LOWER EXTREMITY PERIPHERAL ARTERIAL EXAMINATION PROTOCOL

PURPOSE:

[illegible] ing the lower [illegible] arterial system.

[illegible]

- Leg Pain
- Hypertension
- Diabetes Mellitus
- Follow up of known atherosclerosis and/or stenosis
- [illegible]

[illegible]

[illegible] done for appropriate indications in patients with suspected peripheral arterial disease. Appropriate indications include:

- Exercise-related limb pain
- Limb pain at rest
- [illegible]
- [illegible]
- [illegible]
- Digital cyanosis, cold sensitivity
- Arterial trauma
- Assessment of high-risk patients
- [illegible]
- [illegible]
- [illegible]
- Dialysis access malfunction

[illegible]

PATIENT COMMUNICATION AND POSITIONING

[illegible] should [illegible] verify physician order and appropriate indication for exam to be performed. The patient should be placed in a supine position (if possible) for performance of the duplex exam. The patient's leg to be examined should be placed in a way which allows for maximum access to the vessels to be examined.

PATIENT ASSESSMENT:

[illegible] before the examination is performed. The sonographer [illegible]

EXAMINATION GUIDELINES:

- The sonographer selects the appropriate presets on the YOUR EQUIPMENT ultrasound machine and the appropriate transducer (Linear 5-10MHz) to begin the exam. Gain, depth and focal settings should be appropriate for region of interest and should allow for adequate visualization of the [illegible] arterial system.
- [illegible] patient's leg [illegible] system [illegible] ation [illegible] PTA and DPA. Limited [illegible] should include image and Doppler of the contralateral CFA. The peripheral arterial system is imaged from the groin to the foot in both transverse and longitudinal planes from multiple approaches (anterior, lateral, posterior).
- B-Mode/2D data should be obtained to determine the characteristics of plaque and disease present [illegible] to characterize plaque formations and rule out the presence of ulcerative plaque. Color Doppler will also be utilized to assess flow for locations of aliasing and as guide for the most accurate location to assess by PW Doppler. Color Doppler images will also be utilized to assess for areas of complete occlusion [illegible]
- [illegible] nosis and variations in hemodynamics.
- Doppler spectral analysis is performed in a sagittal plane. Velocity measurements should be obtained at a consistent angle of insonation, between 45 and 60 degrees. To ensure complete interrogation, track the cursor throughout the entire vessel course. Representative samples should be taken at the CFA, [illegible] must be documented at representative [illegible] throughout vessel, as listed on the image protocol. PSV measurements will be utilized to assess areas of stenosis as well as to evaluate normal hemodynamic flow.
- Examinations will include utilization of physiological arterial assessments including: Segmental Limb Pressures, PVR and PPG waveforms as indicated by patient condition and as directed by the physician.
- [illegible] disease. Cuffs will be placed at a [illegible] levels (ankle, calf and thigh). Typical cuff size will be Thigh: 22cm or 12cm (long), Calf: 12cm or 10cm and Ankle: 10cm. Inflation technique: Obtain distal Doppler signal. Inflate cuff to 20-30mmHg above last Doppler sound and waveform. Slowly deflate cuff (2-3 mmHg at a time) until the Doppler sound reappears. The pressure reading when the sound first reappeared is the correct systolic pressure. Record pressures [illegible]
- [illegible] patient limb size. Cuffs will be placed at a minimum of three levels (ankle, calf and thigh). Typical cuff size will be Thigh: 22cm or 12cm (long), Calf: 12cm or 10cm and Ankle: 10cm. Inflation technique: Inflate cuff to 60-80mmHg. Once PVR waveform is stable on display, waveform will be recorded.
- Digital Photoplethysmography (PPG) tracings and Great Toe pressure measurements will be utilized for patients with unobtainable ABI due to non-occluded vessel as well as for patients with ulcerations. Inflation technique: Obtain distal Doppler signal. Inflate cuff

to 20-30mmHg above last Doppler sound and waveform. Slowly deflate cuff (2-3 mmHg at a time) until the Doppler sound reappears. The pressure reading when the sound first reappeared is the correct systolic pressure. For PPG, record waveform [illegible]

- Arterial Duplex imaging [illegible] via the [illegible] assess [illegible] arterial disease [illegible] of stenosis [illegible]
- [illegible] transd[illegible] imag[illegible] body [illegible] or phased/curved transducer. Gray scale imaging will be used to assess vessel anatomy, plaque location, severity and morphology. Color Duplex imaging will be performed to aid in visualization of vessel anatomy and location of stenosis by aliasing characteristics.
- Optimal PW Doppler exam [illegible] angle [illegible] measurements [illegible] wall [illegible] direction [illegible] angle [illegible] [illegible] and supplemental physiological examination findings will be listed on technologist worksheet, with proper description of normal and abnormal findings.

