VASCULAR TECHNOLOGY
PROFESSIONAL PERFORMANCE GUIDELINES

Lower Extremity Arterial Physiologic Evaluations

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PURPOSE

Segmental pressures, pulse volume recordings, Doppler and photoplethysmography waveform evaluations are performed to determine the presence, severity and general location of peripheral arterial occlusive disease (PAD).

APPROPRIATE INDICATIONS

Common indications for lower extremity arterial physiologic evaluation include, but are not limited to:

- Claudication
- Ischemic rest pain
- Arterial ulceration
- Peripheral arterial disease (PAD)
- Suspected arterial embolization
- Pre-procedure assessment (e.g., angioplasty, stent, bypass graft)
- Follow-up endovascular procedure (e.g., angioplasty, stent)
- Follow-up bypass graft
- Prognosis for healing (e.g., ulcerations, amputations)

CONTRAINDICATIONS AND LIMITATIONS

Contraindications for lower extremity arterial physiologic evaluation include, but are not limited to:

- Morbidly obese patients in whom a high-thigh pressure may be not obtainable
- Casts, dressings, staples and/or open wounds
- Suspected or known acute deep venous thrombosis (DVT)
- Incompressible vessels with arterial calcification (TBI may be obtained)
- Post-interventional procedure (e.g., stenting, bypass graft)
- Recent surgery, trauma, ulcers, casts or dressings that should not be compressed by a blood pressure cuff
- Involuntary movement/tremors may render waveform collection suboptimal or unreliable

PATIENT COMMUNICATION

Prior to beginning the exam, the sonographer or examiner 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.
- Respond to questions and concerns about any aspect of the evaluation.
- Educate patient about risk factors and symptoms of peripheral arterial disease.
- 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 assessment of the patient's ability to tolerate the procedure and 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 review of the patient's medical record, if available. A pertinent history includes:

- Previous cardiovascular surgeries
- Current medications or therapies
- Presence of risk factors for peripheral arterial disease
    - Diabetes
    - Hypertension
    - Hyperlipidemia
    - Age
    - Smoking
    - Obesity
    - Cerebrovascular disease
    - Coronary artery disease
    - Family history of PAD
- Presence of symptoms for peripheral arterial disease
    - Claudication
    - Rest pain
    - Ulceration
    - Gangrene
    - Ischemia
    - Hair loss
    - Pallor
    - Dependent rubor
- Results of other relevant diagnostic procedures
- Review of prior ultrasound examinations

- Verify that the requested procedure correlates with the patient's clinical presentation

PATIENT POSITIONING/PREPARATION

The optimal patient positioning and preparation for performing a lower extremity arterial segmental physiologic evaluation includes:

- Supine patient position
- Performed in a warm room to reduce vasoconstriction
- Patient rested for approximately 5-10 minutes prior to beginning examination

INSTRUMENTATION

Non-invasive physiologic studies require separate and distinct equipment from the Duplex ultrasound scanner. Instrumentation must allow the display and permanent recording of pressures with bi-directional Doppler analysis of blood flow, plethysmography and/or oxygen tension measurements.

- Continuous wave (CW) Doppler must provide:
    - Doppler frequencies appropriate for vessels examined
        - Typically range from 4-10MHz
    - Direction sensitive Doppler blood flow meter
    - Doppler waveform display with bi-directional flow capabilities
    - Audible output and permanent recording of Doppler waveforms
- Segmental limb plethysmography must provide:
    - Equipment capable of measuring small segmental volume changes and making permanent recordings of blood pressure measurements
    - Blood pressure cuffs of various sizes for each limb segment and digit evaluated
        - Recommended size is 20% wider than limb diameter
- Pulse volume plethysmography (PVR) must provide:
    - Equipment capable of measuring small limb volume changes and saving permanent PVR waveforms
    - Capability of calibration before each exam
    - Blood pressure cuffs of various sizes for each limb segment and digit evaluated
- Photoplethysmography (PPG) must provide:
    - Electrical sensor for signal display
    - Capable of providing a permanent recording of PPG waveforms

- Treadmill exercise/stress testing (if used) must provide:
    - Motorized treadmill capable of maintaining a constant speed and incline

EXAMINATION PROTOCOL

Throughout each examination, the sonographer should:

- Assess and monitor the patient's physical and mental status, allowing modifications to the procedure plan according to the patient's clinical status.
- Analyze segmental pressure and waveform findings to ensure that sufficient data is provided to the physician to direct patient management and render a final diagnosis.

Single-Level Lower Extremity Arterial Physiologic Exam

A limited exam includes the measurement of bilateral systolic blood pressures to obtain the ankle brachial index, in combination with either Doppler or plethysmographic waveform analysis at the ankle.

*The **ankle brachial index** (ABI) includes:*

- Measurement of bilateral brachial artery systolic pressures and the higher of the two pressures is used to calculate the ABI
- Measurement of bilateral ankle systolic pressures from the distal posterior tibial (PT) artery and distal anterior tibial (AT)/dorsalis pedis (DP) artery and the higher of the two pressures on each side is used to calculate the ABI
    - The ***ankle brachial index*** (ABI) is calculated by dividing the highest ankle pressure from each limb by the highest brachial pressure
        - The ABI may be affected by arterial calcification
- Additional information regarding the presence of disease may be obtained by recording toe PPG waveforms and toe systolic pressures
    - The ***toe brachial index*** (TBI) is calculated by dividing the great toe pressure by the highest brachial pressure

***Doppler waveforms** are obtained and documented from the:*

- Posterior and anterior tibial arteries at the level of the ankle

***Plethysmographic waveforms** are obtained and documented from the:*

- Ankle level
    - PVR waveforms are unaffected by intimal calcification
- Toe PPG waveforms (if indicated)

Multi-Level Lower Extremity Arterial Physiologic Exam

A complete exam includes the measurement of bilateral systolic blood pressures to obtain the ankle brachial index, in combination with either Doppler or plethysmographic waveform analysis from at least three levels.

