# Vascular Studies Unit – Procedural Protocols and Guidelines

Version 1.2

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Introduction

The aim of these protocols is to define the overall objectives for the routine ultrasound scanning of patients and to set the minimum requirements for a complete examination.

It is recognized that there will be occasions when even the minimum requirements may be unattainable, i.e. technically poor candidates, post-op patients etc., and in these circumstances it is the responsibility of the Vascular Scientist to determine when the examination is complete.

These protocols provide a guideline. It is recognized that each examination is unique and will require variations in some areas.

These decisions are dependent on the Vascular Scientists observations during scanning. It is therefore not possible to define a predetermined set of images for each examination.

# Vascular Scientist Responsibilities

* Be familiar with the departmental protocols.
* Perform complete examinations as indicated in these guidelines.
* Check charts, previous ultrasound reports, other imaging reports, lab results, patient medical history etc. for information and correlation.
* Label images correctly (patient’s name, date of birth, hospital number – as required by department)
* Be familiar with the operation of each Ultrasound machine and its capabilities as well as the supplementary equipment i.e. printers, videos etc.
* Use of low power levels, higher gain settings and minimal scanning time without compromising the image or the examination quality. This will reduce patient exposure to potential bio-effects.
* Be aware of MI and TI settings, keeping these to a minimum and always below maximum allowable levels (e.g. MI<0.7, TI< 1.5 for 15minutes scanning time – BMUS Aug 2000)
* Report any equipment defects to the Chief Vascular Scientist.
* Maintain clean and tidy equipment and examination rooms.
* Replenish any cleaning chemicals in a timely fashion.

Vascular Scientist should be familiar with the Society and College of Radiographers and British Medical Ultrasound Society: Guidelines for professional ultrasound practice 5 December, 2016

www.sor.org/learning/document-library

# Recording Procedures

Currently as the department does not have links to the Hospital PACS network then there are no requirements to save images from examinations. It is therefore the Vascular Scientist responsibility that the written exam report is a complete and accurate representation of the findings.

# Reporting

* Vascular Scientist will be responsible for issuing a written report direct to the requesting clinician using the pre-printed report templates see [\\qdat01\data\Vascular](file:///\\qdat01\data\Vascular) Lab\Vascular Studies Unit\Templates
* An electronic copy of the report will be stored on the Vascular Lab Shared Drive Vascular Lab Results - [\\Qdata1\data\Vascular](file:///\\Qdata1\data\Vascular) Lab Results, and on the hospital patient’s record system Notis.
* If requested by the patient the sonographer may give a brief verbal report of the exam findings.

**Performance of the Examination**

Before every examination the vascular scientist must:-

* introduce themselves
* confirm the patient’s identity e.g. full name and date of birth
* ensure they have sufficient information from the referrer in order to determine the exact need for the scan
* explain why the examination is being performed and give an indication of the test’s duration
* obtain verbal consent for the examination
* obtain a pertinent brief relevant medical history from the patient and/or notes to verify that the requested procedure correlates with the patient’s clinical presentation
* consider the use of a chaperone if appropriate
* consider the need for an interpreter
* Permission must be obtained from the patient if the examination is to be performed or observed by a student.

The patient’s privacy and confidentiality is to be respected at all times. Friends and relatives will be allowed in the examination rooms at the discretion of the operator. If the quality of the scan is in any way affected by the presence of these people they may be asked to leave the room.

Society for Vascular Technology Professional Standards Committee Chaperone Guidelines April 2012 www.svtgbi.org.uk

### Infection Control

The Vascular Scientist must be familiar with the Trust Infection Control Policy <http://nuhnet/diagnostics_clinical_support/infection_prevention_control/Pages/home.aspx>. Hands must be cleaned with soap and water or alcohol gel prior to and following any patient contact as per the WHO 5 moments of hand hygiene policy. The operator should be bare below the elbow and all wrist jewellery (including wristwatches) and stoned hand jewellery must be removed.

The examination couch should be covered with clean paper tissue for each patient and wiped clean using disinfectant wipe between patients.

After each investigation probes should be cleaned of any residual gel by wiping with paper towels and then a disinfectant wipe such as Sani-Cloth ‘Active Wipes’ or Clinell ‘Universal Wipes’ . The probe cable and keyboard should also be cleaned.

If the patient is infectious or there is risk of contact with bodily fluids or scanning any patient in ITU or HDU gloves and aprons should be used and the machine and examination couch should also be cleaned with disinfectant wipes.

If patients have open wounds or there is a risk of contact with bodily fluids then a probe cover and single use gel should be used or the wound should be covered with a clear transparent dressing such as a Hydrofilm dressings. Single use gel should also be used for pre-operative scans.

At the end of the day the machine should be cleaned to remove any gel residue including the keyboard, transducer cables and probe holders. All other areas of the ultrasound machine must be cleaned with detergent at least once a week, and kept free from visible soiling and dust at all times.

**Ergonomic Guidelines**

There is an increasing awareness that sonography is the cause of a number of work related disorders. In summary

* 80-95% sonographers scan in pain
* 20% have a career ending injury

## Types of work related disorders

## musculoskeletal (MSI)

## shoulder (rotator cuff) & elbow injuries

## neck & lower back pain

## wrist lesions or pain (carpal tunnel, ganglions & tendonitis)

## eyesight

* stress
* cross infection

Symptoms caused by musculoskeletal injuries are often not noticed until a more serious stage is reached. The time taken from first noticing something to realizing there is an injury varies from <1yr to 3yrs.

|  |  |
| --- | --- |
| **Risk factor** | **Prevention** |
| poor posture | 1. position the monitor so that your spine is straight & at max. height 2. keep head in a neutral position (i.e. can see over the top of the monitor) |
| twisting & rotational movements | 1. avoid long reaches 2. sit square to control panel & screen place so you don’t have to twist 3. avoid twisting or leaning to one side 4. move the patient close to you 5. avoid leaning across the patient without shoulder or elbow support (?lean on the patient use a cushion)  encourage the patient to move where possible e.g. if scanning left sideavoid using joints beyond 50% of their range of movement  1. region to be scanned should be in a position to avoid forward & lateral abduction & sideways stretching |
| poor grip of transducer | 1. adopt a ‘power’ grip with fingers & thumb curved around the transducer as much as possible 2. avoid twisting & rotating the wrist |
| prolonged abduction | 1. avoid abduction >30° 2. left arm should also be positioned at correct height w.r.t. monitor |
| downward pressure | 1. use a power grip on the transducer 2. be aware of amount of downward force used to scan 3. stand or use both arms if need prolonged downward pressure |
| repetitive movements | 1. try to vary your workload   1. change your position frequently |
| improper chairs and tables | 1. need high chair & low table 2. shoulder should not be abducted >30° |
| work intensity | 1. take mini-breaks throughout the day by stretching your fingers and body, looking away from the screen etc. 2. try to vary your workload |
| fatigue | 1. take frequent short breaks 2. need good humidity control 3. minimize onlookers in scan room 4. have good general fitness level |

|  |  |
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|  |  |
| poorly designed equipment | 1. monitors should overhang to allow knees underneath 2. majority of controls should be within 20cms 3. height & position of keyboard should be adjustable 4. cable supports |
| eye fatigue | 1. take frequent rest breaks 2. position lighting so there is no glare on the monitor 3. ensure room not too dim (should be able to read) 4. use a large monitor |

Additional information can be found at The Causes of Musculoskeletal Injury Amongst Sonographers in the UK; Society of Radiographers, June 2002

www.sor.org/learning/document-library

**Protocols**

**Ankle Brachial Pressure Index (ABPI)**

Patient should lay supine and rested before pressures are obtained.

