable calculation of the velocity ratio V2/V1. Note that at the SFA and PFA origins it may not be possible to obtain a V1 measurement; the absolute PSV will then be used to grade the % stenosis. If within the SFA, mark the position and length of any significant stenosis with a single-use surgical marker pen and measure the distance to the medial malleolus^{3,5}.

Also remember to scan contralateral CFA when performing lower limb arterial assessments. In addition to our standard protocol if a patient has an iliac occlusion/severe disease (CIA, EIA or both) please scan contralateral iliac system. This may save the patient coming to VSU twice and speeds up the whole patient management process⁹.



For assessment of the popliteal artery, the patient sits with legs dependent or lies flat with the leg slightly flexed at the knee and externally rotated^{1,2}. Alternatively, having the patient lie on their side can allow a good view of the popliteal artery.

The popliteal artery is identified behind the knee and traced proximally ensuring that the full length of artery through the adductor canal is visualised and assessed^{2,5}.

The first arterial branch of the trifurcation is the anterior tibial (may not be viewed). The tibio-peroneal trunk is traced into the upper calf until it bifurcates into the posterior tibial and peroneal arteries. Waveforms are recorded and the velocities are measured in the popliteal and at each of the run-off artery origins and in any area where a stenosis is identified^{2,11,12}. The number of run-off vessels viewed should be documented (0-3).

Velocity ratios:

Comparing Peak Systolic Velocity (PSV) in reference segment proximal to lesion (V1) with maximum stenotic jet PSV (V2) gives a V2:V1 ratio (namely V2/V1) which can be used as follows^{1,2,10,27,28,29}:

Classification (diameter reduction)	Velocity Ratio	Disease level
0-49%	<2.0	Mild
50-74%	≥2.0	Moderate
75-99%	≥4.0	Severe

Absolute velocities:

For use when it is not possible to obtain a suitable reference V1:²⁴

artery	mean PSV (cm/s)	SD (cm/s)
Aorta	76	17
CIA	111	17
EIA	112	49
CFA	90	41
SFA prox	89	23
SFA mid	83	25
SFA distal	74	21
Popliteal	59	12

- ! The above table shows peak systolic velocities for normal legs.
- ! For a normal distribution, 99% of observations will fall within the range of the mean +/- 2 standard deviations.

For example, if the iliac arteries are largely obscured by bowel gas, but an isolated section of flow is seen in the EIA with a velocity of 300cm/s we can suggest that significant disease is likely. Using the mean velocity in the table above as V1, we can use the same ratio criteria to stratify the severity of disease, e.g. ≥4 would indicate severe disease.

Ankle brachial pressure indices are performed. (See Peripheral waveform assessment)



b) Calf arteries – Calf vessels should be scanned along their length²⁶.

Probe types – 12-3 MHz linear array/ if needed – 5-1 MHz curved array^{2,4}

Measurements – velocities in centimetres per second, length of disease in centimetres^{1,5}.

Patient lies supine or sits on the edge of the bed with their legs dependent (aids visualisation with severe disease, and allows venous filling which can be used to map the course of the arteries)².

The posterior tibial artery is identified posterior to the medial malleolus and is traced proximally. The peroneal artery is visualised deep to the posterior tibial artery (both arteries can be assessed throughout the length of the calf). If unable to visualise the peroneal artery with 12-3MHz – then you must try the 2-5 curved array, or attempt to view from an anterior approach^{2,12,13}.

The anterior tibial artery is identified on the antero-lateral aspect of the ankle (do not apply too much pressure as the artery may be occluded by the transducer) and should be traced to the upper calf^{12,13}.

Velocities and waveforms are recorded from all the calf arteries at the ankle and proximal calf and also at any site of stenosis.

In the presence of proximal disease, calf velocities can be unreliable and disease should be graded mild, moderate, severe or occluded^{1,8}.

c) Prosthetic grafts (usually above knee femoro-popliteal, aorto-bifemoral grafts (ABG), fem-fem crossover).

Probe types – 5-1 MHz curved array, 12- 3 MHz linear array^{2,14}.

