Upper Extremity Vein Mapping for Creation of a Dialysis Access or Peripheral Vascular Bypass Graft

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**Purpose**
Vein mapping of the upper extremity is performed to determine diameter, length and suitability of the superficial veins of the upper extremity for placement of dialysis access, or for use as a peripheral vascular bypass graft.

**Common Indications**
- Renal failure (CRF)
- For patients who have not yet started hemodialysis with the thought of advanced fistula maturity when the dialysis treatment is necessary.
- Patients who have had multiple procedures may also need an exam to evaluate the possible availability of any remaining sites in an extremity for permanent access.
- To assess availability of veins for use as a peripheral vascular bypass graft, upper or lower extremity

**Contraindications and Limitations**
- IV lines and bandages may limit access to the superficial veins.
- History of ischemia, claudication, rest pain, digital ulcerations, trauma, or abnormal wrist/brachial index (these may be limitations for the surgical procedure, but mandates testing in addition to the venous evaluation).
- Patient positioning may prevent accurate measurement of the superficial veins (if the arm is elevated higher than the heart).
- Open wounds may limit access to areas of the circulation and must also be protected from contamination

The exam should NOT be performed the day following hemodialysis, as hypotension and/or dehydration may cause inaccurate results
GUIDELINE 1: PATIENT COMMUNICATIONS AND POSITIONING

The technologist/sonographer/examiner should:

1.1 Introduce self and explain why the vein mapping of the upper extremity is being performed and indicate how long it will take.

1.2 Explain the procedure to the patient, and/or an accompanying adult, taking care to ensure that the patient/adult understands the necessity for each aspect of the evaluation.

1.3 Respond to questions and concerns about any aspect of the vein mapping of the upper extremity.

1.4 Refers a specific diagnostic, treatment or prognosis question to the patient's physician.

1.5 The patient can be in a reversed trendelburg position or in a sitting position, however, proper evaluation of the central veins may not be possible in this position. The sitting position with the arms dependent does promote dilatation of the forearm and upper arm veins, and may be useful after evaluation of central flow. If in the sitting position, the arms may be resting on a pillow for patient comfort and to facilitate easy access for scanning.

1.6 The room should be comfortably warm in order to enhance venous dilatation.

GUIDELINE 2: PATIENT ASSESSMENT

Patient assessment must be performed before the procedure is performed. This includes assessment of the patient’s ability to tolerate the procedure and an evaluation of any contra-indications to the procedure.

The technologist/sonographer/examiner should:

2.1 Obtain a complete and pertinent history by interview of the patient or their representative and/or review of the patient’s medical record when available. A pertinent history includes:
   a. Current medical status
   b. Previous surgeries or invasive procedures involving the affected arm or neck
   c. Current medications or therapies
   d. Presence of any risk factors, recent or past surgery on the intended extremity or chest area:
      ▪ Insertion of a dialysis access graft
      ▪ Recent or prior insertion of a dialysis catheter, central venous line or insertion of a chemotherapy access port
      ▪ Presence of a pacemaker and/or a defibrillator

2.2 Complete a limited or focused physical exam of the extremity.

GUIDELINE 3: EXAMINATION GUIDELINES

Throughout each the exam, sonographic characteristics of normal and abnormal tissues, structures, and blood flow must be observed so that the scanning technique can be adjusted as necessary to optimize image quality and spectral waveform characteristics. The patient's physical and mental status is assessed and monitored during the examination, and modifications are made to the procedure plan according to changes in the patient's clinical condition during the
procedure. Sonographic findings are analyzed throughout the course of the examination to ensure that sufficient data is provided to the physician to direct patient management and render a final diagnosis.

INSTRUMENTATION:

3.1 Use appropriate duplex instrumentation, which includes display of both two-dimensional structure and motion in real-time and Doppler ultrasonic signal documentation with:
   a. Spectral analysis with or without color Doppler imaging and Doppler carrier frequency of at least 3.0 MHz to 12.5 MHz, as the vessels are relatively superficial and this may provide better identification of intraluminal echoes if present.
   b. Hardcopy paper, film or digital storage capabilities

3.2 Follow a standard exam protocol for upper extremity vein mapping for dialysis access graft. Studies are usually unilateral, with assessment of the non-dominant arm whenever possible. The exam may proceed to the dominant arm if the non-dominant arm has inadequate caliber veins for use as a conduit.

3.3 The ARTERIAL evaluation of the upper extremity is very important in the pre-operative assessment for creation of dialysis access, as diversion of blood flow into the hand results from creation of an arteriovenous fistula. Typically, arterial assessment is not required if the protocol is being performed for use of a vein as a peripheral arterial bypass graft. Please refer to “Upper Extremity Arterial Physiologic Evaluation” and “Radial Artery Assessment for Coronary Artery Bypass” in the SVU Guidelines for information concerning measurements, vessels evaluated and Doppler information (spectral and color/power) necessary for arterial evaluations.

