


Vascular Studies Unit VSU Protocol: Lower limb Arterial Duplex Scan RRCV	University Hospitals of Leicester  NHS Trust VSU Reference Number: 012
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Approved By:	Matt Bown, Head of Vascular Service
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Abbreviations	
EIA	External iliac artery
CIA	Common iliac artery
DP	Dorsalis Pedis
TPT	Tibio-peroneal trunk
SFA	Superficial femoral artery
PFA	profunda femoris/femoral artery
ATA	Anterior tibial artery
PTA	Posterior tibial artery
CFA	Common femoral artery
COPD	chronic obstructive pulmonary disease
PSV	peak systolic velocity

Changes Made	By	Date
Review, removed generic equipment & safety section, now separate doc	JW	April 2016
Planned Review, Updated indications/contraindications list, aligned with SVT protocol	All / JW	Sept 2019
Reformatting & planned review	PK	Jan 2021

VSU Protocol: Lower Limb Arterial Duplex Scan

Purpose

The scan is performed on patients to ascertain the presence and site of stenotic or occlusive lesions affecting the lower limb arteries. These lesions can reduce blood flow to the foot and muscle compartments, additionally thrombus collected within aneurysmal dilatations may act as an embolic source. Additionally, a scan may be performed to assess for popliteal entrapment – see Appendix 1.

Duplex scanning allows imaging of all or some of the lower limb vessels from the aorta to the ankle. The colour facility enables patency of the vessels to be determined and highlights areas of velocity increase. The Doppler facility is used to estimate percentage stenosis and to determine a range of flow-limiting or flow-enhancing states.

Common indications

- Claudication
- Rest Pain/Critical limb Ischemia
- Ulceration/tissue loss/gangrene
- Surveillance following intervention
- Popliteal Entrapment
- Suspected aneurysmal disease, both native and as a result of intervention
To exclude arterial disease where compression dressings are being considered

Contraindications and Limitations

Contraindications for arterial duplex ultrasound are few; however, some limitations exist and these may include the following:

- Patients with high body mass index
- The presence of ulcers, wounds, bandaging or casts and for patients who have had recent surgery, ultrasound visualization may be limited due to oedema, haematoma, surgical staples, dressings
- Calcified plaque may cause acoustic shadowing limiting Doppler and B-mode image assessment
- Patients who are unable to lie with their limbs flat or still due to extreme pain or pre-existing co-morbidities e.g. chronic obstructive pulmonary disease (COPD) and arthritis – although these patients may be able to tolerate being examined seated with the limb dependent or with the head of the bed raised where practical.
- Patients who are unable to cooperate due to reduced cognitive functions e.g. Alzheimer's or dementia and through involuntary movements

- Examinations undertaken portably at the patient's bedside maybe limited due to equipment and room dimensions
- The presence of catheters or vascular access lines which limit visualization of the
- Vessels

Communication with patients

The patient must be capable of lying still during the scan and where appropriate, an ability to lie flat will assist greatly in visualisation of the aorto-iliac segment. It is explained that the test is carried out to look at the leg arteries in order to identify any blockages or narrowings that may be contributing to their symptoms. The patient is reassured that the test is painless and advised of the approximate duration of the scan. Verify that the requested procedure correlates with the patient's clinical presentation.

Equipment

Duplex Doppler ultrasound machine with high, medium & low-range frequency probes.

Test Procedure

Select an appropriate frequency transducer, considering vessel depth and body habitus.

For lower limb assessments, evaluation of the following arteries should be included, as appropriate:

- Aorta*
- Common iliac artery (CIA)*
- External iliac artery (EIA)*
- Common femoral artery (CFA)
- Proximal profunda femoris artery (PFA)
- Superficial femoral artery (SFA)
- Popliteal artery**
- Tibio-peroneal trunk (TPT)
- Posterior tibial artery (PTA)
- Peroneal artery
- Anterior tibial artery (ATA)
- Dorsalis Pedis (DP)
- Plantar artery

*Demonstration of a sharp upstroke and a biphasic/triphasic signal usually rules out the necessity to scan the iliac vessels. The aorto-iliac segment is usually only scanned when a damped signal (a visualized increased systolic rise time) is identified in the CFA. However, Vascular Scientists should consider that younger patients may still demonstrate a triphasic CFA waveform in the presence of a significant iliac stenosis, therefore the aorto-iliac segment may need to be scanned.

**If an incidental popliteal aneurysm is found, then the contralateral distal SFA and popliteal artery must also be scanned, along with an Abdominal aorta aneurysm screening scan (please see separate detailed protocol and charts).

It is required, where possible, to perform a full assessment of at least 2 tibial vessels.