[illegible]

1. [illegible]
2. [illegible] ace [illegible] ankle [illegible] cuff size [illegible] refer to above protocol for typical cuff selection).
3. Obtain pressures at the ankle using the bi-directional Doppler to assess the DPA.
4. Obtain pressures at the ankle using the bi-directional Doppler to assess the PTA.
5. Calculate ankle/brachial index for each leg (use the highest arm pressure and highest ankle pressure of the DP/PT for the ratio calculation).
6. Repeat steps 2-5 on the contra-lateral leg.

[illegible]

1. [illegible] ace cuffs around the upper arm, ankle, calf and thigh (utilize appropriate cuff size for segment of limb to be assessed- refer to above protocol for typical cuff selection and inflation technique).
2. Obtain bilateral brachial pressure.
3. Obtain pressures in each ankle cuff using the DPA.
4. Obtain pressures in each cuff at segmental locations using the PTA.
5. Calculate ankle [illegible] (use the highest [illegible]
6. [illegible]
7. [illegible] ons [illegible] obtainable ABI and ulcerations), Great [illegible] performed bilaterally. When great toe pressures are performed, the ratio/index will be calculated using great toe pressure measurement, rather than the ABI ratio (if obtained).

Physiological Arterial Assessment Protocol: Pulse Volume Recording (PVR)

1. [illegible] machine [illegible] perform [illegible]
2. [illegible] seg[illegible] ex[illegible] e, ca[illegible] Utilize appropriate cuff size for segment of limb to be assessed- refer to above protocol for typical cuff selection.
3. Obtain PVR tracings at each limb segment-refer to inflation technique above. Record tracings on patient exam.
4. Repeat steps 1-3 on the contra-lateral leg.

Physiological Arterial Assessment Protocol: Photoplethysmography (PPG)

1. When indicated by patient conditions (including unobtainable ABI and ulcerations), digital PPG waveforms [illegible] digit [illegible] will be performed.
2. PPG [illegible] Utilize [illegible] segment [illegible] should [illegible] cuff [illegible] refer to [illegible] selection and inflation technique.
3. When performed, PPG waveforms and distal flow will be detected with the PPG sensor at the great toe and will be documented, from each limb segment (ankle, calf and thigh) bilaterally.

PRESENTATION AND EXAM FINDINGS

- [illegible] ed [illegible] inter[illegible]
- [illegible] and [illegible] limi[illegible] [illegible] on, [illegible] PTA and DPA in the longitudinal plane; Color image of CFA, PFA/SFA bifurcation, SFA, POP, PTA and DPA in the longitudinal plane; Velocity measurements taken at representative locations within the CFA, PFA, SFA (Proximal and Distal), POP, PTA and DPA.
- Include any extra images involving pathology if present.
- When [illegible] for comparison.
- [illegible] ex[illegible] ons, [illegible] in the [illegible] ende[illegible] s an[illegible]

DIAGNOSTIC CRITERIA:

Diameter reduction	Waveform	Spectral broadening	PSV distal/PSV proximal
No[illegible]	[illegible]	[illegible]	No change
M[illegible]	Triphasic	Present	<2:1
Moderate 20%-49%	Biphasic	Present	<2:1
Severe 50%-99%	Monophasic	Present	[illegible]
Occluded	[illegible]	n/a	[illegible]

P[illegible]

*>4:1 Suggests >75% stenosis, >7:1 suggests >90% stenosis.

Reference:

Table [illegible] Diagnostic criteria for [illegible] diameter reduction [illegible] G[illegible] for [illegible] Te[illegible] Reg[illegible] of [illegible] Vasc[illegible] and [illegible] J[illegible] cardiography, August 2006.

