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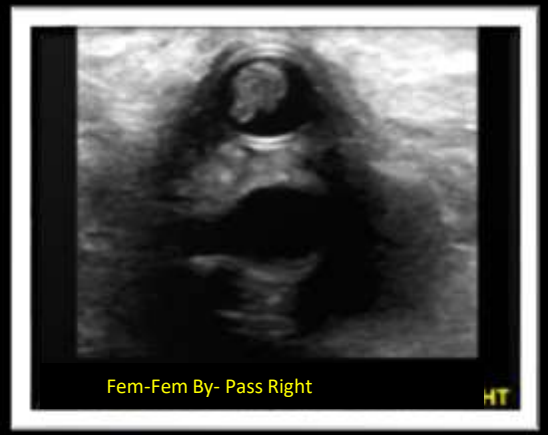
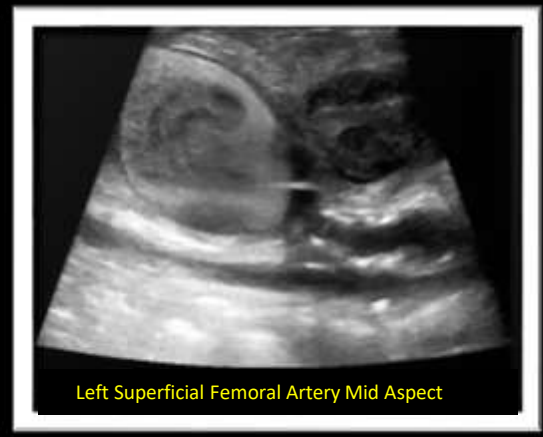
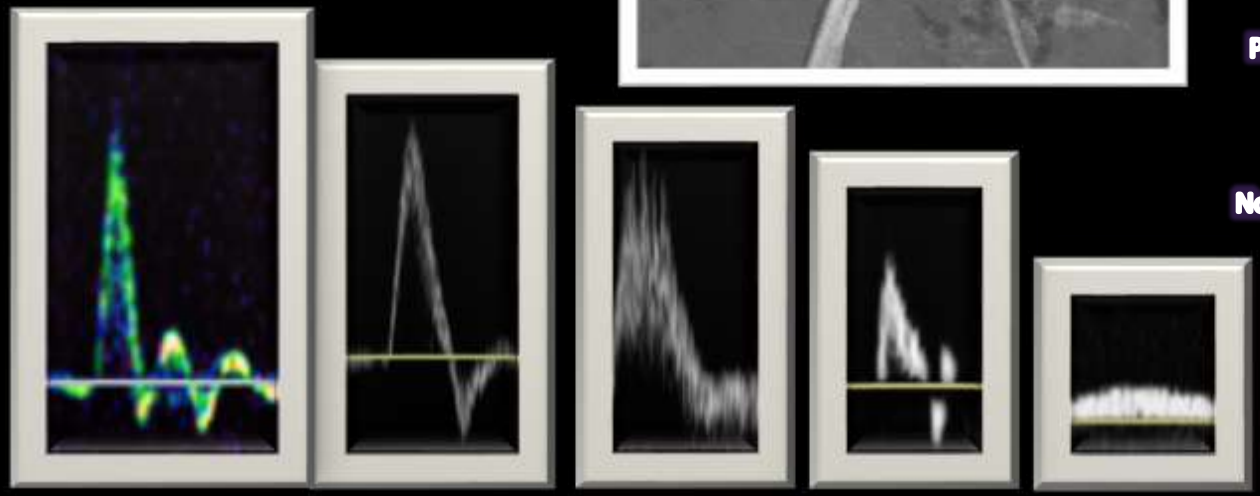
Arterial Duplex
What You Need To Know
Michigan Society Of Ultrasound







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Also Special Thanks Go Out To

- Wayne C. Leonhardt BA, RDMS, RVT
- Robert Mendes M.D
- Bob Scissions RVT,FSVU
- Wayne Smith M.D. RVT,RDMS, RPVI,FACP,FSVM

