

Dear

Freedom of information – ultrasound protocols

I write in response to your request for information in relation to ultrasound protocols in NHS Lothian.

Question:

Please provide information held by Lothian Health Board / NHS Lothian concerning the protocol, policy, standard operating procedure, guidance, or equivalent document governing the performance and reporting of lower limb arterial duplex ultrasound scans.

For this request, "lower limb arterial duplex scan" means a duplex ultrasound assessment of the arteries of the lower limb performed for vascular assessment, including but not limited to assessment for peripheral arterial disease, stenosis, occlusion, reduced flow, or related vascular pathology.

Please provide the following information:

1. Current protocol or policy. A copy of the current protocol, policy, standard operating procedure, guidance, or equivalent document used by NHS Lothian for performing lower limb arterial duplex scans.

Answer:

Please see the attached RIE VL Lower Limb Arterial Duplex Ultrasound Protocol v. 7 2026 attached.

Question:

2. Personnel performing the scan. Information confirming who is authorised or expected to perform lower limb arterial duplex scans, including whether scans are performed by: vascular scientists; sonographers; radiologists; vascular surgeons; other clinicians or healthcare professionals.

Answer:

Vascular scientists.

Question:

3. Anatomical scope of the scan. Information confirming which arteries are routinely assessed during a lower limb arterial duplex scan, including whether the scan protocol includes assessment of: iliac arteries; common femoral artery; profunda femoris artery; superficial femoral artery; popliteal artery; anterior tibial artery; posterior tibial artery; peroneal artery; dorsalis pedis artery; plantar arteries or other arteries of the foot.

Answer:

Iliac arteries – yes, and infra-renal aorta
Common femoral artery – yes
Profunda femoris artery – yes (origin only)
Superficial femoral artery – yes
Popliteal artery – yes
Anterior tibial artery – yes
Posterior tibial artery – yes
Peroneal artery – yes
Dorsalis pedis artery – no
Plantar arteries or other arteries of the foot – no.

Please note, a full arterial duplex request without further comment would consist of the examination of those arteries listed as 'YES' above, however the surgical team will often request a full arterial duplex but will then specify which particular arteries they would like examined in more detail in the request. e.g " Please scan aorto-iliac arteries only" / "Please scan from CFA to distal Popliteal" etc. so the requesting clinician has the ability to tailor / shorten a scan depending on their needs.

Question:

4. Assessment of leg and foot arteries. Please confirm whether arteries in both the leg and foot are routinely scanned and reported, and if not, please identify the circumstances in which foot arteries are included or excluded.

Answer:

Arteries in the leg would be included in the standard protocol. Arteries in the foot would not. Occasionally, arteries in the foot might be requested with a particular treatment plan in mind but that would be at the request of the surgical team and would not be done routinely.

Question:

5. Reporting of findings. Please provide information confirming whether the reporting protocol requires:

- positive findings to be reported, including stenosis, occlusion, reduced flow, abnormal waveforms, or other pathology;
- negative findings to be reported, including confirmation of normal flow, absence of stenosis, or absence of occlusion;
- non-visualisation of any vessel to be reported;
- limitations of the scan to be recorded.

Answer:

The reporting protocol requires all of these elements to be considered. Please note that Vascular Scientists conducting the scan would not diagnose 'other pathology' but would highlight in the report if something has been identified that may warrant further investigation.

Question:

6. Use of national clinical guidelines. Please confirm whether the NHS Lothian protocol or policy follows, incorporates, or refers to any national clinical guidelines, professional standards, or other external guidance. If so, please identify the relevant guidelines or standards, including the version or date where held.

Answer:

NHS Lothian Vascular Laboratory follows the national guidance from the College and Society of Vascular Science (CSVS) - please see attached document.

Question:

7. Changes in the past five years. Please provide information confirming whether there have been any changes in the past five years to:

- how lower limb arterial duplex scans are performed;
- which vessels are assessed;
- whether foot arteries are assessed;
- how positive findings are reported;
- how negative findings are reported;
- the format or content of the scan report.

Answer:

- how lower limb arterial duplex scans are performed - no
- which vessels are assessed - no
- whether foot arteries are assessed - no
- how positive findings are reported - no
- how negative findings are reported - no
- the format or content of the scan report – yes, minor changes to include more detailed information regarding CFA for access.

Question:

8. Previous versions of policies or protocols. If the current protocol or policy has changed within the past five years, please provide copies of the previous versions, together with the dates on which they were in force, if held.

Answer:

All previous versions of the protocol from the past five years are enclosed.

Question:

9. Report template or pro forma. Please provide a copy of any standard reporting template, pro forma, structured report, checklist, or reporting guidance used for lower limb arterial duplex scans, including any previous versions used within the past five years, if held.

Answer:

The template document is attached.

I hope the information provided helps with your request.

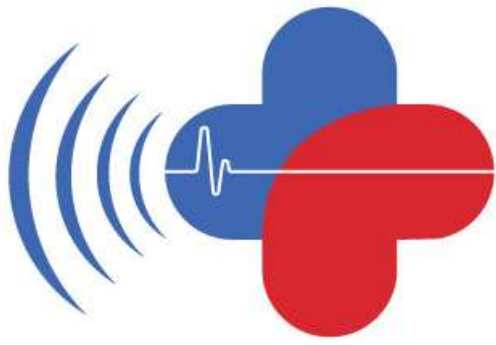
If you are unhappy with our response to your request, you do have the right to request us to review it. Your request should be made within 40 working days of receipt of this letter, and we will reply within 20 working days of receipt. If our decision is unchanged following a review and you remain dissatisfied with this, you then have the right to make a formal complaint to the Scottish Information Commissioner within 6 months of receipt of our review response. You can do this by using the Scottish Information Commissioner's Office online appeals service at <https://www.foi.scot/appeal>. If you remain dissatisfied with the Commissioner's response you then have the option to appeal to the Court of Session on a point of law.

If you require a review of our decision to be carried out, please write to the reviewer at the address at the top of this letter. The review will be undertaken by a Reviewer who was not involved in the original decision-making process.

FOI responses (subject to redaction of personal information) may appear on NHS Lothian's Freedom of Information website at: <https://org.nhsllothian.scot/FOI>

Yours sincerely

Alison Macdonald
Executive Director of Nursing Midwifery and AHPs
Cc: Chief Executive
Enc.



CSVs

THE COLLEGE AND SOCIETY
FOR CLINICAL VASCULAR SCIENCE
Great Britain and Ireland

Vascular Science Guidelines

Arterial Duplex Ultrasound Examination Scan Protocol

Version 2.0

March 2025

Doc Ref PS-PG003



Arterial Duplex Ultrasound Examination Scan Protocol

Version 2.0

March 2025

Doc Ref PS-PG003

Version Number	Change	Author	Date
1.0			
2.0	Revised content and formatting/branding	Author: PSC Review: March 2028 Approval: CSVs Exec committee	March 2025

Purpose

This document was prepared by the Professional Standards Committee (PSC) of the College and Society for Clinical Vascular Science (CSVs) to support the practise and delivery of high quality standardised Clinical Vascular Science. This document may be used in its entirety (or referenced in part with suitable additions made by local policy implementers) by all parties involved with clinical vascular science. Suggestions for improving this document are welcome and should be sent to the Chair of the PSC (see csvs.org.uk for current PSC Chair details).

Introduction

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.²⁻

⁶ This test is also used for surveillance following interventions such as bypass graft or stent.

Common Indications

1. Lower extremities:

Common indications for performing this examination include:

- Claudication
- Rest Pain
- Critical Limb Ischaemia
- Ulceration/tissue loss/gangrene
- Surveillance following intervention
- Suspected aneurysmal disease.
- Suspected pseudoaneurysm.
- Pre – Renal transplant
- Clarify the results of other relevant diagnostic procedures e.g., CTA
- Repeat examinations to confirm prior imaging and Doppler evaluation.
- Verify that the requested procedure correlates with the patient's clinical presentation.
- To exclude arterial disease where compression dressings are being considered.

2. Upper extremities:

Common indications for performance of upper extremity arterial duplex imaging include:

- Known history of peripheral arterial disease
- Ischaemic rest pain
- Arterial ulceration or gangrene
- Pre-procedure assessment for planning of intervention
- Follow up after surgical intervention, i.e., post angioplasty and/or stent placement
- Post-operative surveillance of arterial bypass grafts
- Evaluation of an aneurysm, pseudo-aneurysm, and arterial-venous fistula
- Evaluation of arterial trauma
- Arterial Thoracic Outlet Syndrome (TOS)

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.
- Lower extremity contractures and/or oedema/swelling
- 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 (NICE) guideline² and 'The Provision of Services for Patients with Vascular Disease'⁷ document.

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.

Verification that the requested procedure correlates with the patient's clinical presentation

Patient Preparation

No specific preparation is required for scanning the leg arteries below the groin or for scanning the arteries of the arm.^{2,6}

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 difficult. Some centres use advanced preparation, such as fasting for 6 hours prior to the scan, to improve imaging of these vessels. 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
- Explain 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
- Respond to questions and concerns about any aspect of the evaluation.

- Educate the patient about risk factors for and symptoms of peripheral arterial disease.
- Refer specific diagnostic, treatment, or prognosis questions to the patient's physician.

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 always maintained and due to intimate nature of the examination it may be considered necessary to offer a chaperone.⁸

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 (Vs) and in a normal area of the artery just proximal to the narrowing (Vp). Care should be taken to ensure that Doppler angle is consistently 60 degrees 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 Vs to Vp, 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.⁸⁻¹¹

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 .¹²⁻¹⁴

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.

