Doppler Segmental Pressures – Lower Extremities

Chapter 5

Doppler Segmental Pressures

- Blood pressures obtained from cuffs placed around ankles, calves, thighs, and arms
- Used in identification of PAD
  - Atherosclerosis occlusive disease in legs and arms
- Multiple ways to test:
  - Resting
  - Exercising
  - Reactive Hyperemia

Resting Pressures

Capabilities

- Identifies presence and severity of arterial occlusive disease
- Provides baselines to follow progression of disease
- Evaluates treatment plan
- Results combined with Doppler velocity waveform analysis or volume pulse waveforms

Limitations

- Cannot discriminate between stenosis and occlusion
  - Can only identify general area of issue
- Erroneous results in patients with calcified vessels (diabetes, ESRD) or heart failure
- Multi-level disease can be difficult to interpret
- Dialysis access, DVT, lymphedema may hinder obtaining segmental pressures of limbs

Physical Principles

- Continuous wave Doppler is used for this study
- Transducer must be positioned over the long axis of the vessel at a 45-60-degree angle
- Utilization of appropriate cuff size is critical
  - If cuff is too large, blood pressures are recorded artifactually lower
  - If cuff is too narrow, blood pressures are recorded artifactually higher

Technique

- Essential that patient is resting prior to start of exam
  - Have them laying down while obtaining history
- Patient is supine with extremities at the same level as the heart
- Head may be slightly elevated on a pillow
- Patients legs should be externally rotated to facilitate proper Doppler placement

Technique

- 8-10 MHz transducer
  - Depends on depth of vessel
- Evaluate the long axis of the vessel by positioning probe at a 45-60° angle to the skin
  - Adjust the angle of the probe with slight movements until an optimal signal is obtained
  - Essential to evaluate the quality of the auditory signal in optimizing the Doppler waveform

Appropriate Cuff Size

- Bladder size 12 cm x 40 cm
  - Brachial
  - Calf
  - Ankle
- Bladder size 12 cm x 54 cm
  - High thigh
  - Low thigh
- Bladder size 10 cm x 40 cm (commonly used)
  - Brachial
  - Ankle

Segmental Pressures

Appropriate Cuff Size

- Width of the pneumatic ***cuff should be 20% greater than the diameter of the limb***
  - Should be placed straight on the extremity and fit snugly; as the bladder inflates, it should quickly compress the artery underneath
- If the cuff is too wide for the extremity, the blood pressure measurement is falsely low
- If the cuff is too narrow for the extremity, the blood pressure measurement is falsely elevated