3.4 B-mode gray scale imaging is used to assess the arm veins and in accordance with “Fistula First” a primary fistula would be a physician’s first choice for access for the patient if no previous access has been created. Secondary fistulae can also potentially be created in patients with prior access. To begin this exam:
   a. Evaluate the cephalic, basilic and median cubital veins starting distally (wrist) and progressing proximally to the level of the shoulder and axilla. Patency of the more proximal deep veins should be confirmed including the brachial, axillary, subclavian and innominate veins. Document continuity of cephalic and basilic veins to their termination into the deep system, recording presence of any large branches seen along their course. Be aware of any large collateral veins of the upper arm, neck or chest since these are a likely indication of a more proximal/central obstruction.
   b. B-Mode data interpretation includes determination that vein walls are compressible and free of thrombus. A noncompressible or partially compressible vein indicates the presence of an occluding or partially occluding thrombus within the lumen of the vein, making this portion unacceptable as a conduit.
   c. A tourniquet should be used for maximum dilatation of the veins.
   d. The diameter of the brachial, cephalic and basilic veins is measured in transverse view, throughout their length, using a tourniquet at the axilla (for upper arm) and antecubital fossa (for the forearm) as necessary.
   e. Identification of the median cubital vein is made whenever possible, paying particular attention to the area just proximal to, in the area of the antecubital space, and distal to the antecubital space. It is important to note if the median cubital vein joins both cephalic and basilic veins since it is sometimes used to creat the atrial anastomosis of a fistula.
   f. Any abnormalities including vein thrombosis in the deep or superficial systems, calcification, and wall thickening are identified and documented.
3.5 Spectral Doppler and/or Color:
   a. Doppler spectral analysis is performed in the sagittal plane. All Doppler samples must be performed at an angle of 60 degrees or less with respect to the direction of blood flow, and Doppler cursor alignment is recommended parallel to the vessel walls.
   b. Color Doppler may be used to verify patency of smaller forearm veins.
   c. To ensure complete interrogation of the venous system, spectral waveforms are obtained documenting spontaneous, pulsatile or phasic flow. Demonstrate augmentation by performing distal augmentation.
   d. Record a representative still frame or cineloop image of the venous system demonstrating the compression maneuver.

3.6 If none of the veins in the non-dominant arm are of adequate size to be used as a conduit, or if any abnormalities are identified, the dominant arm is assessed. The same scanning procedure is followed in the non-dominant arm.

GUIDELINE 4: REVIEW OF THE DIAGNOSTIC ULTRASOUND EXAM FINDINGS
4.1 Review data acquired during the examination to ensure that a complete and comprehensive evaluation has been performed and documented.
4.2 Explain and document any exceptions to the routine protocol (i.e., study limitations, omissions or revisions).
4.3 Record all technical findings required to complete the final interpretation on a worksheet, logbook or other form so that the findings can be classified according to the laboratory’s diagnostic criteria based on published or internally validated data.
4.4 Document the exam date, clinical indication(s), technologist performing the exam, and the exam summary in a vascular laboratory logbook or other appropriate method, i.e., computer software, etc.
4.5 Alert the laboratory medical director or health care provider when immediate medical attention is indicated based on findings.

GUIDELINE 5: PRESENTATION OF EXAM FINDINGS
5.1 Provide preliminary results when necessary as provided for by internal guidelines.
5.2 Present record of diagnostic images, data, explanations, and technical worksheet (according to individual laboratory protocol) to the interpreting physician for use in rendering a diagnosis and for archival purposes.

GUIDELINE 6: EXAM TIME RECOMMENDATIONS
High quality and accurate results are fundamental elements of the vein mapping of the upper extremity examination. A combination of indirect and direct exam components is the foundation for maximizing exam quality and accuracy.
6.1 Indirect exam components include pre-exam procedures: obtaining previous exam data; completing pre exam paperwork; exam room and equipment preparatory activities; patient assessment and positioning (Guideline 1 & 2); and, post-exam procedures: cleanup; compiling, processing, reviewing exam data for preliminary and/or formal interpretation (Guidelines 3 and 4); patient communication (Guideline 2); exam charge and billing activities. Recommended time allotment is 30 minutes.
6.2 Direct exam components include equipment optimization, patient positioning throughout the exam and the actual hands-on, examination process (Guideline 3). Recommended time allotment is 35 minutes for a unilateral exam, 50 minutes if bilateral exam if required.

GUIDELINE 7: CONTINUING PROFESSIONAL EDUCATION
Certification is considered the standard of practice in vascular technology. It demonstrates an individual’s competence to perform vascular technology at the entry level. After achieving certification from either ARDMS (RVT credential), CCI (RVS credential) or ARRT RT (VT) credential, an individual must keep current with:

7.1 Advances in diagnosis and treatment of venous disease
7.2 Changes in vein mapping protocols or published laboratory diagnostic criteria involving dialysis access
7.3 Advances in ultrasound technology used for the vein mapping evaluation

APPENDIX
It is recommended that published or internally generated diagnostic criteria should be validated for each ultrasound system used. When validating ultrasound diagnostic criteria, it is important to realize that equipment, operator and interpretation variability is inherent to this process.

REFERENCES