



THE SOCIETY FOR  
VASCULAR TECHNOLOGY OF  
GREAT BRITAIN AND IRELAND

## Vascular Technology Professional Performance Guidelines

### Arterial Duplex Ultrasound Examination

#### Introduction

This guideline was prepared by the Professional Standards Committee (PSC) of the Society for Vascular Technology (SVT) as a template to aid the clinical vascular scientist / vascular sonographers and other interested parties. It can be used in conjunction with locally agreed protocols. It may be used in part or in its entirety with suitable additions made by local policy implementers, and should be read in combination with the following SVT guidelines when setting up an arterial scanning service:

- Vascular Ultrasound Service Specifications <sup>1</sup>

Suggestions for improving these guidelines are welcome, and should be sent to the Chair of the PSC; see [www.svtgbi.org.uk](http://www.svtgbi.org.uk) for current Chair details.

#### Purpose

Arterial Duplex ultrasound examinations are carried out to assess for occlusive and aneurysmal disease in the major arteries of the lower or upper limbs and abdomen <sup>2,3,4</sup>. This test is also used for surveillance following interventions such as bypass graft or stent.

#### Common Indications

Common indications for performing this examination include:

- Claudication
- Rest Pain
- Critical Limb Ischemia
- Ulceration/tissue loss/gangrene
- Surveillance following intervention
- Suspected aneurysmal disease, both native and as a result of intervention
- Pre – Renal transplant
- To exclude arterial disease where compression dressings are being considered
- Evaluation of suspected subclavian steal syndrome
- Evaluation of suspected Thoracic Outlet Syndrome (TOS)
- Evaluation of suspected Popliteal Artery Entrapment Syndrome (PAES)

## **Contraindications and Limitations**

Contraindications for arterial Duplex ultrasound are few; however, some limitations exist and 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 etc.
- 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 (mentally or physically) or those with involuntary movements
- Examinations undertaken portably at the patient's bedside may be limited due to equipment, inappropriate light levels and room dimensions.
- The presence of catheters or vascular access lines which limit visualization of the vessels.

## **Patient Pathway**

An arterial Duplex assessment is often the initial diagnostic test in the pathway of patients with suspected lower or upper limb arterial disease, and particularly where any intervention may be needed. It is used in surveillance programs to follow up patients who have had an intervention such as a bypass graft or stent.

Guidance is given to the use of Duplex in the National Institute for Health and Care Excellence "Peripheral Arterial Disease: diagnosis and management" <sup>5</sup> and Vascular Society Great Britain and Ireland document "The Provision of Services for Patients with Vascular Disease 2015" <sup>6</sup>.

## **Patient Referral**

Referrals for arterial Duplex allow investigation or follow-up of patients with the above clinical indications and can be used to check technical adequacy following intervention.

The referral should include details of the presenting symptoms.

## **Patient Preparation**

No specific preparation is required for scanning the leg arteries below the groin or for scanning the arteries of the arm <sup>2,4</sup>. Access will be required to the patient's legs or arms. Scanning may be difficult in patients with leg ulcers or open wounds or high BMI. Sterile dressings or cling film may allow imaging over broken skin. Bowel gas often makes imaging of the abdominal aorta and iliac arteries <sup>3</sup> difficult. Some centres use advanced preparation, such as fasting for 6 hours prior to the scan, in order to improve imaging of these vessels. Particular care should be taken with any advice given to diabetic patients prior to a scan appointment.

## **Explanation of Examination**

The person undertaking the examination should:

- Introduce themselves
- Confirm the patient's identity e.g. full name and date of birth
- Give an explanation of the procedure and its duration – consideration should be made to the age and mental status of the patient

- Obtain verbal consent for the examination
- Obtain pertinent relevant medical history from the patient and/or notes
  - Presence of risk factors e.g. diabetes, hypertension, hypercholesterolemia etc
  - Presence of cerebrovascular disease e.g. aphasia, dysphasic, paralysis etc.
  - Results of other relevant diagnostics
- Verify that the requested procedure correlates with the patient's clinical presentation

## Examination

The examination may be unilateral or bilateral dependent upon clinical symptoms and departmental policy. The patient is asked to remove their clothing to expose the relevant part to be examined (this may be the lower limb from groin to ankle, upper limb from neck to wrist, or abdomen). The examination is performed with the patient supine. Their dignity and privacy should be maintained at all times and due to intimate nature of the examination it may be considered necessary to offer a chaperone <sup>7</sup>.

During the examination the patient's mental and physical status should be monitored and modifications made to the examination accordingly.

Ankle brachial pressure index (ABPI) may be included according to local requesting policy.

