VASCULAR TECHNOLOGY
PROFESSIONAL PERFORMANCE GUIDELINES

Lower Extremity Arterial Segmental Physiologic Evaluation

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Lower Extremity Arterial Segmental Physiologic Evaluation

**PURPOSE**
Arterial segmental pressure and waveform evaluations are performed to determine the presence, severity and general location of peripheral arterial occlusive disease (PAOD).

**COMMON INDICATIONS**
- Common indications for performance of arterial segmental pressures and waveforms include, but are not limited to:
  - Claudication-exercise (walking) related leg pain
  - Ischemic ulceration and/or gangrene
  - Rest pain
  - Determination of the prognosis for healing (skin lesions, amputations)
  - Follow-up in patients with known PVOD
  - Assessment prior to diagnostic arteriography, endovascular procedures, or lower extremity Revascularization
  - Follow-up monitoring of lower extremity revascularization

**CONTRAINDICATIONS AND LIMITATIONS (LOWER EXTREMITY SEGMENTAL PRESSES)**
Contraindications for evaluation of dialysis access are few; however, some limitations exist and may include the following:
- Patients with suspected or known acute deep venous thrombosis (DVT ) or superficial thrombophlebitis may need to be limited to waveform analysis only or use of a toe/brachial index (TBI)
- Recent surgery, ulcers, casts or bandages that cannot or should not be compressed by pressure cuffs
- Patients with incompressible arteries due to medial calcification (A toe brachial index is recommended in this instance)
- Patients who are post-interventional procedure, i.e., stent placement, arterial bypass graft, segmental, can be contraindicated, depending on physician preference
- Patients who are post lower extremity (ankle level) interventional procedure, i.e., ankle level arterial bypass graft, ankle pressures may be contraindicated
GUIDELINE 1: PATIENT COMMUNICATIONS AND POSITIONING

1.1 Introduce self and explain why the Lower Extremity Segmental Physiologic evaluation is being performed and indicate how long it will take.

1.2 Explain the procedure to the patient, taking care to ensure that the patient understands the necessity for each aspect of the evaluation.

1.3 Respond to questions and concerns about any aspect of the evaluation.

1.4 Educate the patient about risk factors for and symptoms of peripheral arterial disease.

1.5 Refer specific diagnostic, treatment or prognosis questions to the patient's physician.

1.6 The patient should rest for 15 minutes prior to examination.

GUIDELINE 2: PATIENT ASSESSMENT

A patient assessment must be performed before the Lower Extremity Physiologic Evaluation is started. This includes assessment of the patient’s ability to tolerate the procedure and an evaluation of any contraindications to the procedure.

The technologist/sonographer/examiner should:

2.1 Obtain a complete, pertinent history by interview of the patient or patient’s representative and review of the patient’s medical record (when available).

2.2 A pertinent history includes:

   a. Current medical status
   b. Previous vascular/cardiovascular surgeries/interventions
   c. Current medications or therapies
   d. Presence of any risk factors for arterial disease: diabetes; hypertension; hyperlipidemia; coronary artery disease; history of arterial disease, coronary artery, or vascular disease; family history of diabetes or hypertension; age; smoking history
   e. Presence of any symptoms of peripheral arterial occlusive disease: claudication; rest pain; skin changes

2.3 Perform palpation of pulses (femoral, popliteal, dorsal pedal and posterior tibial) and auscultation of bruits (abdominal, femoral, & popliteal (if required in individual laboratory protocols)

2.4 Verify that the requested procedure correlates with the patient’s clinical presentation.
GUIDELINE 3A-3B:
LOWER LEVEL PHYSIOLOGICAL EXAM, SINGLE AND MULTI-LEVEL

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. Segmental pressure and waveform findings are analyzed throughout the course of the examination to ensure that sufficient and accurate data is provided to the physician to direct patient management and render a final diagnosis.

INSTRUMENTATION:
3.1 Use instrumentation that allows a display of the Doppler or plethysmographic waveforms and segmental pressure and includes:
   a. Waveform display capabilities.
   b. Continuous wave handheld Doppler with a carrier frequency that ranges between 4-10 MHz.
   c. Blood pressure cuffs (limb and digital) of varied width and length. Pressure artifacts occur when the cuff size is not appropriate for the girth of the leg or digit. Recommended size is 20% wider than the diameter of the limb.
   d. Hardcopy paper, film or digital storage is required

3A LOWER EXTREMITY SEGMENTAL PHYSIOLOGIC EVALUATION – SINGLE LEVEL (ABI)

3.1A Follow a standard exam protocol for each lower extremity. All studies should be bilateral, unless there are limiting factors, i.e. amputations of one lower extremity (a limited/modified exam may be performed on the thigh, in the case of a below knee amputation). Ankle physiological waveform analysis is typically derived from Doppler or volume plethysmography (VPR) evaluations.

