



VASCULAR TECHNOLOGY PROFESSIONAL PERFORMANCE GUIDELINES

Lower Extremity Arterial Duplex Evaluation

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VASCULAR PROFESSIONAL PERFORMANCE GUIDELINE

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PURPOSE

Duplex ultrasound examination of the lower extremity arteries provides a comprehensive, noninvasive assessment of arterial anatomy, hemodynamics, enabling identification, localization, and characterization of disease. Examination may extend from the abdominal aorta through infrainguinal and infrageniculate arterial systems including pedal vessels to support limb-based clinical decision-making. Using standardized diagnostic criteria, disease can be characterized by plaque morphologies, diameter reduction, flow characteristics, and flow direction (setting up the pedal/wound portion so you can change this verbiage) to guide in objective evaluation of disease severity, treatment planning, and follow-up.

APPROPRIATE INDICATIONS

Common indications for lower extremity arterial duplex imaging include, but are not limited to:

- Suspected Peripheral arterial disease (PAD)
 - Limb discoloration
 - Decreased or absent pedal pulses
 - Changes in limb temperature
 - History of atherosclerotic disease or other risk factors such as diabetes, smoking, hypertension
- Claudication
- Ischemic rest pain
- Arterial ulceration
- Acute limb ischemia
Suspected arterial embolization, acute thrombosis, sudden onset of numbness, tingling.
- Follow-up revascularization procedures (endovascular/bypass)
- Pseudo-aneurysm
- Arterio-venous fistula
- Venous arterialization
- Suspected vascular trauma
- Cool limb
- Loss of pulses

CONTRAINDICATIONS AND LIMITATIONS

Contraindications for lower extremity arterial duplex imaging include, but are not limited to:

- Contraindications and Limitations
 - Patients with clear clinical evidence of acute limb threatening ischemia such as pulselessness, coldness, numbness to the foot should be alerted for possible need for immediate revascularization without addition of duplex imaging.
 - Patients who are immediately, or up to two - three days post-operative for a lower extremity bypass graft may be difficult to image due to the presence of surgical staples, swelling, and tenderness may pose limitation in full arterial study but can rely on other indirect evaluation to evaluate for distal perfusion.
 - Patients with any level of amputation in the lower extremity will subsequently have a limited study.
 - Obese patients may be difficult to evaluate. Using a lower-frequency transducer may help identify deeper vessels.
 - Patients with deep venous thrombosis, bypass grafts and lower extremity stents should not have segmental thigh and calf pressures taken.

PATIENT COMMUNICATION

Prior to beginning the exam, the sonographer/technologist should:

- Introduce self and 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 clearly understood.
- Respond to questions and concerns about any aspect of the examination.
- Refer specific diagnostic, treatment or prognosis questions to the patient's physician.

PATIENT ASSESSMENT

- Perform a pre-examination patient assessment, including evaluation of the patient's ability to tolerate the study and any contraindications. Obtain a focused clinical history through patient interview and/or medical record review, including pertinent risk factors (e.g., smoking, diabetes, hemoglobin A1C, prior vascular interventions) and symptoms of peripheral arterial disease, including claudication characteristics and duration, as well as wound presence, etiology, and duration. A comprehensive history includes:

Verification that the requested examination correlates with the patient's clinical presentation. Prior cardiovascular and/or vascular surgeries or interventions

- Current medications and therapies
- Review of prior vascular studies and ensure comparability of imaging and Doppler parameters

Pertinent Risk factors:

- Diabetes (including most recent hemoglobin A1C)
- Hypertension
- Hyperlipidemia
- Smoking history (including packs per day)
- Obesity
- Cerebrovascular disease
- Coronary artery disease

Symptoms of peripheral arterial disease:

- Claudication (location and onset/distance to symptoms; e.g., buttock, hip, thigh, calf)
- Rest pain
- Non-healing wounds, ulceration, or gangrene (location and duration)
- Associated findings (e.g., hair loss, pallor, dependent rubor)

Focused visual and physical assessment:

- Visually inspect the limb
- Palpation of Common Femoral, Popliteal, and pedal pulses

PATIENT POSITIONING

Patient positioned supine in a neutral position, with the leg slightly externally rotated and

the knee gently flexed.

