**Introduction**

This protocol was prepared by the Senior Vascular Physiologist. The SVT guidelines were used in conjunction with our current lab practices.

Lower Limb Arterial Duplex assessment may require evaluation of the Aorta, iliac system, CFA, PFA, SFA, Popliteal artery, tibioperoneal trunk and/or the calf arteries leading into either the dorsalis pedis and/or the posterior tibial artery or its branches. A more focused exam may also be requested which may only include one of the arteries mentioned above or those within a specific section of the lower limb such as the calf and foot arteries.

This assessment is also employed to perform surveillance following surgical intervention, in particular lower limb bypass grafts and stents.

**Common Indications**

1. Rest Pain/critical limb ischemia
2. Surveillance prior to and following intervention
3. Claudication
4. Suspected aneurysmal disease,
5. Pre Renal Transplant
6. To exclude arterial disease when compression dressings are being considered
7. Arterial waveform analysis

**Limitations**

1. Patients with a high body mass index
2. The presence of open wounds, bandaging/dressings or casts. Visualisation of vessels may also be hampered by oedema, surgical staples and haematoma.
3. Calcified plaques within the arteries may cause acoustic shadowing which will limit Doppler and B-Mode imaging
4. Patients who are unable to lie flat due to pre-existing co morbidities such as chronic obstructive pulmonary disease (COPD)
5. Patients who are unable to transfer on to a bed due to lack of mobility
6. Patients who are unable to co-operate due to reduced cognitive functions such as Alzheimer’s or dementia
7. The presence of catheters or vascular access lines may also limit visualization.

**Patient Pathway**

Lower limb arterial duplex scanning can be beneficial when Digital Subtraction Angiography (DSA) or CT Angiograms with contrast are contraindicated or not possible. A Lower limb arterial Duplex scan post intervention is useful as a surveillance tool particularly due to its non-invasive nature.

**Patient Referral**

The referral should include details of the presenting symptoms.

**Patient Preparation**

No preparation is required. The examination is performed in the supine position. Access to the patient’s abdomen and lower limbs may be required. Sterile dressings will allow for imaging over broken skin. The examination and its duration should be fully explained to the patient and consent obtained. Patient name and date of birth must be confirmed. Relevant medical history should be taken prior to the examination. Such as:

* Presence of risk factors eg diabetes, hypertension, hypercholesterolemia
* Presence of cerebrovascular disease eg aphasia, dysphasia, paralysis etc
* Results of other relevant diagnostics

**Examination**

The examination may be unilateral or bilateral depending on clinical symptoms and consultant referral. The examination is performed in the supine position. The patient will be asked to remove lower limb clothing and wear a disposable gown which will maintain patient dignity at all times. The Patient may also have to provide access to the abdomen in the event of a full lower limb duplex scan from the Aorta to distal arteries.

**Aorta and Iliac Arteries**

1. Gel must be applied to the curvilinear low frequency probe and the AORTA programme selected on the Duplex machine
2. There will be constant adjustment of the different functions on the control panel throughout the exam to ensure optimal imaging and spectral analysis eg., depth, focus, gain, TGC, sample volume size, colour box, colour scale etc
3. Place the curvilinear probe below the diaphragm and image the proximal abdominal aorta in transverse using B Mode.
4. Using the calipers the proximal abdominal aorta should be measured in both transverse and in the longitudinal plane to out rule aneurysmal dilation of the proximal Aorta
5. In transverse B Mode identify the celiac trunk and measure the outer wall AP and transverse diameter accurately using the calipers.
6. In longitudinal with B Mode identify the superior mesenteric artery. From the SMA measure 1.5cm along the anterior wall of the Aorta in the distal direction. Document the longitudinal outer wall AP diameter of the Aorta within 1.5cm distal to the SMA to confirm/outrule a juxtarenal aneurysm.
7. In Transverse B-Mode document the largest aneurysmal portion of the abdominal aorta by documenting the outer wall AP and transverse diameter accurately using the calipers.
8. In the longitudinal plane record the outer wall longitudinal AP diameter of the largest aneurysmal portion of the abdominal aorta. This can be a more accurate representation if the aorta is a tortuous vessel
9. In the transverse plane and the longitudinal plane Colour Doppler is used to assess the presence/absence of flow with the aorta.
10. If the iliac arteries are aneurysmal record the largest aneurysmal portion of the artery by documenting the longitudinal outer wall AP diameter accurately using the calipers.
11. Document patency of the external iliac arteries and/or the presence of a stent. Record PSVs with a Doppler angle between 45-60 degrees if possible. The Doppler cursor must be aligned parallel to the vessel walls or parallel to the blood flow.

**Infrainguinal lower limb arteries**

1. Patient is examined in the supine position with the leg externally rotated and the knee slightly flexed.

**Common Femoral Artery**

1. In B Mode using the curvilinear probe locate the CFA at the groin.
2. Rotate the transducer into the longitudinal plane and assess the CFA for patency. Using Colour Doppler demonstrate normal or abnormal colour filling.
3. Apply ultrasound gel to the correct high frequency linear array probe and select the arterial programme on the Ultrasound Machine.
4. Identify the CFA and assess the artery for aneurysmal dilation and atheromatous changes.
5. Using colour doppler assess for the presence/absence of flow, any colour aliasing may be indicative of increased velocities
6. In longitudinal using Colour Doppler and Spectral Doppler record the PSV in the distal EIA and the proximal CFA. Demonstrate direction of blood flow and record the PSV along the vessel. Note: in the presence of a stenosis, the cursor line must be aligned parallel to the blood flow.
7. In B Mode Identify the CFA bifurcation. Identify the origin of the Profunda Femoris Artery and assess it for atheromatous changes.
8. In longitudinal using Colour Doppler and Spectral Doppler record the PSV at the origin of the PFA.