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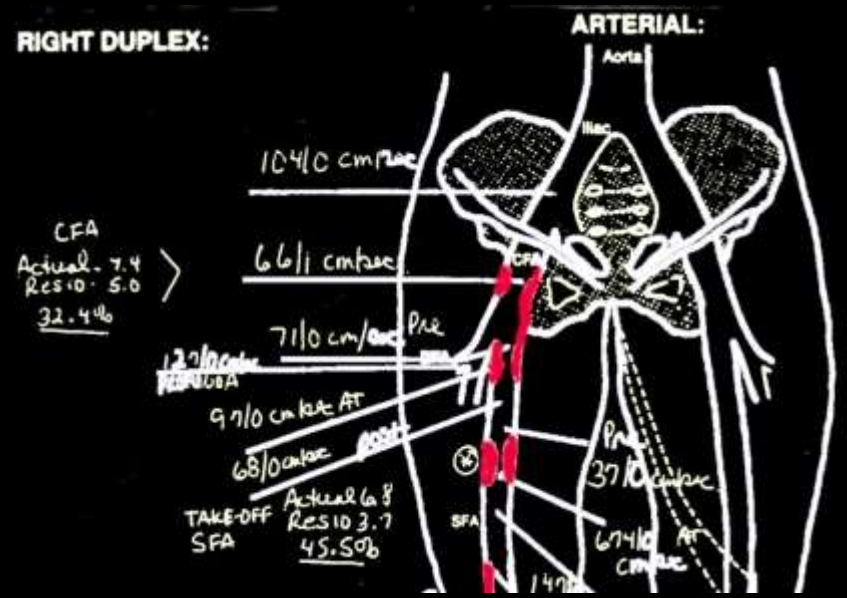
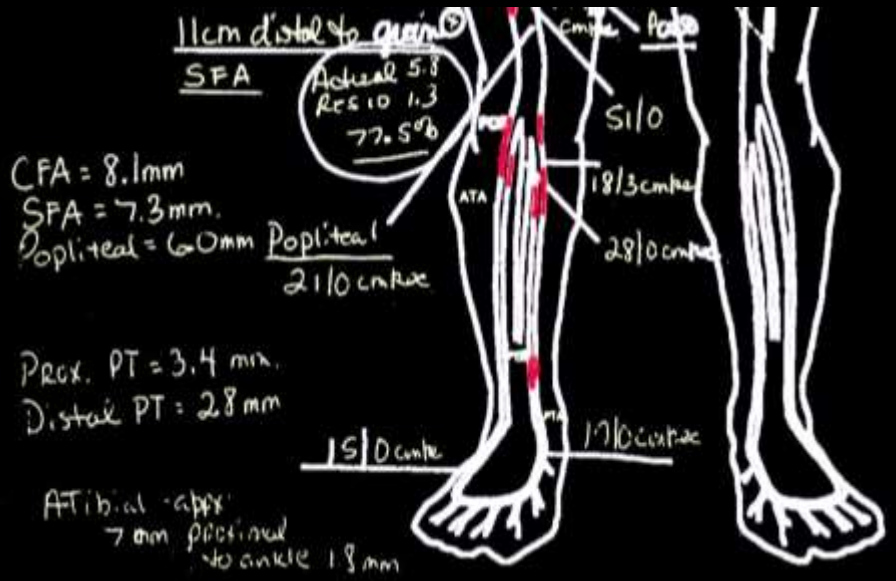