The blood pressure cuff is placed around the patients arm and a Continuous Wave (CW) Doppler is used to insonate the brachial or radial artery.

The blood pressure cuff is inflated to approximately 20mmHg above the level when the Doppler signal disappears and then slowly deflated avoiding slippage of the Doppler probe. The pressure at which the signal returns is then recorded. The cuff is fully deflated and the process repeated to confirm the findings.

The cuff is then removed from the arm and placed around the calf as close to the ankle as possible. The Doppler is used to insonate the posterior tibial artery and anterior tibial or dorsalis pedis artery in turn.

The cuff is then inflated to approximately 20mmHg above the level when the Doppler signal disappears and then slowly deflated as above noting the pressure when the signal returns. This is also repeated as above to ensure reproducibility.

The process is then repeated for the other limb.

All pressures are recorded on the report and the ABPI calculated by dividing the ankle pressure by the arm pressure.

ABPI >0.9 is indicative of no significant disease

<0.9 and >0.5 is indicative of intermittent claudication

<0.5 is indicative of rest pain

Limitations

Elevated pressures may be obtained if using too small a cuff for the limb, in oedematous limbs and for diabetic patients with medial wall calcification.

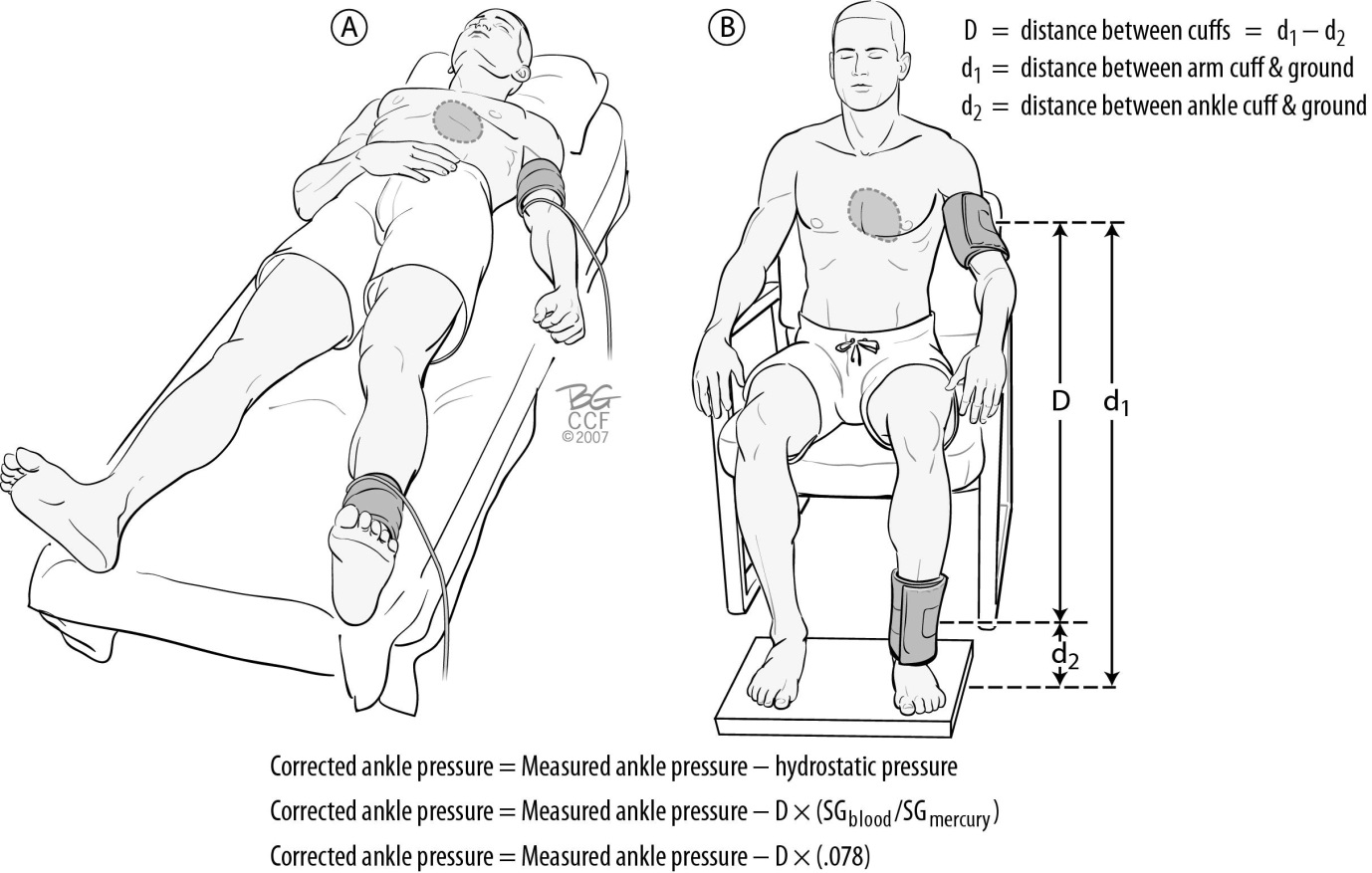
Patient with leg ulcers should have the ulcer cover with Clingfilm and ABPI measurements can be attempted if not too painful for the patient.

Pressure cuffs and Doppler probes should be cleaned with tissue paper and disinfectant wipes at the end of the procedure.

If the patient can not lie flat for ABPI then it can be done in the sitting position using the following formula. (see diagram below)

**Corrected ankle pressure = Measured ankle pressure – distance between cuffs x 0.78**

**(Distance measured in cm)**



**Pole Test**

The patient is laid supine and the Doppler is used to listen to the tibial pulses, the leg is elevated to the level where the pulse stops. The height of the leg above the heart is then measured. The ankle pressure is then calculated by multiplying the height measured \* (.078).

**Treadmill Testing**

Patients may still have symptomatic arterial disease despite the presence of normal resting ABPI’s therefore to exclude a vascular cause for a patients symptoms post excise ABPI’s can be performed.

The patient physical ability and medical fitness to perform a treadmill test should be assessed. Treadmill testing **should not** be attempted on patients with a resting systolic blood pressure of greater than **200mmHg**.

Procedure

* Resting ABPI’s are measured according to the above procedure.
* The treadmill is set to a 7 degree / 10% incline.
* The patient stands at the top of the treadmill and uses the arm rests to maintain their balance.
* The speed of the treadmill is increased steadily up to 3.2 Km/hr or to the level suitable for the patient’s physical ability.
* The patient is told to report the onset of symptoms of foot, calf, thigh or buttock pain / cramp.
* The patients are encouraged to walk past the onset of pain until the need to stop
* If the patient gets symptoms of shortness of breath or angina the test is stopped.
* The test is stopped after 5minutes of walking if it has not already been halted.
* At the end of the exercise the patient is asked to return to the couch as quickly as possible and the pressure measurements repeated from the site of highest resting pressure for both legs and the arm. Ideally these measurement should be taken within a minute of finishing exercise to avoid them recovering to the resting levels.
* ABPI’s can then be recalculated.