Waveforms:

The CSVS arterial waveform nomenclature guidance is to homogenise, standardize and clarify key descriptions of the lower limb Doppler waveform morphology, so that vascular scientists and other interested parties, use the same nomenclature when managing peripheral arterial disease (PAD) patients.¹⁰

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)
- Anterior tibial artery (ATA)
- Peroneal artery

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 Guidelines¹⁶.

Thoracic Outlet Syndrome

Thoracic Outlet Syndrome (TOS) assessment involves real-time Duplex assessment of the Subclavian/Axillary vessels (arteries and veins) at rest and on upper limb provocation/hyper-abduction^{17,18}.

The presence of increased flow velocities, turbulence, and ultimately temporary cessation of flow in the vessel during provocation/hyper-abduction 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 symptoms¹⁷. It is recommended to examine the proximal vessels in the seated position to allow free movement of the upper limb for provocation/hyper-abduction.

Assess the Subclavian artery through the suprasternal, supraclavicular and infraclavicular windows. The Axillary artery may be better imaged with the arm abducted.

The subclavian and axillary veins might also be assessed in a similar way for vein TOS.

Popliteal Artery Entrapment Syndrome.

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 (19).

This may lead to claudication symptoms, embolization, 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 more reliable with the patient standing and on tip toes whilst supporting themselves on the edge of a couch. (21,22)

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 plantar flexion force (19,20).

This dynamic loading can be achieved by the sonographer or assistant applying counter force at the foot during plantar flexion, by patient pushing foot against a wall or other resistance, or by using patient standing induced force techniques (20).

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.

Peripheral Aneurysmal disease.

An association between femoral and popliteal artery aneurysms and abdominal aortic aneurysms (AAAs) has been well recognized. (24) Femoral and popliteal artery aneurysms are limb threatening because of their potential to cause embolism, thrombosis, and, uncommonly, rupture. (23)

The following definition of an arterial aneurysm is suggested: An *aneurysm* is a permanent localized (i.e., focal) dilation of an artery having at least a 50% increase in diameter

compared to the expected normal diameter of the artery in question. In this regard normal arterial diameters determined from local protocols/literature should be considered when reporting on aneurysms (23)

Patients with abdominal aortic aneurysms (AAA) are more prone to develop popliteal artery aneurysms (PAA). Owing to the high prevalence of popliteal artery aneurysms in AAA patients, the poor sensitivity at clinical examination, all patients with AAA should undergo one examination of their popliteal arteries. (24)

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 report structure, 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. Neck diameter and length for pseudoaneurysms.
- 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.

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[Committee\)](#) · [M.David Tilson, MD](#) · [Dhiraj M. Shah, MD](#) · [Larry Hollier, MD](#) · [James C. Stanley, MD](#) [https://www.jvascsurg.org/article/0741-5214\(91\)70051-8/fulltext](https://www.jvascsurg.org/article/0741-5214(91)70051-8/fulltext)

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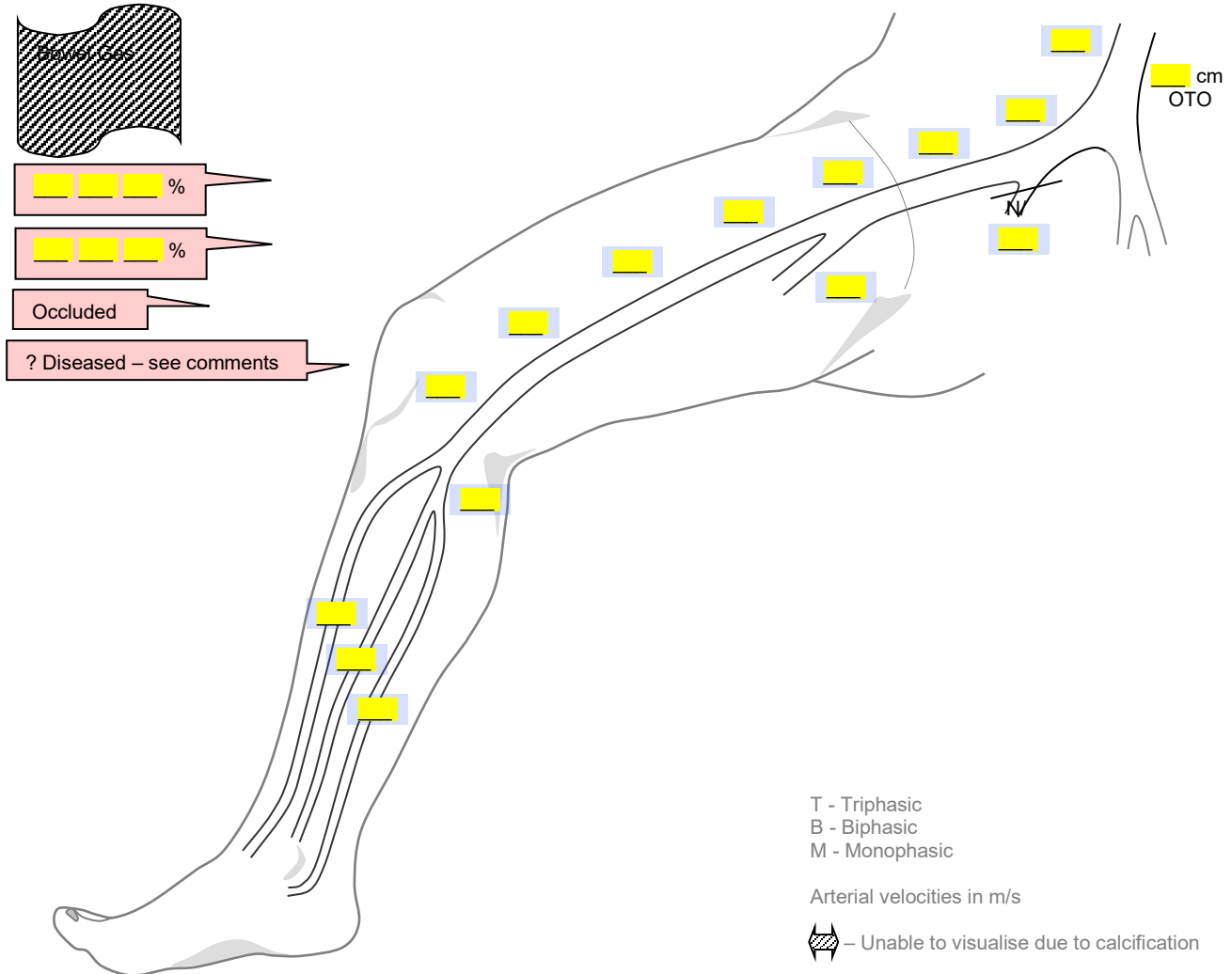
Patient:

CHI:

Date of Scan: 31 July 2026

Referring Consultant: "Type referrer's name here"

Right Lower Extremity Arterial Duplex



Comments:

- "Type comments here"

Scanned by:

Designation: Clinical Vascular Scientist

Royal Infirmary of Edinburgh Vascular Laboratory
Lower Limb Arterial Duplex Ultrasound Assessment Protocol

Version	January 2022
Effective from	January 2022
Review date	2027
Responsible for review	Lead Clinical Vascular Scientist, Protocol Lead
Author	Beth Ness, Clinical Vascular Scientist (2020 and 2022) Sarah Jane Carmichael, Chief Clinical Vascular Scientist (August 2012)
Approved by	Karen Gallagher, Lead Clinical Vascular Scientist
Superseded documents	Lower Limb Arterial Duplex Ultrasound Assessment Protocol (2020) Lower Limb Arterial Duplex Scanning Protocol (Infra-inguinal) (August 2012) Aorta-Iliac Artery Duplex Scanning Protocol (August 2012)

Logbook of staff who have read and agreed to follow the protocol:

Name	Job title	Signed	Date
Sarah Jane Carmichael	Chief Clinical Vascular Scientist	Sarah Jane Carmichael	Aug 2020

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Purpose and Principals

Peripheral arterial disease is most commonly caused by atherosclerotic disease that leads to stenosis and occlusion of the lower limb arteries (Menêses et al., 2017), however, other possible causes include arteritis and arterial entrapments (Mintz and Weinberg, 2015). In addition to causing lifestyle limiting claudication symptoms, uncontrolled disease can progress on to critical limb ischemia which is associated with a high rate of limb loss, morbidity and mortality (Vartanian and Conte, 2015; Dua and Lee, 2016).

Duplex ultrasound is an important imaging modality for defining the anatomic pattern of occlusive disease in the arteries supplying the lower extremity (Chen et al., 2014).

Common Indications

Common indications for the performance of lower limb arterial duplex ultrasound assessment include:

- Symptomatic patients, for example those with intermittent claudication, rest pain, tissue necrosis, ulceration and/or gangrene
- For suspected lower limb arterial disease, for example where the clinician is unable to palpate pulses
- For suspected aneurysmal disease (native or iatrogenic), for example due to a palpable pulsatile mass or ischemic digits (? emboli source)
- To monitor progression of known lower limb arterial disease
- Pre intervention, for example prior to angioplasty
- Post intervention, for example to determine the success of angioplasty
- Pre-renal transplant
- To determine lower limb arterial disease prior to compression dressings
- Post arterial trauma

Contraindications and Limitations

Contraindications for the performance of lower limb arterial duplex ultrasound assessment include:

- Obesity
- Leg swelling or oedema
- Recent surgery (sutures, staples, dressings, haematoma, etc)
- Scar tissue from previous surgery
- Casts, bandaging, open wounds or ulceration
- Heavily calcified arteries
- Bowel gas
- Peritoneal dialysis catheter or stoma bag

- Patient discomfort, for example severe rest pain when leg elevated
- Patient limited mobility, for example those who are unable to lie supine
- Patients who are unable to cooperate due to reduced cognitive functions, for example due to dementia or involuntary movements

Equipment

Ultrasound Instrumentation:

Utilise appropriate ultrasound instrumentation with B-mode, colour Doppler and pulse wave Doppler functionality, for example, Siemens ACUSON S2000 or Juniper ultrasound systems.