WHAT YOU NEED TO HAVE & KNOW



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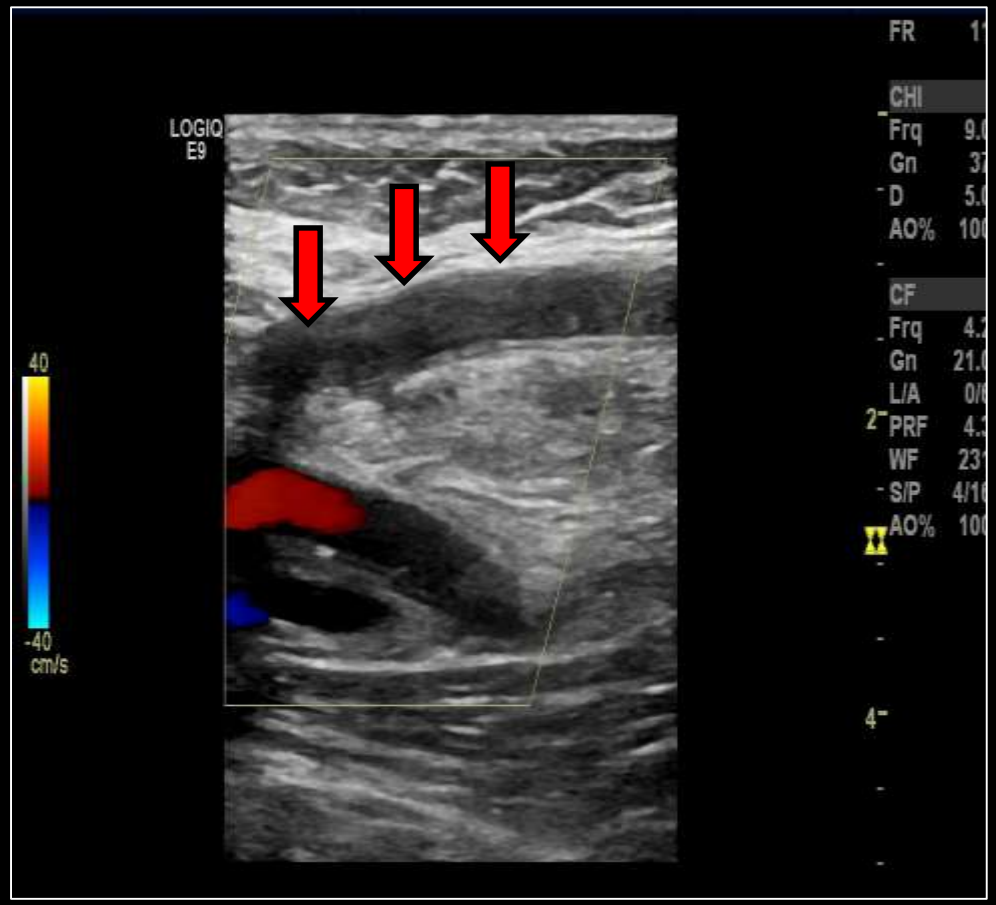
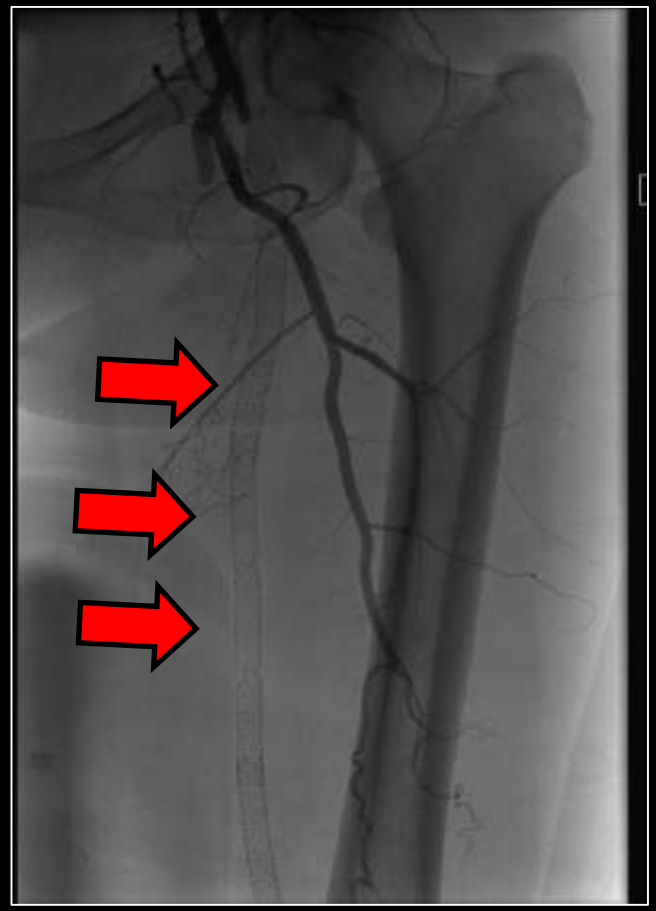
My Ultimate Goal Everyday

Make Duplex The Gold Standard……

#1 Imaging Goal Is To Strive To Be Gold Standard !





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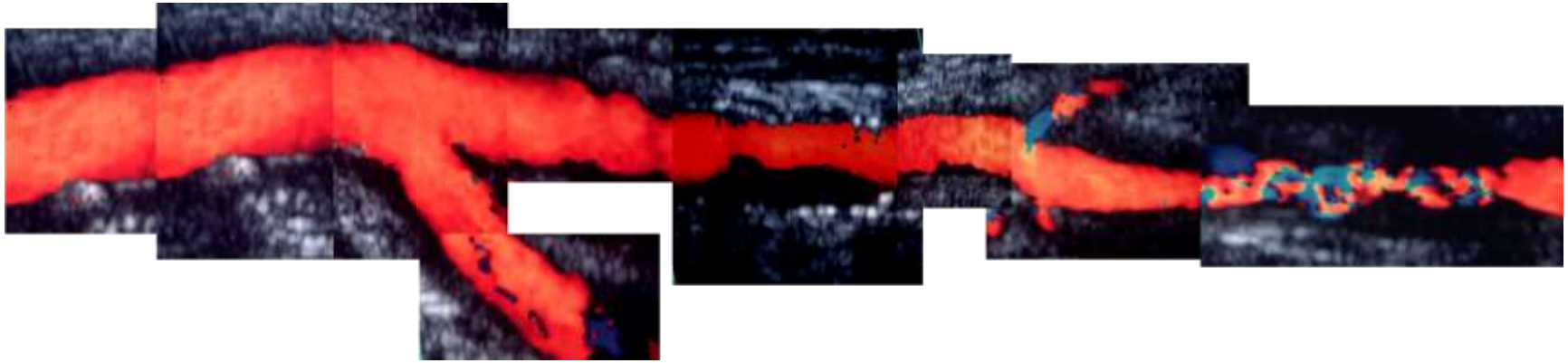
Goals