If there is no fall in the post exercise ABPI compared to the resting ABPI then vascular disease can be excluded. (Unless you suspect the reading to be unreliable due to calcified arteries)

If testing is being performed on an ‘athlete’ for pain on extending exercise then the treadmill or turbo bike should be set appropriately to evoke the patient’s symptoms.

**Aortic Aneurysm Screening (AAA)**

**Purpose**

To assess the abdominal aorta and the iliac vessels for signs of aneurysmal dilatations.

Expansile abdominal mass or a family history of aneurysmal disease are indications for the test. The limitations of the test can be the size of the abdomen and overlying bowel gas.

**Patient Preparation**

No specific preparation is require however if bowel gas is found to be a problem morning appointment with refraining from breakfast may help to reduce this.

Procedure

* The patient should be placed supine on the couch
* Usually a curvilinear transducer 3.5Mh or 4Mhz should be used, for slim patient a higher frequency linear transducer may be adequate.
* The aorta should be scanned from the diaphragm to the iliac bifurcation in longitudinal and cross sectional imagining. (the presence of proximal anterior branches and pulsatility can be used to positive identify the aorta)
* The iliac vessels should also be scanned in their entirety.
* All measurements of diameter should be made in the longitudinal plane and not the transvers plane to avoid slice error. Measurements should be taken from the inner of the top wall to the inner of the bottom wall to align with the National Abdominal Aortic Screening Program (NAAASP).
* Measurements required are
  + super renal aorta anterior posterior (AP) diameter
  + maximal AP diameter of the aorta
  + maximal transverse diameter measured from the lateral flank
  + both common iliac maximal AP diameter
* The position of the aneurysm with respect to the renal vessels should be noted. In most situations it will be difficult to determine the level of the renal arteries and therefor the position in relation to the superior mesenteric artery (SMA) should be noted.
* Any unusual configuration of the aneurysm, e.g. saccular aneurysms, dissections, or abnormal thrombus, should be noted.

Surveillance

Patients with a confirmed aneurysm should be placed into a surveillance program unless they have been assessed as medically unfit for an aneurysm repair. The surveillance interval should be: -

AAA diameter >3cm and <4.5cm yearly scans

>4.5cm and <5.5cm three monthly scans

>5.5cm referral for consideration of CT

If the aneurysm has grown by more than 5mm within six months then the report should be sent to the referring clinician as a matter of urgency. If the patient is tender over the aneurysm during the exam then the on call Vascular SpR should be contacted to assess the patient.

**AAA scanning for NAAASP**

The department accept referrals from the Nottinghamshire Abdominal Aortic Aneurysm Screening Program for patients that were not visualised on their initial community screening scans, patients that may need mobility aids to transfer on to the bed and quality assurance recall scans requested by the Clinical Skills Trainer (CST) from the screening program.

The non-visualised scan can be performed by and member of the department trained to do AAA scanning but must follow the procedure highlighted below. The other referrals can only be performed by members of the department that have completed appropriate National Abdominal Aortic Aneurysm Screening Program NAAASP training.

Referrals will be e-mailed by the Nottingham screening office to the vascular lab administrator.

**Scan measurements**

The maximum anterior to posterior diameter of the abdominal aorta should be measure with the probe in a longitudinal and transverse plane. The measurement should be made from inner to inner wall.

The images should be stored on the ultrasound machine and then transferred to the AAA Screening Images on the network drive([\\qdata1\](file:///\\\\qdata1\\)).

The AAA report form for the NAAASP should be completed; any incidental findings should be reported on the form.

If the aorta measures larger than 5.5cm then the reports should be sent urgently to the screening program office.

**Arterial Duplex of Lower Limb**

Purpose

This duplex ultrasound examination is used to assess the arteries of the lower limb from aorta to ankle to determine the location and severity of vascular disease (occlusive and aneurysmal).

The Vascular Lab will accept referrals from the Vascular Surgical Team and for the following appropriate reasons:-

* Plastic Surgery for imaging the crural vessels to help with skin flap formation.
* Transplant surgeons to assess iliac patency prior to kidney transplant.
* Cardiac surgery for assessment of iliac arteries for patient that may require cardiac access from the groin.
* Diabetic team for foot ulcers and absent foot pulses.

Common Indications

Indications for a lower limb arterial duplex ultrasound include:

* Intermittent claudication
* Ischaemia rest pain
* Gangrene
* Ulceration
* Follow-up imaging post-angioplasty/thrombolysis (+/- stent) or post-surgery (embolectomy, endarterectomy, bypass graft).
* Evaluation of aneurysm, pseudo aneurysm

Contraindications and limitations

There are very few contraindications for lower limb arterial duplex imaging; however the following limitations may affect the scan quality and completeness.

* Patient immobility – e.g. fixed flexion deformity, inability to move lower limb.
* Arterial calcification, particularly of the crural vessels
* Patient habitus and bowel gas may limit the successful imaging of the aorta and iliac vessels.
* Ulcers, casts, dressings, wounds etc. may affect the ability to image certain areas.

Patient positioning

The patient should remove lower limb clothing to expose the leg from the groin to the ankle. The examination is performed supine with the leg externally rotated; the patient’s position may need to be altered to obtain adequate views of the popliteal artery.

Procedure

The examination can be of one limb or both depending in the patients symptoms. The scan should generally start at the level of the common femoral artery (CFA) and the arteries should be imaged from groin to the ankle.

If triphasic waveforms were not obtained from the CFA, or there is an increased rise time/acceleration time, >100ms, (Oates, 2001), or there is clinical suspicion of aorto-iliac disease then the aorta, common iliac (CIA) and external iliac artery (EIA) should also be investigated.

Young patients and patients with distal occlusive disease may have triphasic flow in CFA in the presence of iliac disease (Sensier et al, 1998) and the iliac segments may need to be examined in this group of patient.

If there is disease in the CIA/EIA or CFA then the contralateral CFA +/- CIA and EIA should be accessed to determine patency for radiological access.

If both anterior tibial (AT) and posterior tibial (PT) vessels are patent it is not usually necessary to access the peroneal vessel as well.

Interpretation and grading of the disease

All segments should be imaged in order to determine the patency, stenosis, presence of disease and aneurismal dilatations with a view to producing a site-specific, representative map.

Velocities and phasisity of waveforms should be recorded at various points along the arterial tree, specifically CFA, profunda femoris (PFA) origin, superficial femoral (SFA) origin and distally, popliteal artery (PopA) distally, AT and PT distally. For areas of stenosis the highest velocity through the stenosis and the velocity approximately 2cm proximal to the stenosis should be recorded. Stenosis should be graded using the following velocities ratios:

|  |  |
| --- | --- |
| **Velocity Ratio** | **Diameter reduction** |
| <2 | 0 – 49% |
| >2 | 50 – 74% |
| >4 | 75 – 99% |
| No flow detected | Occluded |

Reporting of the results

The report should be recorded on an arterial duplex form. Flow velocities and the phasicity of the waveform, together with the location and degree of stenosis/occlusions should be recorded on the diagram. The length of occlusions and dimeter of occluded vessels should also be included to help in treatment planning. The diameters of arteries if abnormal (larger or smaller than average diameters) should also be included.

The written report should describe the findings; giving site of and reasons for any sub-optimal areas of the scan, or vessels not imaged.