Measurements – velocities in centimetres per second, diameter (anterior-posterior AP, medial-lateral ML) in centimetres, length of disease in centimetres^{1,2}.

Similar scanning protocols as above, except only the segments just proximal, mid and distal to the grafts are assessed. Particular attention is paid to the proximal and distal anastomosis where waveform shapes and velocities are recorded. ABPI are taken to assess any disease progression in non-treated segments (patient has usually had a full assessment prior to surgery)^{16,17}.

With fem-fem crossover grafts it is important to record the direction of flow through the graft^{1,2,18}.

With ABG and fem-fem crossover grafts, the common femoral waveforms are recorded^{1,2,18}.



Waveforms, peak velocities, ABPIs and any areas of re-stenosis/new disease are recorded¹⁷.

d) Vein grafts (usually below knee)

Probe types – 12-3MHz linear array².

Measurements – velocities in centimetres per second, diameter (anterior-posterior AP, medial-lateral ML) in centimetres, length of disease in centimetres^{1,2}.

Similar scanning protocols to above, except only the segments just proximal, mid and distal to the grafts are assessed. Care is taken to scan the length of the graft and velocities and waveforms are recorded at areas of stenosis (usually valve cusps). Waveforms, peak velocities, ABPI and any areas of re-stenosis/new disease are recorded. Avoid taking ABPI on fem-distal grafts as inflating the cuff leads to danger of occluding the graft^{2,19,20}.

If peak velocity is less than 45cm/s - graft is probably at risk of failure and this must be noted in the report².

e) Stent/angioplasty assessment

Probe types – 12-3 MHz linear array^{4,6}.

Measurements – velocities in centimetres per second, diameter (anterior-posterior AP, medial-lateral ML) in centimetres, length of disease in centimetres^{1,2}.

Similar scanning protocol to above. Care is taken particularly at the just proximal to, mid and just distal to the stent/angioplasty site. Waveforms, peak velocities, ABPIs and any areas of re-stenosis/new disease are recorded^{2,20}.

f) Pseudo-aneurysm diagnosis and compression.

Probe types – 12-3 MHz linear array^{4,6}.

Measure site of the feeder jet from the femoral bifurcation – if jet lies at or within 1cm of the bifurcation the pseudo-aneurysm will be usually be suitable for compression. The size of the sac must be measured in LS and TS, this is particularly important if the management results in thrombin injection as the radiologist will judge how much to use based on the size of the sac.

Suitability for compression depends on the position and width of the jet: the wider the jet the less likely it is going to successfully compressed. If the pseudo-aneurysm lies directly above the jet it will make it difficult to compress, the deeper the aneurysm i.e. if it originates off the posterior wall again it will be difficult to compress^{1,2,21,22}.

The dimensions of the pseudo-aneurysm must be recorded – length, AP and ML²¹.



If no colourflow is seen filling a pseudo-aneurysm but there is evidence of fresh haematoma the report should state “no evidence of patent pseudo-aneurysm but areas of fresh haematoma noted, cannot exclude a thrombosed pseudo-aneurysm or slow bleed”.

If the pseudo-aneurysm is deemed to be suitable for compression then it is necessary to arrange for the patient to come down on their bed. The patient may require analgesics as the compression can cause significant discomfort – the SHO/HO needs to supply and if necessary administer the pain relief.

Using the L7-5 probe, the vascular scientist needs to apply pressure over the jet of the pseudo-aneurysm and should attempt to occlude it. The first compression should last 10 minutes and the circulation should be checked with a hand held Doppler at the ankle to ensure patency. After 10 minutes the pseudo-aneurysm needs to be checked to see if it is thrombosed or partially thrombosed. If still patent further compressions of 10 minutes need to be performed, up to a maximum of three sessions. If after the third session the pseudo-aneurysm is still patent then the patient should be referred to interventional radiologist for thrombin injection.

If the pseudo-aneurysm has thrombosed then we need to rescan the patient the next day to ensure it remains occluded^{2,22,23}.

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