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**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 or exercise (walking) related leg pain
- Ischemic ulceration or gangrene
- Rest pain
- Determination of the prognosis for healing (skin lesions, amputations)
- Follow-up in patients with known PAOD
- Assessment prior to diagnostic arteriography or lower extremity revascularization (to establish baseline flow)
- Follow-up after diagnostic arteriography or lower extremity revascularization

CONTRAINDICATIONS AND LIMITATIONS (LOWER EXTREMITY SEGMENTAL PRESSURES)

- Patients with suspected or known acute deep venous thrombosis (DVT)
- Recent surgery, ulcers, casts or bandages that cannot or should not be compressed by pressure cuffs
- Patients with incompressible vessels due to medial calcification (A Toe Brachial Physiologic Evaluation is recommended in patients with incompressible vessels due to medial calcification.)
- Patients who are post-interventional procedure, i.e., stent placement, arterial bypass graft, segmental pressures may be contraindicated
- 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 COMMUNICATION AND POSITIONING

- 1.1 Introduce yourself 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 Refers specific diagnostic, treatment or prognosis questions to the patient's physician.
- 1.6 The patient should rest for at least 15 minutes prior to examination.
- 1.7 The patient should lay supine with the heart at approximately the same level as the extremities.

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.

- 2.1 Obtain a complete, pertinent history by interview of the patient or patient's representative and review of the patient's medical record. A pertinent history includes:
 - a. Current medical status
 - b. Previous vascular/cardiovascular surgeries
 - c. Current medications or therapies
 - d. Presence of any risk factors for arterial disease: diabetes; hypertension; hyperlipidemia; peripheral vascular disease; coronary artery disease; family history of arterial disease, coronary artery, or vascular disease; family history of diabetes or hypertension; age; smoking
 - e. Presence of any symptoms of peripheral arterial occlusive disease: claudication; rest pain; skin changes; bruits
- 2.2 Perform palpation of pulses (femoral, popliteal, dorsal pedal and posterior tibial) and auscultation of bruits (abdominal, femoral, popliteal)
- 2.3 Verify that the requested procedure correlates with the patient's clinical presentation.

GUIDELINE 3A – 3B:

3A EXAMINATION GUIDELINES FOR LOWER EXTREMITY SEGMENTAL PHYSIOLOGIC EVALUATION – SINGLE LEVEL (ANKLE–BRACHIAL INDEX [ABI])

3B EXAMINATION GUIDELINES FOR LOWER EXTREMITY SEGMENTAL PHYSIOLOGIC EVALUATION – 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 data is provided to the physician to direct patient management and render a final diagnosis.

The patient should rest for at least 15 minutes prior to testing and is examined in the supine position with the extremities at approximately the same level as the heart.

The technologist/sonographer/examiner:

- 3.1 Use instrumentation that allows a display of the Doppler or plethysmographic waveforms and segmental pressure measurements and includes:
- Waveform display capabilities
 - Continuous wave handheld Doppler with a carrier frequency that ranges between 5-8 MHz
 - Hardcopy paper, film or digital storage capabilities

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

- 3.2A Follow a standard exam protocol for each lower extremity. While all studies should be bilateral, amputations of one lower extremity will result in a unilateral study. Ankle physiological waveform analysis is typically Doppler or air plethysmography in origin. Waveform and pressure information is used to identify the presence, absence and the severity of disease.
- Doppler Waveforms: Doppler waveform data are obtained at the posterior tibial and dorsalis pedis arteries. All Doppler waveforms must be performed at a 45 degree angle to the skin or area being insonated. At least three representative waveforms should be obtained in both vessels. Gain settings should be standardized.
 - Air Plethysmography Waveforms: At least three representative air plethysmography waveforms should be obtained at the ankle. Standardized inflation pressures must be used in all pulse volume cuffs. Gain settings should be standardized.
 - Both the posterior tibial (PT) and dorsalis pedis (DP) arteries are used to measure systolic ankle pressure. If no PT or DP arterial signals are found, record the anterior tibial and/or the peroneal artery pressure.
- 3.3A Calculate the ankle/arm brachial index (ABI) by dividing the highest ankle blood pressure from each leg by the highest arm pressure.
- $$\text{Ankle/Arm Index} = \frac{\text{Highest Ankle Systolic Blood Pressure}}{\text{Highest Arm Systolic Blood Pressure}}$$
- A toe brachial index (TBI) is calculated by dividing the toe pressure by the higher of the two brachial pressures.
 - Audio interpretation of the signals should attempt to classify the signals as triphasic, biphasic, or monophasic.