A high frequency (for example, 12-3 or 9-4 MHz) linear array transducer should be selected for the femoral, popliteal and crural arteries. A higher frequency (for example, 16-4 or 18-6 MHz) linear array transducer may be preferable for very superficial arteries, for example to image the dorsalis pedis artery. A low frequency (for example, 5-1 or 6-2 MHz) curvilinear array transducer should be selected to visualise the aorta and iliac arteries, or if imaging of the femoral, popliteal and/or crural arteries is difficult, for example due to high patient BMI.

Ultrasound Room, Scanning Couch and Chair:

See the Royal Infirmary of Edinburgh Vascular Laboratory (RIE VL) Supplementary Ultrasound Assessment Protocol (2020).

Patient Communication

Prior to commencing the ultrasound assessment, the vascular scientist should:

- Introduce themselves to the patient
- Ask the patient to confirm their name and date of birth, matching these details with both the referral and the details on the ultrasound machine
- Verify that the requested assessment and information on the referral are correct
- Clearly and concisely explain the ultrasound assessment to the patient, including the purpose and the typical length
- Ask the patient about symptoms associated with lower limb arterial disease, for example walking distance and rest pain
- Address any patient concerns and questions about any aspect of the examination, referring specific questions regarding diagnosis, treatment or prognosis to their vascular consultant

Once the ultrasound assessment has been completed, the vascular scientist should:

- Explain that the images will be reviewed, and a report produced for their vascular consultant
- Inform the patient about the follow-up of the results, for example this may be via written correspondence to the patient or the patient's General Practitioner

See the RIE VL Supplementary Ultrasound Assessment Protocol (2020) for information on patient consent, and the Society for Vascular Technology Chaperone Guidelines (April 2012) for information on chaperones.

Patient Preparation and Positioning

Patient Preparation:

The patient should remove restrictive clothing to expose from their groin to their ankle, for example by removing their trousers/skirt, shoes and socks. When scanning the abdomen, the patient should lift their shirt.

Patients are not requested to fast prior to this ultrasound assessment.

Patient Positioning:

The patient should be asked to lie supine on the scanning couch with their arms down by their sides and their head slightly elevated to a level of comfort. The patient should be encouraged to relax their legs in a slightly abducted position and may be asked to rotate the leg being assessed externally or internally. The crural arteries may be assessed with the patient supine and the knee flexed. If appropriate, the patient may be asked to lie prone or in a right/left lateral decubitus position.

When scanning the abdomen, the patient should be encouraged to relax. When supine acoustic windows prove inadequate when scanning the abdomen, for example in patients with a large abdominal girth, a right lateral decubitus position may be useful.

Examination Protocol

Using B-mode imaging, colour flow imaging and spectral Doppler, assess the abdominal aorta, common iliac artery (CIA), internal iliac artery (IIA) origin, external iliac artery (EIAs), common femoral artery (CFA), profunda artery origin, superficial femoral artery (SFA), popliteal artery, tibioperoneal (TP-) trunk, peroneal artery, posterior tibial artery (PTA) and anterior tibial artery (ATA).

B-Mode Imaging:

- Optimise the B-mode image, including appropriate adjustment of gain, time gain compensation, zoom and depth.
- To begin the assessment, in transverse view, place the transducer at the level of the inguinal ligament and identify the CFA/SFA/profunda artery bifurcation.
- Image the arterial segments listed above to identify the presence of plaque, dissections, aneurysmal disease, and sites of previous interventions (for example, stents and endarterectomy sites).
- Assess plaque appearance and identify characteristics of, for example: homogenous occlusive disease with low echogenicity indicative of fresh thrombus; heterogenous occlusive disease with strong echoes indicative of old non-uniform calcified areas of atheroma; and fibrous thickening indicative of a vascular arteritis.
- In transverse view, measure the maximum anterior-posterior (AP) diameter of the abdominal aorta using calipers measuring from inner-to-inner (ITI) and outer-to-outer (OTO) edge at peak systole.
- For aneurysmal disease distal to the aorta, in transverse view, measure the maximum AP and lateral aneurysm diameters at peak systole from OTO edge. In longitudinal view, measure the maximum AP aneurysm diameter at peak systole from OTO edge.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Colour Flow Imaging:

- Optimise the colour flow image, including appropriate adjustment of gain, colour scale and colour box size.
- Starting at the CFA/SFA/profunda artery bifurcation in longitudinal view, image the entire length of the arterial segments listed above to confirm patency (presence/absence of blood flow), and identify potential stenosis (areas of aliasing, flow disturbance and/or velocity jets), dissections, collateral vessels and direction of flow.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Spectral Doppler:

- Optimise the spectral Doppler trace, including appropriate adjustment of gain and scale.
- In longitudinal view, obtain a spectral Doppler waveform and measure the peak systolic velocity (PSV) from the arterial segments listed above to confirm patency (presence/absence of blood flow),

and identify stenosis, dissections and direction of flow. Ensure the Doppler angle is correctly aligned to the blood flow and $\leq 60^\circ$.

- At sites of stenosis, obtain a spectral Doppler waveform from and measure the pre-stenotic PSV proximal to the stenosis, the maximum PSV at the stenotic site, and the post stenotic PSV. The PSV ratio is a comparison between the pre-stenotic PSV and the maximum PSV at the stenotic site, and is used to grade stenosis severity. See Table 1 for the classification of peripheral arterial stenosis.

Table 1: Criteria for the Classification of Peripheral Arterial Stenosis (Charing Cross Hospital).

PSV ratio	% reduction
2:1	50%
3:1	60%
4:1	75%
5:1	80%
6:1	80%
7:1	85%
8:1	90%
9:1	90-95%
10:1	+95%

See the RIE VL Abdominal Aortic Aneurysm Ultrasound Assessment Protocol (2020) and the RIE VL Popliteal Artery Aneurysm Duplex Ultrasound Assessment Protocol (2020) for the assessment of abdominal aortic, CIA and popliteal artery aneurysms.

Minimum Image Requirements

Static images should be digitally stored during the assessment. See the Society for Vascular Technology Guidance on Image Storage and Use, for Vascular Ultrasound Scans (April 2012) for further information.

Minimum Image Requirements:

- Longitudinal view duplex ultrasound image including spectral Doppler waveform and PSV measurement from the aorta, CIA, EIA, CFA, Profunda artery origin, SFA (at origin, mid thigh and knee), mid popliteal artery, TP-trunk, distal peroneal artery, ATA at ankle, and PTA at ankle
- Transverse view B-mode image of the aorta with maximum AP diameter measurement

Review of the Diagnostic Scan Findings

Once the ultrasound assessment has been completed, the vascular scientist should:

- Utilise Genesis² to generate a report using the standard template, documenting the following:
 - Correct patient demographics, date of assessment, assessment type and the name and status of the vascular scientist
 - PSV (in m/s to 1dp) and waveform from each of the arterial segments assessed
 - Presence, location, length and plaque appearance of occlusive lesions
 - Presence, location, plaque appearance and degree of stenotic lesions, including pre-stenotic PSV and the maximum PSV at the stenotic site
 - Presence, location and plaque appearance of disease <50%
 - Any other abnormality, for example aneurysmal disease
 - Incidental findings, for example Baker's cyst
 - Any limitations of the assessment, for example difficult examination due to bowel gas
- Ensure appropriate efficient communication of urgent ultrasound results

Urgent Results:

Prior to the patient leaving the department, the vascular scientist should alert the vascular doctor on call or referring vascular consultant when immediate attention is indicated. Significant new findings for urgent review include:

- Homogenous occlusive disease with low echogenicity indicative of fresh thrombus

Exam Time Recommendations

Recommended time for completion of a unilateral lower limb arterial duplex ultrasound assessment (including reporting) is 1 hour and 15 minutes. Recommended time for completion of a bilateral lower limb arterial duplex ultrasound assessment (including reporting) is 2 hour and 30 minutes.

References

Chen, Q., Shi, Y., Wang, Y. and Li, X. (2015). Patterns of Disease Distribution of Lower Extremity Peripheral Arterial Disease. *Angiology*. **66**(3): 211-218.

Dua, A. and Lee, C.J. (2016). Epidemiology of Peripheral Arterial Disease and Critical Limb Ischemia. *Techniques in Vascular and Interventional Radiology*. **19**(2): 91-95.

Menêses, A.L., Ritti-Dias, R.M., Parmenter, B., Golledge, J. and Askew, C.D. (2017). Combined Lower Limb Revascularisation and Supervised Exercise Training for Patients with Peripheral Arterial Disease: a Systematic Review of Randomised Controlled Trials. *Sports Medicine*. **47**(5): 987-1002.

Mintz, A.J. and Weinberg, I. (2015). Nonatherosclerotic PAD: Approach to Exertional Pain in the Lower Extremities. *Current Cardiology Reports*. **17**(8): 66.

Vartanian, S.M. and Conte, M.S. (2015). Surgical Intervention for Peripheral Arterial Disease. *Circulation Research*. **116**(9): 1614-1628.

Royal Infirmary of Edinburgh Vascular Laboratory
Lower Limb Arterial Duplex Ultrasound Assessment Protocol

Version	Feb 2022
Effective from	Feb 2022
Review date	2027
Responsible for review	Lead Clinical Vascular Scientist, Protocol Lead
Author	Heather Anderson, Accredited Vascular Scientist.
Approved by	Karen Gallagher, Lead Clinical Vascular Scientist
Superseded documents	v3.0 2022

Version Control

This table should detail the version history for this document. It should detail the key changes when a version is amended.

