

## PHYSIOLOGICAL MEASUREMENT – SERVICE SPECIFICATIONS

### Vascular Technology

#### **Test : Duplex Assessment and Surveillance of Arteriovenous (AV) Fistulae (pre and post fistula formation)**

(i) Pre AV fistula assessment: This investigation uses ultrasound to image and assess flow in vessels prior to surgery for creation of a fistula in patients with chronic renal failure who are going to need dialysis.

(ii) AV Fistula Assessment: This investigation uses ultrasound to image and assess flow to determine the patency of the fistula and to identify any abnormalities that may be present.

Vascular access is essential for patients with chronic renal failure who need renal dialysis. The best form of access is an autogenous arteriovenous fistula. This is formed by a surgical procedure in which an anastomosis (join) between an artery and a vein is made to create a fistula. Sometimes, the artery and vein are joined by a synthetic graft. The fistula creates high pressure blood flow in an easily accessible vein, which is ideal for the repeated needle punctures which are required to divert blood to a dialysis machine in patients with chronic renal failure.

An access fistula is normally created in the arm, but occasionally vessels in the leg are used. A fistula takes time to 'mature', as the arterialised draining vein enlarges in response to the increased flow. Typically, this takes about 2 months. A duplex scan can be used if problems are suspected during this period.

(i) Pre AV fistula assessment: An ultrasound probe is used to scan the veins and the arteries of the arm to give detailed information about the location, size and suitability of the vessels prior to fistula access surgery.

(ii) AV Fistula assessment: An ultrasound probe is used to scan the fistula, which is usually at the wrist or cubital fossa. Flow characteristics in the fistula and also the inflow and outflow to the fistula are assessed. This may be requested when there are concerns about the functioning of the fistula or as part of a routine surveillance program.

#### **PATIENT PATHWAY**

These investigations will be utilised and apply to renal patient pathways for patients who have chronic renal failure.

(i) Pre AV fistula assessment scans will apply, in particular, to patients who are approaching end stage renal failure and will be requiring renal replacement therapy and who have chosen haemodialysis. This assessment will also apply to patients already on haemodialysis whose current access is failing, to patients who are switching from peritoneal dialysis to haemodialysis and to patients whose renal transplants have failed and are needing to start or restart haemodialysis .

As the preferred access route for haemodialysis is an autogenous arteriovenous fistula and this typically takes 2 months to 'mature', it is important that pre operative assessments and surgery are planned and take place as early as possible.

(ii) AV Fistula Assessment scans will apply to patients who already have an access fistula for renal dialysis. An investigation may be requested if there is a suspicion that the fistula is not

'maturing' or is not functioning normally. It may be requested as part of a routine surveillance program.

These investigations should be organised to minimise the number of hospital visits.

Further detailed guidance is given in a report jointly produced by The Renal Association, The Vascular Society and The British Society of Interventional Radiology: 'The Organisation and Delivery of the Vascular Access Service for Maintenance Haemodialysis Patients' <sup>1</sup>

## **REFERRAL**

The joint working group report<sup>1</sup> gives guidance on pre operative assessment and recommends that units have in place a policy to ensure that assessment does not delay surgery.

Fistula assessment scans are requested to determine the patency of the fistula or graft and to identify abnormalities that may be present.

### **Clinical Indications**

(i) Pre AV fistula assessment:

Indication is planned fistula surgery. In some centers all patients who are to undergo fistula surgery undergo pre fistula assessment, however this is not mandatory, and it may just be requested in patients with small veins on clinical examination<sup>1</sup>

(ii) AV Fistula assessment:

The Society for Vascular Technology of Great Britain and Ireland (SVT) Vascular Laboratory Procedures (VLP) part V , Assessment of Renal Dialysis arteriovenous fistula and access graft section 2.1<sup>2</sup> and the Society for Vascular Ultrasound (SVU) guidelines for 'Evaluation of Dialysis Access' <sup>3</sup> give detailed indications for fistula investigations. These include: difficult needle placement, elevated venous pressure, pulsatile thrill, loss of thrill or decrease in strength of thrill in the fistula, swelling or discomfort in the hand during or after dialysis. This investigation may also be requested when the fistula fails to 'mature' or where this is delayed or where a 'steal' is suspected when the hand has become ischaemic. It may also be requested as part of a routine surveillance program.

