Arterial Duplex
What You Need To Know
Michigan Society Of Ultrasound

Left Superficial Femoral Artery Mid Aspect

Fem-Fem By- Pass Right

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• Wayne Smith M.D. RVT, RDMS, RPVI, FACP, FSVM
What You Need To Have & Know
My Ultimate Goal Everyday

Make Duplex The Gold Standard......
#1 Imaging Goal Is To Strive To Be Gold Standard!
Goals

Provide reproducible noninvasive procedure

Gather morphologic and physiologic data that defines the location of Disease

Quantify hemodynamic significance of disease
Duplex Implementation & Setup

Small Sample Size (1.5 mm)

Compound (B-Mode + Color) Imaging

PRF High enough to prevent aliasing

Low Wall Filter (50 Hz) to display low flow

Multiple focal zones to promote image enhancement
Normal Peak Systolic Velocities

<table>
<thead>
<tr>
<th>Artery</th>
<th>CM/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorta</td>
<td>80 ± 25</td>
</tr>
<tr>
<td>External Iliac</td>
<td>119 ± 22</td>
</tr>
<tr>
<td>Common Femoral</td>
<td>114 ± 25</td>
</tr>
<tr>
<td>SFA Proximal</td>
<td>91 ± 14</td>
</tr>
<tr>
<td>SFA Distal</td>
<td>94 ± 14</td>
</tr>
<tr>
<td>Popliteal</td>
<td>69 ± 14</td>
</tr>
</tbody>
</table>
Classification of Disease

Mild: Symptomatic; decreased pulses; bruit

Moderate: Asymptomatic at rest; claudication with stress; significant drop in ABI with stress

Severe: Rest pain in feet and/or toes; poor wound healing; ulcer(s); tissue necrosis; gangrene
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD) Abnormal Criteria “Waveforms”

- **Proximal to an Occlusion:** Low Velocity High Resistance (monophasic/biphasic)
- **Distal to an Obstruction:** Low Velocity, Low Resistance (monophasic)
- **Acceleration Time > 144 msec:** proximal obstruction ≥ 75% Stenosis Iliac Artery (Delayed Systolic Acceleration) Low Velocity, Low Resistance (monophasic)

*Techniques in Noninvasive Vascular Diagnosis, 2010*
## Interpretation Criteria

<table>
<thead>
<tr>
<th>% Stenosis</th>
<th>Peak Velocity</th>
<th>Velocity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt; 150 cm/sec</td>
<td>&lt; 1.5:1</td>
</tr>
<tr>
<td>30% - 49%</td>
<td>150 – 200 cm/sec</td>
<td>1.5:1 – 2:1</td>
</tr>
<tr>
<td>50% - 75%</td>
<td>200 – 400 cm/sec</td>
<td>2:1 – 4:1</td>
</tr>
<tr>
<td>&gt; 75%</td>
<td>&gt; 400 cm/sec</td>
<td>&gt; 4:1</td>
</tr>
<tr>
<td>Occlusion</td>
<td>No color Doppler</td>
<td></td>
</tr>
</tbody>
</table>
Lower Extremity Arterial Duplex Imaging for Peripheral Arterial Disease (PAD)  

Abnormal Criteria “Velocity Ratios” 

<table>
<thead>
<tr>
<th>% STENOSIS</th>
<th>PEAK VELOCITY</th>
<th>VELOCITY RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;150 cm/sec</td>
<td>&lt;1.5:1</td>
</tr>
<tr>
<td>30%-49%</td>
<td>150-200 cm/sec</td>
<td>1.5:1 - 2:1</td>
</tr>
<tr>
<td>50%-75%</td>
<td>200-400 cm/sec</td>
<td>2:1 - 4:1</td>
</tr>
<tr>
<td>&gt;75%</td>
<td>&gt;400 cm/sec</td>
<td>&gt;4:1</td>
</tr>
<tr>
<td>Occlusion</td>
<td>No Color Saturation</td>
<td></td>
</tr>
</tbody>
</table>