References

Oates, C: Cardiovascular Haemodynamics and Doppler Waveforms Explained. 2001 Greenwich Medical Media Ltd

Kohler TR, Nance DR, Cramer MM, Vandenburghe N, Strandness DE: Duplex scanning for diagnosis of aortoiliac and femoropopliteal disease. A prospective study. Circulation 76:1074-1080 (1987).

Sensier, Y, Bell, P, London, N, (1998) “The ability of qualitative assessment of the common femoral doppler waveform to screen for significant aortoiliac disease.’ European Journal of Vascular and Endovascular Surgery. 15(4): 357-64.

Resources

Society for Vascular Ultrasound Vascular Technology Professional Performance Guidelines Lower Limb

Extremity Venous Duplex Evaluation 2011 www.svunet.org

American Institute of Ultrasound in Medicine Practice Guideline for the Performance of Peripheral Venous

Ultrasound Examinations 2010 www.aium.org

Australasian Society for Ultrasound in Medicine Policies and Statements D20 Peripheral Venous Ultrasound

2007 www.asum.com.au

**Carotid Artery Assessment**

**Purpose**

Extracranial cerebrovascular Duplex ultrasound examinations are carried out to assess for the presence of pathology and the haemodynamic status of the common carotid artery (CCA), internal carotid artery (ICA) external carotid artery (ECA) and vertebral artery. The department will accept direct referrals from Vascular Surgery, Stroke Medicine and Neurology.

**Common Indications**

* Common indications for performance of this examination can include:
* Transient ischemic attacks (TIA)
* Amaurosis fugax
* Cerebrovascular Accident (CVA)
* Follow-up of known carotid stenosis
* Post intervention follow-up e.g. carotid endarterectomy, stent or bypass
* Trauma in the distribution of the carotid artery e.g. suspected dissection, arteriovenous fistula or pseudo aneurysm
* Pulsatile neck masses
* Evaluation of suspected subclavian steal syndrome

**Examination:**

The patient is asked to adjust their clothing to expose the neck area. The patient is examined in the supine position with their head/neck positioned in such a manner that allows the CVS maximum access to the vessels to be examined. The patient’s dignity and privacy should be maintained at all times.

The standard examination should examine bilaterally the arterial supply to the head encompassing the common carotid artery (CCA), carotid bifurcation, external carotid artery (ECA) and internal carotid artery (ICA) to its most accessible distal extracranial segment. The vertebral artery should be identified to confirm direction of flow. In the presence of reversed or partially reversed flow the subclavian artery should be examined.

The CCA, carotid bifurcation, ECA and ICA are identified in B Mode using the transverse plane and longitudinal plane; B-mode can be used to classify echogenicity of any plaque according to the Gray-Weale Plaque Classification.

**Gray-Weale Plaque Classification.** Gray-Weale AC et al (1988)



Type 5 Unclassified / Calcified

Using longitudinal plane with colour and spectral doppler, the extracranial carotid arteries should be assessed for any areas for velocity increase or turbulence from the CCA to the distal ICA and the vertebral artery.

Peak systolic velocities (PSV) and end diastolic velocities (EDV) should be measured and documented for the CCA and ICA, and PSV for the ECA. Direction of flow must also be documented in the vertebral artery.

The anatomical location of any haemodynamically significant lesion should be documented.

The CAVATAS criteria below should be used primarily for grading stenosis.

|  |  |  |  |
| --- | --- | --- | --- |
| % Diameter Reduction | PSV (cm/s) | EDV (cm/s) | PSVICA/PSVCCA |
| 0-29 | <100 | <40 | <3.2 |
| 30-49 | 110-130 | <40 | <3.2 |
| 50-59 | >130 | <40 | <3.2 |
| 60-69 | >130 | 40-110 | 3.2-4.0 |
| 70-79 | >210 | 110-140 | >4.0 |
| 80-95 | >210 | >140 | >4.0 |
| 96-99 | "STRING FLOW" | | |
| 100 | "NO FLOW" | | |

Adapted for CAVATAS from Sidhu P and Allan P. (1997).

These criteria apply to grading of ICA stenosis only and the percentages are equivalent to NASCET diameter stenosis.

The *Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom* CP Oates et al, can also be used if required to help stratify any discrepancies in grading from the CAVATAS criteria. ICA PSV/ CCA PSV of greater than 2 is particularly useful as a discriminator of greater than 50% stenosis.

*Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom*

CP Oates et al

|  |  |  |  |
| --- | --- | --- | --- |
| Percentage Stenosis (NASCET) | Internal carotid peak systolic velocity cm/sec | Peak systolic velocity ratio  ICA PSV /CCA PSV | St Mary’s Ratio  ICA PSV /CCA EDV |
| <50 | <125 | <2 | <8 |
| 50-59 | >125 | 2-4 | 8-10 |
| 60-69 |  |  | 11-13 |
| 70-79 | >230 | >4 | 14-21 |
| 80-89 |  |  | 22-29 |
| >90 but less than near occlusion | >400 | >5 | >30 |
| Near occlusion | High, low - string flow | Variable | Variable |
| Occlusion | No flow | Not applicable | Not applicable |

### The following criteria should be used for grading ECA stenosis:-

Normal – no evidence of plaque present

### Minor – PSV <200cm/sec

### Moderate – PSV 200-300cm/sec

### Severe – PSV >300cm/sec

**Zwiebel, 2000**

The following criteria should be used for grading CCA disease:-

Normal – no intimal thickening or plaque seen

Intimal thickening - when intima measures ≥0.10cm

Minor – minor wall plaques with no change in velocity

Moderate – large wall plaques but no velocity change

>50% stenosis- plaque present with a doubling of velocity compared to proximal CCA

**The Report**

The reporting should include:

* Which arteries have been assessed & record the presence/absence of disease
* The following velocities should be recorded on the report form:
  + PSV & EDV in the CCA 1-2cm below the bifurcation
  + PSV & EDV in the ICA at the point of highest velocity
  + PSV in the ECA at the point of highest velocity
* Percentage degree of stenosis
* Any limitations e.g. calcified plaque causing acoustic shadowing

**RESOURCES:**

Society for Vascular Ultrasound Vascular Technology Professional Performance Guidelines Extracranial Cerebrovascular Duplex Ultrasound Evaluation 2011 www.svunet.org

American Institute of Ultrasound in Medicine Practice Guideline for the Performance of an Ultrasound

Examination of the Extracranial Cerebrovascular System 2011 www.aium.org

Australasian Society for Ultrasound in Medicine Policies and Statements D17 Extracranial Cerebrovascular Ultrasound www.asum.com.au

Physiological Measurement – Service Specifications Vascular Technology Test: Carotid Duplex www.svtgbi.org.uk

de Bray J M, Baud J M, Dauzat M 1997 Consensus concerning the morphology and the risk of carotid plaques. Cerebrovascular Disease 7: 289–296

European Carotid Plaque Study Group 1995 Carotid artery plaque composition – relationship to clinical presentation and ultrasound B-mode imaging. European Journal of Endovascular Surgery 10: 23–30

Bock RW et al Carotid plaque morphology and interpretation of the echolucent lesions. Diagnostic vascular ultrasound. Edward Arnold, London, pp 225–236 1992

Carotid artery stenosis: grey-scale and Doppler ultrasound diagnosis – Society of Radiologists in Ultrasound Consensus Conference’ Grant EG et al Radiology 2003; 229: 340-346

Oates CP et al., Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom, Eur J Vasc Endovasc Surg (2008), http://www.bmus.org/policiesguides/CarotidRecommendationsPublishedPaperCO.pdf

National Institute for Health and Clinical Excellence Stroke Diagnosis and initial management of acute and transient ischaemic attack (TIA) July 2008 www.nice.org.uk

**Venous Duplex Assessment for DVT and Deep Venous Insufficiency of the Lower Limb**

**Purpose**

Duplex ultrasound examination is used to assess the deep and superficial venous system of the lower limb (groin to ankle level) to determine the presence or absence of thrombosis and incompetence. The department will only accept referrals from the vascular surgeons.