Cuff Method

Three Cuff Method

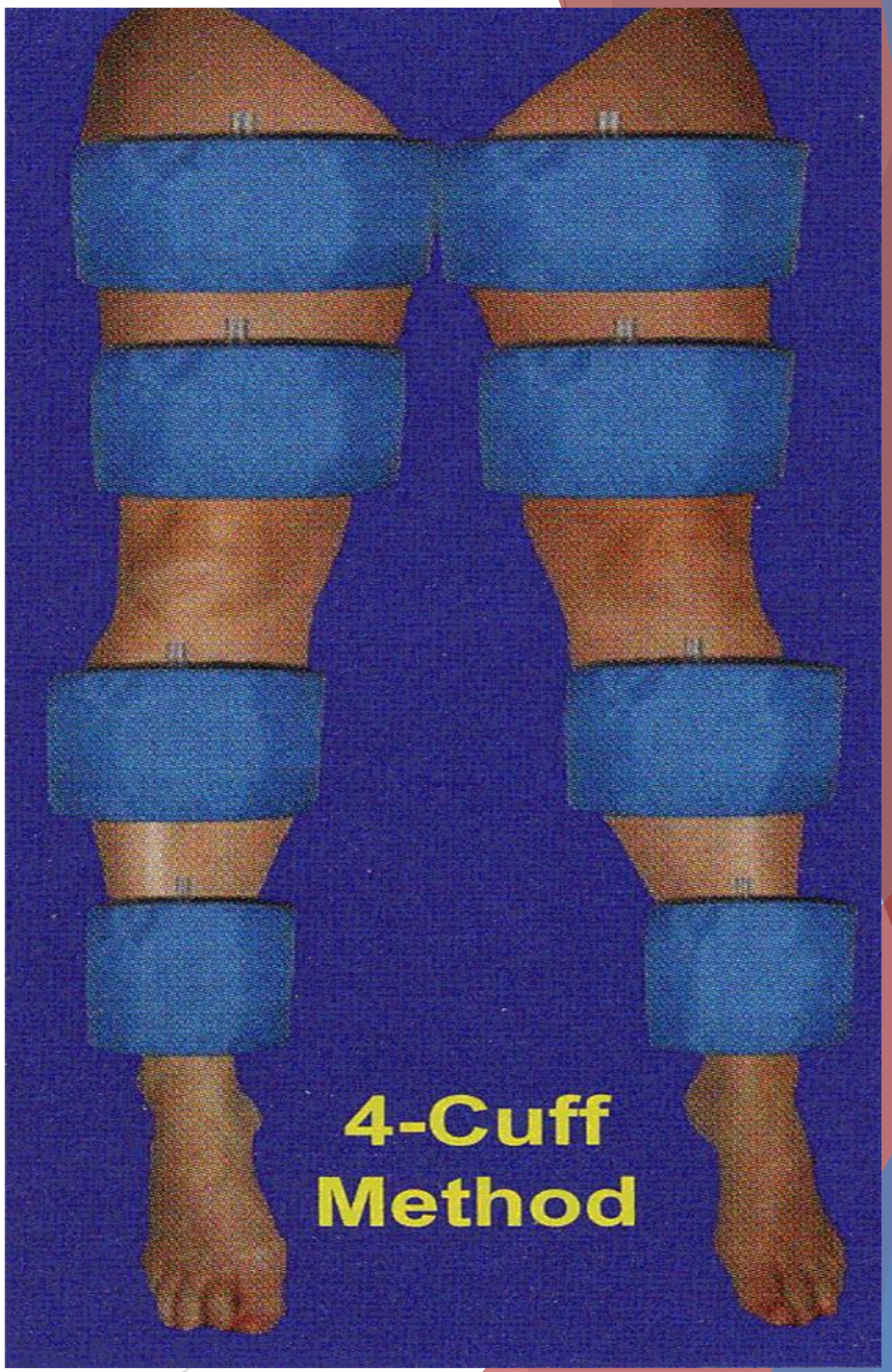
- One large cuff at the thigh level
  - Advantage: thigh pressure obtained is generally more accurate due to the artificial pressure elevation generated by the four-cuff method
  - Disadvantage: Does not allow for differentiation of the proximal and distal thigh pressures

Cuff Method

Four Cuff Method

- Two cuffs placed at the thigh level
  - Advantage: allows for differentiation of the proximal and distal thigh pressures
  - Disadvantage: limited by the patients thigh length – cannot have cuffs overlap


3-Cuff
Method


4-Cuff
Method

Technique

- Bilateral Brachial blood pressures are obtained
- Segmental pressures are obtained (one leg at a time) bilaterally using a hand-held sphygmomanometer with manual inflation or a computerize system with automatic inflation and digital display
  - Ankle – 1st
  - Below the knee – 2nd
  - Above the knee – 3rd
  - High Thigh – 4th

Technique

- 1. Cuffs are individually inflated until the Doppler signal disappears
- 2. Valve on the manometer can be opened slightly allowing slow deflation of the pneumatic cuff
- 3. Once the cuff deflates to a pressure equal to the patient's systolic blood pressure, the Doppler device will once again detect flow with an audible signal
- 4. The point at which the flow becomes evident (audible signal) is the patient's systolic pressure and should be recorded as such

Tips:

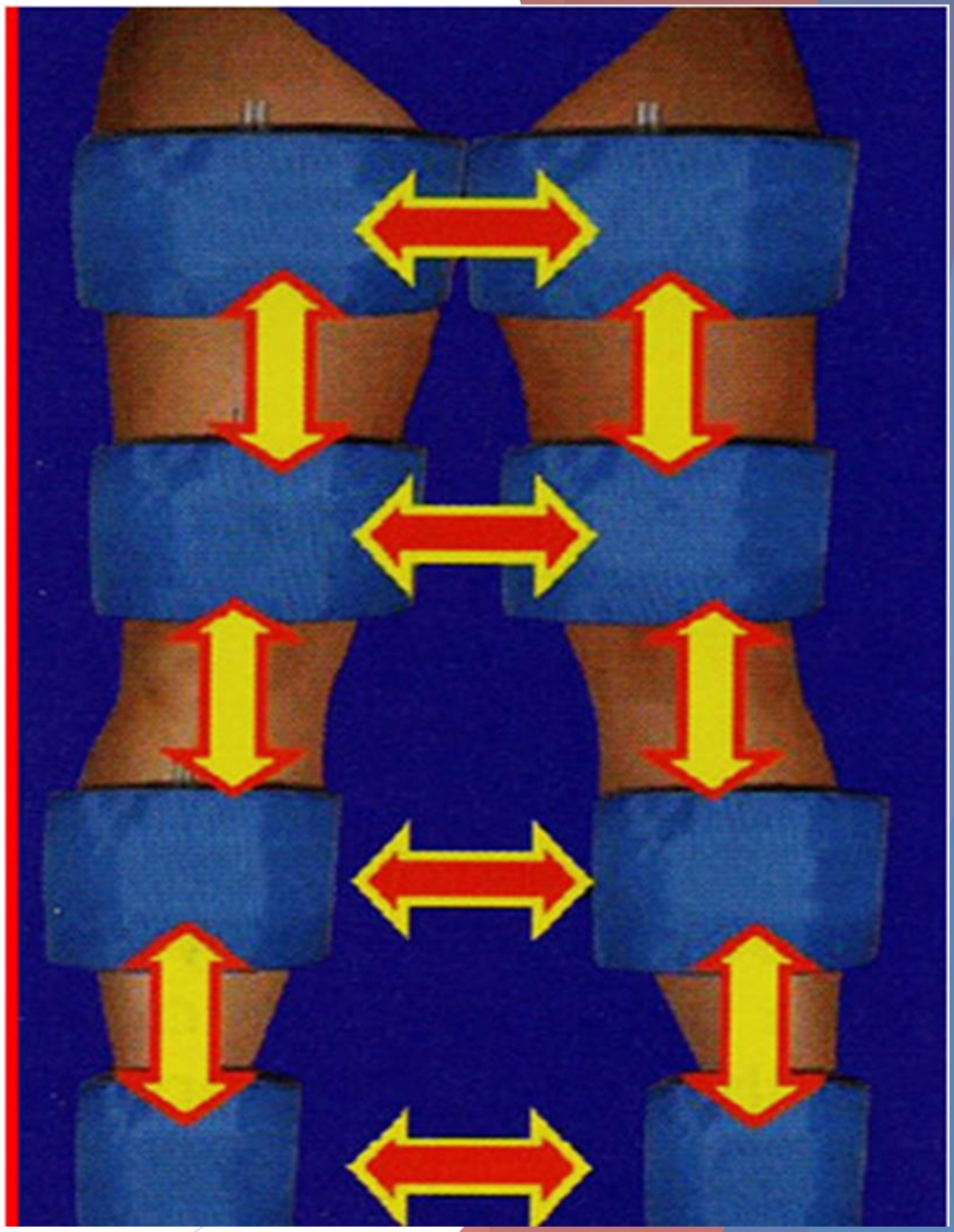
- Starting at the ankle, use **both** the DPA and PTA to take the ankle pressures
  - Of these two pressures, use the site with the highest ankle pressure to obtain the remaining segmental pressures beginning with the calf
- It is important to start and the ankle level and work proximally
  - Starting at the thigh and working down to the ankle will create falsely low-pressure measurements

Tips:

- Cuff should be inflated to 20-30 mmHg *above* the highest brachial pressure initially
  - Listen for complete cessation of blood flow
- If pressure measurements need to be repeated, allow sufficient time for arterial flow to stabilize before re-inflating the cuff
- Brachial and ankle pressures can be used if a complete study is not necessary
  - "ABI" ankle brachial index

Interpretation

- Difference in systolic pressure between any two adjacent levels in the leg should be < 20-30 mmHg
  - Abnormal > 20-30 mmHg
- Limb to contralateral limb pressures at the **same level** should not exceed 20-30 mmHg



Interpretation

- Brachial pressures should not exceed 20 mmHg difference
  - Gradient of 20 mmHg or higher suggests innominate, subclavian, axillary, or brachial obstruction

Interpretation

Normal:

- Thigh pressure measurements are typically 20-40 mmHg higher than brachial systolic pressures (depends on size of thigh cuff)
- Ankle pressures should be equal or slightly higher than the brachial systolic pressure
- Segmental pressures are usually combined with Doppler velocity waveforms or PVR's for further interpretation

Interpretation

- Ankle/Brachial Index (ABI) is calculated by dividing the ankle pressure by the higher of the two brachial pressures
- Also called Ankle/Arm Pressure Index (API) or Ankle/Arm Index (AAI)