INSTRUMENTATION

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

- Typically, a linear 12-3 MHz transducer
 - Superficial structures may require a higher frequency transducer
 - Deeper structures or edematous tissue may require a lower frequency transducer
- Real-time two-dimensional grayscale imaging for anatomic assessment, with Doppler signal acquisition including spectral analysis and color and/or power Doppler, utilizing appropriately optimized imaging parameters to ensure diagnostic accuracy.
- Digital storage of static images and/or cineloop is required

EXAMINATION PROTOCOL

Sonographers/technologists should follow a standardized imaging protocol. A complete evaluation includes grayscale imaging, color Doppler, and spectral Doppler analysis of all accessible lower extremity arteries, extending from the common femoral artery through the tibial and pedal vessels when clinically indicated. Studies may be unilateral or limited based on laboratory-specific protocols or physician orders.

Throughout each examination, the sonographer/technologist should:

- Observe sonographic characteristics of normal and abnormal tissues, vessel structures, and blood flow
- Analyze sonographic findings, including plaque morphology (e.g., complex/heterogeneous versus smooth/homogeneous) and hemodynamic waveform patterns
- Adjust imaging techniques and parameters in real time to optimize image quality and diagnostic accuracy
- Utilize appropriately optimized imaging parameters for all acquired images to ensure diagnostic accuracy
- Ensure that sufficient diagnostic data are obtained to support physician interpretation and clinical decision-making
- Accurately annotate all grayscale, color Doppler, and spectral Doppler images
- Assess and monitor the patient's physical and mental status, modifying the examination as needed

Physiologic testing (e.g., ankle-brachial index [ABI], segmental pressures, pulse volume recordings) may be performed to identify hemodynamically significant arterial disease and determine if further imaging is warranted. These studies are not equivalent to arterial duplex imaging but are often complementary. An ABI is typically obtained in conjunction with duplex imaging to support sonographic findings and reduce diagnostic discrepancies.

Grayscale and color Doppler imaging of the lower extremity arteries should be performed in a longitudinal plane. Transverse imaging may be helpful. Longitudinal grayscale and color Doppler images should be documented for each normal arterial

segment and in areas of stenosis, previous intervention or other abnormality. Color Doppler is used to localize areas of flow disturbance and stenosis. Power Doppler is useful to confirm possible vessel occlusion or low flow states.

Pedal duplex imaging should be included as part of the comprehensive lower extremity arterial duplex examination to assess distal perfusion and support limb-based clinical decision-making.

Grayscale Imaging - Transducer Orientation

- Cross-sectional/Transverse
 - Useful for assessment of vessel position, vessel orientation, location of bifurcation level and evaluating areas of atherosclerosis.
 - When image qualities permits, plaque characterization is assessed.
- Longitudinal/Sagittal
 - Essential for acquisition of Doppler spectra.
 - Used for appropriate placement of sample volume for assessment of Doppler characteristics of arterial flow. The sample volume should be placed in the center of the vessel at a 60-degree angle or less for optimum Doppler signals.
 - Useful in identifying and confirming presence/extent of atherosclerotic plaque and assessing plaque morphology when image quality permits.
 - Antegrade flow (to extremity) is assigned as red while retrograde flow is assigned as blue.

Examination Protocol and Vessel Identification

- Distal External Iliac Arteries (DEIA)
 - Obtain longitudinal grayscale and/or color Doppler from the distal segment.
 - Longitudinal PW Doppler signals from the distal segment.
- Common Femoral Artery (CFA)
 - Obtain transverse grayscale image of the proximal and distal segments. Any areas of dilatation should be additionally documented with diameter measurements. (Included additional information for provider suggesting high bifurcation of the CFA).
 - Obtain longitudinal grayscale and/or color Doppler image from the CFA.
 - Longitudinal PW Doppler signals from the proximal and distal segments.
 - If there is an anatomically short segment of the CFA; a measurement in the proximal segment only is acceptable.
- Profunda Femoris Artery (PFA)
 - Obtain longitudinal grayscale and/or color Doppler image from the proximal PFA.
 - Obtain Longitudinal PW Doppler signals from the proximal PFA.
- Superficial Femoral Artery (SFA)
 - Obtain longitudinal grayscale and/or color Doppler image from the origin, proximal, mid, and distal segments.
 - Obtain PW Doppler signals from the origin, proximal, mid, and distal segments.
- Popliteal Artery (POP)

