VASCULAR TECHNOLOGY

PROFESSIONAL PERFORMANCE GUIDELINES

Evaluation of Hemodialysis Access

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PURPOSE

To determine patency and flow adequacy of hemodialysis access: arteriovenous fistula (AVF) or arteriovenous graft (AVG). And to identify abnormalities that may be present.

COMMON INDICATIONS

Common indications for performance of this examination include, but are not limited to:

- "Failure to mature"on the basis of physical examination
- Symptoms and signs of disease present
  - Signs of access site malfunction during dialysis (e.g., low blood flows, elevated recirculation times, increased venous pressure)
  - Palpable mass associated with the AVF or AVG
  - Loss of palpable thrill of the AVF or AVG
  - Arm swelling
  - Signs of arterial steal syndrome (e.g., hand pain, pallor, signs of digital ischemia)
- Difficult access cannulation
- Follow-up access revision

CONTRAINDICATIONS AND LIMITATIONS

Contraindications and limitations may include the following:

- Open wounds and/or wound dressings
- Indwelling catheters
- Acoustic shadowing from calcification
- Dialysis or fistulogram performed on the same day (flow volumes may be lower, compression of access for possible steal phenomenon not recommended)

PATIENT COMMUNICATION

Prior to beginning the exam, the sonographer or examiner should:

- Introduce themselves, explain why the examination is being performed and indicate how much time the examination will take.
- Verify the patient's name and date of birth or utilize facility-specific patient identifiers.
- Explain the procedure, taking into consideration the age and mental status of the patient and ensuring that the necessity for each portion of the evaluation is understood.

- Respond to questions and concerns about any aspect of the evaluation.
- Refer specific diagnostic, treatment or prognosis questions to the patient's physician.

PATIENT ASSESSMENT

A patient assessment should be completed before the evaluation is performed. This includes an assessment of the patient's ability to tolerate the procedure and an evaluation of any contraindications to the procedure. The sonographer or examiner should obtain a complete, pertinent history by interview of the patient or patient's representative and a review of the patient's medical record, if available. A pertinent history includes:

- Previous cardiovascular surgeries
- Current medications or therapies
- Results of other relevant diagnostic procedures (e.g., operative notes, revisions/fistulograms, currents status of dialysis)
- Review of prior examinations to ensure that the evaluation duplicates prior imaging and Doppler parameters.
- Verify that the requested procedure correlates with the patient's clinical presentation

Perform a limited or focused physical exam, including observation and localization of any signs or symptoms of access dysfunction.

- Determine access patency by the presence of a palpable thrill as well as the strength and consistency of thrill throughout the access (Note: prominent pulsatility is abnormal).
- Provide a visual inspection of the limb and access site noting scars, areas of redness, ecchymosis, swelling, dilatation, and presence of collateral vessels.

PATIENT POSITIONING

- Patient positioning is most often supine, with the arm relaxed and extended out to the side with the area to be evaluated closest to the sonographer. For patient comfort, it is helpful to support the arm on a bedside table/pillow.
- An access located in the thigh area should be evaluated in the supine position.

INSTRUMENTATION

Utilize appropriate duplex instrumentation with the appropriate frequencies for the vessels being examined:

- Typically, a linear 5-7 MHz transducer
  - Superficial structures may require a higher frequency transducer
  - Deeper structures or edematous tissue may require a lower frequency

transducer

- Display of two-dimensional structures and motion in real-time
  - Doppler ultrasonic signal documentation
  - Spectral analysis with color and/or power Doppler imaging
- Digital storage of images

EXAM PROTOCOL

Sonographers should follow a standard imaging protocol. A complete evaluation includes B-mode imaging, spectral Doppler analysis, and color Doppler imaging of all accessible portions of the hemodialysis access.

Throughout each examination, the sonographer or examiner should:

- Observe sonographic characteristics of normal and abnormal tissues, structures, and blood flow, allowing necessary adjustments to optimize exam quality
- Assess and monitor the patient's physical and mental status, allowing modifications to the procedure plan according to the patient's clinical status
- Analyze sonographic findings to ensure that sufficient data is provided to the physician to direct patient management and render a final diagnosis
- Accurately annotate B-mode, color and spectral Doppler images

Doppler is used primarily to document patency of the vessels and access, as well as, identify any areas of stenosis in the inflow artery, anastomosis, within the access or in the outflow vessels.

- Doppler spectral analysis is performed in the sagittal plane.
- Velocity measurements should be obtained from a longitudinal plane at an angle of 60° parallel to the direction of the blood flow/vessel walls.
  - Maintain a Doppler angle between 45° and 60° whenever possible. Angles greater than 60° must be avoided.
  - Doppler angles less than 45° may be necessary due to patient anatomy.
  - To obtain peak velocity, utilize color Doppler to note areas of concern and "walk" the spectral Doppler cursor throughout these areas. Post-stenotic turbulence should be documented when present.
- When a stenosis is identified, velocities should be documented proximal to, within, and distal to the stenosis.
- Flow volumes should be calculated and used to determine fistula maturation.
- Functional disorders can also be identified using flow volumes.

Arteriovenous Fistula

The standard exam for an arteriovenous fistula includes assessment of the inflow (afferent) artery, arteriovenous anastomosis, and outflow (efferent) vein.