### **Contra indications**

There are no specific contraindications for either of these assessments. If operative wounds are present, they may need to be covered by a clear dressing to allow full evaluation.

## **EQUIPMENT**

### **Specification**

A high resolution imaging ultrasound duplex scanner which has colour, power and pulsed Doppler modalities is required. A flat linear array high resolution transducer (probe) should be available covering nominal frequencies of 5-10MHz.

The Royal College of Radiologists (RCR) has more detailed technical standards for ultrasound equipment<sup>4</sup>

([www.rcr.ac.uk/docs/radiology/pdf/StandardsforUltrasoundEquipmentJan2005.pdf](http://www.rcr.ac.uk/docs/radiology/pdf/StandardsforUltrasoundEquipmentJan2005.pdf)).

The vascular and arterial specifications are given on pages 15 to 17 of this document. Further guidance can be found in Vascular Laboratory Procedures (VLP) part V section 4.1<sup>2</sup>. It should be noted that a range of relatively low cost portable scanners is now available, not all of which will be suitable for vascular work.

It is important that the duplex scanner is of ergonomic design as explained in the health and safety section to minimise the risk of operator work related musculoskeletal disorders.

### **Maintenance**

Equipment should be regularly safety-tested and regularly maintained in accordance with the manufacturer's recommendations. Further information is available from the British Medical Ultrasound Society (BMUS): 'Extending the provision of ultrasound services in the UK'<sup>5</sup>.

### **QA and Calibration**

Quality assurance (QA) procedures should be in place to ensure a consistent and acceptable level of performance of all modalities of the duplex scanner. Such procedures are likely to be set up with involvement from Medical Physics Departments or service engineers as they require specialist skills and will require both imaging and flow phantoms.

Detailed guidance on the QA of the imaging modality of duplex scanning is contained in the IPEM report 102 (Quality Assurance of Ultrasound Imaging Systems)<sup>6</sup>. The IPEM report 70 (Testing of Doppler Ultrasound Equipment) contains extensive information relating to performance testing of the pulsed and colour Doppler modalities of duplex scanners<sup>7</sup>.

Further general guidance is available in VLP part I section D2.1<sup>2</sup> and in the 'Guidelines for professional working standards: Ultrasound practice'<sup>8</sup>.

### **Set up procedures**

An appropriate probe should be selected. All duplex control settings should be set to defaults appropriate for this investigation. Equipment manufacturer will normally provide appropriate default peripheral arterial and venous settings. Detailed guidance on the appropriate control settings for pre fistula scanning and fistula scanning is given in the VLP part V sections 4.2<sup>2</sup>. It is important to note that there are usually very high flow velocities in a fistula and the colour flow scale should be adjusted appropriately.

### **Infection control**

There are no nationally agreed standards for vascular ultrasound scanning but local infection control policies should be in place and extensive guidance is given in the VLP part I section D1.2<sup>2</sup>. BMUS advises that users should refer to manufacturer's instructions for the cleaning and disinfection of probes and transducers and general care of equipment. It should be noted that ultrasound probes can be damaged by some cleaning agents and so manufacturer's specifications should always be followed. Sterile ultrasound gel and sheaths should be available and used in appropriate cases. It is important to note that these patients are particularly vulnerable to infection<sup>2</sup>.

### **Accessory equipment:**

Examination couches and scanning stools must be of appropriate safety standard and ergonomic design to prevent injury, particular consideration should be given to reducing the risk of operator work related musculoskeletal disorders<sup>9</sup>.