The following appropriate techniques should be used to evaluate the lower arterial systems:

- 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 position of spectral Doppler when quantifying stenoses.
- Pulsed wave or spectral Doppler should be used to determine the direction or absence of flow, and measure the velocity of flow to enable assessment of stenoses/occlusions.

Any areas where the colour flow Doppler appears disturbed should always be interrogated with pulsed Doppler. The highest peak systolic velocity should be measured at the site of the disturbance or narrowing (Vs) and in a normal area of the artery just proximal to the narrowing (Vp). Care should be taken to ensure that the Doppler angle is 60° or less in line with flow, when recording velocity measurements. The scan should aim to determine patency, stenoses, diffuse disease and aneurysmal dilatations with a view to producing a site-specific, representative map. As a minimum, velocities and waveforms should be recorded in each of the vessel segments.

Interpretation and grading of disease

The main criterion used to grade the degree of narrowing in the artery is the ratio of V_s to V_p , known as the peak systolic velocity (PSV) ratio. The PSV ratio is used to grade the severity of the narrowing. A PSV ratio of >2 is generally used to define a stenosis that is causing a greater than 50% reduction in the diameter of the artery. A PSV ratio of >4 is generally used to define a stenosis that is causing a greater than 75% reduction in the diameter of the artery. Historically in the VSU a ≥ 3 ratio is flagged as significant in a lower limb vein bypass grafts.

Changes in the shape of Doppler waveforms are important criteria in determining the presence of disease. Multiphasic waveforms are representative of normal flow, whereas monophasic/damped waveforms usually represent diseased flow.

Comment should be made on the heterogeneity and appearance of the arterial disease (such as highlighting acute thrombus or embolus, versus established atheroma, and significant calcification).

Diameter Reduction	Velocity Ratio (V_s/V_p)	Comments
0 – 49%	<2	Triphasic, mild spectral broadening and increase in EDV recorded as degree of narrowing approaches
50 – 74%	≥ 2	Bi- or monophasic waveform Some increase in EDV Spectral broadening +/- flow disturbance Some damping distally
75 – 99%	≥ 4	Usually monophasic Significant increase in EDV Marked turbulence + spectral broadening Damped flow distally
Occluded	No flow detected	High resistance flow proximally

Ref: Thrush & Hartshorne, Peripheral Vascular Ultrasound: How, Why, When (Second Edition) 2005

N.B. In the single visit clinic setting limited investigations may be carried out as per clinical requirements.

Reporting of Results

The report is a recording and interpretation of observations made during the arterial duplex ultrasound examination; it should be written by the person undertaking the examination and viewed as an integral part of the whole examination. The report should include correct patient demographics; date of examination; examination type and the name and status of the person reporting the examination.

The report consists of a schematic diagram, and should include:

- An indication of which arteries have been assessed commenting on the presence/absence of flow, as appropriate
- The anatomical position and length of any occlusions or stenosis
- The anatomical position and size of any aneurysms
- Any limitations of the assessment e.g. due to body habitus/calcified vessels/ bowel gas
- Comments on the shape of the Doppler waveform at different locations

In the presence of an SFA occlusion it is helpful to the Radiologists to know whether a stump of patent vessel is identifiable proximally and whether any thrombus present appears fresh. Where no disease is noted, a reference velocity and waveform is noted in each vessel segment imaged.

Patients are not given a formal report by the Clinical Vascular Scientist at the time of attending for their scan but are informed that the report will be forwarded to the referring consultant. However, a verbal report may be given at the discretion of the Clinical Vascular Scientist.

The report should be signed by the operator carrying out the test. Where a computer generated reporting system is used, the locally agreed verification and authorization procedure should be followed. The report should be written as soon as possible following the assessment.

Red Flags:

Any urgent findings, should be brought to the attention of the referring clinician immediately, and noted on the report.

- New Onset critical ischaemia
- Rest Pain
- Significant decline in symptoms since referral
- Large aneurysm
- Graft significant findings
- Clinical significant incidental findings or concerns (eg. new DVT)

Supporting References

- NICE Guidelines (CG147) Aug 2012, Peripheral Arterial Disease: Diagnosis and Management
- Allard. L. *et al*, (1999). 'Review of the assessment of single level and multilevel arterial occlusive disease in lower limbs by duplex ultrasound'. Ultrasound in Medicine and Biology. 25(4): 495-502.
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- Sensier. Y. Bell. P.. London. N. (1998). 'The ability of qualitative assessment of the common femoral Doppler waveform to screen for significant aortoiliac disease'. European Journal of Vascular and Endovascular Surgery. 15(4): 35 7-64.
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- Thrush & Hartshorne, Peripheral Vascular Ultrasound: How, Why, When (Second Edition) 2005
- SVT Professional Performance Guidelines: Guidelines for Lower and Upper limb Arterial Duplex assessment, 2019