

LOWER ARTERIAL DOPPLER

Vascular Protocol for Lower Extremity Arterial Doppler Examinations

Purpose: Arterial Doppler examinations utilize gray scale imaging with Doppler waveform spectral analysis to evaluate the location, extent, and severity of peripheral vascular disease.

Physiologic exams utilize a continuous wave Doppler probe and a zero-crossing recorder. Segmental systolic blood pressure measurements together with segmental Doppler or Plethysmography waveforms are performed to localize and characterize peripheral arterial disease.

Common Indications:

- Claudication
- Rest pain - Limb or digital pain at rest
- Trophic changes – Hair loss, nail thickening, etc.
- Decreased or absent peripheral pulses
- Non-healing wounds or ulcers
- Peripheral vascular disease
- Pre-gangrenous or black digits, cyanosis
- Arterial trauma or aneurysm
- Raynaud's syndrome/phenomenon
- Follow up of known stenosis
- Post-op or post-intervention

Contraindications and Limitations:

- Patients with casts or bandages
- Patients with acute clot or venous thrombosis in the lower extremities should not be cuffed
- Any site of trauma, surgery, ulceration, or graft placement should not be cuffed
- Calcified vessels which may falsely elevate pressures (typically encountered in patients with diabetes or end-stage renal disease)
- Patients who are unable to cooperate due to mental status changes (dementia, Alzheimer's, etc.) and involuntary movement
- Patients who are unable to lie flat due to chronic obstructive pulmonary disease (C.O.P.D.) or arthritis in the spine.
- Patient's with too large or too small digits/Patient's body habitus
- FOR HYPEREMIC AND TREADMILL EXAMS –
 - History of angina, myocardial infarction
 - Significant shortness of breath at rest.

Exam Specifics:

- **(A) Lower Extremity Arterial (LEA):** Initial Exam or Follow Up Exam for established disease, embolectomy, thrombectomy, endarterectomy, percutaneous transluminal angioplasty (PTA), angiogram, Fem-Fem bypass graft, Aorta-Bifem bypass graft, Ax-Fem bypass graft, iliac stents: a (4) cuff method is utilized for segmental pressures and the small 1.6 or 2.0 digit cuff for great toe pressures. Pressures and waveforms are taken at the Brachial Artery (BRA), Dorsalis Pedis artery (DP), Posterior Tibial artery (PT), Calf, Lower and Upper thigh, and the great toe, bilaterally.
 - **Exceptions:** Patient with DVT – any lower/upper arterial Doppler exam ordered on a patient with DVT should not have any segmental pressures taken on the affected extremity. Segmental waveforms and TBI will suffice. ABI's should not be performed unless specifically asked for by the ordering physician.
- **(B) Lower Extremity Arterial (LEA) Limited:** Post Intervention (Lower Extremity) Exam, an intervention is a unilateral femoral stent or lower arterial bypass (excludes Fem-Fem, Ax-Fem Aorta- Bifem or iliac stents): BP

cuffs are placed on the arms, at each ankle and the great toes. Pressures and waveforms are taken at the Brachial Artery (BRA), Dorsalis Pedis artery (DP), Posterior Tibial artery (PT) and great toe of leg with bypass or stent. The contra-lateral leg should have pressures taken at all levels.

- **(C) Lower Extremity Arterial Screen (LEAS):** Post Intervention (Lower Extremity) Exam, bilateral femoral stent, or bilateral lower arterial bypass (excludes Fem-Fem, Ax-Fem or iliac stents): Blood pressure cuffs are placed on the arms, at each ankle and the great toes. Pressures and waveforms are taken at the Brachial Artery (BRA), Dorsalis Pedis artery (DP), Posterior Tibial artery (PT) and great toe bilaterally.
- **(D) Ankle Brachial Index Screen (ABI's):** This test is completed to check for peripheral arterial disease of the legs. It is also used to see how well a treatment is working (such as medical treatment, angioplasty, or surgery). Blood pressure cuffs are placed on the arms and at each ankle. Pressures and waveforms are taken at the Brachial Artery (BRA), Dorsalis Pedis artery (DP), and Posterior Tibial artery (PT) bilaterally.

Documentation and Technique:

- Verify settings of the equipment used. Settings should be:
 - Legs
 - Baseline at 10
 - Amplitude at 20
 - Sweep speed 25mm
 - **Any change in amplitude should be documented**
 - Digits
 - Sweep speed 10mm
 - Amplitude 100 **OR size that BEST documents the waveform.** Amplitude should be consistent for all digits.
- Pressure measurements should be taken with the patient in the supine position with the extremity at the same level as the heart. Pressures recorded with the patient sitting will be falsely elevated due to the effects of hydrostatic pressure and should be noted on the exam.
- Choose the correct sized cuffs for each section of the limb.
 - Cuff positions may include:
 - High thigh, low thigh, calf, ankle (4-cuff method)
 - 12 cm width on upper/lower thigh/calf (some patients may require a smaller cuff on the calf; cuff width should be at least 20% greater than the diameter of the limb)
 - 10 cm width on arm and ankle (some patients may require larger cuff on arm and ankle; cuff width should be at least 20% greater than the diameter of the limb)
 - Place the cuffs in the correct locations – they should be placed straight and fit snugly.
- *** Using the Doppler probe, recording the waveforms at 25mm/sec chart speed, **obtain segmental Doppler waveforms and pressures** from the following: (Use 45-60° angle to the skin with enough pressure to keep contact, but not so much that the probe compresses the artery.)
 - Brachial Artery (Right and Left) – (BRA)
 - Moving to the ankles, starting with the right or left leg
 - Dorsalis Pedis artery - (DP)
 - Posterior Tibial artery – (PT)
 - Utilizing the higher pedal pressure to monitor blood flow, complete the segmental pressures if necessary. (Refer to exam protocol A, B C or D on page 2)
 - Store the pressures in the appropriate location on the LEA segmental screen.
- Repeat from *** for contralateral leg.
- Utilizing the PPG sensor at sweep speed 10mm, amplitude 100 **OR size that BEST documents the waveforms,** **Record** the waveform and pressure on the following:
 - Great Toe (bilaterally)