## **PATIENT**

### **Information and consent**

There is no legal requirement that written patient consent be obtained prior to either a pre AV fistula assessment or an AV fistula assessment duplex examination. However, patients should be fully informed about the nature and conduct of the examination so that they can give verbal consent. VLP I 3.2<sup>2</sup> gives guidance on the explanation of the test. It is desirable that this information is provided in written format and is given prior to their attendance. This information should also be verbally explained to the patient when they attend for the investigation. Suggestions of additional information to include are given on:

- (i) [www.bmus.org/publications/pu-patientinfo.asp](http://www.bmus.org/publications/pu-patientinfo.asp)
- (ii) [www.rcr.ac.uk/docs/patients/worddocs/leaflet5.doc](http://www.rcr.ac.uk/docs/patients/worddocs/leaflet5.doc)

VLP part V sections 3 and 3.1<sup>3</sup> gives further information.

### **Clinical history**

The written referral for the investigation should contain relevant clinical history. But this information should be verified and clarified for any discrepancies as explained in VLP part I section E.1<sup>3</sup>.

(i) With a pre AV fistula assessment, relevant clinical history will include details of any previous fistula, central venous catheterisation or limb trauma.

(ii) For an AV fistula assessment, the referral should include details of the fistula to be scanned and the nature of any concerns relating to the current fistula. These are complex scans and having as much information as possible will aid the investigation.

Specific guidance for history taking for pre fistula assessment and fistula scans are given in VLP part V sections 3.3<sup>2</sup>.

### **Preparation**

No specific preparation is required for either the pre AV fistula assessment or the AV fistula assessment. Ideally an AV fistula assessment should be arranged for before a dialysis session if the fistula is already being used for dialysis. If an open wound is present, then a clear dressing or sterile gel pad may be needed<sup>2</sup>. Access will be required to the patient's arm ( or sometimes leg). The patient may sit or lie, but it is important to ensure that the veins are adequately filled.

## **ENVIRONMENT**

A private room ( or curtained off area in a larger multiscan bay unit) is required to carry out the scan. The room should be dark, with no natural light entry, and should have dimmer switch lighting. Air conditioning is required due to heat production from the scanning equipment. The ultrasound manufacturer should supply appropriate guidance on air

conditioning requirements. A cold environment can cause arteries to constrict making them difficult to image.

Further general guidance on the environment is given in the BMUS document<sup>5</sup>.

## **PROCEDURE**

(i) Pre AV fistula assessment:

The non dominant arm is usually investigated first, only proceeding to the other arm or to the legs if suitable vessels for fistula formation have not been identified. The transducer is positioned on the arm and is manipulated to obtain optimal images of the deep and superficial veins. Compression and augmentation are used to confirm patency and to check for any thrombus. Detailed information about the size and location of the superficial veins (usually the cephalic and basilic veins) is obtained to assess for suitability for fistula formation. A detailed procedure for assessing the deep and superficial veins in the arms is given in the VLP Part V, Upper Limb Venous duplex Assessment, Section 5<sup>2</sup>,

The scanner settings are changed to investigate the arm arteries. The transducer is manipulated to obtain optimal images of the arteries and to note any areas of plaque or calcification. The colour and pulsed Doppler are used to assess flow and to detect any areas of narrowing. A detailed procedure for assessing the arteries in the arm is given in the VLP Part V Duplex Ultrasound Assessment of the upper limb arteries and bypass grafts section 5.2<sup>2</sup>

(ii) AV Fistula assessment:

The transducer is positioned on the part of the arm ( or leg ) where the fistula is located. The colour and pulsed Doppler are used to assess the flow in the inflow artery, at the anastomosis, throughout the fistula and in the outflow veins. For synthetic grafts, there will also be an outflow anastomosis that will need to be investigated. It is likely that the colour flow scale will need to be set to a high level. The colour and pulsed Doppler modalities are used to determine flow direction and detect any stenoses. The flow in the artery distal to the anastomosis may also be assessed if there are clinical indications of steal. Further detail is given in VLP V section 5 'Assessment of the haemodialysis access fistula'<sup>2</sup>.

