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Physiologic Evaluation of Extremity Arteries Ultrasound Protocol

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Contact: (866) 761-4200, Option 1

Indications:

Indications for the examination include, but are not limited to:

1. Evaluation of exercise induced limb pain.
2. Assessment of digital or extremity ulceration, gangrene, and/or rest pain.
3. Follow-up of surgical and endovascular procedures.
4. Evaluation of wound healing potential.
5. Patients with chronic kidney disease requiring dialysis.
6. Evaluation of cold sensitivity or discoloration of extremities or digits.
7. Evaluation of suspected thoracic outlet syndrome.
8. Evaluation of suspected steal distal to an arteriovenous fistula or graft.
9. Preoperative assessment for arterial harvesting.
10. Assessment for the presence of peripheral vascular disease as part of an assessment of overall atherosclerosis burden.
11. Preoperative assessment for renal transplant.

There are no absolute contraindications for this examination.

Required Images

Description of the component parts of the examination:

1. Segmental limb pressures

The laboratory should have a protocol specifying the size of the cuff to be used at each location where blood pressure is commonly obtained. Extremity pressures are taken using a hand held continuous wave (CW) Doppler to listen for return of arterial blood flow. Blood pressure readings can be assessed instead using spectral Doppler tracings or photoplethysmography to

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determine when blood flow returns as the blood pressure cuff is deflated. Digital pressure can be assessed using photoplethysmography to determine when blood flow returns. Bilateral brachial pressures are obtained when possible. The highest brachial pressure is the pressure used in index calculations (e.g., ankle-brachial index [ABI]) for the upper extremities, lower extremities, or digits.

2. CW (continuous wave) Doppler waveforms

CW Doppler waveforms can be obtained from one or more arteries. In the lower extremity, the arteries most commonly assessed are the common femoral, superficial femoral, popliteal, posterior tibial, and dorsalis pedis. In the upper extremity, arteries commonly assessed are the subclavian, axillary, brachial, radial, and ulnar. Those performing the examination should be familiar with the appropriate external anatomic landmarks to ensure accurate performance of the examination. There should be strict adherence to technique, including attempting to maintain as close to a 60-degree Doppler angle as possible.

3. Pulse volume recordings (PVRs)

PVRs can be obtained at one or more levels. In the lower extremity, the most common places to obtain waveforms are in the upper thigh, lower thigh, calf, and ankle. A waveform can be obtained in the toes using a photoplethysmography cell.

4. Transcutaneous oxygen tension measurements

Measurement of the transcutaneous oxygen tension (tcPO₂) can be used to assess the delivery of oxygen to the skin in an area of questionable viability. The tcPO₂ probe has an oxygen sensor comprised of a central platinum cathode that is surrounded by a circular silver-silver halide anode. Surrounding the oxygen sensor is a heating element that warms the skin to 43 to 45 degrees C in order to optimize cutaneous vasodilatation and oxygen delivery. After the desquamated cells are cleaned from the skin, a coupling solution such as distilled water is applied to the skin, and the tcPO₂ sensor is affixed to the testing site with an overlying occlusive adhesive dressing that prevents exposure to room air. Free oxygen diffuses from the vascular space through the extravascular soft tissues and skin. Upon contact with the tcPO₂ sensor it undergoes a chemical reduction that generates a recordable electrical current that is proportional to the oxygen tension.

Physiological tests are indirect tests. Results are used to infer the presence or absence of disease. Specific locations in the arterial tree are not directly assessed with physiological techniques. See the Peripheral Arterial Ultrasound Protocol Using Color and Doppler for duplex evaluation of the arteries. Duplex Doppler ultrasound permits direct assessment of the arterial segments that may be involved with disease.

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The physiological examination may be done at one level only (e.g., the ankle) or at multiple levels of the extremity. Whether done at one level or at multiple levels, the examination should be bilateral when possible so that flow in the two limbs can be compared. If possible, it should include PVRs or CW Doppler waveforms at the ankle to allow the accuracy of the ABIs at the ankle to be internally validated.

The examination is best performed in a warm room so that the effects of peripheral vasoconstriction are minimized. The patient should be recumbent for the examination and ideally should be at rest for at least 5 minutes before starting the examination to diminish any effects that prior physical activity might have on the examination.

Physiological tests, particularly ankle pressure measurements, may be repeated after exercise of the involved limb when indicated. This is particularly valuable for the assessment of claudication. When the patient is exercised, use of a treadmill is recommended when possible (though nontreadmill exercise using heel lifts has also been validated). Treadmill exercise provides for reproducible quantification of exercise while allowing simultaneous assessment of symptoms produced during exercise. Symptoms that occur during exercise should also be recorded as well as the elapsed time from the start of exercise to the point at which the symptoms occurred. Total time of exercise should be recorded. Pressure measurements that are taken after the exercise stops should be done as quickly as possible to achieve highest accuracy. Postexercise pressures are taken in each leg. Subsequently, they may be taken in the arm with the highest pressure.

Equipment Specifications

Arterial waveforms are obtained with a CW Doppler instrument 2 to 10 MHz with a zero-crossing detector. The instrument should have audio output through a speaker or headphones. The instrument should also have a digital or analog recording device so that waveforms can be saved.

The same CW Doppler instrument can be used to detect arterial waveforms for the performance of segmental pressures. Appropriately sized blood pressure cuffs attached to a manometer are necessary to perform segmental blood pressures. A rapid inflation device is helpful. Small cuffs are necessary to measure digital pressures. A photoelectric plethysmograph can be used to assist in digital pressure measurement. A treadmill with adjustable speed and incline is recommended for reproducible, quantifiable exercise testing. A digital or analog display is desirable to allow for recording of the exercise parameters used.

PVRs can be performed with the same cuffs used to measure pressures, connected to an air-filled plethysmograph.