3B LOWER EXTREMITY SEGMENTAL PHYSIOLOGIC EVALUATION – MULTI-LEVEL

- 3.2B Follow a standard exam protocol for each examination. All initial studies are bilateral unless there are limiting factors, i.e., amputation. Waveforms can be obtained using either Doppler or air 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 a 45 angle to the skin or area being insonated. At least three representative waveforms (i.e.; cardiac cycles) should be obtained at all levels. Gain settings should be standardized.

- a. Air plethysmography waveforms: At least three representative waveforms must be obtained at the thigh, calf and ankle bilaterally. Standardized inflation pressures must be used in all cuffs. Gain settings should be standardized.
 - b. Systolic segmental pressures are recorded at the brachial, thigh, calf and ankle levels, bilaterally. Both the posterior tibial (PT) 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.
- 3.3B Toe pressure and a toe-brachial index may be performed in patients with evidence of tibial vessel non-compressibility.
Toe brachial index (TBI) is calculated by dividing the toe pressure by the higher of the two brachial pressures.
- 3.4B If lower extremity stress testing is indicated, a treadmill or reactive hyperemia evaluation is performed. (**Note:** when exercising the elderly 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 altered accordingly.)

The **contraindications** below apply to **treadmill exercise testing**:

- ABI less than 0.5
- Chest pain of recent onset
- Previous myocardial infarction (MI) or coronary artery bypass graft (CABG)
- Evidence of shortness of breath
- Unsteadiness when walking
- Uncontrolled angina
- Hypertension (>200 mmHg)

Treadmill **exercise** testing is **discontinued if**:

- The patient has completed 5 minutes of exercise or symptoms force the patient to stop
- The patient experiences chest, shoulder, neck, jaw or arm pain
- There are any signs of dyspnea, fatigue, or feeling faint

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

Variable load protocols use varying speed(s), grade(s) and time(s), until

- a. Symptoms occur and the patient is forced to terminate the exercise protocol.
 - a. Alternatives to treadmill testing include:
 - i. Reactive Hyperemia. Reactive hyperemia is generally performed using a pneumatic cuff at the thigh level. The cuff is inflated above suprasystolic pressure for 3-5 minutes or until the patient can no longer tolerate the cuff inflation.
 - ii. Hall Walking: Have the patient walk in the hall to try to induce claudication. Follow the same procedure below for post exercise testing.
 - iii. Toe Ups: The patient is asked to do 50 -100 toe ups to induce claudication. Follow the same procedure below for post exercise testing.
 - b. Ankle pressure measurements and ABI are determined, bilaterally, immediately post-treadmill (or other alternative method of inducing claudication.) 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.

GUIDELINE 4: REVIEW OF THE DIAGNOSTIC EXAM FINDINGS

- 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 exam 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

- 5.1 Provides preliminary results when necessary as provided for by internal guidelines.
- 5.2 Presents 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 communication (Guideline 2); **post-exam activities**: exam room cleanup; compiling, reviewing and processing exam data 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 includes equipment optimization and the actual hands-on, examination process (Guideline 2). Recommended time allotment is 35- 45 minutes.
- 6.3 Treadmill Exercise Testing or Reactive Hyperemic Testing (Guideline 3.5) may be necessary in some cases. Recommended time allotment is 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, all Registered Vascular Technologists must keep 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 published 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 is inherent to this process.

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