Version	Date Implemented	Details of key changes
v1.0	Aug 2012	Available to view in shared drive
v2.0	Aug 2020	Available to view in shared drive
v3.0	Jan 2022	Available to view in shared drive
v4.0	Feb 2020	Addition of version control box Updates SVT guidelines

Contents:

- 1.0 Purpose and Principals**
- 2.0 Common Indications**
- 3.0 Contraindications and Limitations**
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- 5.0 Patient Communication**
- 6.0 Patient Preparation and Positioning**
- 7.0 Examination Protocol**
- 8.0 Minimum Image Requirements**
- 9.0 Review of the Diagnostic Scan Findings**
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1.0 Purpose and Principals

Peripheral arterial disease is most commonly caused by atherosclerotic disease that leads to stenosis and occlusion of the lower limb arteries (Menêses et al., 2017), however, other possible causes include arteritis and arterial entrapments (Mintz and Weinberg, 2015). In addition to causing lifestyle limiting claudication symptoms, uncontrolled disease can progress on to critical limb ischemia which is associated with a high rate of limb loss, morbidity and mortality (Vartanian and Conte, 2015; Dua and Lee, 2016).

Duplex ultrasound is an important imaging modality for defining the anatomic pattern of occlusive disease in the arteries supplying the lower extremity (Chen et al., 2014).

2.0 Common Indications

Common indications for the performance of lower limb arterial duplex ultrasound assessment include:

- Symptomatic patients, for example those with intermittent claudication, rest pain, tissue necrosis, ulceration and/or gangrene
- For suspected lower limb arterial disease, for example where the clinician is unable to palpate pulses
- For suspected aneurysmal disease (native or iatrogenic), for example due to a palpable pulsatile mass or ischemic digits (? emboli source)
- To monitor progression of known lower limb arterial disease
- Pre intervention, for example prior to angioplasty
- Post intervention, for example to determine the success of angioplasty
- Pre-renal transplant
- To determine lower limb arterial disease prior to compression dressings
- Post arterial trauma

3.0 Contraindications and Limitations

Contraindications for the performance of lower limb arterial duplex ultrasound assessment include:

- Obesity
- Leg swelling or oedema
- Recent surgery (sutures, staples, dressings, haematoma, etc)
- Scar tissue from previous surgery
- Casts, bandaging, open wounds or ulceration
- Heavily calcified arteries
- Bowel gas
- Peritoneal dialysis catheter or stoma bag

- Patient discomfort, for example severe rest pain when leg elevated
- Patient limited mobility, for example those who are unable to lie supine
- Patients who are unable to cooperate due to reduced cognitive functions, for example due to dementia or involuntary movements

4.0 Equipment

Ultrasound Instrumentation:

Utilise appropriate ultrasound instrumentation with B-mode, colour Doppler and pulse wave Doppler functionality, for example, Siemens ACUSON S2000 or Juniper ultrasound systems.

A high frequency (for example, 12-3 or 9-4 MHz) linear array transducer should be selected for the femoral, popliteal and crural arteries. A higher frequency (for example, 16-4 or 18-6 MHz) linear array transducer may be preferable for very superficial arteries, for example to image the dorsalis pedis artery. A low frequency (for example, 5-1 or 6-2 MHz) curvilinear array transducer should be selected to visualise the aorta and iliac arteries, or if imaging of the femoral, popliteal and/or crural arteries is difficult, for example due to high patient BMI.

Ultrasound Room, Scanning Couch and Chair:

See the Royal Infirmary of Edinburgh Vascular Laboratory (RIE VL) Supplementary Ultrasound Assessment Protocol (2020).

5.0 Patient Communication

Prior to commencing the ultrasound assessment, the vascular scientist should:

- Introduce themselves to the patient
- Ask the patient to confirm their name and date of birth, matching these details with both the referral and the details on the ultrasound machine
- Verify that the requested assessment and information on the referral are correct
- Clearly and concisely explain the ultrasound assessment to the patient, including the purpose and the typical length
- Ask the patient about symptoms associated with lower limb arterial disease, for example walking distance and rest pain
- Address any patient concerns and questions about any aspect of the examination, referring specific questions regarding diagnosis, treatment or prognosis to their vascular consultant

Once the ultrasound assessment has been completed, the vascular scientist should:

- Explain that the images will be reviewed, and a report produced for their vascular consultant
- Inform the patient about the follow-up of the results, for example this may be via written correspondence to the patient or the patient's General Practitioner

See the RIE VL Supplementary Ultrasound Assessment Protocol (2020) for information on patient consent, and the Society for Vascular Technology Consent & Chaperone Guidelines (2020) for information on chaperones.

6.0 Patient Preparation and Positioning

Patient Preparation:

The patient should remove restrictive clothing to expose from their groin to their ankle, for example by removing their trousers/skirt, shoes and socks. When scanning the abdomen, the patient should lift their shirt.

Patients are not requested to fast prior to this ultrasound assessment.

Patient Positioning:

The patient should be asked to lie supine on the scanning couch with their arms down by their sides and their head slightly elevated to a level of comfort. The patient should be encouraged to relax their legs in a slightly abducted position and may be asked to rotate the leg being assessed externally or internally. The crural arteries may be assessed with the patient supine and the knee flexed. If appropriate, the patient may be asked to lie prone or in a right/left lateral decubitus position.

When scanning the abdomen, the patient should be encouraged to relax. When supine acoustic windows prove inadequate when scanning the abdomen, for example in patients with a large abdominal girth, a right lateral decubitus position may be useful.

7.0 Examination Protocol

Using B-mode imaging, colour flow imaging and spectral Doppler, assess the abdominal aorta, common iliac artery (CIA), internal iliac artery (IIA) origin, external iliac artery (EIAs), common femoral artery (CFA), profunda artery origin, superficial femoral artery (SFA), popliteal artery, tibioperoneal (TP-) trunk, peroneal artery, posterior tibial artery (PTA) and anterior tibial artery (ATA).

B-Mode Imaging:

- Optimise the B-mode image, including appropriate adjustment of gain, time gain compensation, zoom and depth.
- To begin the assessment, in transverse view, place the transducer at the level of the inguinal ligament and identify the CFA/SFA/profunda artery bifurcation.
- Image the arterial segments listed above to identify the presence of plaque, dissections, aneurysmal disease, and sites of previous interventions (for example, stents and endarterectomy sites).
- Assess plaque appearance and identify characteristics of, for example: homogenous occlusive disease with low echogenicity indicative of fresh thrombus; heterogenous occlusive disease with strong echoes indicative of old non-uniform calcified areas of atheroma; and fibrous thickening indicative of a vascular arteritis.
- In transverse view, measure the maximum anterior-posterior (AP) diameter of the abdominal aorta using calipers measuring from inner-to-inner (ITI) and outer-to-outer (OTO) edge at peak systole.
- For aneurysmal disease distal to the aorta, in transverse view, measure the maximum AP and lateral aneurysm diameters at peak systole from OTO edge. In longitudinal view, measure the maximum AP aneurysm diameter at peak systole from OTO edge.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Colour Flow Imaging:

- Optimise the colour flow image, including appropriate adjustment of gain, colour scale and colour box size.
- Starting at the CFA/SFA/profunda artery bifurcation in longitudinal view, image the entire length of the arterial segments listed above to confirm patency (presence/absence of blood flow), and identify potential stenosis (areas of aliasing, flow disturbance and/or velocity jets), dissections, collateral vessels and direction of flow.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Spectral Doppler:

- Optimise the spectral Doppler trace, including appropriate adjustment of gain and scale.
- In longitudinal view, obtain a spectral Doppler waveform and measure the peak systolic velocity (PSV) from the arterial segments listed above to confirm patency (presence/absence of blood flow),

and identify stenosis, dissections and direction of flow. Ensure the Doppler angle is correctly aligned to the blood flow and $\leq 60^\circ$.

- At sites of stenosis, obtain a spectral Doppler waveform from and measure the pre-stenotic PSV proximal to the stenosis, the maximum PSV at the stenotic site, and the post stenotic PSV. The PSV ratio is a comparison between the pre-stenotic PSV and the maximum PSV at the stenotic site, and is used to grade stenosis severity. See Table 1 for the classification of peripheral arterial stenosis.

Table 1: Criteria for the Classification of Peripheral Arterial Stenosis (Charing Cross Hospital).

PSV ratio	% reduction
2:1	50%
3:1	60%
4:1	75%
5:1	80%
6:1	80%
7:1	85%
8:1	90%
9:1	90-95%
10:1	+95%

See the RIE VL Abdominal Aortic Aneurysm Ultrasound Assessment Protocol (2022) and the RIE VL Popliteal Artery Aneurysm Duplex Ultrasound Assessment Protocol (2022) for the assessment of abdominal aortic, CIA and popliteal artery aneurysms.

8.0 Minimum Image Requirements

Static images should be digitally stored during the assessment. See the Society for Vascular Technology Guidance on Image Storage and Use, for Vascular Ultrasound Scans (2020) for further information.