- Obtain longitudinal grayscale and/or color Doppler image from the proximal (above knee), mid and distal (below knee) segments of the popliteal artery.
 - Obtain PW Doppler signals from the proximal (above knee), mid and distal (below knee) segments.
 - Any areas of dilatation should be additionally documented with diameter measurements.
- **Tibioperoneal Trunk Artery (TPT)**
 - Obtain one longitudinal grayscale and/or color Doppler image.
 - Obtain one PW Doppler signal.
- **Anterior Tibial Artery (ATA)**
 - Obtain longitudinal grayscale and/or color Doppler image in the ATA.
 - Obtain PW Doppler signals from the proximal, mid and distal segments. Document any abnormal areas.
- **Posterior Tibial Artery (PTA)**
 - Obtain longitudinal grayscale and/or color Doppler image in the PTA.
 - Obtain PW Doppler signals from the proximal, mid and distal segments. Document any abnormal areas.
- **Peroneal Artery (PER)**
 - Obtain longitudinal grayscale and/or color Doppler image in the peroneal artery.
 - Obtain PW Doppler signals from the proximal, mid and distal segments. Document any abnormal areas.
- **Pedal Duplex Imaging (when pedal artery evaluation is requested)**
 - Pedal Artery Duplex Protocol standardizes six PAT measurements in the setting of a wound: one at the target artery to the wound bed, and five at named pedal arteries— Arcuate, First Dorsal Metatarsal, Medial Plantar, Lateral Plantar, and Deep Plantar arteries.
 - In the setting of no wound, the Arcuate and Lateral plantar arteries may be obtained.
 - Pedal artery duplex imaging is typically performed with a linear transducer (8–12 MHz); however, a high-frequency probe (12–18 MHz) or 15 MHz “hockey-stick” linear transducer is ideal for imaging small metatarsal arteries or thin feet.
 - Maintain a spectral Doppler insonation angle $\leq 60^\circ$, centering the sample caliper in the arterial lumen. Adjust the color PRF, typically below 10 cm/s, and fine-tune color gain for complete filling.
 - To ensure diagnostic accuracy, lower the baseline, use a wall filter ≤ 50 Hz, medium sweep speed to display approximately four cardiac cycles within the spectra. Reduce the velocity scale so the waveform occupies three-quarters to nearly the full height of the display, enhancing temporal resolution and measurement precision. PAT is measured from the systolic onset to the systolic peak of the arterial waveform, ensuring reproducible and reliable results.
- **Target Artery to the wound bed (#1)**
 - Place the probe proximal to the wound bed

- **Arcuate Artery (PAT #2)**
 - Follow the distal anterior tibial artery to the dorsalis pedis over the cuneiform bone. Identify the bifurcation of the Arcuate and First Dorsal Metatarsal arteries and record PAT
- **Dorsal Metatarsal Artery (PAT #3)**
 - First Dorsal Metatarsal Artery: Continue distally from the dorsalis pedis/arcuate bifurcation to visualize the artery supplying the hallux
- **Medial Plantar Artery (PAT #4)**
 - With the probe indicator oriented toward the heel, align the probe in a long axis proximal to the first metatarsal head. The key landmark is the flexor hallucis longus tendon, with the medial plantar artery visualized superficial to it
- **Lateral Plantar Artery (PAT #5)**
 - Lateral Plantar Artery: Begin with the probe in transverse orientation at the midfoot, positioning the center of the transducer in line with the fourth toe and the plantar vein centered in the grayscale image. Elongate the lateral plantar vein, then activate color Doppler to visualize the lateral plantar artery adjacent to it. Measure one PAT at the midfoot within the lateral plantar artery.
- **Deep Plantar Artery (PAT #6)**
 - Once the lateral plantar artery is identified, slide the probe distally toward the ball of the foot, with the probe indicator towards the heel, maintaining alignment between the second and third toes. The deep plantar artery will be visualized diving into the foot at this level. Measure PAT at this location.