## **Protocol**

Protocols for pre AV fistula assessment and for AV fistula assessment scans should be set up in accordance with VLP part V section 5<sup>2</sup> and agreed with referring clinicians. It is important to follow the sequence of events outlined in the protocol to avoid missing important information.

(i ) Pre AV fistula assessment:

As a minimum the innominate, internal jugular, subclavian, axillary and brachial veins should be assessed for patency. The diameters of the cephalic and basilic veins should be measured along their course and their patency confirmed. The investigation should also confirm that the cephalic and basilic veins remain superficial. The subclavian, axillary, brachial, radial and ulnar arteries should be assessed and any narrowing or calcification should be documented. The position of the brachial bifurcation should be noted.

(ii) AV fistula assessment:

The investigation should begin by imaging at the level of the inflow artery. Colour and pulsed Doppler should be used to assess the inflow including direction of flow. The anastomosis, fistula and outflow should then be assessed as described above. Care should be taken that the Doppler angle is  $60^{\circ}$  or less when recording velocity measurements. An estimate of volume flow either within the supply artery or within the fistula itself may be useful but it should be noted that volume flow estimates are prone to large error margins.

## **Documentation**

It is recognised that the recording of ultrasound images is operator dependent and may not fully represent the entire examination.

(i) Pre AV fistula assessment:

The diameters at different levels of the arm of the superficial veins (cephalic and basilic veins) should be recorded. The extent, location and morphology of any areas of plaque or thrombus in the arteries or veins should be documented.

(ii) AV Fistula assessment:

The overall diameter of the fistula should be included, as well as the diameters of any areas where the vessel appears dilated or narrowed. The presence of any thrombus should be noted and its location. If the fistula appears narrowed, the maximum peak systolic velocity within the narrowing should be recorded and compared with the peak systolic velocity within a normal section of the fistula. The estimated volume flow (where measured) should be recorded. The size and location of any significant branches should be documented.

Documentation should be done in accordance with the locally agreed protocol. Any stored images should have patient identification, examination date, organisation and department identification.

Further explanation and guidance is given in section 4 of the UKAS Guidelines<sup>8</sup>.

## **INTERPRETATION & REPORT**

### **Criteria**

(i) Pre AV fistula assessment:

The diameter of the cephalic or basilic vein at the proposed site of the vascular access is the main factor that determines whether a site is suitable for fistula placement. However there are no nationally agreed minimum vein diameters and therefore this should be agreed locally with the vascular access surgeons ( typically the cut off diameter is 2.5 mm). The veins (deep and superficial) must also be free from thrombus. The proximal arteries should be free from significant PVD, this is usually typified by triphasic flow patterns and no localised increase in peak systolic velocity to indicate stenosis.

(ii) AV Fistula assessment:

Multiple factors are used to determine whether a fistula is functioning adequately, typical normal parameters are:

Minimum fistula diameter of 4mm,  
Estimated volume flow  $>500\text{ml}/\text{min}$ <sup>10</sup>

No focal increase in peak systolic velocity within the fistula (velocities are commonly raised at the anastomosis of an AVF)

Low resistance pulsed Doppler waveforms in the inflow artery and the fistula.

Detailed guidance is given in VLP V section 6<sup>2</sup>.

### **Minimum report content**

There are no specific recommendations for the structure and content of reports for these investigations, but many referrers find a pictorial report with written conclusions helpful.

#### **(i) Pre AV fistula assessment:**

As a minimum, the report should include the diameter of the vein and artery at the level of the planned fistula site. A more complete report would include proximal vein diameters. Any evidence of stenosis or thrombus within the vessel lumens, wall calcification or dilatation should be noted in the report together with severity and location. Comments on the shape of the arterial Doppler waveform at different locations are also helpful.

#### **(ii) AV Fistula assessment:**

As a minimum, the report should include volume flow (where measured) and the diameter and depth of the fistula. Any evidence of stenosis should be included and the shape of the Doppler waveforms in the inflow artery and fistula should be commented upon. Where the investigation was a surveillance scan, the report should note the timing of the next scan.