Standard Image Protocol: Lower Extremity Arterial Duplex

A complete examination is bilateral [illegible] ordered for Pseudoaneurysm evaluation and will interrogate the [illegible] with representative images taken at locations specified w[illegible] [illegible] of in[illegible]

To supplement 2D/Gray scale imaging, Color and/or Power Doppler will be utilized to evaluate for abnormal color flow patterns/aliasing and identify areas of stenosis. Color and/or Power Doppler will also be utilized to assist in determining the optimal location for PW Doppler sampling as well as to assist in determining the course and anatomy of the vessels.

PW [illegible] will be taken [illegible] and at all are[illegible] parallel to [illegible] obstruction is noted, PW Spectral Do[illegible] will be taken at and distal to the area of stenosis.

For imaging, have patient bend appropriate leg slightly (frog-leg position).

1. Long CFA
2. Long CFA w/ Color
3. Long CFA w/ PW Doppler (include PSV measurement)
4. [illegible]
5. [illegible] w/ Color
6. Long DFA Proximal w/ Doppler (include PSV measurement)
7. Long SFA Proximal
8. Long SFA Proximal w/ Color
9. Long SFA Proximal w/ PW Doppler (include PSV measurement)
10. Long SFA Mid
11. Long SFA Mid [illegible]
12. [illegible] (include PSV measurement)
13. Long SFA Distal
14. Long SFA Distal w/ Color
15. Long SFA Distal w/ PW Doppler (include PSV measurement)
16. Long Pop
17. Long Pop w/ Color
18. Long Pop w/ PW Doppler (include PSV measurement)
19. [illegible]
20. [illegible]
21. Long PTA w/ PW Doppler (include PSV measurement)
22. Long DPA
23. Long DPA w/ Color
24. Long DPA w/ PW Doppler (include PSV measurement)
25. When [illegible] Doppler [illegible] of [illegible] aorta, common iliac artery and [illegible]

Variations to Standard Protocol

Lower Extremity Arterial Duplex Protocol:
Bypass Graft Surveillance and Native Artery Evaluation

- 2D/Color images and PW Doppler velocity measurements with documentation of the [illegible]
- [illegible] Doppler [illegible] measurements with documentation of [illegible] portions of native artery to indicate relationship to bypass graft. If additional pathology is suspected or indicated, the entire course of the native vessel will be evaluated with 2D and/or Color Doppler imaging in order to assess for aneurysm or other pathology.
- 2D/Color images with PW Doppler velocity measurements and interrogation of [illegible] graft [illegible]
- [illegible] remaining portions of arterial system, proximal and distal to bypass graft, with 2D/Color images and PW Doppler velocity measurements.

Lower Extremity Arterial Duplex Protocol: Stent Surveillance and Evaluation

- 2D/Color images and PW Doppler with velocity measurements of proximal, mid and distal portion of the stent.
- Co[illegible] the [illegible] 2D/Color images and [illegible] Doppler with velocity measurements.

Lower Extremity Arterial Duplex Protocol: Pseudoaneurysm

- Limited examination can be performed to exclude the presence of pseudoaneurysm.
- 2D/Color PW Doppler interrogation of proximal portion of the [illegible] arterial [illegible] 2D/Color images and PW Doppler measurements of vascular neck extending from CFA to pulsatile mass.

Lower Extremity Arterial Duplex Protocol: Limited/Follow-up Examination

- Limited/Unilateral examinations are only performed for evaluation of pseudoaneurysm. A complete bilateral examination is required for all follow-up patients [illegible] interval changes [illegible]

LOWER EXTREMITY ARTERIAL DUPLEX PROCEDURE & IMAGE PROTOCOL
SUPPLEMENTAL / ANCILLARY TESTING

[illegible] s [illegible] phys [illegible] clud [illegible] of peripheral arterial disease.

Exercise Testing

- Additional [illegible] if indicated [illegible] Segmental [illegible]
- [illegible] ankle/brachial indices will be evaluated for changes and compared to resting ankle/brachial indices.

Photoplethysmography (PPG) Testing

- [illegible] will be utilized [illegible] ents [illegible] wav [illegible] istics
- Diagnostic considerations will be taken for PPG tracings with motion artifact, external light artifact and other artifactual components.

Great Toe Pressure Measurements

- [illegible] those [illegible] en [illegible] able [illegible] can [illegible]
- [illegible] pressure measurements will be performed only in conjunction with PPG testing.
- Great Toe/Brachial Indices will be calculated when these [illegible]