Minimum Image Requirements:

- Longitudinal view duplex ultrasound image including spectral Doppler waveform and PSV measurement from the aorta, CIA, EIA, CFA, Profunda artery origin, SFA (at origin, mid thigh and knee), mid popliteal artery, TP-trunk, distal peroneal artery, ATA at ankle, and PTA at ankle
- Transverse view B-mode image of the aorta with maximum AP diameter measurement

9.0 Review of the Diagnostic Scan Findings

Once the ultrasound assessment has been completed, the vascular scientist should:

- Utilise Genesis² to generate a report using the standard template, documenting the following:
 - Correct patient demographics, date of assessment, assessment type and the name and status of the vascular scientist
 - PSV (in m/s to 1dp) and waveform from each of the arterial segments assessed
 - Presence, location, length and plaque appearance of occlusive lesions
 - Presence, location, plaque appearance and degree of stenotic lesions, including pre-stenotic PSV and the maximum PSV at the stenotic site
 - Presence, location and plaque appearance of disease <50%
 - Any other abnormality, for example aneurysmal disease
 - Incidental findings, for example Baker's cyst
 - Any limitations of the assessment, for example difficult examination due to bowel gas
- Ensure appropriate efficient communication of urgent ultrasound results

Urgent Results:

Prior to the patient leaving the department, the vascular scientist should alert the vascular doctor on call or referring vascular consultant when immediate attention is indicated. Significant new findings for urgent review include:

- Homogenous occlusive disease with low echogenicity indicative of fresh thrombus

10.0 Exam Time Recommendations

Recommended time for completion of a unilateral lower limb arterial duplex ultrasound assessment (including reporting) is 1 hour and 15 minutes. Recommended time for completion of a bilateral lower limb arterial duplex ultrasound assessment (including reporting) is 2 hour and 30 minutes.

11.0 References

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The Society for Vascular Technology for Great Britain and Ireland (2020)
Consent and Chaperone Guidelines

Available at https://www.svtgbi.org.uk/media/resources/Chaperone_2020.pdf

Accessed 25th Jan 2022

The Society for Vascular Technology for Great Britain and Ireland (2020)
Guidance on image storage and use, for vascular ultrasound scans.

Available at

https://www.svtgbi.org.uk/media/resources/Image_storage_2020.pdf

Accessed 25th Jan 2022

The Society for Vascular Technology for Great Britain and Ireland (April 2021)
Vascular Technology Professional Performance Guidelines Arterial Duplex Ultrasound Examination

Available at https://www.svtgbi.org.uk/media/resources/Arterial_PPG_-_29.03.21.pdf

Accessed 23rd Feb 2022

Royal Infirmary of Edinburgh Vascular Laboratory
Lower Limb Arterial Duplex Ultrasound Assessment Protocol

Version	May 2022
Effective from	May 2022
Review date	2027
Responsible for review	Lead Clinical Vascular Scientist, Protocol Lead
Author	Heather Anderson, Accredited Vascular Scientist.
Approved by	Karen Gallagher, Lead Clinical Vascular Scientist
Superseded documents	v4.0 2022

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This table should detail the version history for this document. It should detail the key changes when a version is amended.

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v3.0	Jan 2022	Available to view in shared drive
v4.0	Feb 2022	Addition of version control box Updates SVT guidelines
v5.0	May 2022	Addition to section 8.0 (B-mode long and trans CFA views)

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1.0 Purpose and Principals

Peripheral arterial disease is most commonly caused by atherosclerotic disease that leads to stenosis and occlusion of the lower limb arteries (Menêses et al., 2017), however, other possible causes include arteritis and arterial entrapments (Mintz and Weinberg, 2015). In addition to causing lifestyle limiting claudication symptoms, uncontrolled disease can progress on to critical limb ischemia which is associated with a high rate of limb loss, morbidity and mortality (Vartanian and Conte, 2015; Dua and Lee, 2016).

Duplex ultrasound is an important imaging modality for defining the anatomic pattern of occlusive disease in the arteries supplying the lower extremity (Chen et al., 2014).

2.0 Common Indications

Common indications for the performance of lower limb arterial duplex ultrasound assessment include:

- Symptomatic patients, for example those with intermittent claudication, rest pain, tissue necrosis, ulceration and/or gangrene
- For suspected lower limb arterial disease, for example where the clinician is unable to palpate pulses
- For suspected aneurysmal disease (native or iatrogenic), for example due to a palpable pulsatile mass or ischemic digits (? emboli source)
- To monitor progression of known lower limb arterial disease
- Pre intervention, for example prior to angioplasty
- Post intervention, for example to determine the success of angioplasty
- Pre-renal transplant
- To determine lower limb arterial disease prior to compression dressings
- Post arterial trauma

3.0 Contraindications and Limitations

Contraindications for the performance of lower limb arterial duplex ultrasound assessment include:

- Obesity
- Leg swelling or oedema
- Recent surgery (sutures, staples, dressings, haematoma, etc)
- Scar tissue from previous surgery
- Casts, bandaging, open wounds or ulceration
- Heavily calcified arteries
- Bowel gas
- Peritoneal dialysis catheter or stoma bag

- Patient discomfort, for example severe rest pain when leg elevated
- Patient limited mobility, for example those who are unable to lie supine
- Patients who are unable to cooperate due to reduced cognitive functions, for example due to dementia or involuntary movements

4.0 Equipment

Ultrasound Instrumentation:

Utilise appropriate ultrasound instrumentation with B-mode, colour Doppler and pulse wave Doppler functionality, for example, Siemens ACUSON S2000 or Juniper ultrasound systems.

A high frequency (for example, 12-3 or 9-4 MHz) linear array transducer should be selected for the femoral, popliteal and crural arteries. A higher frequency (for example, 16-4 or 18-6 MHz) linear array transducer may be preferable for very superficial arteries, for example to image the dorsalis pedis artery. A low frequency (for example, 5-1 or 6-2 MHz) curvilinear array transducer should be selected to visualise the aorta and iliac arteries, or if imaging of the femoral, popliteal and/or crural arteries is difficult, for example due to high patient BMI.

Ultrasound Room, Scanning Couch and Chair:

See the Royal Infirmary of Edinburgh Vascular Laboratory (RIE VL) Supplementary Ultrasound Assessment Protocol (2020).

5.0 Patient Communication

Prior to commencing the ultrasound assessment, the vascular scientist should:

- Introduce themselves to the patient
- Ask the patient to confirm their name and date of birth, matching these details with both the referral and the details on the ultrasound machine
- Verify that the requested assessment and information on the referral are correct
- Clearly and concisely explain the ultrasound assessment to the patient, including the purpose and the typical length
- Ask the patient about symptoms associated with lower limb arterial disease, for example walking distance and rest pain
- Address any patient concerns and questions about any aspect of the examination, referring specific questions regarding diagnosis, treatment or prognosis to their vascular consultant

Once the ultrasound assessment has been completed, the vascular scientist should:

- Explain that the images will be reviewed, and a report produced for their vascular consultant
- Inform the patient about the follow-up of the results, for example this may be via written correspondence to the patient or the patient's General Practitioner

See the RIE VL Supplementary Ultrasound Assessment Protocol (2020) for information on patient consent, and the Society for Vascular Technology Consent & Chaperone Guidelines (2020) for information on chaperones.

6.0 Patient Preparation and Positioning

Patient Preparation:

The patient should remove restrictive clothing to expose from their groin to their ankle, for example by removing their trousers/skirt, shoes and socks. When scanning the abdomen, the patient should lift their shirt.

Patients are not requested to fast prior to this ultrasound assessment.

Patient Positioning:

The patient should be asked to lie supine on the scanning couch with their arms down by their sides and their head slightly elevated to a level of comfort. The patient should be encouraged to relax their legs in a slightly abducted position and may be asked to rotate the leg being assessed externally or internally. The crural arteries may be assessed with the patient supine and the knee flexed. If appropriate, the patient may be asked to lie prone or in a right/left lateral decubitus position.

When scanning the abdomen, the patient should be encouraged to relax. When supine acoustic windows prove inadequate when scanning the abdomen, for example in patients with a large abdominal girth, a right lateral decubitus position may be useful.

7.0 Examination Protocol

Using B-mode imaging, colour flow imaging and spectral Doppler, assess the abdominal aorta, common iliac artery (CIA), internal iliac artery (IIA) origin, external iliac artery (EIAs), common femoral artery (CFA), profunda artery origin, superficial femoral artery (SFA), popliteal artery, tibioperoneal (TP-) trunk, peroneal artery, posterior tibial artery (PTA) and anterior tibial artery (ATA).

B-Mode Imaging:

- Optimise the B-mode image, including appropriate adjustment of gain, time gain compensation, zoom and depth.
- To begin the assessment, in transverse view, place the transducer at the level of the inguinal ligament and identify the CFA/SFA/profunda artery bifurcation.
- Image the arterial segments listed above to identify the presence of plaque, dissections, aneurysmal disease, and sites of previous interventions (for example, stents and endarterectomy sites).
- Assess plaque appearance and identify characteristics of, for example: homogenous occlusive disease with low echogenicity indicative of fresh thrombus; heterogenous occlusive disease with strong echoes indicative of old non-uniform calcified areas of atheroma; and fibrous thickening indicative of a vascular arteritis.
- In transverse view, measure the maximum anterior-posterior (AP) diameter of the abdominal aorta using calipers measuring from inner-to-inner (ITI) and outer-to-outer (OTO) edge at peak systole.
- For aneurysmal disease distal to the aorta, in transverse view, measure the maximum AP and lateral aneurysm diameters at peak systole from OTO edge. In longitudinal view, measure the maximum AP aneurysm diameter at peak systole from OTO edge.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Colour Flow Imaging:

- Optimise the colour flow image, including appropriate adjustment of gain, colour scale and colour box size.
- Starting at the CFA/SFA/profunda artery bifurcation in longitudinal view, image the entire length of the arterial segments listed above to confirm patency (presence/absence of blood flow), and identify potential stenosis (areas of aliasing, flow disturbance and/or velocity jets), dissections, collateral vessels and direction of flow.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Spectral Doppler:

- Optimise the spectral Doppler trace, including appropriate adjustment of gain and scale.
- In longitudinal view, obtain a spectral Doppler waveform and measure the peak systolic velocity (PSV) from the arterial segments listed above to confirm patency (presence/absence of blood flow),

and identify stenosis, dissections and direction of flow. Ensure the Doppler angle is correctly aligned to the blood flow and $\leq 60^\circ$.