JVS, 1989,10:522-529

Rumack, In Diagnostic Ultrasound, 4th ed. 2011
Arterial Duplex Imaging Case

History: 64 yr old female, history of CAD, PAD, + smoker
Post intervention ABI 0.26

What is your diagnosis?
- Thrombosed Saphenous Vein
- Occluded SFA
- AVF
- Occluded insitu fem pop

Occluded Graft
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

Overview

- Purpose
- Overview of Peripheral Arterial Disease (PAD)
- Definition of Terms
- Clinical Examples of PAD
- Acute/Chronic Symptoms of PAD
- Clinical Indications
- Exam Components

Patient Preparation and Assessment (ABI examination/limitations)
- Instrumentation
- Patient Position
- Color Flow Imaging
- Arterial Anatomy (Aorta/Iliac/Common/ Superficial Femoral, Profunda/Popliteal/ Tibioperoneal Arteries
Lower Extremity Arterial Duplex Imaging for Peripheral Arterial Disease (PAD)

Overview (continued)

- Imaging Technique and Procedure
- Documented Images
- Normal/Abnormal Diagnostic Criteria
- Waveform Interpretation
- Native/Synthetic Grafts & Stents
- Examples of Lower Extremity Arterial Disease
- Ancillary Findings
- Technical Considerations
- Limitations
- Summary
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

PAD Overview:

- Narrowing of blood vessels characterized by Atherosclerotic Occlusive Disease; inadequate perfusion to the lower extremity results in a non-healing wound, which often leads to infection, tissue loss, and amputation
- Affects approximately 8 to 12 million Americans
- Prevalence of PAD increases with age
- 12%-20% of Americans age 65 plus (4.5 to 7.6 million) have PAD
- Affects men and women equally
- African Americans have a higher incidence than Caucasians

Circulation. 94:3026-3049, 1996
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

PAD Overview Continued:

- Atherosclerosis accounts for >90% of cases
- Plaques tend to localize at the bifurcations or proximal segments, as well as in the distal femoral and adductor canal segments in the lower extremities
- Femoral/Popliteal Arteries are affected in 80%-90% of symptomatic PAD patients, the Tibioperoneal Arteries in 40%-50%, and Aortoiliac Arteries in 30%
- Diabetic patients develop lower extremity obstruction primarily in the Tibioperoneal Arteries

Circulation. 94:3026-3049, 1996
Diagnosis of PAD increases risk for M.I. or CVA by 5 times
Arteriosclerosis At Junctional Regions Usually

Normal artery

Artery narrowed by atherosclerosis

Plaque
Know Your Patient

History
Pathology
Risk Factors
Physical Signs
Current medications or therapies
Results of previous noninvasive studies
Results of previous vascular interventions
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

PAD Risk Factors:

- Diabetes Mellitus
- Cigarette Smoking
- Increasing age (65 Years Plus)
- Hypertension
- Coronary Artery Disease
- Family history of Cardiovascular Disease

Circulation. 94:3026-3049, 1996
One Of The Many Reasons To Quit Smoking

• To Keep Your Bulldog Happy And In Alignment
PERIPHERAL ARTERIAL DISEASE

- Asymptomatic: 66%
- Symptomatic: 34%

Prevalence of PAD Increases with Age

Figure adapted from Creager M. Management of Peripheral Arterial Disease. Medical, Surgical, and INTERVENTIONAL ASPECTS. 2000.


Basic Starting Points

- Warm room temperature, especially if digit assessment is going to take place. Vasoconstriction may take place in digits if room <70 degrees.

- Have patient rest a few minutes (3-5) before starting the examination.