NOTE: CMS currently requires acquisition of Doppler waveforms during single level physiological exams be done with equipment “different and separate from a duplex instrument” and that two waveforms be obtained (PT/AT and DP, when applying CPT code 93922.

a. Doppler Waveforms: Doppler waveform data are obtained at the posterior tibial and dorsalis pedis arteries. All Doppler waveforms should be performed at a 45 degree angle (or at an angle in which the “best” audible signal is achieved) to the skin or area being insonated. At least three representative waveforms should be obtained in both vessels. Gain settings should be maximized to display characteristics present.

b. Volume Plethysmography Waveforms (VPR): At least three representative plethysmography waveforms should be obtained at the ankle. Standardized inflation pressures must be used in all pulse volume cuffs. Gain settings should be optimized for good amplitude.

c. Systolic pressures are measured in both the posterior tibial (PT) and dorsalis pedis (DP) arteries. If no PT or DP arterial signals are found, attempt to record the distal anterior tibial (just above flexor joint at the ankle) and/or the peroneal artery (just above the lateral malleolus at the ankle) pressure.

3.2B Calculation of data for physician interpretation

   a. Calculate the ankle/brachial index (ABI) by dividing the highest ankle blood pressure from each leg by the highest arm pressure. Ankle Brachial Index = Highest Ankle Systolic Pressure / Highest Brachial Systolic Pressure
b. A toe brachial index (TBI) is calculated by dividing the toe pressure by the higher of the two brachial pressures.
c. Audio interpretation of the signals should attempt to classify the signals as triphasic, bi-, or monophasic.
d. Hardcopy of the signals should be classified as triphasic, bidirectional or unidirectional biphasic, or monophasic.

3B: LOWER EXTREMITIES SEGMENTAL PHYSIOLOGIC EVALUATION
– MULTI-LEVEL

3.1B Follow a standardized protocol for each examination. All initial studies are bilateral unless there are limiting factors, i.e., amputation (a limited/modified exam may be performed in the thigh in the case of a below knee amputation). Waveforms can be obtained using either Doppler or volume plethysmography techniques.

Waveforms: Doppler waveform data are obtained at the common femoral, superficial femoral, popliteal, posterior tibial and dorsal pedal arteries. All Doppler waveforms must be performed at an appropriate angle to the skin or area being insonated in order to optimize waveform morphology and audible Doppler signals. At least three representative waveforms (i.e.; cardiac cycles) should be obtained at all levels. Gain settings should be maximized to define waveform morphology at each level.

NOTE: CMS currently requires acquisition of Doppler waveforms during multilevel level physiological exams be done with equipment “different and separate from a duplex instrument” and that two waveforms be obtained (PT/AT and DP, when applying CPT code 93923.

a. Volume plethysmography waveforms. At least three representative waveforms must be obtained at the thigh, calf and ankle bilaterally. (Standard of practice with this method is 4 levels – otherwise you would need CW Doppler to differentiate inflow from outflow disease). Standardized inflation pressures must be used in all cuffs. Gain setting should be maximized at the calf with remaining settings left at that established.
b. Systolic segmental pressures are recorded at the brachial, thigh, calf and ankle levels, bilaterally. Both the posterior or anteriotibial tibial (PT/AT) and dorsalis pedis (DP) arteries are used to measure the ankle pressure. The pedal artery that yields the higher ankle pressure is used to obtain the calf and thigh pressures.

3.2B Toe pressure and a toe-brachial index may be performed in patients with evidence of incompressible tibi al vessels. Toe brachial index (TBI) is calculated by dividing the toe pressure by the higher of the two brachial pressures.

3.3B If lower extremity stress testing is indicated, a motorized treadmill or reactive hyperemia evaluation is performed. (Note: when exercising any patient, the examiner should be familiar with the risk factors and contraindications related to this test and be aware that the protocol may need to be modified for any individual patient.)

Note: new regulations require that when billing for CPT code 93924, exercise MUST be carried out with motorized treadmill or using reactive hyperemia. (It cannot be done using hallway walking or “toe-up” activity).