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

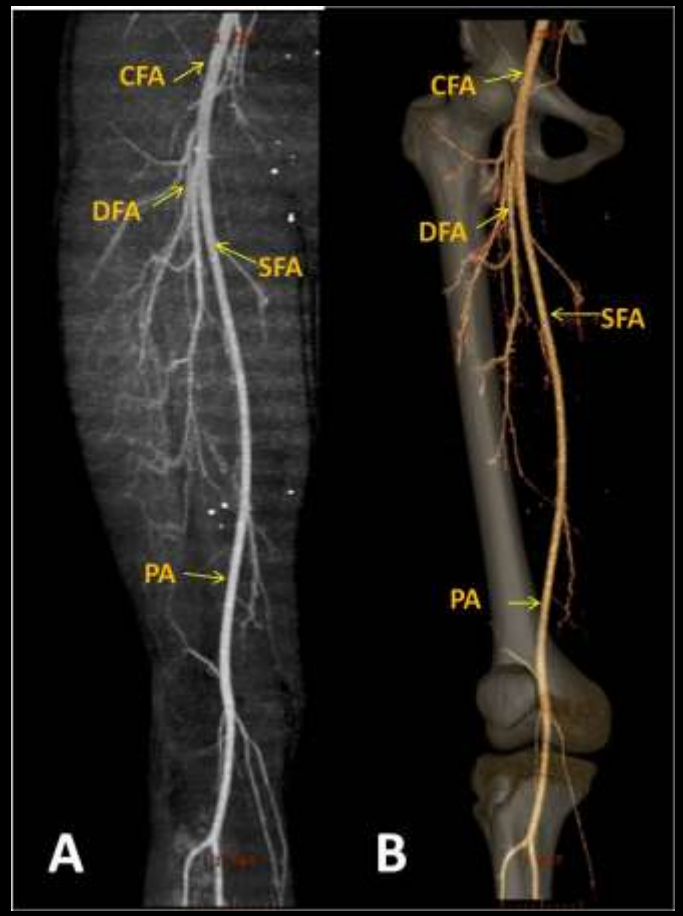
PRF High enough to prevent aliasing

Low Wall Filter (50 Hz) to display low flow

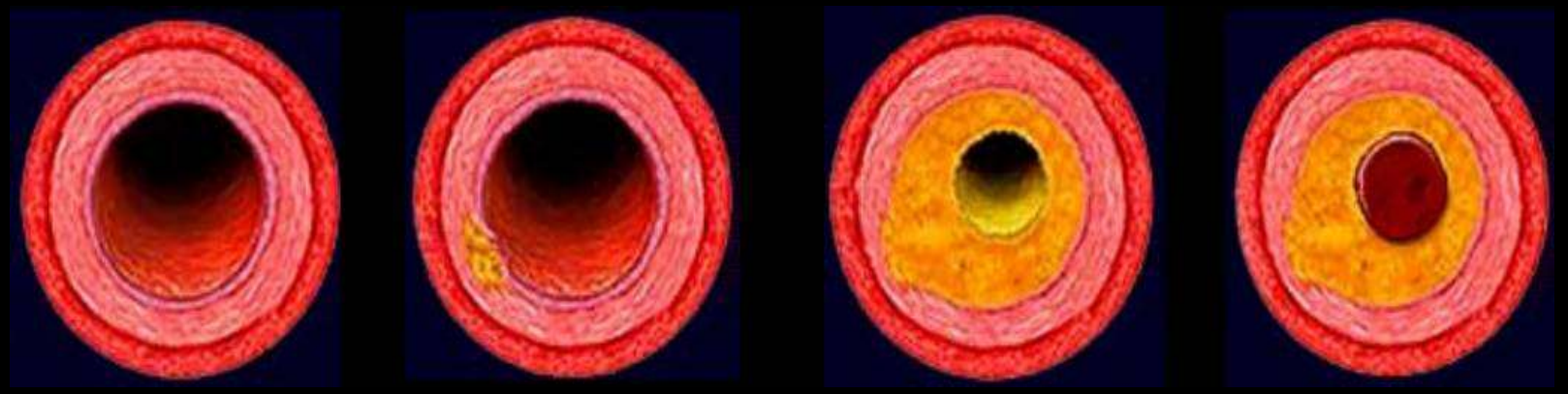
Multiple focal zones to promote image enhancement