*Recent ambulation can cause change in arterial waveform patterns*
Establish An Algorithm

- **Remember Patients Are #1 Concern**
- Ankle brachial indices
- PVR/Segmental Pressures
- Duplex
- Level of disease
- Insonate proximal
Patient Positioning and Preparation

Patients should take all scheduled prescription medications as usual, e.g. Heart, B/P, Diabetes

No Smoking (Vasoconstriction)

Supine / Reversed Trendelenburg
External Hip rotation; Knee flexed
If Prone—pillow under ankles for use with Popliteal; Peroneal; PT
Lower Arterial Duplex Imaging

Limitations

- Obesity—visualization difficulties
- Wound incision tenderness, hematoma
- Vessel wall calcification / acoustic shadowing
- Open wounds, cast / dressings, skin staples, sutures
The Arterial Duplex Work Sheet
“Old School”

Communication
Protocol

Aorta
Common / External Iliac
Hypogastric (Internal Iliac)
Common Femoral
Profunda Femoris
Superficial Femoral
Popliteal
Anterior / Posterior Tibial
Peroneal
Dorsalis Pedis
Plantar &/or Pedal Arch
Popliteal Artery

Branches:
- Posterior tibial artery (largest)
- Anterior tibial artery (smallest)
- Geniculate branches = collateral source

Evaluate for aneurysm and Baker’s Cyst
Common Indications

Evaluation / Follow-up:

-- Claudication

-- Ischemic rest pain

-- Ischemic ulcer(s)

Evaluation of arterial trauma

Intervention (surgery; PTA; stent) assessment

Post - intervention follow-up (BPG; PTA; stent)

Evaluation for aneurysm; pseudoaneurysm; A-V
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

Definition of Terms:

- Intermittent Claudication; Muscle cramping, tightening, & burning pain produced during exercise (walking) due to insufficient blood flow to the legs
- Arterial insufficiency occurs with exercise – Pulses are detected at rest and disappear immediately after exercise
- Pain is relieved by stopping the exercise/walking and standing for 2-5 minutes
- Patients describe muscular pain and cramping in the calves, thigh, and or buttocks
- The site of Claudication is distal to the obstructed arterial segment ie... Calf Claudication seen with Femoral/Popliteal disease, thigh symptoms seen with Iliofemoral disease

Introduction to Vascular Ultrasonography, 2012
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

Definition of Terms Continued:

- Pseudoclaudication/Neurogenic Claudication: Term often used to describe leg symptoms (pain, numbness, weakness) in the buttocks, thighs, legs, and feet occurring with prolong standing or ambulating that mimic true Claudication
- Such symptoms are related to spinal, neurologic, orthopedic, or non-vascular etiologies i.e., arthritis
- Examples of such etiologies include; spinal stenosis, herniated lumbar disc, hypertrophic osteoarthritis of the lumbar spine and hip
- Relief of pain usually 10 min, patients need to lie down, sit, or bend at the waist (positional) to relieve discomfort

Introduction to Vascular Ultrasonography, 2012
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

Definition of Terms:

- Rest Pain: Critical ischemia (insufficient blood flow to tissues) of the distal limb when the patient is at rest (usually occurs at night), pain or tingling is so severe that the weight of bed sheets increases the discomfort
- Pain is aggravated in the horizontal position
- Pain is relieved by hanging the leg in a dependent position
- Patients with ischemic rest pain present with asymmetric discomfort
- Patients with peripheral neuropathy have pain in both extremities and the discomfort is not relieved by dependency
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

Definition of Terms Continued:

- Elevation Pallor/Dependent Rubor: Significant clinical signs of arterial insufficiency
- Patients with rest pain or near critical ischemic flow reduction will manifest pallor (from pink to pale) in fair-skinned people and to gray or ashen color in dark-skinned people of the plantar surface and toes upon elevation and rubor, (purplish-red hue) upon dependency. The extremity is cool to the touch

- Postural Assessment; (Normally the foot and leg should remain the same color with elevation and dependency) Feet are elevated above the head 60 degrees for 1 minute then placed suddenly in a dependent position. Pallor within 25 seconds of elevation indicates severe Dz. Rubor that appears within 25-40 seconds indicates severe ischemia. If rubor disappears quickly with elevation and returns in < 25 seconds, consider reflux Dz

JDMS 20.5-13, Jan/Feb 2004
Definition of Terms Continued:

- Gangrene: Critical limb ischemia resulting in localized areas of tissue death; common sites; toes, feet, fingers, hands
- Usually appears in a toe as a focal blackened area; without treatment it may spread to other toes and eventually the foot and lower leg
- Two major types “Dry and Wet” most cases of dry gangrene are not infected; all cases of wet gangrene considered to be infected
- “Wet” gangrene results from an untreated infected wound
- “Dry” gangrene caused by reduction of blood flow, tissue becomes cold and black, dries and eventually sloughs off
The Ankle-Brachial Index (ABI)

- ABI measurement is the optimal method to detect PAD
  - Inexpensive, accurate, and office-based
  - Provides an international standard, validated by angiographic detection, for defining PAD prevalence
  - Predicts limb survival, propensity for wound healing, and short- and long-term patient survival\(^1\),\(^2\)

- When is an ABI measurement indicated?
  - Presence or suspicion of claudication; pain at rest; or nonhealing foot ulcer
  - Age $\geq$70 years or $\geq$50 years with risk factors (diabetes, smoking)

\(^1\)McKenna et al. *Atherosclerosis*. 1991;87:119-128.
ABI: Predictor of Survival

Go And Complete your Assessment With The Old Pocket Doppler
ANKE-L-BRACHIAL INDEX

- Obtain bilateral brachial systolic pressures
- Acquire Doppler signals and pressures in the PTA, DP and Peroneal arteries
- Use the highest ankle and brachial pressures to obtain an ABI

 ABI Scale (resting)

- >0.96 = normal
- <0.95 = abnormal
- <0.8 = probable claudication
- <0.5 = multi-level disease, or long segment occlusion
- <0.3 = ischemic rest pain
ANKE-BRACHIAL INDEX

- Obtain bilateral brachial systolic pressures
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\[
\text{ABI} = \frac{\text{Highest brachial systolic pressure}}{\text{Highest ankle pressure}}
\]

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- <0.95 = abnormal
- <0.8 = probable claudication
- <0.5 = multi-level disease, or long segment occlusion
- <0.3 = ischemic rest pain
Limitations of resting ABI’s

- Diabetic tibial-peroneal calcification
- Elderly patient’s calcify also
- Renal failure patients
Ankle Brachial Index

Interpretation – High ABI – Non-compressible vessels
High ABI Spells Trouble

• ABI > 1.3 is abnormal
• Non-compressible ABI’s
• 65% increased risk of heart failure, CVA
• Singular assessment vs Global
TOE PRESSURE

- Useful for evaluating small vessel disease and when the larger vessels are non-compressible
- Small cuff is placed around the base of the great toe and inflated until signals disappear
- Slowly deflate cuff until signals return
- Record pressure and calculate Toe/Brachial Index

\[
\text{Toe/Brachial Index (TBI) = \frac{\text{toe pressure}}{\text{highest brachial pressure}}}
\]

TBI less than 0.66 is considered abnormal
PPG (Photoplethysmography)

• LED (Light Emitting Diode)
• Measures cutaneous blood content
• Infrared light from red blood cells in cutaneous capillaries
• Warm room to prevent capillaries from vasoconstricting (no smoking)
• Scission’s Research Study
PPG

• PPG is a very useful diagnostic tool of choice to monitor digits perfusion.
• *Contralateral comparison* of digits are very important
• Also incorporate bilateral assessment on all patients when the situation allows.
PHOTOPLETYSMOGRAHY

- Normal
  Steep acceleration with a notched reflected diastolic wave

- Mild disease
  Steep acceleration but a decreased rate of fall during deceleration

- Moderate disease
  Slower acceleration and marked slowing of deceleration

- Severe disease
  Loss of amplitude and pulsatility with no definable configuration
Always compare contralateral flow parameters in any form of duplex when questions exist!

Any difference on right?