**Common Indications**

Common indications for performance of this examination include:

* Swelling
* Pain
* Tenderness
* ? Source of pulmonary embolism (PE)
* Post Thrombotic Syndrome

**Contraindications and Limitations**

* Contraindications for lower limb venous duplex ultrasound for the assessment of DVT are unlikely; however, some limitations may preclude a complete examination and may these could include :-
* Obesity
* Casts, dressings, open wounds etc can limit visualisation.
* Severe oedema/swelling.
* Limited mobility
* Patients who are unable to cooperate due to reduced cognitive functions e.g.
* Alzheimer’s or dementia and through involuntary movements Examinations undertaken portably at the patient’s bedside maybe limited due to equipment and room dimensions
* Patient discomfort
* When examining the abdominal veins bowel gas

**Examination:**

The patient is asked to expose the lower limb from groin to ankle. The patient is examined in the supine position with couch in a reversed Trendelenburg position and the leg externally rotated.

The calf vessels may be examined with the patient sat on the edge of the couch with the leg dependant.

Start the examination in the groin at the level of the common femoral vein (CFV).

The CFV should be examined to assess for spontaneous flow respiratory and cardiac modulation, augmentation, compressibility and colour filling.

If abnormal/none phasic flow is detected in the CFV the iliac veins and inferior vena cava need to be examined.

If thrombus is detected in the CFV the diameter of the vein and distance the thrombus is from the bifurcation should be recorded.

Continue to examine the lower limb veins distally examining the length of the femoral vein (FV), the proximal profunda femoris vein (PFV), and popliteal vein (PopV) for patency and signs of DVT or thrombotic scarring.

For acute DVT referrals the calf veins (gastrocnemius veins, posterior tibial veins and peroneal veins) should be imaged as above commenting on patency and signs of DVT or thrombotic scarring. This may be performed either with the patient supine or sitting up.

The upper great saphenous (GSV) and small saphenous vein (SSV) should be examined and if thrombus is noted within 5 cm of the sapheno-femoral (SFJ) or sapheno-popliteal junction (SPJ) this should be highlighted on the report. The length of the thrombosed section should be reported.

If thrombus is identified in any of the veins examined the extent of the thrombus should be quantified making reference to the anatomical position of the thrombus and it’s upper and lower extent with reference to anatomical landmarks; whether it is occlusive, non-occlusive or free-floating. An attempt should be made to evaluate if the thrombus is acute or chronic, from its echogenicity, attachment and vein dilation.

If the referral is for chronic venous insufficiency then the veins need to be assessed for reflux. A measurement of reflux in the distal PopV with calf augmentation, and with the patient sitting on the edge of the couch with the leg dependant, should be measure as a baseline point for any futures scans on that patient. The reflux should be quantified for duration and high or low volume flow, a pictorial representation of augmented flow and reflux flow with time measurements and peak velocities may be useful.

**Reporting:**

The reporting should include:

* The presence/absence of phasic flow in the proximal veins
* Which veins have been assessed & record the presence/absence of thrombus
* Where thrombus is identified, the location, length/extent, degree of restriction should be estimated for the CFV, proximal FV, distal FV and the popliteal vein(more or less than 50% restricted) and whether the thrombus is acute or chronic should be documented
* Any limitations encountered during the examination

**Venous Duplex Assessment for Incompetence of Lower Limb**

**Purpose**

The test will document the presence of thrombus, the presence and degree of reflux in the deep or superficial venous systems. The anatomy of the varicosities and the presence of incompetent perforators.

The unit with receive referrals from patients with recurrent varicose veins, complicated primary veins, venous ulcers, suspected deep vein thrombosis or deep vein insufficiency. The unit will only receive referrals via a vascular surgeon or the multidisciplinary Leg Ulcer Clinic or Lymphedema clinic.

## Procedure

The CFV, FV and Pop V should be assessed as per the **Venous Duplex Assessment for DVT and Deep Venous Insufficiency of the Lower Limb protocol.**

The patient should be positioned supine in the reversed Trendelenburg position, standing with the weight on their contralateral leg or sitting/resting on the edge of the couch with the leg dependant.

* the saphenofemoral junction (SFJ) should be assessed for patency and reflux using distal compression or valsalva.
* the presence and competency of any anterior or posterior tributaries should be noted.
* the great saphenous vein (GSV) is scanned throughout its length and assessed for patency, competency, presence of thrombotic scarring and site of any perforators.
* the diameter of GSV should be noted, if it is incompetent, to help determine the most suitable treatment.
* The patient’s position may need to be adjusted to enable the PopV to be accessed for patency, competency and thrombus.
* the saphenopopliteal junction (SPJ) should be assessed for patency and reflux using distal compression. Variations in anatomy such as high junctions and giacomini veins should be noted.
* the small saphenous vein (SSV) is scanned to the lateral aspect of the ankle noting any large tributaries, perforators, thrombus or incompetence.
* If the SSV is incompetent then diameters need to be recorded.

Any varicosities that have not been accounted for by completed the above steps should be imaged directly to determine their origin and diameters of vessels.

Reflux identified should be graded as follows:-

* + <0.5 seconds competent
  + >0.5 seconds incompetent

*Coleridge-Smith et al*

The below criterial for treatment suitability should be used.

RF/VNUS ablation

An incompetent segment of GSV or SSV, of at least 10cm in length, through which a catheter would be able to be passed. Veins that are too tortuous or have significant thrombotic scarring are not likely to be suitable for this treatment.

Foam treatment

Veins that are too large are not likely to be suitable for this treatment. GSV were a significant portion of the vein is larger than 9mm in diameter, SSV were a significant portion of the vein is larger than 7mm or where there are numerous large varicosities of greater than 7mm should be flagged as not suitable for foam treatment.

Reference

Coleridge-Smith, P, Labropoulos,N, Partsch H, Myers K, Nicolaides A, Cavezzi A. Duplex ultrasound

investigation of the veins in chronic venous disease of the lower limbs –UIP Consensus Document. Part 1 Basic principles. Eur J Vasc Endovasc Surg 2006; 31:83-92,

**Iliac Scanning protocol for assessment for organ transplant**

**Background**

Kidney (and pancreas) transplants are performed when the native organ is failing, to improve the patient’s quality of life, and, in kidneys patients, remove the need for dialysis. Imaging of the aorto-iliac vessels pre transplantation is primarily performed for surgical planning (Benjamens et al, 2020). Peripheral vascular disease/calcification is very prevalent among patients with end-stage renal disease and can jeopardize the organ transplantation (DeBolle et al 2016). In some cases, a pre-operative endarterectomy may be performed, to improve the outcome of the organ transplant (Ploussard et al, 2009). Knowing both the arterial and venous status of the recipient vessels allows the surgeons to plan the procedure. The size of the iliac vessels is only important comparatively, to help select the most suitable vessels, i.e. the side with the larger vessels will likely be chosen for the operation.