The report should be signed by the operator carrying out the test. Where a computer generated reporting system is used, such as those used in radiology departments, the verification and authorisation procedure should be followed.

The report should be made available to the referring clinician in a timely manner. But any urgent findings should be brought to the attention of the referring clinician immediately.

## **WORKFORCE**

It is well recognised that ultrasound diagnosis is highly operator-dependent, and it is essential that the workforce has the appropriate competencies and underpinning knowledge. This is achieved by ensuring the workforce has followed recognised education and training routes. This applies to both medically and non-medically qualified individuals. In addition, it is essential that these studies are carried out by someone who has a good understanding of fistula malfunctions<sup>1</sup>.

### **Education and training requirements**

All staff carrying out and reporting investigations should have successfully completed one of the following education and training routes:

- (i) Full SVT accreditation (AVS)  
([www.svtgbi.org.uk/Accreditation/Accreditation\\_Doc.pdf](http://www.svtgbi.org.uk/Accreditation/Accreditation_Doc.pdf))
- (ii) Post graduate qualification in ultrasound imaging from a Consortium for Accreditation of Sonographic Education (CASE) accredited course with successful completion of

an arterial and venous module which has included clinical competency in peripheral arterial and venous duplex scanning. A list of CASE accredited courses can be found at [www.case-uk.org](http://www.case-uk.org).

- (iii) Radiologists carrying out these investigation should have completed core training in vascular imaging and intervention and have demonstrated competency to level 3.
- (iv) Medical and surgical staff should have successfully followed the RCR recommendations for training in vascular scanning to level 2 competencies in peripheral extremity arteries ( Ultrasound training recommendations for medical and surgical specialties. BFCR(05)2 [www.rcr.ac.uk/docs/radiology/pdf/ultrasound.pdf](http://www.rcr.ac.uk/docs/radiology/pdf/ultrasound.pdf))

### **Regulation**

It is important that both staff and employers are aware that although ultrasonography is not currently a regulated profession, there is a move towards statutory regulation of all healthcare science groups in the future. Current statutory or voluntary registration includes:

- (i) Registered on the SVT Voluntary Register
- (ii) UK Registered Physicians on the General Medical Council (GMC) Specialist Register
- (iii) Registered Clinical Scientist with Health Professions Council (HPC)
- (iv)     Registered on the National Voluntary Register for Sonographers held by the Society & College of Radiographers (SCoR).

### **Maintaining competence**

It is important that scanning competence is maintained by all personnel performing this investigation either by performing a minimum number of scans each year or through a CPD scheme. Criteria for ensuring continuing competence are set by the professional bodies.

Details are available on:

- (i) [www.svtgbi.org.uk/Accreditation/Accreditation\\_Doc.pdf](http://www.svtgbi.org.uk/Accreditation/Accreditation_Doc.pdf)
- (ii) [www.rcr.ac.uk/docs/radiology/pdf/ultrasound.pdf](http://www.rcr.ac.uk/docs/radiology/pdf/ultrasound.pdf)
- (iii) [www.sor.org/public/educpd/cpd\\_policy.htm](http://www.sor.org/public/educpd/cpd_policy.htm)

### **Continuing Professional Development (CPD)**

Staff must undertake continuing professional development, to keep abreast of current techniques and developments, and to renew and extend their skills.

- (i) Society for Vascular Technology (SVT) accredited staff must maintain their accreditation by meeting the CPD requirements of the SVT. ([www.svtgbi.org.uk/Accreditation/Accreditation\\_Doc.pdf](http://www.svtgbi.org.uk/Accreditation/Accreditation_Doc.pdf))
- (ii) Staff with a post graduate qualification in ultrasound imaging should meet the CPD requirements of SCoR registration ([http://www.sor.org/public/ult/ult\\_search.php](http://www.sor.org/public/ult/ult_search.php)).
- (iii) Medical and surgical staff should follow the requirements outlined for maintenance of skills as well the need to include ultrasound in their ongoing CME. ([www.rcr.ac.uk/docs/radiology/pdf/ultrasound.pdf](http://www.rcr.ac.uk/docs/radiology/pdf/ultrasound.pdf))

## **AUDIT, SAFETY & QA**

## **Safety**

The provider should be aware of the guidelines for the safe use of ultrasound equipment produced by the Safety Group of BMUS. In particular, they should be aware of ultrasound safety precautions related to vascular scanning. These are outlined in VLP section D1.1<sup>2</sup>.