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

- B-Mode should be used to image the artery and assess for, aneurysmal dilation and vessel contents e.g. atheromatous plaque, thrombus.
- 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 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 optimised colour flow Doppler appears disturbed should always be interrogated with Pulsed Doppler. The highest peak systolic velocity should be measure at the site of the disturbance or narrowing ( $V_s$ ) and in a normal area of the artery just proximal to the narrowing ( $V_p$ ). Care should be taken to ensure that Doppler angle is consistently  $60^\circ$  or less on each image when recording velocity measurements.

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 greater than 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 greater than 4 is generally used to define a stenosis that is causing a greater than 75% reduction in the diameter of the artery <sup>8,9,10,11</sup>. Changes in the shape of Doppler waveforms are important criteria in determining the presence of disease. Multiphasic waveforms generally represent normal flow/vessels, whereas monophasic/damped waveforms usually represent the presence of proximal/distal disease.

For bypass graft assessment, the entire length of the graft should be scanned paying particular attention to the anastomoses. The inflow and outflow 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 inflow and outflow to the stented area.

In cases of diameter mismatch (e.g. large diameter graft joined onto a smaller diameter outflow vessel), consideration can be given to using a distal peak systolic velocity instead of  $V_p$  <sup>12,13</sup>.

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

- Abdominal 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)

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

- Brachiocephalic artery
- Subclavian artery
- Axillary artery
- Brachial artery
- Radial artery
- Ulnar artery

An appropriate number of relevant annotated images that represent the entire ultrasound examination should be stored, in accordance with local protocol and the SVT Image Storage Guidelines<sup>14</sup>.

### **Thoracic Outlet Syndrome**

Thoracic Outlet Syndrome (TOS) assessment involves real-time Duplex assessment of the Subclavian/Axillary vessels at rest and on upper limb provocation/hyperabduction<sup>15</sup>. The presence of increased flow velocities, turbulence and ultimately temporary cessation of flow in the vessel during provocation/hyperabduction indicates positive TOS. It should be noted that false positive TOS may be detected in healthy asymptomatic subjects and it is therefore necessary for Duplex findings to correlate with patient's clinical symptoms<sup>16</sup>. It is recommended to examine the proximal vessels in the seated position to allow free movement of the upper limb for provocation/hyperabduction. Assess the Subclavian artery through the suprasternal, supraclavicular and infraclavicular windows. The Axillary artery may be better imaged with the arm abducted.

### **Popliteal Artery Entrapment Syndrome (PAES)**

Popliteal Artery Entrapment Syndrome (PAES) results from the abnormal course of the popliteal artery in relation to the medial head of the Gastrocnemius or other muscles<sup>17</sup>. This may lead to claudication symptoms, embolisation and ischaemia, but often with no apparent reduction in foot pulses at rest. Symptoms arise from the intermittent entrapment of the artery from extrinsic compression during exercise

Measure PSV in the popliteal artery and TP-trunk and proximal ATA with the foot at rest followed by dorsiflexion, plantarflexion or any other position that induces symptoms. Although the measurements may be taken with the patient in the prone position with feet over hanging the couch to allow full flexion movement, it is often easier with the patient standing and on tip toes whilst supporting themselves on the edge of a couch. Use colour Doppler and B-mode imaging to look for regions of compression and use spectral Doppler to look for velocity changes. It is important to assess the arteries under some degree of forced provocation as the majority of PAES occurs with sustained holding of  $\geq 70\%$  of maximal plantarflexion force<sup>18,19</sup>. This dynamic loading can be achieved by the sonographer or assistant applying counterforce at the foot during plantarflexion, by patient pushing foot against a wall or other resistance, or by using patient standing induced force techniques<sup>19</sup>. If the test is negative, the patient can try similar exertion that provokes symptoms, and immediately repeat the scan in the weight-bearing standing position with force exerted through the leg. Cine loops may be useful to capture the dynamic changes. Always test both legs.

## Reporting

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.

There are no specific recommendations for the structure and content of reports for upper and lower limb arterial scans, many referrers find a pictorial report with written conclusions helpful.

The report 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 stenoses.
- 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.

Where the investigation was a surveillance or follow up scan of an intervention, the report should give details of the intervention and should specifically comment on the patency and flow in the region of the intervention.

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 authorisation procedure should be followed.

The report should be written as soon as possible following the assessment, and be made available to the referring clinician on the day of the test. Any urgent findings should be brought to the attention of the referring clinician immediately according to local policy and this should be documented in the report. Incidental findings should also be recorded in the report and acted upon as per locally agreed policy.

## General considerations

Measurement technique should ensure accuracy is optimised as appropriate to the clinical scenario, this may require:

- Optimal adjustment to scale, gain and cursor placement for velocity measurements
- Selection of an appropriate probe including knowledge of probe resolution (axial/lateral) for linear measurements.
- Ensuring reported linear measurements are consistent with the level of accuracy/resolution possible, including the use of rounding where appropriate.
- Optimised technique for volume flow measurements, applying knowledge of all sources of error and ensuring reported measurements do not imply a level of accuracy which is not possible.