**Indications:**

The patient is near requiring an organ transplant. The iliac vessels are scanned to assess suitability for transplant and plan any future procedures.

At NUH, the transplant or renal consultants will request iliac assessment if the groin pulses are poor or if they are to be referred to Cambridge for a pancreas transplant.

**Contraindications/Limitations:**

* Excessive bowel gas
* Large body habitus
* Stoma bag/external line inserted

**Protocol**

Arterial:

Using B-mode, colour Doppler and spectral Doppler, assess the aorta, CIA, EIA and CFA bilaterally.

For each vessel:

* measure diameter in mm, taking note of any significant variations in size (ectatic, aneurysmal, small calibre)
* take a waveform and record velocity in cm/s
* Note any stenosis, calcification or other disease and grade it accordingly (>50%, minor, <50%, plaque, thrombus).

Venous:

Using B-Mode, colour Doppler and spectral Doppler assess the IVC, CIV, EIV and CFV bilaterally.

For each vessel:

* measure diameter in mm, taking note of any variations in size
* Check the flow is phasic with respiration
* Note any DVT or scarring, measuring the lumen size/diameter reduction

In the CFV, perform a Valsalva manoeuvre to check the veins are competent.

**Report**

Collate all information using the iliac transplant assessment report sheet, including all the measurements outlined above.

Send a PDF copy of the report to the requesting consultant via email, and upload onto NOTIS.

**Reference List**

Benjamens, S., Rijkse, E., te Velde-Keyzer, C., Berger, S., Moers, C., de Borst, M., Yakar, D., Slart, R., Dor, F., Minnee, R. and Pol, R., 2020. Aorto-Iliac Artery Calcification Prior to Kidney Transplantation. *Journal of Clinical Medicine*, 9(9), p.2893.

DeBolle, S., Ochieng, I., Saha, A. and Sung, R., 2020. Evaluation of the Effectiveness of Screening for Iliac Arterial Calcification in Kidney Transplant Candidates. *Annals of Transplantation*, 25.

Ploussard, G., Mongiat-Artus, P., Meria, P., Tariel, E., Gaudez, F., De Kerviler, E., Legendre, C., Peraldi, M., Glotz, D. and Desgrandchamps, F., 2009. What is the relevance of systematic aorto-femoral Doppler ultrasound in the preoperative assessment of patients awaiting first kidney transplantation: a monocentric prospective study. *Nephrology Dialysis Transplantation*, 25(1), pp.270-274.

**Endovascular Aneurysmal Repair Assessment**

**Purpose**

Surveillance is a critical component to the overall EVAR treatment. It is predicted on the assumption that the natural history after endovascular repair is unpredictable hence a lifelong surveillance is recommended without exceptions. Its purpose is to aid in assessment of complications such as endoleak, limb dysfunction, stenosis enlarging aneurysmal size or other anatomical or hemodynamic impairment that affects endograft function.

**Common Indications**

Following EVAR operation, surveillance must be done at a certain interval.

-Post-OP (within day 1 or 2)

-Routine yearly scan (based on date of operation)

(A CT scan is performed at approximately 6 weeks)

ASSESSMENTS INCLUDE:

Measurement of residual sac

Assess for presence of endoleak

Graft patency

In-stent or Graft stenosis and kinking

Distal outflow

Presence of seroma, pseudoaneurysm or collection on the access site.

Scan x-over graft for patency, stenosis, false aneurysm and graft infection or collection (only if applicable)

Contraindications and limitations

The following limitations may affect the scan quality and completeness.

Patient body habitus

Presence of extensive bowel gas

Patient unable to lie flat on bed

Graft shadowing or attenuation

Patient discomfort

Dressings or open wounds on the examination site

Abdominal wall hernias

Presence of ascites

Vessel or graft tortuosity

Technical consideration: It is important to know the details of the procedure prior to scan. This will assist in understanding structural details of what has been placed, what normal anatomy may have been altered and what complications may be associated with device placed. Obtain History of previous treatment e.g. angioplasty or embolization. Obtain results of other relevant diagnostics & previous vascular studies.

**Communication and patient positioning**

The patient should lie flat and adequately exposed for imaging the abdomen, flanks and groins. Encourage patient to report any discomfort when doing the test. Obtain optimal images with the least amount of discomfort.

Procedure

B-MODE

• Optimize machine settings and select appropriate transducer.

• Routine post-placement ultrasound includes high resolution B-mode assessment of entire endograft attachment sites and entire residual aneurysm sac.

• Scan aorta with anterior approach B-mode in transverse plane.

• Obtain maximum AP long and transverse diameter of the residual sac and record.

• Examine the residual aneurysm sac for areas of echolucency or motion/pulsation in the excluded lumen that may represent endoleak.

COLOUR FLOW IMAGING:

* Turn the colour flow imaging to assess flow and presence of endoleak.
* Scan entire endograft and aneurysm sac from the diaphragm or origin of renal down to common femoral arteries, evaluating the stent for integrity and kinking.
* Any complications following endograft placement (i.e. stenosis, occlusion, hematoma, arteriovenous fistula, intimal flaps, dissection or pseudo aneurysm at access sites) should be thoroughly documented.
* When intervention (PTA with or without stent) has occurred for occlusion disease, the length of treated are should be carefully assessed, particularly if stent (s) have been placed.
* The stent should be evaluated for alignment, full deployment and relationship to the vessel wall. The Doppler cursor should be carefully walked throughout the entire length of the stents.
* Examine the aneurysm sac throughout in both sagittal and transverse planes to detect flow that may represent endoleak. Special attention should be directed to hypoechoic areas and absence of flow confirmed by Doppler.
* Examine carefully the proximal and distal stent graft attachment sites and to the origin of the inferior mesenteric and lumbar arteries to detect endoleak(s).
* Record colour Doppler image of patent aneurysm sac branches (i.e. lumbar, inferior mesenteric artery, internal iliac artery) and document flow direction
* Record PW spectral waveforms of the endoleak detected (document direction of flow and the source of flow and characteristics of the waveform (low resistance, high resistance or ‘to and fro’)
* Identify endoleak(s) as to location and origin (see classification table) and should be included in the report.
* Arterial flow hemodynamic were documented throughout the endograft using spectral Doppler velocity measurements.
* Colour Doppler imaging was adjusted for optimum sensitivity for lower velocities.
* Peak systolic velocities were obtained in the iliac vessels to assess for presence of limb flow anomalies

Reporting:

* Report should be done by the Scientist who performed the scan.
* Report should include maximum residual sac size.
* Endoleak (s) should be described and reported according to table below:

Endoleak Type:

* + Type Ia Ib Proximal (a) or distal (b) limb attachment leak
  + Type II Lumbar or IMA vessel involvement
  + Type III Graft fabric tear or modular limb connection failure
  + Type IV Sac increase due to graft porosity
  + Type V Sac increase due to endotension
* EIA flow velocities/waveform and acceleration time.
* Flow assessment of the crossover graft should be included (if applicable) Include any incidental findings on the report e.g. false aneurysm, seroma, haematoma, dissections etc.
* Include any limitation of the study e.g. large firm abdomen, overlying bowel gas, patient habitus, calcification etc.

Inform the referring consultant or SpR Vascular on call for any critical result, such as a newly diagnosed type 1 endoleak so that appropriate treatment plan can be enforced prior to patient discharge.