Is this normal?
• **NO!**

• Note the abnormal perfusion seen bilaterally

• Minimal to no flow was seen in the right 2\textsuperscript{nd}, 3\textsuperscript{rd}, 4\textsuperscript{th} and 5\textsuperscript{th} digits
Toe/Brachial Indices

• Relationship of systolic pressure to prognosis for healing of skin lesions of the toes or feet

• Absolute Toe Pressure (mm Hg) (%) Probability of healing

<table>
<thead>
<tr>
<th>Pressure (mm Hg)</th>
<th>No diabetes</th>
<th>Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 20</td>
<td>29</td>
<td>25</td>
</tr>
<tr>
<td>20 to 30</td>
<td>73</td>
<td>40</td>
</tr>
<tr>
<td>30 to 55</td>
<td>100</td>
<td>85</td>
</tr>
<tr>
<td>Above 55</td>
<td>100</td>
<td>97</td>
</tr>
</tbody>
</table>
### Relationship to Peripheral Vascular Disease

<table>
<thead>
<tr>
<th>Ankle / Brachial Index (ABI)</th>
<th>Toe / Brachial Index (TBI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal:</strong> 0.97 to 1.25</td>
<td><strong>Normal:</strong> &gt; 0.80</td>
</tr>
<tr>
<td><strong>Mild:</strong> 0.75 to 0.96</td>
<td><strong>Claudication:</strong> 0.20 to 0.50</td>
</tr>
<tr>
<td><strong>Moderate:</strong> 0.50 to 0.74</td>
<td><strong>Rest Pain:</strong> &lt; 0.20</td>
</tr>
<tr>
<td><strong>Severe:</strong> &lt; 0.50</td>
<td><strong>Critical:</strong> &lt; 0.30</td>
</tr>
</tbody>
</table>
Run-off Disease

- Tibial vessels
  - Anterior Tibial Artery (Dorsalis Pedis)
    - Anterior and lateral to tibia
  - Posterior Tibial Artery
    - Posterior to medial malleolus
  - Peroneal Artery
    - Lateral calf
- Non-healing ulcers (foot or lower leg)
- Diabetic patients
Run Off Calcification

Left Posterior Tibial Artery
Digital Artery Calcification
How Long Does It Take To Go To The Darn Hospital?

• E.R.
• 53 year old
• Pain in his left foot for the past 1-2 months
• Been soaking feet in Epsom salts
• Uses Black Salve
• Couldn’t take odor nor appearance anymore
Physical Signs Chronic

Cutaneous skin changes:
- Hair loss
- Shiny looking skin
- Brittle, thickened, deformed nails
- Exercise limiting activity due to limb pain
Physical Signs General

- Pulses diminished or absent
- If pulse(s) “bounding” suspect aneurysm
- Bruit can = stenosis or arteriovenous fistula
Pathology

- Thrombosis
- Atherosclerosis
- Thrombo-emboli
  - Small Vessel
  - Raynaud’s
  - Buerger’s
- Aneurysm
- Arteritis
- Trauma
- Entrapment
  - TOS
  - Popliteal
Physical Signs Critical

**Dependent Rubor**
- Limb cooling: If ulcers—minimal bleeding
- Limb pallor with 2-3’ elevation—dependent rubor upon lowering limb below heart level
- Night pain: Sleeping with limb in dependent position—arterial flow assisted by gravity

**Arterial Ulcer**
Typically thrombotic or embolic in origin

The “P ’s”: Pain, Pallor, Paresthesias  Pulselessness, Paralysis

“THE” P = sudden onset of ACUTE pain

Limb threatening—needs immediate attention tissue death can occur within 4 to 6 hours
Is this Arterial or Venous disease?
Arterial or Venous?
Left External Iliac Artery
• Normal flow is laminar with multiphasic waveform
• Flow reversal due to high peripheral vascular resistance
• Reverse flow less prominent with decreased resistance due to vasodilatation, e.g. reactive hyperemia; warm limb
Lower Artery Anatomy

External Iliac
Common Femoral
Profunda Femoris
Superficial Femoral
Popliteal
Anterior Tibial
Posterior Tibial
Peroneal
Dorsalis Pedis
What is Normal?

