

Site(s)	Document Number	Approved	Page 1 of 6
All Sites	VAS-DP-9	Kelly Swagell	
Title		Version Date	Version Number:
Lower limb arterial ultrasound		Dec 2021	1.2

Scope & purpose

Lower limb arterial duplex ultrasound examinations are carried out to assess for the presence, location and severity of vascular disease (occlusive and aneurysmal). This is done by assessing the pathology and the haemodynamic status of the aorta, common iliac, internal iliac, external iliac, common femoral, superficial femoral, profunda femoral, popliteal, tibio-peroneal trunk, posterior tibial, peroneal, anterior tibial and dorsalis pedis arteries.

Common indications for performance of this examination can include:

- Intermittent claudication
- Ischemic rest pain
- Gangrene
- Ulceration
- Post-surgical intervention follow-up e.g. angioplasty
- ? aneurysm
- ? pseudoneurysm
- Bypass grafts

Personnel

Clinical vascular scientists (CVS), including trainees.

Principles / performance characteristics

To determine the presence or absence of peripheral arterial / atherosclerotic disease of arteries of the lower limbs, including anatomical variants; using B-mode, colour and spectral Doppler.

Service users & background

Patients with suspected peripheral arterial disease may be referred as part of their work up, in conjunction with other imaging modalities. This diagnostic investigation aims to establish if peripheral arterial disease is a possible cause for their symptoms and the patient's amenability for surgical intervention (ref 1).

There are few contraindications for lower limb arterial duplex ultrasound; however, limitations may include the following:

- Bowel gas
- Raised BMI
- Severe oedema/swelling
- Dressings, casts, open wounds, staples, haematoma etc.
- Acoustic shadowing
- Patients who are unable to lie flat
- Patients who are unable to cooperate due to reduced cognitive functions e.g. Alzheimer's or dementia and through involuntary movements
- Examinations undertaken at the patient's bedside may be limited due to equipment and room dimensions
- Patient discomfort

Site(s)	Document Number	Approved	Page 2 of 6
All Sites	VAS-DP-9	Kelly Swagell	
Title		Version Date	Version Number:
Lower limb arterial ultrasound		Dec 2021	1.2

Facilities, equipment & special supplies

Duplex ultrasound machine with both linear and curvilinear transducers available. There should be a selection of transducers delivering a wide range of frequencies (high and low).

Ultrasound gel to provide a couplant between transducer and patient.

Examination couch should be height adjustable. The CVS's chair should provide good lumbar support, be height adjustable and allow for the CVS to move close to the examination couch.

Cleaning materials should be available in line with local and manufacturer's guidelines. These are available either in each procedure room or located in the laboratory store room.

Calibration

Across all sites annual calibration and safety checks of the ultrasound equipment are performed by Clinical Engineering (Trust contract with GE Healthcare).

Quality control

Second opinions from vascular scientist colleagues are requested routinely if clarification is sought.

Trainee vascular scientists have all arterial scans checked until they are signed off by a senior colleague for competency.

Environmental & safety controls

Infection control procedures followed in accordance with Trust infection control and risk assessment policies – Please see 'Personal Protective Equipment (PPE) for infection prevention and control' policy, 'Hand Hygiene' policy and 'Staff Risk Assessments' which are all available through the Trust Intranet.

Tristel wipes are for cleaning the ultrasound machines and probes after patient use. Universal Clinell wipes are for cleaning all other equipment. Where high risk infection presents or post-op wounds are present use probe covers with sterile gel or Tegaderm dressings, in addition to routine cleaning.

Site(s)	Document Number	Approved	Page 3 of 6
All Sites	VAS-DP-9	Kelly Swagell	
Title		Version Date	Version Number:
Lower limb arterial ultrasound		Dec 2021	1.2

Lower limb arterial ultrasound procedure (ref 1 and 2)

	Preceding document: <i>VAS-MP-6 Patient management</i>
1.	The patient is asked to adjust their clothing to expose the lower limbs. The patient is examined in the supine position with the leg to be scanned slightly flexed and externally rotated to allow the CVS maximum access to the vessels to be examined. The patient's dignity and privacy should be maintained at all times. Gowns and blankets can be used, as required.
2.	<p>The scan is performed in both B-mode and colour flow imaging, in both longitudinal and transverse planes, and spectral Doppler in longitudinal planes. B-mode should be used to image the artery and assess for aneurysmal dilation and vessel contents e.g. atheromatous plaque. Colour Doppler should be used to assess for the presence/absence of flow and aid the correct positioning of spectral Doppler when quantifying stenoses (see table 1 in the reporting section for grading criteria). Spectral Doppler should be used to determine direction of flow, stenotic flow and absence of flow.</p> <p>The following arteries should be assessed: abdominal aorta, common iliac, internal iliac, external iliac, common femoral, superficial femoral, profunda femoral, popliteal, tibio-peroneal trunk, posterior tibial, peroneal, anterior tibial and dorsalis pedis arteries.</p> <p>The scan may be bilateral or unilateral depending on the request and the patient's symptoms.</p> <p>The machine controls should be optimised continually throughout the scan to obtain the best image to aid with diagnosis.</p>
3.	<p>The abdominal aorta should be measured in transverse plane and the maximal external diameter of the aorta in both anterior-posterior and right-left planes should be measured. If an abdominal aortic aneurysm is identified, please refer to the AAA protocol - [VAS-DP-3].</p> <p>In the event of diagnosing a popliteal aneurysm (50% increase in diameter):</p> <ul style="list-style-type: none"> • The presence of atheroma and/or thrombus in an aneurysm must be documented since this presents an increased chance of embolisation and occlusive thrombosis • Describe the shape e.g. saccular or fusiform • If the aneurysm is compressing the popliteal vein document this on the report • If the aneurysm is occluded or very large the anterior tibial, posterior tibial and peroneal arteries should also be assessed
4.	<p>Peak systolic velocity (PSV) and waveforms should be taken and documented at the:</p> <ol style="list-style-type: none"> a) Aorta b) Common iliac artery c) Origin of the internal iliac artery d) External iliac artery e) Common femoral artery (CFA). Additionally, the rise time (RT) in the CFA can be measured and documented if felt that it provides additional information to aid