Pedal Acceleration Time Criteria

Correlation of PAT with Degrees of Ischemia				
	No ischemia Class 1	Mild ischemia Class 2	Moderate Ischemia Class 3	Severe Ischemia Class 4
Clinical symptoms	Asymptomatic	Greater than 2 block claudication	Less than 2 block claudication	CLTI Tissue Loss; Rest Pain
PAT	20– 120 ms	121 – 180 ms	181 – 224 ms	Greater than 225 ms
ABI	1.3 – 0.9	0.89 – 0.69	0.68 - 0.50	0.49 – 0.00
Toe Pressure	> 30 mmHg		< 30 mmHg	
TCP02	> 44		< 26	
Sommerset J et al. AVS 2019 Pinelo A et al. AVS 2024 Trihan et al. Front Cardiovasc Med 2022				

Bypass Graft Examination: Document velocities and longitudinal color Doppler images in the following:

- Inflow artery, proximal anastomosis, proximal graft, mid graft, thigh graft, distal anastomoses, and outflow to the bypass graft.
 - Abnormalities require additional images when present
- In the presence of pathology, spectral waveforms should be recorded proximal to, within, and distal to the lesion.

Ankle- Brachial and Toe Indices:

- Refer to resting ankle brachial and toe indices protocol for complete outline.

Considerations

- All spectral derived velocity information is obtained with a documented Doppler insonation angle of **60 degrees** or less. Color Doppler may assist in determining the presence or absence of flow, direction of flow and the localization of highest mean frequencies (i.e. a diameter reduction).
- Sample volume size (SVS) and location
- SVS should be small (1.5-2.0mm in length), especially when evaluating for spectral broadening.
- SVS can be lengthened in cases where attempts are being made to document high velocity jets or detect flow in suspected occlusions, both being situations where evaluations of spectral broadening are not an issue.

The sample volume should be placed center stream in the blood vessel.

- Adjustments of Doppler gain
 - Care should be taken to optimally adjust Doppler gain to assure proper representation as to the extent of spectral broadening.
- Color Doppler imaging
 - Facilitates visualization of the arterial bifurcations.
 - May add confidence in the diagnosis of a segmental occlusion and may augment information provided by grayscale imaging such as identification of plaque or thrombus not visible with grayscale image or in the assessment of surface contour of plaque.
 - Can aid in determining the presence or absence of flow as well as flow direction.
- Power Doppler imaging
 - Aids in determining if a possible occlusion has a string sign or trickle flow.
 - Increased sensitivity.
 - Non-directional dependent on equipment capabilities.
- In the event of a stenosis, document Doppler signals proximal to the stenosis, within the stenosis and just distal to the stenosis, evaluating post-stenotic Doppler signals.
- In the presence of stents, document flow velocities and longitudinal color Doppler images at the proximal attachment site, mid stent, and distal attachment, and within the treated segment if angioplasty alone was performed.
 - In the presence of venous arterialization, the duplex evaluation should document the complete hemodynamic pathway, including the inflow artery, arteriovenous anastomosis, and the conduit (mid, and distal segments) extending to the ankle.

Assessment should include flow characteristics and flow volume within the pedal venous system (e.g., conduit and lateral plantar vein), as well as evaluation of the outflow vein (e.g., great saphenous or small saphenous vein) to characterize overall circuit integrity and perfusion.

- Additional Doppler signals or color Doppler images necessary to document or classify disease should be included.

PRESENTATION OF EXAM FINDINGS

- Review of Examination Findings
 - Promptly notify the vascular laboratory Medical Director or responsible healthcare provider of urgent or critical findings (e.g., suspected limb-threatening ischemia, cold extremity, loss of motor function, gangrene) in accordance with departmental policies
 - Provide preliminary results when appropriate, in accordance with laboratory-specific guidelines.
 - Present a complete record of diagnostic images, data, technical worksheet, and relevant explanations to the interpreting physician
 - Ensure interpretation is completed within two business days, with a finalized and signed report available within four business days, including both sonographer and interpreting physician identification
 - Review all acquired images to confirm a complete examination and document any deviations from protocol with explanation

EXAM TIME RECOMMENDATIONS

High quality, accurate results are fundamental elements of the lower extremity arterial duplex examination. 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, 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).
 - 93925 90 minutes
 - 93926 60 minutes

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