- **Waveform**
  - 60 degree angle (or less)
  - Quick rise time (>144msec)
  - Clean spectral window
  - Triphasic

- **Color**
  - Smooth (laminar), No Aliasing
  - Forward and reverse components

- **Gray Scale**
  - Clean lumen
  - Smooth borders
Normal

Abnormal
Normal Waveform
Minimal Plaque In
Lower Arterial System

Left CFA

Normal
Abnormal
Clinical Correlation

• Secondary imaging does not always provide significant insight
• Sometimes it does!!!
• Keep a folder of such events
• Q.A.
• Departmental education
Closer Look
This is Really BLUE TOE SYNDROME
Blue–Footed Booby
Clinical History

• 48 year male
• 3 PPD smoker 35 years
• Left lower leg pain
• Twisted leg and felt pain and “pop”
• Rural physician (Rice treatment) 5 days
• Patient lives 1.5 hrs. away
• F/u apt 5 days could tolerate discomfort
Left Deep Femoral Artery (Profunda)
Left SFA Proximal Aspect
Arterial Duplex Pearl

161 cm/s

62 cm/s
CFA-SFA-DFA (Profunda)

Bifurcation and SFA adductor canal level are common sites for development of PAD

*Profunda Femoris = Major collateral*

- Note disease severity for treatment options

May require lower frequency transducer at the distal thigh (adductor hiatus) level
- Posterior approach may offer better view
Take Home......

• In resting normal cases with no evidence of profunda stenosis, the flow is seen is typically lower than that of the proximal SFA due to branch distribution.

• Take home note in this case the velocity difference in the mid SFA image the velocity decrease along with the waveform breakdown.
Left Lower Digits
Question

What would one most likely expect to see after seeing the image to the right?

A. Acute DVT
B. Aortic Aneurysm
C. Takayasu’s Arteritis
D. Multilevel arterial disease
E. B and D
Arteries Bifurcate Before Veins
Left Common Femoral Vein
Popliteal Artery Aneurysm
What Else Should One Always Insonate?
Contralateral Arterial System

Always check the contralateral CFA, Popliteal, Iliac and Abdominal Aorta
Right Common Femoral Artery
Right CFA Dissection

Type B Dissection
Arterial Disease
If present must be characterized by:

- Severity*

- Location*
  (Inflow - Outflow - Run-off - Multilevel)

- Extent

- Etiology, when possible
Visual Break
Everything Is Not Always at Is Appears....
43 YEAR OLD MALE

My darn toes have been killing me the past 2 weeks

No cardiac disorders
No Migraine drug use
Quit Smoking 20 years ago
Farmer working in the field, Feet were wet and cold
Did a little drinking after work

Aorta, CFA, SFA and Pop clean as a whistle.

What you think is going on?

Wild Turkey Induced Frostbite
This Past Week
Run Off and Popliteal
Silent Doppler Flow
Traditional gold standard for LE-PAD assessment

However: expensive, invasive, poor screening tool and provides only anatomic (no hemodynamic) data.
Giant cell arteritis (GCA), the most common form of systemic vasculitis in adults, preferentially involves large and medium-sized arteries in patients over the age of 50.
Transducer Selection

5 MHz
- CFA, SFA, Profunda, Deep Tibial

7.5 MHz
- Very superficial (near field) imaging

2 to 3 MHz
- Aorta and Iliac
- 2 MHz = best color, 3 MHz = best Image
LE Arterial Duplex Imaging: Invaluable Assets
PVR and Segmental Pressures vs. Duplex

- **What's Better?**
- **Why?**
- **What's Faster?**
- **What's Cheaper?**
- **What's easier to understand?**
Technique

Waveform Technique

- Measures volume changes—changes in cuff volume reflect blood volume changes
- Air injected into PVR cuff at preset pressure
- Waveforms resemble intra-arterial pressure pulse contours