## REFERENCES:

<sup>1</sup> [Society for Vascular Technology Service specification document](#)

<sup>2</sup> Society for Vascular Ultrasound Professional Performance Guidelines; Upper extremity arterial duplex evaluation  
<http://www.svunet.org/svunet/practicemanagementamian/professionalperformaceguidelines>

- <sup>3</sup> Society for Vascular Ultrasound Professional Performance Guidelines; Abdominal aortoiliac arterial duplex evaluation.  
<http://www.svunet.org/svunet/practicemanagementmain/professionalperformanceguidelines>
- <sup>4</sup> Society for Vascular Ultrasound Professional Guidelines; Lower extremity arterial duplex evaluation.  
<http://www.svunet.org/svunet/practicemanagementmain/professionalperformanceguidelinex>
- <sup>5</sup> [National Institute for Health and Care Excellence “Peripheral Arterial Disease: diagnosis and management”](#)
- <sup>6</sup> [Vascular Society Great Britain and Ireland document The Provision of Services for Patients with Vascular Disease](#)
- <sup>7</sup> [Society for Vascular Technology Chaperone Guidelines](#)
- <sup>8</sup> “Accuracy and reproducibility of Duplex ultrasonography in grading femoro-popliteal stenoses” Leng, G C; et al. J Vascular Surgery (1993); 17 (3): 510-7  
[https://www.jvascsurg.org/article/0741-5214\(93\)90151-B/abstract](https://www.jvascsurg.org/article/0741-5214(93)90151-B/abstract)
- <sup>9</sup> [“Quantitative Vascular Measurements in arterial occlusive disease”](#) Ota, H; et al. Radiographics (2005); 25(5): 1141-58.
- <sup>10</sup>. [“Appropriate use criteria for peripheral vascular ultrasound and physiological testing part I: Arterial ultrasound and physiological testing:](#)  
A Report of the ACCF/ACR/AIUM/ASE/ASN/ICAVL/SCAI/SCCT/SIR/SVM/SVS. *J Vasc Surg.* 2012;56(1):e17-e51.
- <sup>11</sup> [“Comparison of contrast arteriography to arterial mapping with colour-flow duplex imaging in the lower extremities”](#) Cossman, D V; et al. J Vascular Surgery (1989); 10(5): 522-9.
- <sup>12</sup> “Early detection of saphenous vein arterial bypass graft stenosis by colour-assisted duplex sonography: a prospective study”. Polak, J. *Am J Roentgenology* (1990); 154(4): 857-61.  
<https://www.ncbi.nlm.nih.gov/pubmed/2107689>
- <sup>13</sup> “Optimal Ultrasound Criteria for grading stenosis of the superficial femoral artery” Goa, M; et al. *Ultrasound in Medicine and Biology* (2018); 44(2): 350-8.  
[https://www.umbjournal.org/article/S0301-5629\(17\)32389-X/abstract](https://www.umbjournal.org/article/S0301-5629(17)32389-X/abstract)
- <sup>14</sup> [Society for Vascular Technology Image Storage Guidelines.](#)
- <sup>15</sup>. “Thoracic Outlet Syndrome (TOS)”, William C. Shiel Jr., MD, FACP, FACR , Jerry R. Balentine, DO, FACEP, [https://www.medicinenet.com/thoracic\\_outlet\\_syndrome/article.htm](https://www.medicinenet.com/thoracic_outlet_syndrome/article.htm)
- <sup>16</sup>. “The false-positive rate of thoracic outlet syndrome shoulder maneuvers in healthy subjects” Plewa MC <sup>1</sup>, Delinger M, DOI: 10.1111/j.1553-2712.1998.tb02716.x ,  
<https://pubmed.ncbi.nlm.nih.gov/9562199/>
- <sup>17</sup>. “Popliteal Artery Entrapment Syndrome: Ultrasound Imaging, Intraoperative Findings, and Clinical Outcome.” Ümit Altintas, MD, Ulf V. J. Helgstrand, Dr. Med, Marc A. Hansen, MD, *Journal of Vascular and Endovascular Surgery* (2013) Volume: 47 issue: 7, page(s): 513-518,  
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[18. "A new diagnostic approach to popliteal artery entrapment syndrome" Charles Williams, Dominic Kennedy, Matthew Bastian-Jordan, Journal of Medical Radiation Sciences, Volume 62, Issue 3, \(2015\) Pages 226-229](#)

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19. Functional Popliteal Artery Entrapment Syndrome: Poorly Understood and Frequently Missed? A Review of Clinical Features, Appropriate Investigations, and Treatment Options (2014) [Matthew Hislop](#), [Dominic Kennedy](#), [Brendan Cramp](#), and [Sanjay Dhupelia](#), Journal of Sports Medicine  
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