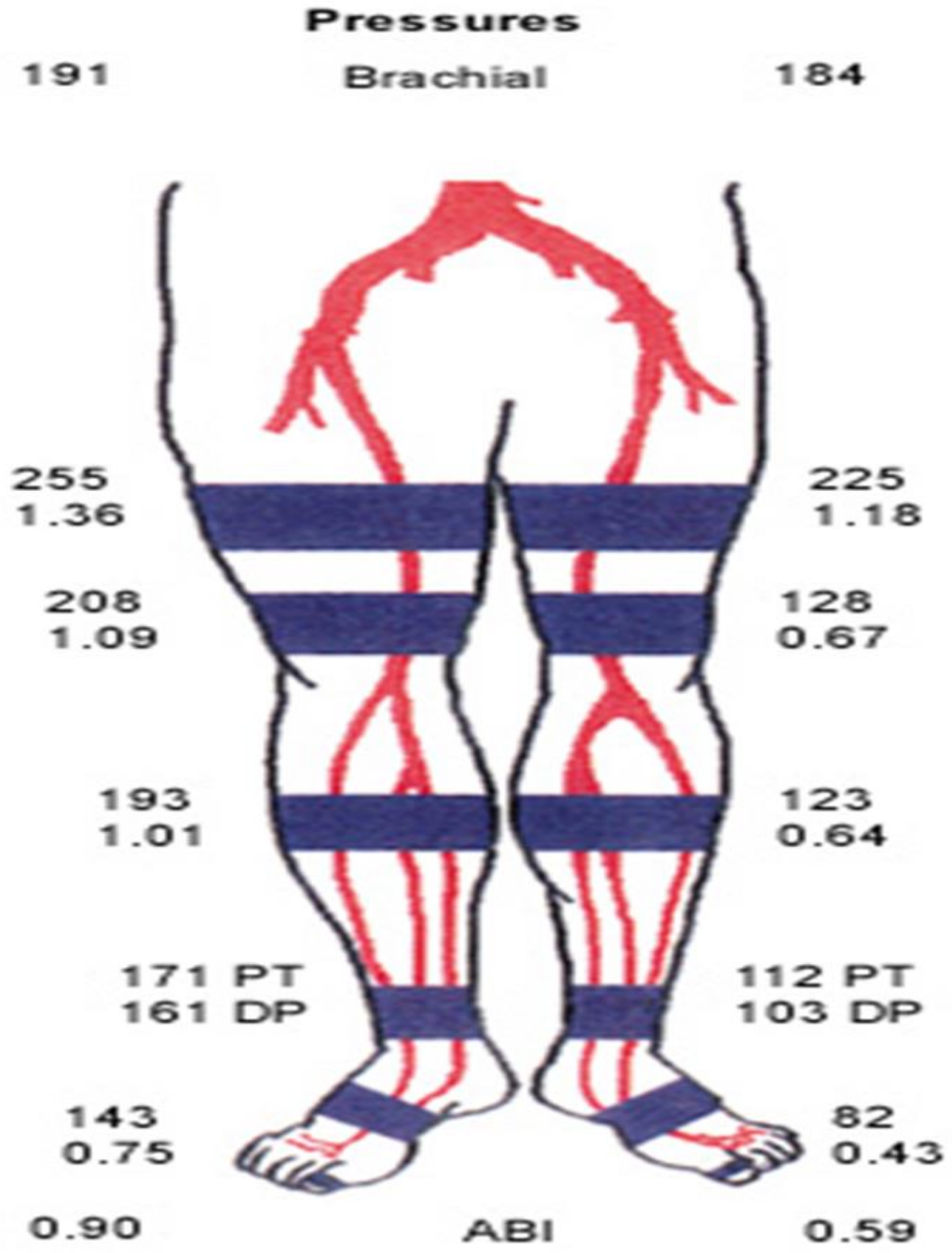
Normal and Abnormal ABI Findings

Ankle/Brachial Index	Findings
> 1.0	Normal
> 0.9 - 1.0	Asymptomatic minimal obstructive disease (considered WNL)
0.8 - 0.9	Mild arterial disease
0.5 - 0.8	Claudication (moderate disease)
< 0.5	Rest pain (severe arterial disease)