3.4B The contraindications below apply to motorized treadmill exercise testing:
- 4ABI less than 0.5
- Chest pain (angina) unless physician present
• Previous myocardial infarction (MI) or coronary artery bypass graft (CABG) unless cleared by MD
• Shortness of breath
• Unsteadiness when walking
• Hypertension (>200 mmHg systolic pressure)

3.5C Treadmill exercise testing is discontinued if:
• The patient has completed 5 minutes of exercise or symptoms of claudication force the patient to stop
• The patient experiences chest, shoulder, neck, jaw or arm pain
• There are any signs of SOB, fatigue, or faintness.

Motorized treadmill testing is generally performed at a constant speed and grade, e.g. 2 mph; 10-12% grade, for five minutes or until symptoms occur and the patient is forced to terminate the exercise protocol.

a. An alternative to treadmill testing approved by CMS is reactive hyperemia. Reactive hyperemia is performed using a pneumatic cuff at the thigh level. The cuff is inflated to suprasystolic pressure for 3-5 minutes or until the patient can no longer tolerate the cuff inflation. (Note: placing the cuff around the distal thigh makes this technique more tolerable)

b. Ankle pressure measurements and ABI are determined, bilaterally, immediately post-treadmill beginning with the symptomatic limb or the limb with the lowest ABI pre-exercise. Typically, the higher of the PT or DP ankle pressures is used to record the post-stress measurements. Post-stress ankle pressure measurements are repeated at 1-2 minute intervals for up to 10 minutes, or until ankle pressure measurements return to pre-exercise levels.

c. If reactive hyperemia is used for stress testing, the blood pressure is likely to return to pre-stress levels more rapidly. Some laboratories test each leg separately in order to facilitate pressure measurements more quickly. If reactive hyperemia is used, the brachial pressure need not be recorded post test. Results are based on the amount of pressure drop (should this occur) and time to recovery.

GUIDELINE 4: REVIEW OF THE DIAGNOSTIC EXAM FINDINGS

The technologist/sonographer/examiner should:

4.1 Review data acquired during the evaluation to ensure that a complete and comprehensive evaluation has been performed and documented.

4.2 Explain and document any exceptions to the evaluation protocol (i.e., study limitations, omissions or revisions).

4.3 Record all technical findings required to complete the final diagnosis on a worksheet, logbook or other appropriate form so that the measurements can be classified according to the laboratory’s diagnostic criteria (based on published or internally validated data).

4.4 Document exam date, clinical indication(s), technologist performing the evaluation and summary in a laboratory logbook or other appropriate medium, i.e. computer software.

4.5 To determine any change in follow-up studies, review previous exam documentation so that the current evaluation can document a change in status. The examination protocol may need to be modified to address previous findings and current physical needs.
GUIDELINE 5: PRESENTATION OF EXAM FINDINGS

The technologist/sonographer/examiner should:

5.1 Provide preliminary results when necessary as provided for by internal guidelines.
5.2 Present record of data, explanations, and technical worksheet to the interpreting physician for use in rendering a diagnosis and for archival purposes.
5.3 Alert vascular laboratory Medical Director or appropriate health care provider when immediate medical attention is indicated.

GUIDELINE 6: EXAM TIME RECOMMENDATIONS

High quality, accurate results are fundamental elements of lower extremity arterial segmental physiologic evaluation. 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: review of previous exam data; completion of pre-exam paperwork; exam room and equipment preparatory activities; patient assessment and positioning (Guideline 1); patient (Guideline 2); post-exam activities: exam room cleanup; compiling, reviewing and processing exam for preliminary and/or formal interpretation (Guidelines 4-5); and, patient charge and billing activities. Recommended time allotment is 30 minutes.

6.2 Direct exam components include equipment optimization and the actual hands-on, examination process (Guideline 2). Recommended time allotment is 25-30 minutes. Treadmill Exercise Testing or Reactive Hyperemic Testing (Guideline 3.5) may be necessary in some cases. Recommended time allotment is 20-30 minutes.

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), or CCI (RVS credential), or ARRT (RT-V), the individual must remain current with:

7.1 Advances in diagnosis and treatment of peripheral arterial disease.
7.2 Changes in Lower Extremity Arterial Segmental Physiologic Evaluation, single level or multi-level, protocols or established (internally validated) laboratory diagnostic criteria.
7.3 Advances in ultrasound technology used for the peripheral arterial evaluation.
7.4 Advances in other technology used for the peripheral arterial 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 are inherent to this process.

REFERENCES