NOTE: When the dorsalis pedis artery (DP) and the posterior tibial artery (PT) waveforms are triphasic and the pressures at these sites are equal to or greater than the pressure in the brachial arteries, the result indicates a normal ankle-brachial index (ABI). Therefore, you do NOT need to continue with segmental pressures up the extremity **unless this is the patient's initial exam. If the initial exam, complete a full lower arterial extremity exam.**

- Record the waveforms (bilaterally) upon the completion of the segmental pressures:
 - Popliteal artery
 - Common femoral artery

Note: When weak signals are detected, it can be difficult to distinguish between arterial and venous flow. Therefore, a “Direction Sensing Doppler” is needed. The venous signal will augment with distal limb compression while the arterial signal will either remain or diminish. Arterial signals can be difficult to inosinate if scar tissue is present. The waveforms may be attenuated or prohibit good angle which will produce less than optimal signal. These conditions should be noted for the interpreting physician. In addition, if the room is cold or the extremity itself is cold, the third component of late diastole can be absent. This can be resolved by covering the patient and/or the extremity to warm it.

Once exam is completed,

- Verify that required images are stored
- Thank patient for coming, allow him/her to re-dress if needed/escort them out of testing area
- Complete the remainder of the encounter by following the “*Post Processing Procedures.*”

University of Chicago	
Diagnostic Ankle Brachial Index (ABI) Criteria	
ABI	Severity
≥ 0.95 - 1.0	Normal
0.80 - 0.94	Mild Disease
0.50 - 0.79	Moderate Disease
0.30 - 0.49	Severe Disease
≤ 0.29	Critical Disease

Source: 1) Internally validated at the University of Chicago Medical Center Vascular Center 2) Inside Vascular Ultrasound – *Vascular reference guide*; Copyright 2013 by Inside Ultrasound, Inc., Lower Extremity Segmental Pressures and Doppler Waveforms; Pg. 123, 132

NOTE:

- An ABI of > 1.3 suggests calcific disease and is considered non-diagnostic. As an alternative means of estimating disease severity, use the toe/brachial index. A diagnosis of disease severity (normal, mild, moderate, severe, critical) can also be made based solely on waveform analysis when calcific disease is present.

PLETHYSMOGRAPHY (PPG-TOES): (Performed in conjunction with complete LEA)

Documentation and Technique:

- Perform the Lower Extremity Arterial Doppler (LEA) per protocol.
- Blood pressure measurements should be taken with the patient in the supine position with the extremity at the same level as the heart. Pressures recorded with the patient sitting will be falsely elevated due to the effects of hydrostatic pressure.
- *** Place digital cuff at the base of the first toe encompassing at least 75% of the toe circumference. (Digital cuff -1.6, 1.9, or 2.5cm)
- Digits
 - Sweep speed 10mm
 - Amplitude 100 OR **size that BEST documents the waveform.** Amplitude should be consistent for all digits.
- Record the baseline flow pattern by placing the PPG sensor on the pad of the digit. This allows us to see the waveform pattern clearly. Use either double sided tape, Velcro strap or metal clip provided with the Parks Flo-Lab to secure the sensor to the toe.

NOTE: Some patients’ toes may be too short, affected by gangrene or ulcers to allow PPG and/or blood pressure cuff access, and should be documented. PPG waveforms should be obtained on ALL toes, when possible, even if blood pressures cannot be obtained.

- Inflate the digital cuff while recording the waveform at 10mm/sec speed until flow ceases. As you deflate the cuff, watch for the return of flow pattern. When the flow returns, this is the systolic blood pressure for the toe.
- Record pressure.
- Repeat from *** on the remaining digits/ or proceed with contralateral toes, as necessary.

NOTE: Patient motion can affect the PPG waveform. Therefore, the patient needs to remain as still as possible during the exam.

Once exam is completed,

- Verify that required images are stored
- Thank patient for coming, allow him/her to re-dress if needed/escort them out of testing area
- Complete the remainder of the encounter by following the “*Lower Arterial Post Processing Procedures.*”

University of Chicago Diagnostic Toe Brachial Index (TBI) Criteria

TBI	Severity
> 0.70	Normal
0.60 – 0.69	Mild Disease
0.59 – 0.40	Moderate Disease
<0.39	Severe Disease

Source: 1) Internally validated at the University of Chicago Medical Center Vascular Center 2) Inside Vascular Ultrasound – *Vascular reference guide*; Copyright 2013 by Inside Ultrasound, Inc., Lower Extremity Segmental Pressures and Doppler Waveforms; Pg. 123, 13.