*The **ankle brachial index** (ABI) includes:*

- Measurement of bilateral brachial artery systolic pressures and the higher of the two pressures used to calculate the ABI
- Measurement of bilateral ankle systolic pressures from the distal posterior tibial (PT) artery and distal anterior tibial (AT)/dorsalis pedis (DP) artery and the higher of the two pressures on each side is used to calculate the ABI
    - The ***ankle brachial index*** (ABI) is calculated by dividing the highest ankle pressure from each limb by the highest brachial pressure
        - The ABI may be affected by arterial calcification
- Additional information regarding the presence of disease is obtained by recording toe PPG waveforms and toe systolic pressures
    - The ***toe brachial index*** (TBI) is calculated by dividing the great toe pressure by the highest brachial pressure

Segmental pressures at the thigh, calf and ankle levels are obtained in cases with an abnormal ABI

- Four cuff technique: includes high thigh, low thigh, calf and ankle pressures
- Three cuff technique: includes thigh, calf and ankle pressures

***Doppler waveforms** are obtained and documented from the:*

- Common femoral artery
- Mid superficial femoral artery (when indicated)
- Popliteal artery
- Posterior and anterior tibial arteries at the level of the ankle

**Gain settings should be maximized at each level to display Doppler waveform characteristics*

***Plethysmographic waveforms** are obtained and documented from the:*

- Thigh (includes high thigh and low thigh waveforms if using the four cuff method)
- Calf
- Ankle
- Toe PPG waveforms (if indicated)

**Gain setting are optimized to display PVR waveform characteristics, but left unchanged between levels*

Lower Extremity Arterial Physiologic Exam with Treadmill Exercise/Stress Testing

If indicated and ordered by a qualified physician, a non-invasive physiologic study at rest and following motorized treadmill stress testing may be performed. Treadmill testing is generally set at a constant speed and grade (e.g., 2 mph, 10% grade) for five minutes, or until symptoms occur and the patient is forced to stop.

Resting exam *includes the measurement of bilateral systolic blood pressures to obtain the ankle brachial index, in combination with either Doppler or plethysmographic waveform analysis at the ankle. This is followed by treadmill exercise for five minutes, or until symptoms occur and the patient is forced to stop.*

Following treadmill exercise*, bilateral ankle pressure measurements are obtained at timed intervals with the patient in a supine position:*

- Begin the ankle pressure measurements in the symptomatic limb or limb with the lowest pre-exercise ankle pressure.
- Use the pedal artery that yielded the higher pre-exercise ankle pressure to record the post-exercise ankle pressure.
- Use the brachial artery that yielded the higher pre-exercise pressure to obtain a post-exercise pressure and calculate the ABI.
- Repeat the post-exercise ABI/pressure measurements at one to two minute intervals for up to 10 minutes, or until ankle pressures return to pre-exercise levels.
    - testing results are based on initial ankle pressure decrease and time required for the ankle pressures to return to pre-exercise levels.

Alternatives to treadmill testing

When treadmill testing is contra-indicated or not possible, a physiologic study at rest and following other stress maneuvers may be appropriate. These are generally performed for five minutes, or until symptoms occur and the patient is forced to stop. These are not considered equivalent to treadmill testing. Alternatives to treadmill testing include:

- Hall walking (until symptomatic or for 5 minutes)
- Toe raises (until symptomatic or for 50 toe raises)
- Post occlusive reactive hyperemia
    - Requires occlusive pneumatic cuff inflation at the thigh level for three to five minutes or until the patient can no longer tolerate it
- Repeat post-stress ABI/pressure measurements at one to two minute intervals for up to 10 minutes, or until ankle pressures return to pre-exercise levels
    - testing results are based on initial ankle pressure decrease and time

required for the ankle pressures to return to pre-stress levels

Contraindications to treadmill exercise/stress testing

When exercising any patient, the examiner should be familiar with risk factors and contraindications related to this test and aware that the protocol may need to be modified for individual patients. Contraindications for treadmill exercise/stress testing include:

- ABI less than 0.5
- Non-compressible vessels (ABI > 1.3)
- Chest pain (unless physician present)
- Questionable or unstable cardiac status
- Shortness of breath
- Unsteadiness when walking
- Hypertension (>180mmHg systolic brachial pressure)

Treadmill exercise/stress testing should be discontinued if:

- Patient completes five minutes of exercise or claudication forces patient to stop
- Patient experiences chest, shoulder, neck, jaw, or arm pain
- Patient experiences shortness of breath, fatigue, or faintness

REVIEW OF THE DIAGNOSTIC EXAMINATION FINDINGS

The sonographer or examiner should:

- Review data acquired during the lower extremity arterial physiologic exam 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).
- Determine any change in follow-up studies, review previous exam documentation, document any change in status; and, to duplicate prior imaging and Doppler parameters.
- Record 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 EXAMINATION 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.
- Sonographer and interpreting physician name must appear on the final report. Finalized/signed report should be available within four business days.
- Alert vascular laboratory Medical Director or appropriate health care provider when immediate medical attention is indicated based on departmental guidelines and procedures.

EXAMINATION TIME RECOMMENDATIONS

High quality, accurate results are fundamental elements of lower extremity physiologic examinations. 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).
    - 93922 39 minutes
    - 93923 59 minutes
    - 93924 73 minutes

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