LE Waveform Protocol

Thigh cuff  (36 x 18 cm) @ 65 mmHg
Calf and Ankle  (22 x 12 cm) @ 65 mmHg
Transmetatarsal  (12 x 7 cm) @ 65 mmHg
Digit(s)  (9 x 3 or 7 x 2 cm) @ 40 mmHg
**Technique: PVR**

**Pressure Technique**

- Measures limb pressure (beneath cuff)
  - **Bernoulli Principle**

- Bladder (20% wider than limb diameter)
  - Too narrow: Falsely elevated pressures

- Limbs level with heart; 15’ pre-exam rest

- Inflate (20-30 mmHg) above suprasystolic B/P
  - Slow drop (2 - 4 mmHg / sec) until first beat

**LE Pressure Protocol:**

1. **3 Cuff:** Thigh (22 cm)
   - Calf and Ankle — PT / DP (10-12 cm)

2. **4 Cuff:** Upper/Lower Thigh Cuffs (11 cm)
   - Calf and Ankle — PT / DP (10-12 cm)
PVR vs. Duplex

- CFA to Ankle Waveforms + ABI
  -- CW or PW or PVR
- Ankle + TM + Toe Waveforms + TBI
- SegPres + SegWave + ABI and/or TBI
- Aorto-Iliac to Ankle: Gray scale + Doppler
- FemPop + PT / AT: Gray scale + Doppler
NORMAL
BILATERAL

SEGMENTAL PRESSURE
AND PVR STUDY

Brachial
RIGHT LEFT
149 140

PVR 63mmHg 50ccs RIGHT Thigh
Gain: 4 Speed:25 Amp: 19

PVR 63mmHg 50ccs LEFT Thigh
Gain: 4 Speed:25 Amp:18

AB:1.11  
TBI: 0.83

PVR 63mmHg 50ccs LEFT Calf
Gain: 4 Speed:25 Amp: 27

PVR 63mmHg 50ccs RIGHT Calf
Gain: 4 Speed:25 Amp:26

173 168

RIGHT  LEFT
182 175

PVR 63mmHg 10ccs RIGHT Ankle
Gain: 6 Speed:25 Amp:22

PVR 63mmHg 10ccs LEFT Ankle
Gain: 6 Speed:25 Amp:23

163 156
166 150

PVR 63mmHg 10ccs RIGHT Metatarsal
Gain: 6 Speed:25 Amp:24

PVR 63mmHg 10ccs LEFT Metatarsal
Gain: 6 Speed:25 Amp:19

124 116

AB:1.05
TBI: 0.76
Normal—Right
Fem-Pop—Left

SEGMENTAL PRESSURE
AND PVR STUDY

Brachial
RIGHT LEFT
162 154

164 158

168 110

170 DP 100

180 PT 102

ABI: 1.11  ABI: 0.63
Inflow
Bilateral
Technique: Arterial Duplex

Technique

Imaging: B-Mode; B-Flow
Imaging: Doppler: Color-Flow; Power
Doppler: Pulsed wave spectral analyses
Appropriate probes/(settings)—yada, yada, yada

LE Protocols

Aortoiliac to ankle level
CFA to ankle level
Site-specific level(s)
Fem Pop + distal PT/AT
PVR vs Duplex Controversy—More Opinion Based

PVR (+ Pressures)
YES - defines global limb perfusion and not vessel specific
YES - can not differentiate arterial stenosis vs. occlusion
YES, YES, YES, YES - Cheap, Quick, Simple, Reproducible
Historically - as accurate as duplex; ?? Current accuracy
YES - exam pays less, but > productivity & revenue potential
YES - waveforms affective with calcification; **NO**, not pressures
Difficult to interpret - not relatable to Doppler - Depends

Duplex
YES - Equipment costs more than PVR
YES - Duplex produce direct and PVR indirect assumptions
YES - limited reliability with vessel calcification
YES - can localize region(s) of disease and severity
YES - more time consuming and technically challenging
YES - vessel specific; can differentiate stenosis vs. occlusion
Accuracy similar to angiography - Depends
Questions....
Thank You

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