Inflow Artery (Afferent)

- Obtain peak systolic (PSV) and end diastolic (EDV) velocities at least 2 cm cephalad to the arteriovenous anastomosis
- Measure flow volume, approximately 2cm cephalad to the arteriovenous anastomosis
    - Obtain diameter on B-Mode image
    - Optimize spectral window and obtain Time-Averaged Mean Velocity (TAMV)
        - Open sample volume to include entire diameter of vessel
        - Use a 60-degree angle
        - Measure 2-3 cardiac cycles

Arteriovenous Anastomosis

- Obtain PSV and EDV
    - Compare to the PSV obtained in the afferent artery
- Obtain diameter measurement on B-mode image
    - Note any areas of narrowing or abnormality

Outflow Vein (Efferent)

- Obtain transverse diameter measurements on B-mode image
    - Proximal, mid, distal outflow vein
        - Include additional measurements at areas of abnormality (e.g., narrowing, wall thickening)
        - Note venous tributaries that may decrease fistula maturation
- Measure depth (skin line to top of vessel) when indicated for fistula maturation
- Note any extrinsic findings (hematoma, seroma, aneurysm, pseudoaneurysm)
- Measure flow volume, approximately 2cm cephalad to the arteriovenous anastomosis
    - Select the mid-portion of the vein in an area that is straight and non- tapering
    - Obtain diameter on B-Mode image
    - Optimize spectral window and obtain Time-Averaged Mean Velocity (TAMV)
        - Open sample volume to include entire diameter of vessel
        - Use a 60-degree angle
        - Measure 2-3 cardiac cycles
- Significant stenosis along the efferent vein is indicated when PSV doubles along contiguous segments.
    - Obtain PSV and EDV proximal to, within, and distal to stenosis
    - Follow the venous outflow to its origin
        - The cephalic and basilic vein confluence with the deep venous system

are common sites for stenosis

Arteriovenous Graft

The standard exam for an arteriovenous graft includes assessment of the arterial inflow, arterial anastomosis, graft body, venous anastomosis, and outflow vein.

Inflow Artery

- Obtain PSV and EDV velocities at least 2 cm cephalad to the arterial anastomosis

Arterial Anastomosis

- Obtain PSV and EDV
- Obtain diameter measurement on B-mode image
    - Note any areas of narrowing or abnormality

Graft

- Obtain PSV and EDV along the body of the graft
    - Include arterial side, loop end, and venous side for a loop graft
    - Include serial segments along the length of a straight graft
- Flow volume measures are obtained from the arterial and venous side of a loop graft and within the mid-portion of a straight graft
    - Obtain diameter on B-Mode image
    - Optimize spectral window and obtain Time-Averaged Mean Velocity (TAMV)
        - Open sample volume to include entire diameter of vessel or graft
        - Use a 60-degree angle
        - Measure 2-3 cardiac cycles
- Include diameter measurements from any areas of narrowing or abnormality

Venous Anastomosis

- Obtain PSV and EDV
- Obtain diameter measurement on B-mode image
    - Note any areas of narrowing or abnormality

Outflow Vein

- Evaluate for any areas of abnormality using B-mode, color and spectral Doppler or according to facility-specific protocol.

Additional Images

Central Venous System

- B-mode, color, and/or spectral Doppler images may be obtained of the internal jugular, innominate, subclavian, and/or axillary veins to evaluate for a central venous obstruction.

Stents

Stents may be present in the hemodialysis access (arterial inflow, graft, or outflow vein). To assess stent patency:

- Measure PSV and EDV proximal to, within, and distal to the stent.

Steal Phenomenon

- Digit discoloration, complaints of numbness, or pain in the hand suggests a steal phenomenon may be present
- Document arterial flow beyond the arterial anastomosis with spectral Doppler waveforms
- Digital waveforms and pressures may be obtained using physiologic equipment to further quantify flow to the hand and digits.
    - Additional maneuvers may include compression of the hemodialysis access with arterial flow documentation to assess for normalization of the arterial flow.

REVIEW OF DIAGNOSTIC EXAM FINDINGS

The sonographer or examiner should:

- Review data acquired during the hemodialysis access evaluation to ensure that a complete and comprehensive evaluation has been performed and documented.
- Explain and document any exceptions to the protocol (i.e., study omissions or revisions).
- To determine any change in follow-up studies, review previous exam documentation to document any change in status; and/or duplicate prior imaging and Doppler parameters.
- Record the technical findings required to complete the final diagnosis on a worksheet or other appropriate method (e.g., computer software), so that the findings can be classified according to the laboratory diagnostic criteria
- Document the exam date, clinical indications, sonographer performing the evaluation, and exam summary in the patient's medical record.

PRESENTATION OF EXAM FINDINGS

The sonographer or examiner should:

- Provide preliminary results when necessary as provided for by laboratory specific guidelines.
- Present record of diagnostic images, data, explanations, and technical worksheet to the interpreting physician. Interpretation must be available within two business

days.

- The sonographer's and interpreting physician's names must appear on the final report. The finalized/signed report should be available within four business days.
- Alert the vascular laboratory medical director or appropriate healthcare provider when immediate medical attention is indicated based on departmental guidelines and procedures.

EXAM TIME RECOMMENDATIONS

High quality, accurate results are fundamental elements of the hemodialysis access evaluation. A combination of indirect and direct exam components is the foundation for maximizing exam quality and accuracy.

- Indirect exam components include:
    - Pre-exam activities: obtaining previous exam data, initiating exam worksheet and paperwork, equipment and exam room preparation, patient assessment and positioning, and patient communication
    - Post-exam activities: exam room cleanup, compiling and processing exam data for preliminary and/or formal interpretation, and exam billing activities.
- Direct exam components include:
    - Equipment optimization and the actual hands-on, examination process
- While study times may vary depending on testing protocols, patient condition, and clinical complexity of the evaluation being performed, these are the times necessary to provide a quality diagnostic evaluation. Listed are the recommended examination times for performing each CPT related to this guideline, which were derived from the direct time inputs from the Resource Based Relative Value Scale (RBRVS).
    - 93990 59 minutes

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