EVAR follow up protocol

|  |  |  |  |
| --- | --- | --- | --- |
| Time interval post op | Duplex | CT | Abdo X Ray |
| Pre discharge | yes | - | yes |
| 3 months | - | yes | - |
| Yearly | yes | - | no |

fEVAR follow up protocol

|  |  |  |  |
| --- | --- | --- | --- |
| Time interval post op | Duplex | CT | Abdo X Ray |
| Pre discharge | yes | - | yes |
| 3 months | - | yes | - |
| Yearly | yes | Yes (for first 5 years) |  |

Recourses:

From the Society for Clinical Vascular Surgery Duplex ultrasound imaging alone is sufficient for midterm endovascular aneurysm repair surveillance: A cost analysis study and prospective comparison with computed tomography scan

Brian R. Beeman, MD, Lynne M. Doctor, BA, Kevin Doerr, RVT, Sandy McAfee-Bennett, RVT,

Matthew J. Dougherty, MD, and Keith D. Calligaro, MD, Philadelphia, Pa

Journal of vascular Surgery Volume 50, Issue 5, November 2009, Pages 1012-1018From the Southern Association for Vascular Surgery Endoleak after endovascular aneurysm repair: Duplex ultrasound imaging is better than computed tomography at determining the need for intervention Greg C. Schmieder, MD, Christopher L. Stout, MD, Gordon K. Stokes, MD, F. Noel Parent, MD, and Jean M. Panneton, MD, Norfolk Va

**Arterio-Venous Fistula Pre op Duplex Mapping**

Purpose

Vein Mapping is done for the purpose of assessing suitable veins that will be needed for the creation of haemodialysis access. The unit will accept referrals via the Renal or Vascular consultants.

Contraindications and limitations:

The following limitations may affect the scan quality and completeness

* Patients with open wounds, fresh incision, ulceration or skin staples
* Patients with oedema, pain
* Patients who are unable to cooperate due to reduced cognitive functions e.g.

Alzheimer’s or dementia and through involuntary movements

* Patient position and inability to move ( surgical procedure , traction or paralysis)
* Some examinations undertaken portably at the patient’s bedside maybe limited due to equipment and room dimensions.

**Patient positioning**

The patient may be sitting or resting supine with arms dependent. Patient position should be optimized to help dilate the veins. The room should be kept warm to reduce the risk of vasoconstriction and the application of a tourniquet may be useful for small calibre veins.

Patient should ideally remove their clothing to enable access to the whole of the arm. For leg veins the patient should be kept supine in the reverse **Trendelenburg position.**

**Procedure:**

The Examination starts with the Radial artery at the wrist, velocity, waveform and diameter are measured at this point and recorded. (Optimal internal measurement should be >2.0mm) Follow the radial artery up the arm, back into the brachial artery where again the velocity waveform and diameter are measured and recorded. If the waveform is good bi/triphasic flow with a good upstroke in the radial and brachial arteries there is no need to examine the more proximal arterial tree. However, if significant disease is suspected from the brachial artery waveform then more proximal imaging is necessary. A high bifurcation of the brachial artery should be recorded, and in this instance the waveform, diameter and velocity of the radial and ulnar arteries at the elbow should be recorded. The waveform in the ulnar artery at the wrist should be performed, if this is good bi/triphasic flow then there is no need to examine the remainder of this vessel. The presence of wall calcification and stenosis should be included in the report.

Identify and measure the cephalic vein at the wrist, noting also if it is posterior or lateral. Follow the cephalic vein up the arm and measure at each point where it seems to significantly change diameter, usually 2-3 measurements of the lower arm cephalic vein is sufficient. The vein should also be compressed by probe pressure as you move up the arm, taking note of any thrombus, scarring, and thickened valves within the vessel. At the elbow, note into which veins the lower arm cephalic drains, sometimes it will just continue up the arm and becomes the upper arm cephalic vein, but it often drains via the basilic vein, perforators and the upper arm cephalic. Locate the upper arm cephalic vein, begin at the elbow and measure this again at points of significantly changing diameter, and also examine the vein for thrombus right up to the anastomosis with the subclavian vein. Usually a 2-3 point of measurement of the upper arm cephalic is sufficient. If a good calibre cephalic vein is present from the wrist on the non-dominant hand it is not necessary to scan the other arm.

Next examine the calibre and presence of thrombus in the basilic vein from the elbow up into the axilla. With the basilic vein the point at where it drains into the deep veins of the arm can be variable, and ideally for a BVT fistula a long length of superficial length is needed, therefore if the BVT drains into the brachial veins rather than the axillary veins, it needs to be documented that the basilic vein is short. Once the superficial veins of the arm have been examined, proceed to the shoulder to examine the subclavian vein. Identify the subclavian vein and use spectral Doppler to interrogate the flow with the vessel and ensure that it is phasic. A subclavian vein with continuous flow may indicate a more proximal occlusion/stenosis.

If there forearm cephalic vein measures less than 2.5mm in diameter then place a tourniquet around the around the upper forearm for approximately 2min and repeat the diameter measurements of the cephalic vein at the wrist. If the cephalic vein remains unsuitable for fistula creation the procedure should be repeated for the other arm.

If the patient has a pace maker in place then both arms should be scanned.

**Leg mapping**

Examine the arterial circulation of the leg from the CFA to distal SFA as per lower limb arterial protocol include the vessel diameters and any stenosis on the report.

Examine the CFV, FV and the POPV as per the DVT protocol and note the CFV diameter.

The GSV needs to be assessed for thrombus, scarring and thickened valves and calibre to the knee level and also noting large branches. Both legs should be assessed

REFERENCE:

Norris R, Walker R., Donald A. (2005) Vascular Laboratory Practice (First Edition)

VASCULAR TECHNOLOGY PROFESSIONAL PERFORMANCE GUIDELINES Lower Extremity Vein Mapping 2011 http://account.svunet.org/files/positions/LE-Vein-Mapping-2011.pdf

**Arterio-Venous Fistula Duplex Assessment**

**Purpose**

Duplex ultrasound is used to assess the function of arterio-venous fistulae (AVF) for

haemodialysis. This guide can be used in conjunction with local protocols agreed between sonography and renal and/or vascular departments.

**Common Indications**

Common indications for performing this examination include:

* post-op. surveillance
* ?failing AVF (e.g. pulsatile flow, low arterial volume, high venous pressure)
* difficulty accessing for dialysis
* suspected steal syndrome
* arm swelling
* ?aneurysm or false aneurysm
* post intervention (e.g. angioplasty.)

**Contraindications and Limitations**

Contraindications or limits for AVF examination include:

* wound dressings
* recent bleeding from the access site
* very aneurysmal or tortuous fistula
* patients unable to cooperate due to impaired cognition (e.g. dementia) or from involuntary movements.

**Examination**

The patient is asked to remove their clothing to expose the upper limb. The patient is

examined in the seated position or supine, head and shoulders can be raised. The limb to be examined may be abducted to nearly 90 degrees and the arm rested on the CVS’s lap/pillow.

When possible, it is best to assess fistulae before dialysis. Examine the entire fistula circuit, from arterial inflow to distal venous outflow. Pay particular attention to the anastomosis, perianastomotic region, and the region for dialysis access, any areas of aliasing, and the outflow vessels.