- At sites of stenosis, obtain a spectral Doppler waveform from and measure the pre-stenotic PSV proximal to the stenosis, the maximum PSV at the stenotic site, and the post stenotic PSV. The PSV ratio is a comparison between the pre-stenotic PSV and the maximum PSV at the stenotic site, and is used to grade stenosis severity. See Table 1 for the classification of peripheral arterial stenosis.

Table 1: Criteria for the Classification of Peripheral Arterial Stenosis (Charing Cross Hospital).

PSV ratio	% reduction
2:1	50%
3:1	60%
4:1	75%
5:1	80%
6:1	80%
7:1	85%
8:1	90%
9:1	90-95%
10:1	+95%

See the RIE VL Abdominal Aortic Aneurysm Ultrasound Assessment Protocol (2022) and the RIE VL Popliteal Artery Aneurysm Duplex Ultrasound Assessment Protocol (2022) for the assessment of abdominal aortic, CIA and popliteal artery aneurysms.

8.0 Minimum Image Requirements

Static images should be digitally stored during the assessment. See the Society for Vascular Technology Guidance on Image Storage and Use, for Vascular Ultrasound Scans (2020) for further information.

Minimum Image Requirements:

- For purposes of radiology access (angioplasty etc) save one longitudinal and one cross section view of CFA, BOTH in B-mode to demonstrate plaque burden and patent lumen.
- Longitudinal view duplex ultrasound image including spectral Doppler waveform and PSV measurement from the aorta, CIA, EIA, CFA, Profunda artery origin, SFA (at origin, mid thigh and knee), mid

popliteal artery, TP-trunk, distal peroneal artery, ATA at ankle, and PTA at ankle

- Transverse view B-mode image of the aorta with maximum AP diameter measurement

9.0 Review of the Diagnostic Scan Findings

Once the ultrasound assessment has been completed, the vascular scientist should:

- Utilise Genesis² to generate a report using the standard template, documenting the following:
 - Correct patient demographics, date of assessment, assessment type and the name and status of the vascular scientist
 - PSV (in m/s to 1dp) and waveform from each of the arterial segments assessed
 - Presence, location, length and plaque appearance of occlusive lesions
 - Presence, location, plaque appearance and degree of stenotic lesions, including pre-stenotic PSV and the maximum PSV at the stenotic site
 - Presence, location and plaque appearance of disease <50%
 - Any other abnormality, for example aneurysmal disease
 - Incidental findings, for example Baker's cyst
 - Any limitations of the assessment, for example difficult examination due to bowel gas
- Ensure appropriate efficient communication of urgent ultrasound results

Urgent Results:

Prior to the patient leaving the department, the vascular scientist should alert the vascular doctor on call or referring vascular consultant when immediate attention is indicated. Significant new findings for urgent review include:

- Homogenous occlusive disease with low echogenicity indicative of fresh thrombus

10.0 Exam Time Recommendations

Recommended time for completion of a unilateral lower limb arterial duplex ultrasound assessment (including reporting) is 1 hour and 15 minutes. Recommended time for completion of a bilateral lower limb arterial duplex ultrasound assessment (including reporting) is 2 hour and 30 minutes.

11.0 References

Chen, Q., Shi, Y., Wang, Y. and Li, X. (2015). Patterns of Disease Distribution of Lower Extremity Peripheral Arterial Disease. *Angiology*. **66**(3): 211-218.

Dua, A. and Lee, C.J. (2016). Epidemiology of Peripheral Arterial Disease and Critical Limb Ischemia. *Techniques in Vascular and Interventional Radiology*. **19**(2): 91-95.

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The Society for Vascular Technology for Great Britain and Ireland (2020)

Consent and Chaperone Guidelines

Available at https://www.svtgbi.org.uk/media/resources/Chaperone_2020.pdf

Accessed 25th Jan 2022

The Society for Vascular Technology for Great Britain and Ireland (2020)

Guidance on image storage and use, for vascular ultrasound scans.

Available at

https://www.svtgbi.org.uk/media/resources/Image_storage_2020.pdf

Accessed 25th Jan 2022

The Society for Vascular Technology for Great Britain and Ireland (April 2021)

Vascular Technology Professional Performance Guidelines Arterial Duplex Ultrasound Examination

Available at https://www.svtgbi.org.uk/media/resources/Arterial_PPG_-_29.03.21.pdf

[_29.03.21.pdf](https://www.svtgbi.org.uk/media/resources/Arterial_PPG_-_29.03.21.pdf)

Accessed 23rd Feb 2022

Royal Infirmary of Edinburgh Vascular Laboratory
Lower Limb Arterial Duplex Ultrasound Assessment Protocol

Version	v6.0
Effective from	Jan 2023
Review date	Jan 2025
Responsible for review	Lead Clinical Vascular Scientist, Protocol Lead
Author	Heather Anderson, Accredited Vascular Scientist.
Approved by	Karen Gallagher, Lead Clinical Vascular Scientist
Superseded documents	v5.0 May 2022

Version Control

This table should detail the version history for this document. It should detail the key changes when a version is amended.

Version	Date Implemented	Details of key changes
v1.0	Aug 2012	Available to view in shared drive
v2.0	Aug 2020	Available to view in shared drive
v3.0	Jan 2022	Available to view in shared drive
v4.0	Feb 2022	Addition of version control box Updates SVT guidelines
v5.0	May 2022	Addition to section 8.0 (B-mode long and trans CFA views)
v6.0	Jan 2023	Updated SVT Guidance/references

Contents:

- 1.0 Purpose and Principals**
- 2.0 Common Indications**
- 3.0 Contraindications and Limitations**
- 4.0 Equipment**
- 5.0 Patient Communication**
- 6.0 Patient Preparation and Positioning**
- 7.0 Examination Protocol**
- 8.0 Minimum Image Requirements**
- 9.0 Review of the Diagnostic Scan Findings**
- 10.0 Exam Time Recommendations**
- 11.0 References**

1.0 Purpose and Principals

Peripheral arterial disease is most commonly caused by atherosclerotic disease that leads to stenosis and occlusion of the lower limb arteries (Menêses et al., 2017), however, other possible causes include arteritis and arterial entrapments (Mintz and Weinberg, 2015). In addition to causing lifestyle limiting claudication symptoms, uncontrolled disease can progress on to critical limb ischemia which is associated with a high rate of limb loss, morbidity and mortality (Vartanian and Conte, 2015; Dua and Lee, 2016).

Duplex ultrasound is an important imaging modality for defining the anatomic pattern of occlusive disease in the arteries supplying the lower extremity (Chen et al., 2014).

2.0 Common Indications

Common indications for the performance of lower limb arterial duplex ultrasound assessment include:

- Symptomatic patients, for example those with intermittent claudication, rest pain, tissue necrosis, ulceration and/or gangrene
- For suspected lower limb arterial disease, for example where the clinician is unable to palpate pulses
- For suspected aneurysmal disease (native or iatrogenic), for example due to a palpable pulsatile mass or ischemic digits (? emboli source)
- To monitor progression of known lower limb arterial disease
- Pre intervention, for example prior to angioplasty
- Post intervention, for example to determine the success of angioplasty
- Pre-renal transplant
- To determine lower limb arterial disease prior to compression dressings
- Post arterial trauma

3.0 Contraindications and Limitations

Contraindications for the performance of lower limb arterial duplex ultrasound assessment include:

- Obesity
- Leg swelling or oedema
- Recent surgery (sutures, staples, dressings, haematoma, etc)
- Scar tissue from previous surgery
- Casts, bandaging, open wounds or ulceration
- Heavily calcified arteries
- Bowel gas
- Peritoneal dialysis catheter or stoma bag

- Patient discomfort, for example severe rest pain when leg elevated
- Patient limited mobility, for example those who are unable to lie supine
- Patients who are unable to cooperate due to reduced cognitive functions, for example due to dementia or involuntary movements

4.0 Equipment

Ultrasound Instrumentation:

Utilise appropriate ultrasound instrumentation with B-mode, colour Doppler and pulse wave Doppler functionality, for example, Siemens ACUSON S2000 or Juniper ultrasound systems.

A high frequency (for example, 12-3 or 9-4 MHz) linear array transducer should be selected for the femoral, popliteal and crural arteries. A higher frequency (for example, 16-4 or 18-6 MHz) linear array transducer may be preferable for very superficial arteries, for example to image the dorsalis pedis artery. A low frequency (for example, 5-1 or 6-2 MHz) curvilinear array transducer should be selected to visualise the aorta and iliac arteries, or if imaging of the femoral, popliteal and/or crural arteries is difficult, for example due to high patient BMI.

Ultrasound Room, Scanning Couch and Chair:

- See the latest [RIE VL Supplementary Ultrasound Assessment Protocol \(v2.0 2023\)](#)

5.0 Patient Communication

Prior to commencing the ultrasound assessment, the vascular scientist should:

- Introduce themselves to the patient
- Ask the patient to confirm their name and date of birth, matching these details with both the referral and the details on the ultrasound machine
- Verify that the requested assessment and information on the referral are correct
- Clearly and concisely explain the ultrasound assessment to the patient, including the purpose and the typical length
- Ask the patient about symptoms associated with lower limb arterial disease, for example walking distance and rest pain
- Address any patient concerns and questions about any aspect of the examination, referring specific questions regarding diagnosis, treatment or prognosis to their vascular consultant

Once the ultrasound assessment has been completed, the vascular scientist should:

- Explain that the images will be reviewed, and a report produced for their vascular consultant
- Inform the patient about the follow-up of the results, for example this may be via written correspondence to the patient or the patient's General Practitioner
- See the latest **RIE VL Supplementary Ultrasound Assessment Protocol (v2.0 2023)** for information on patient consent, and the **SVT Consent and Chaperone Guidelines (May 2020)** for information on chaperones.