Site(s)	Document Number	Approved	Page 4 of 6
All Sites	VAS-DP-9	Kelly Swagell	
Title		Version Date	Version Number:
Lower limb arterial ultrasound		Dec 2021	1.2

	<p>diagnosis of proximal disease (RT >120ms suggests a dampened waveform and may be suggestive of significant proximal disease - ref 3)</p> <ul style="list-style-type: none"> f) Proximal, mid and distal superficial femoral artery (SFA) g) Origin of the profunda and distally if the SFA is occluded h) Prox/mid and distal popliteal artery i) Tibio-peroneal trunk j) Proximal and distal posterior tibial artery (PTA). k) Proximal and distal peroneal artery l) Proximal and distal anterior tibial artery (ATA) m) Dorsalis pedis artery n) Any sites of significant atheroma
5.	<p>When any significant plaque or disease is identified the following should be documented:</p> <ul style="list-style-type: none"> a) Plaque visual density and homogeneity. Specifically calcification and thrombus b) Length of occlusion, if possible measure precisely with the linear or curvilinear probe c) Calculate the peak systolic velocity ratio (PSVR) and estimate the degree of stenosis. d) Any dilatations - measure the maximum external diameter e) Flow reversal f) Fluid collections around vessels g) Trauma/pseudoaneurysm/arteriovenous (AV) fistulae
6.	<p>For bypass grafts, the entire length of the graft should be scanned paying particular attention to the anastomoses. Document any evidence of a calibre mismatch at the anastomoses if raised velocities are detected. Take PSV measurements in the proximal, mid and distal graft and at the anastomoses. The immediate inflow and outflow vessels should also be assessed. Similarly, for stent insertions, particular attention should be given to imaging and assessing flow through the stent together with an assessment of the immediate inflow and outflow vessels to the stented area. If PSVs of <45cm/s (ref 4) and monophasic waveforms are detected in the bypass then the vascular team is informed before the patient leaves the department.</p>
	<p>Subsequent documents: VAS-MP-6 Patient management, VAS-MP-1 Results processing</p>

Site(s)	Document Number	Approved	Page 5 of 6
All Sites	VAS-DP-9	Kelly Swagell	
Title		Version Date	Version Number:
Lower limb arterial ultrasound		Dec 2021	1.2

Reporting

The diagrammatic report is a record and interpretation of observations made during the lower limb arterial duplex ultrasound examination; it should be written by the CVS undertaking the examination.

The report should include correct patient demographics, date of examination, examination type, the name and status of the CVS and any clinical history deemed relevant.

The report should include:

- Which arteries have been assessed including PSVs and waveforms
- The position of any lesions should be drawn
- For significant stenosis the PSVs, PSVR and percentage stenosis should be documented
- Any limitations e.g. difficult examination due to body habitus

Table 1: Arterial velocity grading criteria.

Peak Systolic Velocity Ratio (Vs/Vp)	Reported stenosis
< 2	<50% stenosis
2	~50% stenosis
2.1-3.9	50-74% stenosis
4	~75% stenosis
>4	>75% stenosis
No flow detected	Occluded

Vs = Highest PSV at site of stenosis, Vp = pre-stenosis PSV(ref 5).

If synthetic grafts, stents or patches are present they should be drawn with dashes on sides of the artery or graft.

All diameter measurements to be documented in centimetres.

Ensure appropriate efficient referral of critical ultrasound results to the referring clinical team are made prior to the patient leaving the department.

Any incidental findings should be documented and further imaging recommended when clinically appropriate.

References

1.	VAS-ED-5. Vascular Technology Professional Performance Guidelines Arterial Duplex Ultrasound Examination (2021).
2.	VAS-ED-24. Society for Vascular Ultrasound Professional Performance Guidelines Lower Extremity Arterial Duplex Evaluation (2019).
3.	Oates, C. (2008). <i>Cardiovascular Haemodynamics and Doppler Waveforms Explained</i> , 1st edn. Cambridge University Press: Cambridge
4.	Bandyk, D.F. et al. (1985). 'A low flow velocity predicts failure of femoropopliteal and femorotibial bypass grafts', <i>Surgery</i> , 98(4), pp.799-809

Site(s)	Document Number	Approved	Page 6 of 6
All Sites	VAS-DP-9	Kelly Swagell	
Title		Version Date	Version Number:
Lower limb arterial ultrasound		Dec 2021	1.2

5.	Thrush, A. and Hartshorne, T. (2010). <i>Vascular Ultrasound: How, why and when</i> , 3rd edn, Elsevier Limited: London (p138)
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