The examination should generally start with measurement of volume flow within the brachial artery. Volume flow measurements should be repeated three times as there is a large source of error in these measurements and the average reading should be recorded (discounting any anomalous measurements). The inflow artery (Brachial in a Brachio-cephalic fistula, Radial and Brachial in a Radio-cephalic fistula) should also be examined for stenosis as in the upper limb arterial duplex protocol. If the patient is complaining of a very cold or painful hand, then the AVF may be stealing blood from the hand. In this instance the distal radial artery should be checked for reverse flow and the ulnar artery examined.

Proceed to the arterial anastomosis and examine for narrowing. High velocities can be expected at a normal anastomosis, and therefore deduction of a stenosis purely from velocity information can prove difficult. If a stenosis is suspected it may help to also measure the residual lumen. At the anastomosis a lumen measurement of 3mm is usually considered adequate. In addition, sometimes the aliasing, colour bleeding and turbulent flow in the colour Doppler mode can make it difficult to examine the anastomosis. In this instance B-flow can be helpful in examining the flow and vessel calibre at the anastomosis.

Following examination of the anastomosis the anastomosed vein should be followed throughout its length to examine for stenosis should be quantified in the same way as arterial scans with areas of aliasing on colour flow being interrogated with spectral Doppler, with a doubling in velocity generally representing a significant stenosis of >50%. However, in AVF’s there may be instances where a doubling in velocity may represent just a change in calibre of the vein rather than a stenosis itself. This can be seen in large almost aneurysmal fistulas, where the velocity is low through the aneurysmal section and then as the fistula becomes normal calibre again the velocity through this segment may more than double, without there actually being a stenosis as such. Lumen measurements again can be useful in this instance as segments where the lumen exceeds 4-5 mm are rarely have a significant (>50%) stenosis despite the apparent increase in velocity from the adjacent segment. If a stenosis is identified the velocities should be recorded on the report sheet. Sometimes it may be possible to see the cause of the stenosis, such as a valve, and this should also be recorded.

Volume flow measurements should be obtained from the fistula, preferably at a site with least turbulence and uniform vein diameter (which will depend on the site and anatomy of the fistula) and again flow measurements should be repeated three times and average reading should be recorded (discounting any widely anomalous measurements). The fistula should be followed to the deep venous anastomosis in a Brachio-cephalic and Basilic vein transposition and examined for stenosis. If an outflow stenosis is suspected, e.g.  high venous pressures on dialysis or prolonged bleeding following dialysis, the Subclavian vein should also be assessed for stenosis. Sometimes if examined with the patient sitting up, the Subclavian vein can be compressed and may show to be narrow in calibre with elevated velocities. In this instance the patient should be asked to lie back on the couch and the Subclavian vein re-examined. In a radio-cephalic fistula the fistula should be followed usually until suitable drainage has been identified as these often drain via the upper arm cephalic, the Basilic vein and perforators at the elbow. Sometimes however, needling sites in and RC fistula may be in these upper arm vessels, in which case this vessel needs to be examined in its entirety to the anastomosis with the deep veins.

It is useful also to examine the fistula in cross section as this can help give a general overview of the AVF and identify any large branching vessels. Large branching vessels can divert flow away from the main vein and these should be documented on the report and the volume flow measured. Moreover, scanning in cross section may also help to identify any aneurysmal sections, (although these should be measured in long section).

Characterization of collections should also be noted (may be abscess, haematoma or seroma for queries of fistula swelling be sure to rule presence of false aneurysm.

In cases wherein a false aneurysm has been detected, measure the size of the false aneurysm AP long and transverse (mm) identify the size of the defect and note whether the aneurysm is patent or not.

Referral of urgent results should be made to the referring consultant and/or appropriate medical/surgical team as per local protocol, so treatment plans can be developed, enforced or expedited accordingly.

**RESOURCES:**

Society for Vascular Ultrasound; Vascular Technology Professional Performance Guidelines; Evaluation of Dialysis Access 2012 www.svunet.org

Society for Vascular Technology Physiological Measurement Service Specifications; Duplex Assessment and Surveillance of Arteriovenous (AV) Fistula (pre and post fistula formation) www.svtgbi.org.uk

American Institute of Ultrasound in Medicine Practice Guideline for the Performance of a Vascular Ultrasound Examination for Postoperative Assessment of Dialysis Access 2007 www.aium.org

Freedman B, Deane C. Ultrasound in Haemodialysis Access. *Ultrasound* (2005) 13:2 86-92

Cullen N, Powell S. Interpretation of duplex in Arteriovenous dialysis access: a review of pathologies.

Ultrasound 2011; 19:76 - 84. American Institute of Ultrasound in Medicine Practice Guideline for the Performance of a Vascular Ultrasound Examination for Postoperative Assessment of Dialysis Access 2007 www.aium.org

Ferring M, Henderson J, Wilmink A, Smith S. Vascular ultrasound for the pre-operative evaluation prior to arteriovenous fistula formation for haemodialysis: review of the evidence. *Nephrology Dialysis Transplant* (2008)23: 1809-1815

**Temporal Artery Scans**

The vascular Lab accepts direct referrals from the Rheumatology or Ophthalmology team via emails for patients suspected of having giant cell arteritis (GCA).

Referral Criteria

* Suspect GCA in patients aged >50 presenting with raised inflammatory markers (preferably CRP) and relevant clinical features which include:
* Recent onset headache, usually temporal
* Scalp pain
* Jaw or tongue claudication
* Visual symptoms (amaurosis fugax, visual loss, blurring or diplopia)
* Temporal artery abnormalities
* Patients not fulfilling these criteria do not fall within the remit of this pathway

Patients will be started on prednisolone treatment when suspected of GCA so the ultrasound appointments should be made ideally within 48hr of referral. If the result of the ultrasound is negative the patients will need a biopsy appointment for further investigation. The results of the ultrasound scan should be emailed to [tab.referrals@nuh.nhs.uk](mailto:tab.referrals@nuh.nhs.uk) on the same day.

Machine Settings

The hockey stick L8-18i (or 12ML) probe should be used.

Grey Scale Settings

* Frequency 18MHz
* Focus 5mm
* Depth 1-2cm
* B gain 35-45dB
* Line density 3
* Frame rate>15

Colour Settings

* Frequency 10MHz
* PRF 2-3kHz
* Wall filter as low as possible
* Colour gain 2-18

Scan Technique

The patient should be supine with the head rotated away from the side of investigation. Start imaging from the level of the tragus. The common superficial TA and its proximal frontal, distal frontal and parietal branches should be imaged along their length in both transverse and longitudinal planes. The diameter and intimal thickness in the longitudinal plane of each of these vessels should be measured and stored.

An increase in diameter of the intima creating a ‘halo’ appearance is regarded as a positive indicator for GCA. If a halo sign is suspected pressure should be applied with the transducer to compress the vessel. Incomplete compression is confirmation of a halo sign.

Excessive tortuosity of the vessels making complete visualization difficult should be reported.

Area of stenosis or arteriosclerosis(hyperechoic irregular walls) should also be noted but are not indicators of GCA.

Both sides of the head should be examines as well as the axillary arteries.

See below table for reporting degree of intimal thickness.

Common superficial >0.42mm

Frontal branch > 0.34mm

Parietal branch >0.29mm

Axillary Artery >1.0mm

*Ultrasound cut-off values for intima-media thickness of temporal, facial and axillary arteries in giant cell*

*Arteritis Valentin S. Scha¨ et al Rheumatology 2017;56:1479\_1483*