**Superficial Femoral Artery**

1. In longitudinal B Mode identify the origin of the Superficial Femoral Artery. In longitudinal using Colour Doppler and Spectral Doppler record the PSV at the origin of the SFA.
2. B-Mode should be used to image the artery in transverse and the longitudinal plane to assess aneurysmal dilation, measure length of plaques and in the presence of plaque measure the reduced AP lumen diameters.
3. Colour Doppler should be used to assess for the presence/absence of flow and aid in the position of Spectral Doppler when recording PSVs along the vessel. Anatomical locations such as upper thigh, mid thigh, adductor canal, and lower thigh should be referenced. Any areas of colour aliasing or disturbed flow within the vessel should be investigated as a source of stenosis/occlusion.
4. Spectral Doppler should be used to determine the presence or absence of flow. Remember the optimum Doppler angle is 60 degrees. Record PSVs along the vessel and proximal, at and distal to any identified plaques. Thus allowing for accurate quantification of any stenosis present.

**Popliteal Artery**

1. Identify the Popliteal Artery above the Popliteal Crease. Repeat steps 22 - 24 when assessing this vessel and the Tibeoperonal trunk (TPT).
2. Document the origin of the Anterior Tibial Artery and its patency.

**Calf arteries**

1. Assess the ATA, PTA and peroneal arteries in the same manner repeating steps 22 - 24. Anatomical locations such as origin, upper calf, mid calf, lower calf should be referenced.

**Arteries of the foot.**

1. When assessing the foot vessels employ the high frequency probe. Anatomical locations such as above the ankle, at the ankle, below the ankle, upper dorsum of foot, lower dorsum of the foot and at the medial malleolus should be referenced appropriately. Any areas of colour aliasing or disturbed flow within the vessel should be investigated as a source of stenosis/occlusion.

**BYPASS GRAFT**

1. In transverse and B Mode begin the scan by assessing the native vessel proximal to the bypass graft. This may be the CFA, SFA or Popliteal artery depending on which native artery is occluded. Assess the artery for aneurysmal dilation and atheromatous changes.
2. Using colour doppler assess for the presence/absence of flow, any colour aliasing may be indicative of increased velocities
3. In longitudinal using Colour Doppler and Spectral Doppler record the PSV in the native vessel. Demonstrate direction of blood flow and record the PSV along the vessel. Note: in the presence of a stenosis, the cursor line must be aligned parallel to the blood flow.
4. Record the PSV within the native vessel proximal to the bypass graft anastomosis site.
5. Assess the anastomosis site in Transverse using B Mode and Colour Doppler.
6. In longitudinal using Colour Doppler and Spectral Doppler record the PSV at the anastomosis site.
7. In transverse B Mode Identify the proximal graft. Duplex ultrasound can depict the echogenic walls of synthetic grafts.
8. In longitudinal, using Colour Doppler and Spectral Doppler demonstrate direction of blood flow and record the PSV along the bypass graft. Anatomical locations mentioned above can be referenced.
9. Identify the distal anastamosis site, documenting any increase in PSV and/or stenosis at the distal anastomosis site.
10. Assess the native vessel distal to the anastomosis site for patency/absence of flow. Record the PSV of the outflow vessel. In cases of diameter mismatch (distal graft diameter larger than the native outflow vessel) measure their AP diameters using the calipers and document it in the report.

**Interpretation**

The main criteria used to grade the degree of narrowing or the stenosis within an artery is known as the peak systolic velocity ratio. In the presence of plaque, if the velocity doubles a greater than 50 percent stenosis is diagnosed, if the velocities increase by at least 4 times a greater than 70 percent stenosis is diagnosed in line with the grading criteria of the Non-Invasive Vascular Unit.

The same criteria are employed when interrogating bypass grafts and their anastomosis sites.

Low volume flow with velocities less than 0.4m/s may be indicative of impending graft failure or some distal pathology. Note: in aneurysmal portions of the graft this may not be true.

In cases of diameter mismatch (distal graft diameter larger than the native outflow vessel) measure their AP diameters using the calipers. PSV within the smaller outflow vessel may be significantly higher than the distal graft, so in the absence of plaque this may be secondary to reduction in size of the vessel only.

**Reporting**

The report is a recording and interpretation of observations made during the assessment. It should be written by the Vascular Physiologist who performed the exam**.**

The Non-Invasive Vascular Unit has a standardised reporting system for each examination so that all Vascular Physiologists and clinicians alike can understand the report.

The report should include:

* Patient name, Medical Record Number, Date of examination, examination type, Vascular Physiologists initials.
* Which side and vessels were examined, their patency and AP lumen diameter size. Any atheroma/thrombus identified within the vessels.
* Any aneurysmal dilation within the vessels.
* Anatomical location of stents and/or bypass.
* Qualitatively note the nature of the plaque eg calcified, echolucent, irregular, smooth and include the length and anatomical position
* Percentage degree of stenosis
* Any incidental findings such as perigraft fluid collections, arteriovenous fistulas, pseudo aneurysms and dissections.
* Any significant disease progression since the previous exam.
* Any limitations encountered during exam for example calcified plaque causing acoustic shadowing
* Recommendations for further imaging in the event of a limited examination
* An appropriate amount of annotated images that represent the entire ultrasound examination in accordance with department protocol
* Any significant or unexpected findings should be recorded using the PACS peervue system
* The referring doctor/team must be contacted at time of examination referring them to the report findings in the patient’s chart so that a treatment plan can be developed or expedited.