All staff should be aware of local safety rules and resuscitation procedures.

Sonographers are at risk of work related musculoskeletal disorders. To minimise this risk the scanner and its control panel, the examination couch and scanning stool must be of appropriate safety standard and ergonomic design. Advice can found at:

[www.svtgbi.org.uk/Resources/Health\\_and\\_Safety/health\\_and\\_safety.html](http://www.svtgbi.org.uk/Resources/Health_and_Safety/health_and_safety.html)

A recently published document by the Society and College of Radiographers ( SCoR)

‘Prevention of Work Related Musculoskeletal Disorders in Sonography’<sup>9</sup> gives clear guidance on this issue.

## **QA and Audit**

There are no specific requirements but a mechanism of audit/quality control to ensure patients continue to receive the expected level of diagnostic accuracy should be in place.

QA and audit programs should cover:

- Equipment performance
- Patient service
- Quality of investigation

VLP part I section D 2<sup>2</sup> gives guidance which covers all these areas. The BMUS document<sup>5</sup> and UKAS Guidelines<sup>8</sup> also give guidance. Equipment QA is covered in more detail in the equipment section of this document.

## **References:**

<sup>1</sup> ‘The Organisation and Delivery of the Vascular Access Service for Maintenance Haemodialysis Patients’ 2006

<sup>2</sup> ‘Vascular Laboratory Procedures’ published by the Institute of Physics in Engineering and Medicine on behalf of the Society of Vascular Technology for Great Britain and Ireland.

<sup>3</sup> ‘Evaluation of Dialysis Access ‘ Society for Vascular Ultrasound 2009

<sup>4</sup> ‘Standards for Ultrasound Equipment’ Royal College of Radiologists 2005

<sup>5</sup> ‘Extending the provision of ultrasound services in the UK’ BMUS 2003

<sup>6</sup> ‘Quality Assurance of Ultrasound Imaging Systems’ IPEM report 102 2010

<sup>7</sup> ‘Testing of Doppler Ultrasound Equipment’ IPEM report 70 1994

<sup>8</sup> ‘Guidelines for professional working standards: Ultrasound practice’ UKAS 2007

<sup>9</sup> ‘Prevention of Work Related Musculoskeletal Disorders in Sonography’ Society and College of Radiographers 2007

<sup>10</sup> Robbin ML, Chamberlain NE, Lockhart ME, Gallichio MH, Young CJ, Deierhoi MH, Allon M. Haemodialysis arteriovenous fistula maturity: US Evaluation. Radiology 2002;225:59 -64

## **Websites:**

[www.18weeks.nhs.uk](http://www.18weeks.nhs.uk)  
[www.rcr.ac.uk](http://www.rcr.ac.uk)  
[www.bmus.org](http://www.bmus.org)  
[www.svtgbi.org.uk](http://www.svtgbi.org.uk)  
[www.case-uk.org](http://www.case-uk.org)  
[www.ipem.ac.uk](http://www.ipem.ac.uk)  
[www.hpc-uk.org](http://www.hpc-uk.org)  
[www.rcplondon.ac.uk](http://www.rcplondon.ac.uk)  
[www.vascularsociety.org.uk](http://www.vascularsociety.org.uk)  
[www.vasbi.org.uk](http://www.vasbi.org.uk)  
[www.renal.org](http://www.renal.org)  
[www.bsir.org](http://www.bsir.org)  
[www.sor.org](http://www.sor.org)  
[www.svunet.org](http://www.svunet.org)