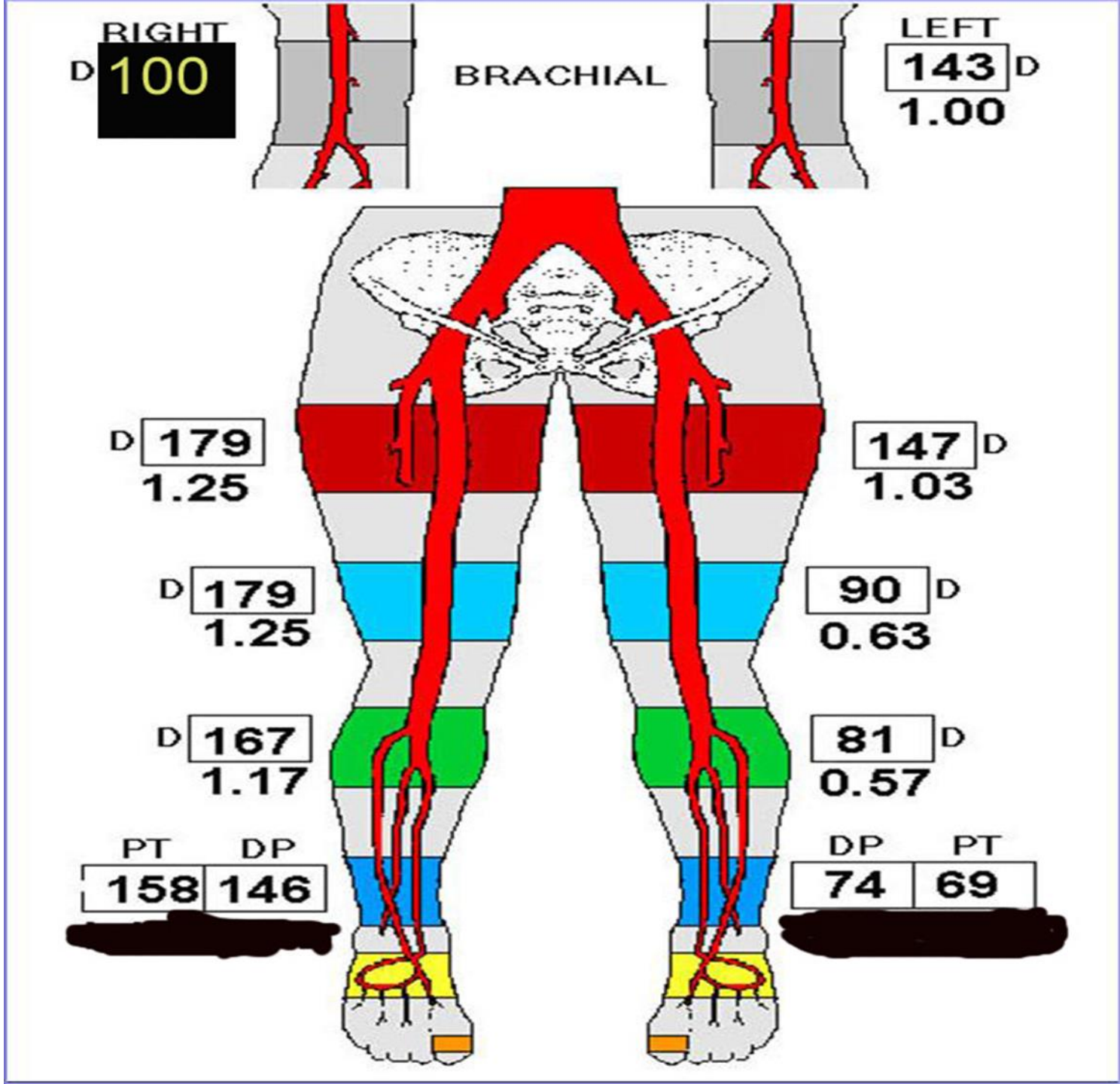
Limitations

- Rigid Arteries:
  - Calcifications will produce falsely elevated measurements
  - Pressures exceeding 250 mmHg are considered “CNO” Cannot Occlude; or Non-Compressible “NC”
- Tissue Density:
  - Obese patients and those with severe edema may have falsely elevated pressures

What is your interpretation?



What is your interpretation?



Exercise Pressures

Exercise Pressures

- Patients who complain of claudication only with exercise usually have an ABI close to 1.0 prior to exercise and an ABI in the 0.6 to 0.8 range following exercise
  - Requires additional testing

Capabilities

- Helps differentiate between true claudication and pseudo-claudication
- Determines presence or absence of collaterals
- Treadmill is great at reproducing symptoms

Limitations

- Shortness of breath
- Severe HTN
- Cardiac problems that limit activity
- Stroke
- Walking disturbances/inability to walk without assistance

Technique

- After resting pressures are obtained, patient is instructed to exercise to induce symptoms
- Treadmill – follow protocol approved by medical director
  - Standard protocol is 1.5 mph at < 12% grade for 5 minutes
- Post-exercise pressures should be taken immediately and then every 2 minutes until pressures return to pre-exercise levels

Technique

- Resting pressures are completed
- Patient walks on the treadmill following the facility protocol for a maximum of 5 minutes or until the symptoms make them stop
  - Document walking time, distance, and location of pain
- Pressures are immediately measured:
  - First, in the ankle of the more symptomatic leg
  - Then, the opposite ankle
  - Lastly, the arm with the previously higher brachial pressure

Interpretation

Normal Response:

- Increase in pressures after exercise (or slight decrease) with immediate return to pre-exercise pressures

Single Segment Occlusive Disease:

- Ankle pressures fall to low or unrecordable levels immediately after exercise and return to resting values within 5 minutes

Multi-Segment Occlusive Disease:

- Ankle pressures that remain decreased or unrecordable for up to 12 minutes

Severe Ischemia:

- Post-exercise pressures are unrecordable for 15-20 minutes or more

Reactive Hyperemia

Reactive Hyperemia

- This method may be used when patients cannot be exercised
- Cannot be performed on patients with bypass graft or stents
- Large thigh cuff is placed around the thigh and inflated 20-30 mmHg above highest brachial pressure and maintained for 3-5 minutes
  - Produces ischemia and vasodilation distal to the cuff
- Once the thigh cuff is released, the ankle pressure changes are similar to post exercise

Interpretation

- Normal Response:
  - Demonstrates a 17-34% drop in ankle pressure
- Single Segment Occlusive Disease:
  - Demonstrates ~ 50% drop in ankle pressure
- Multi-Segment Occlusive Disease:
  - Demonstrates a > 50% drop in ankle pressure
- Severe Ischemia:
  - Demonstrates a >70% drop in ankle pressure