6.0 Patient Preparation and Positioning

Patient Preparation:

The patient should remove restrictive clothing to expose from their groin to their ankle, for example by removing their trousers/skirt, shoes and socks. When scanning the abdomen, the patient should lift their shirt.

Patients are not requested to fast prior to this ultrasound assessment.

Patient Positioning:

The patient should be asked to lie supine on the scanning couch with their arms down by their sides and their head slightly elevated to a level of comfort. The patient should be encouraged to relax their legs in a slightly abducted position and may be asked to rotate the leg being assessed externally or internally. The crural arteries may be assessed with the patient supine and the knee flexed. If appropriate, the patient may be asked to lie prone or in a right/left lateral decubitus position.

When scanning the abdomen, the patient should be encouraged to relax. When supine acoustic windows prove inadequate when scanning the abdomen, for example in patients with a large abdominal girth, a right lateral decubitus position may be useful.

7.0 Examination Protocol

Using B-mode imaging, colour flow imaging and spectral Doppler, assess the abdominal aorta, common iliac artery (CIA), internal iliac artery (IIA) origin, external iliac artery (EIAs), common femoral artery (CFA), profunda artery origin, superficial femoral artery (SFA), popliteal artery, tibioperoneal (TP-) trunk, peroneal artery, posterior tibial artery (PTA) and anterior tibial artery (ATA).

B-Mode Imaging:

- Optimise the B-mode image, including appropriate adjustment of gain, time gain compensation, zoom and depth.
- To begin the assessment, in transverse view, place the transducer at the level of the inguinal ligament and identify the CFA/SFA/profunda artery bifurcation.
- Image the arterial segments listed above to identify the presence of plaque, dissections, aneurysmal disease, and sites of previous interventions (for example, stents and endarterectomy sites).
- Assess plaque appearance and identify characteristics of, for example: homogenous occlusive disease with low echogenicity indicative of fresh thrombus; heterogenous occlusive disease with strong echoes indicative of old non-uniform calcified areas of atheroma; and fibrous thickening indicative of a vascular arteritis.
- In transverse view, measure the maximum anterior-posterior (AP) diameter of the abdominal aorta using calipers measuring from inner-to-inner (ITI) and outer-to-outer (OTO) edge at peak systole.
- For aneurysmal disease distal to the aorta, in transverse view, measure the maximum AP and lateral aneurysm diameters at peak systole from OTO edge. In longitudinal view, measure the maximum AP aneurysm diameter at peak systole from OTO edge.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Colour Flow Imaging:

- Optimise the colour flow image, including appropriate adjustment of gain, colour scale and colour box size.
- Starting at the CFA/SFA/profunda artery bifurcation in longitudinal view, image the entire length of the arterial segments listed above to confirm patency (presence/absence of blood flow), and identify potential stenosis (areas of aliasing, flow disturbance and/or velocity jets), dissections, collateral vessels and direction of flow.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Spectral Doppler:

- Optimise the spectral Doppler trace, including appropriate adjustment of gain and scale.
- In longitudinal view, obtain a spectral Doppler waveform and measure the peak systolic velocity (PSV) from the arterial segments listed above to confirm patency (presence/absence of blood flow), and identify stenosis, dissections and direction of flow. Ensure the Doppler angle is correctly aligned to the blood flow and $\leq 60^\circ$.

- At sites of stenosis, obtain a spectral Doppler waveform from and measure the pre-stenotic PSV proximal to the stenosis, the maximum PSV at the stenotic site, and the post stenotic PSV. The PSV ratio is a comparison between the pre-stenotic PSV and the maximum PSV at the stenotic site, and is used to grade stenosis severity. See Table 1 for the classification of peripheral arterial stenosis.

Table 1: Criteria for the Classification of Peripheral Arterial Stenosis (Charing Cross Hospital).

PSV ratio	% reduction
2:1	50%
3:1	60%
4:1	75%
5:1	80%
6:1	80%
7:1	85%
8:1	90%
9:1	90-95%
10:1	+95%

See the [RIE VL Abdominal Aortic Aneurysm Duplex Ultrasound Assessment Protocol \(v4.0 Jan 2023\)](#) and the [RIE VL Popliteal Artery Aneurysm Duplex Ultrasound Assessment Protocol \(v3.0 Jan 2023\)](#) for the assessment of abdominal aortic, CIA and popliteal artery aneurysms.

8.0 Minimum Image Requirements

Static images should be digitally stored during the assessment. See the [SVT Guidance on Image Storage and Use, for Vascular Ultrasound Scans \(v2.0 Jan 2020\)](#) for further information.

Minimum Image Requirements:

- For purposes of radiology access (angioplasty etc) save one longitudinal and one cross section view of CFA, BOTH in B-mode to demonstrate plaque burden and patent lumen.
- Longitudinal view duplex ultrasound image including spectral Doppler waveform and PSV measurement from the aorta, CIA, EIA, CFA, Profunda artery origin, SFA (at origin, mid thigh and knee), mid popliteal artery, TP-trunk, distal peroneal artery, ATA at ankle, and PTA at ankle

- Transverse view B-mode image of the aorta with maximum AP diameter measurement

9.0 Review of the Diagnostic Scan Findings

Once the ultrasound assessment has been completed, the vascular scientist should:

- Utilise Genesis² to generate a report using the standard template, documenting the following:
 - Correct patient demographics, date of assessment, assessment type and the name and status of the vascular scientist
 - PSV (in m/s to 1dp) and waveform from each of the arterial segments assessed
 - Presence, location, length and plaque appearance of occlusive lesions
 - Presence, location, plaque appearance and degree of stenotic lesions, including pre-stenotic PSV and the maximum PSV at the stenotic site
 - Presence, location and plaque appearance of disease <50%
 - Any other abnormality, for example aneurysmal disease
 - Incidental findings, for example Baker's cyst
 - Any limitations of the assessment, for example difficult examination due to bowel gas
- Ensure appropriate efficient communication of urgent ultrasound results

Urgent Results:

Prior to the patient leaving the department, the vascular scientist should alert the vascular doctor on call or referring vascular consultant when immediate attention is indicated. Significant new findings for urgent review include:

- Homogenous occlusive disease with low echogenicity indicative of fresh thrombus

10.0 Exam Time Recommendations

Recommended time for completion of a unilateral lower limb arterial duplex ultrasound assessment (including reporting) is 1 hour and 15 minutes. Recommended time for completion of a bilateral lower limb arterial duplex ultrasound assessment (including reporting) is 2 hour and 30 minutes.

11.0 References

Chen, Q., Shi, Y., Wang, Y. and Li, X. (2015). Patterns of Disease Distribution of Lower Extremity Peripheral Arterial Disease. *Angiology*. **66**(3): 211-218.

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Royal Infirmary of Edinburgh Vascular Laboratory
Lower Limb Arterial Duplex Ultrasound Assessment Protocol

Version	V7.0
Effective from	Jan 2026
Review date	Jan 2029
Responsible for review	Lead Clinical Vascular Scientist, Protocol Lead
Author	Jack Wilson, Accredited Vascular Scientist.
Approved by	Karen Gallagher, Lead Clinical Vascular Scientist
Superseded documents	V6.0 Jan 2023

Version Control

This table should detail the version history for this document. It should detail the key changes when a version is amended.

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v1.0	Aug 2012	Available to view in shared drive
v2.0	Aug 2020	Available to view in shared drive
v3.0	Jan 2022	Available to view in shared drive
v4.0	Feb 2022	Addition of version control box Updates SVT guidelines
v5.0	May 2022	Addition to section 8.0 (B-mode long and trans CFA views)
v6.0	Jan 2023	Updated SVT Guidance/references
V7.0	Jan 2026	Updated SVT Guidance/references. Pseudoaneurysm referrals to be given priority when booking. Proximal and Distal POPA images now included in minimum image requirements.

Contents:

- 1.0 Purpose and Principals**
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- 4.0 Equipment**
- 5.0 Patient Communication**
- 6.0 Patient Preparation and Positioning**
- 7.0 Examination Protocol**
- 8.0 Minimum Image Requirements**
- 9.0 Review of the Diagnostic Scan Findings**
- 10.0 Exam Time Recommendations**
- 11.0 References**

1.0 Purpose and Principals

Peripheral arterial disease is most commonly caused by atherosclerotic disease that leads to stenosis and occlusion of the lower limb arteries (Menêses et al., 2017), however, other possible causes include arteritis and arterial entrapments (Mintz and Weinberg, 2015). In addition to causing lifestyle limiting claudication symptoms, uncontrolled disease can progress on to critical limb ischemia which is associated with a high rate of limb loss, morbidity and mortality (Vartanian and Conte, 2015; Dua and Lee, 2016).

Duplex ultrasound is an important imaging modality for defining the anatomic pattern of occlusive disease in the arteries supplying the lower extremity (Chen et al., 2014).

2.0 Common Indications

Common indications for the performance of lower limb arterial duplex ultrasound assessment include:

- Symptomatic patients, for example those with intermittent claudication, rest pain, tissue necrosis, ulceration and/or gangrene
- For suspected lower limb arterial disease, for example where the clinician is unable to palpate pulses
- For suspected aneurysmal disease (native or iatrogenic), for example due to a palpable pulsatile mass or ischemic digits (? emboli source)
- To monitor progression of known lower limb arterial disease
- Pre intervention, for example prior to angioplasty
- Post intervention, for example to determine the success of angioplasty
- Pre-renal transplant
- To determine lower limb arterial disease prior to compression dressings
- Post arterial trauma

Referrals that suggest suspicion of Pseudoaneurysm should be given priority. Outpatient referrals should be offered the first available appointment.

3.0 Contraindications and Limitations

Contraindications for the performance of lower limb arterial duplex ultrasound assessment include:

- Obesity
- Leg swelling or oedema
- Recent surgery (sutures, staples, dressings, haematoma, etc)
- Scar tissue from previous surgery
- Casts, bandaging, open wounds or ulceration

- Heavily calcified arteries
- Bowel gas
- Peritoneal dialysis catheter or stoma bag
- Patient discomfort, for example severe rest pain when leg elevated
- Patient limited mobility, for example those who are unable to lie supine
- Patients who are unable to cooperate due to reduced cognitive functions, for example due to dementia or involuntary movements

4.0 Equipment

Ultrasound Instrumentation:

Utilise appropriate ultrasound instrumentation with B-mode, colour Doppler and pulse wave Doppler functionality, for example, Mindray A20 or Canon Aplio i700 ultrasound systems.

A high frequency (for example, 12-3 or 9-4 MHz) linear array transducer should be selected for the femoral, popliteal and crural arteries. A higher frequency (for example, 16-4 or 18-6 MHz) linear array transducer may be preferable for very superficial arteries, for example to image the dorsalis pedis artery. A low frequency (for example, 5-1 or 6-2 MHz) curvilinear array transducer should be selected to visualise the aorta and iliac arteries, or if imaging of the femoral, popliteal and/or crural arteries is difficult, for example due to high patient BMI.

Ultrasound Room, Scanning Couch and Chair:

- See the latest [RIE VL Supplementary Ultrasound Assessment Protocol \(v3.0 2026\)](#)

5.0 Patient Communication

Prior to commencing the ultrasound assessment, the vascular scientist should:

- Introduce themselves to the patient
- Ask the patient to confirm their name and date of birth, matching these details with both the referral and the details on the ultrasound machine
- Verify that the requested assessment and information on the referral are correct
- Clearly and concisely explain the ultrasound assessment to the patient, including the purpose and the typical length
- Ask the patient about symptoms associated with lower limb arterial disease, for example walking distance and rest pain

- Address any patient concerns and questions about any aspect of the examination, referring specific questions regarding diagnosis, treatment or prognosis to their vascular consultant

Once the ultrasound assessment has been completed, the vascular scientist should:

- Explain that the images will be reviewed, and a report produced for their vascular consultant
- Inform the patient about the follow-up of the results, for example this may be via written correspondence to the patient or the patient's General Practitioner
- See the latest [RIE VL Supplementary Ultrasound Assessment Protocol \(v3.0 2026\)](#) for information on patient consent, and the [SVT Consent and Chaperone Guidelines \(June 2023\)](#) for information on chaperones.

6.0 Patient Preparation and Positioning

Patient Preparation:

The patient should remove restrictive clothing to expose from their groin to their ankle, for example by removing their trousers/skirt, shoes and socks. When scanning the abdomen, the patient should lift their shirt.

Patients are not requested to fast prior to this ultrasound assessment.

Patient Positioning:

The patient should be asked to lie supine on the scanning couch with their arms down by their sides and their head slightly elevated to a level of comfort. The patient should be encouraged to relax their legs in a slightly abducted position and may be asked to rotate the leg being assessed externally or internally. The crural arteries may be assessed with the patient supine and the knee flexed. If appropriate, the patient may be asked to lie prone or in a right/left lateral decubitus position.

When scanning the abdomen, the patient should be encouraged to relax. When supine acoustic windows prove inadequate when scanning the abdomen, for example in patients with a large abdominal girth, a right lateral decubitus position may be useful.

7.0 Examination Protocol

Using B-mode imaging, colour flow imaging and spectral Doppler, assess the abdominal aorta, common iliac artery (CIA), internal iliac artery (IIA) origin, external iliac artery (EIAs), common femoral artery (CFA), profunda artery

origin, superficial femoral artery (SFA), popliteal artery, tibioperoneal (TP-) trunk, peroneal artery, posterior tibial artery (PTA) and anterior tibial artery (ATA).

B-Mode Imaging:

- Optimise the B-mode image, including appropriate adjustment of gain, time gain compensation, zoom and depth.
- To begin the assessment, in transverse view, place the transducer at the level of the inguinal ligament and identify the CFA/SFA/profunda artery bifurcation.
- Image the arterial segments listed above to identify the presence of plaque, dissections, aneurysmal disease, and sites of previous interventions (for example, stents and endarterectomy sites).
- Assess plaque appearance and identify characteristics of, for example: homogenous occlusive disease with low echogenicity indicative of fresh thrombus; heterogenous occlusive disease with strong echoes indicative of old non-uniform calcified areas of atheroma; and fibrous thickening indicative of a vascular arteritis.
- In transverse view, measure the maximum anterior-posterior (AP) diameter of the abdominal aorta using calipers measuring from inner-to-inner (ITI) and outer-to-outer (OTO) edge at peak systole.
- For aneurysmal disease distal to the aorta, in transverse view, measure the maximum AP and lateral aneurysm diameters at peak systole from OTO edge. In longitudinal view, measure the maximum AP aneurysm diameter at peak systole from OTO edge.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Colour Flow Imaging:

- Optimise the colour flow image, including appropriate adjustment of gain, colour scale and colour box size.
- Starting at the CFA/SFA/profunda artery bifurcation in longitudinal view, image the entire length of the arterial segments listed above to confirm patency (presence/absence of blood flow), and identify potential stenosis (areas of aliasing, flow disturbance and/or velocity jets), dissections, collateral vessels and direction of flow.
- Image areas of disease in both longitudinal and transverse views to ensure thorough interrogation.

Spectral Doppler:

- Optimise the spectral Doppler trace, including appropriate adjustment of gain and scale.

- In longitudinal view, obtain a spectral Doppler waveform and measure the peak systolic velocity (PSV) from the arterial segments listed above to confirm patency (presence/absence of blood flow), and identify stenosis, dissections and direction of flow. Ensure the Doppler angle is correctly aligned to the blood flow and $\leq 60^\circ$.
- At sites of stenosis, obtain a spectral Doppler waveform from and measure the pre-stenotic PSV proximal to the stenosis, the maximum PSV at the stenotic site, and the post stenotic PSV. The PSV ratio is a comparison between the pre-stenotic PSV and the maximum PSV at the stenotic site, and is used to grade stenosis severity. See Table 1 for the classification of peripheral arterial stenosis.

Table 1: Criteria for the Classification of Peripheral Arterial Stenosis (Charing Cross Hospital).

PSV ratio	% reduction
2:1	50%
3:1	60%
4:1	75%
5:1	80%
6:1	80%
7:1	85%
8:1	90%
9:1	90-95%
10:1	+95%

See the [RIE VL Abdominal Aortic Aneurysm Duplex Ultrasound Assessment Protocol \(v5.0 Jan 2026\)](#) and the [RIE VL Popliteal Artery Aneurysm Duplex Ultrasound Assessment Protocol \(v4.0 Jan 2026\)](#) for the assessment of abdominal aortic, CIA and popliteal artery aneurysms.

8.0 Minimum Image Requirements

Static images should be digitally stored during the assessment. See the [SVT Guidance on Image Storage and Use, for Vascular Ultrasound Scans \(v3.0 Oct 2023\)](#) for further information.

Minimum Image Requirements:

- For purposes of radiology access (angioplasty etc) save one longitudinal and one cross section view of CFA in B-mode to demonstrate plaque burden and patent lumen.

- Longitudinal view duplex ultrasound image including spectral Doppler waveform and PSV measurement from the aorta, CIA, EIA, CFA, Profunda artery origin, SFA (at origin, mid thigh and knee), popliteal artery (proximal and distal), TP-trunk, distal peroneal artery, ATA at ankle, and PTA at ankle
- Transverse view B-mode image of the aorta with maximum AP diameter measurement

9.0 Review of the Diagnostic Scan Findings

Once the ultrasound assessment has been completed, the vascular scientist should:

- Utilise Genesis² to generate a report using the standard template, documenting the following:
 - Correct patient demographics, date of assessment, assessment type and the name and status of the vascular scientist
 - PSV (in m/s to 1dp) and waveform from each of the arterial segments assessed
 - Presence, location, length and plaque appearance of occlusive lesions
 - Presence, location, plaque appearance and degree of stenotic lesions, including pre-stenotic PSV and the maximum PSV at the stenotic site
 - Presence, location and plaque appearance of disease <50%
 - Any other abnormality, for example aneurysmal disease
 - Incidental findings, for example Baker's cyst
 - Any limitations of the assessment, for example difficult examination due to bowel gas
- Ensure appropriate efficient communication of urgent ultrasound results

Urgent Results:

Prior to the patient leaving the department, the vascular scientist should alert the vascular doctor on call or referring vascular consultant when immediate attention is indicated. Significant new findings for urgent review include:

- Homogenous occlusive disease with low echogenicity indicative of fresh thrombus
- Patent pseudoaneurysm
- Acute Arterial Dissection

10.0 Exam Time Recommendations

Recommended time for completion of a unilateral lower limb arterial duplex ultrasound assessment (including reporting) is 1 hour and 15 minutes.

Recommended time for completion of a bilateral lower limb arterial duplex ultrasound assessment (including reporting) is 2 hour and 30 minutes.

11.0 References

Chen, Q., Shi, Y., Wang, Y. and Li, X. (2015). Patterns of Disease Distribution of Lower Extremity Peripheral Arterial Disease. *Angiology*. **66**(3): 211-218.

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Vartanian, S.M. and Conte, M.S. (2015). Surgical Intervention for Peripheral Arterial Disease. *Circulation Research*. **116**(9): 1614-1628.