Normal Peak Systolic Velocities

	CM/S
Aorta	80 ± 25
External Iliac	119 ± 22
Common Femoral	114 ± 25
SFA Proximal	91 ± 14
SFA Distal	94 ± 14
Popliteal	69 ± 14



Classification of Disease

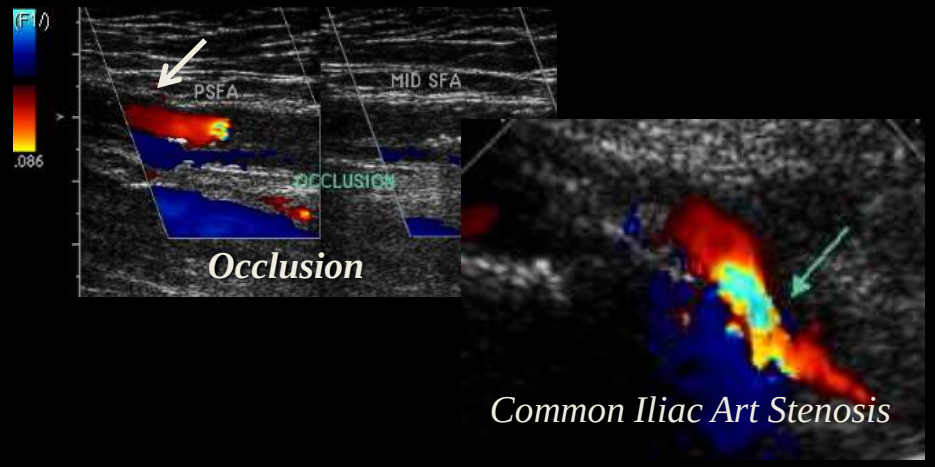


Mild : Symptomatic; decreased pulses; bruit

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

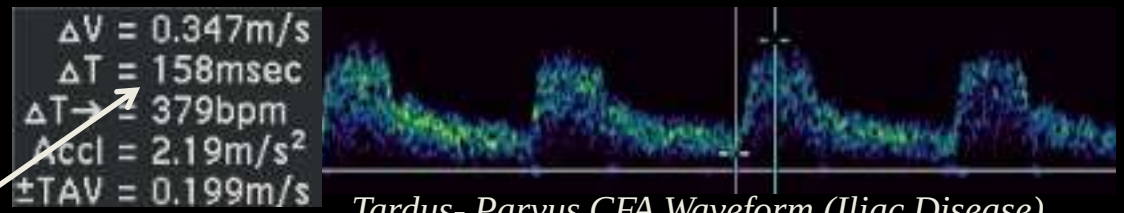
Severe : Rest pain in feet and/or toes; poor wound healing; ulcer(s); tissue necrosis; gangrene

Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD) Abnormal Criteria "Waveforms"

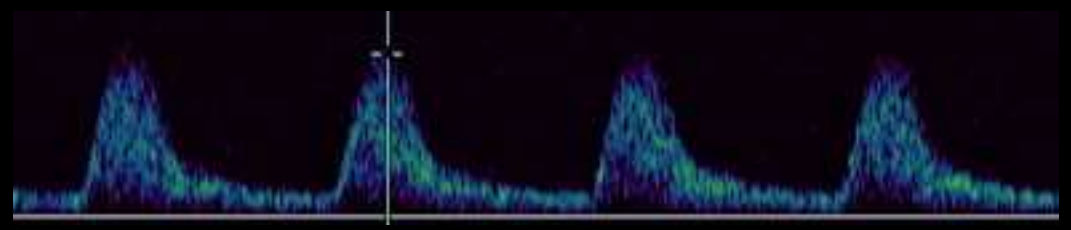


Common Iliac Art Stenosis

Low Velocity High Resistance (proximal to an Occlusion)



Tardus- Parvus CFA Waveform (Iliac Disease)



Monophasic Distal to an Obstruction

- 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

% Stenosis	Peak Velocity	Velocity Ratio
Normal	< 150 cm/sec	< 1.5:1
30% - 49%	150 – 200 cm/sec	1.5:1 – 2:1
50% - 75%	200 – 400 cm/sec	2:1 – 4:1
> 75%	> 400 cm/sec	> 4:1
Occlusion	No color Doppler	

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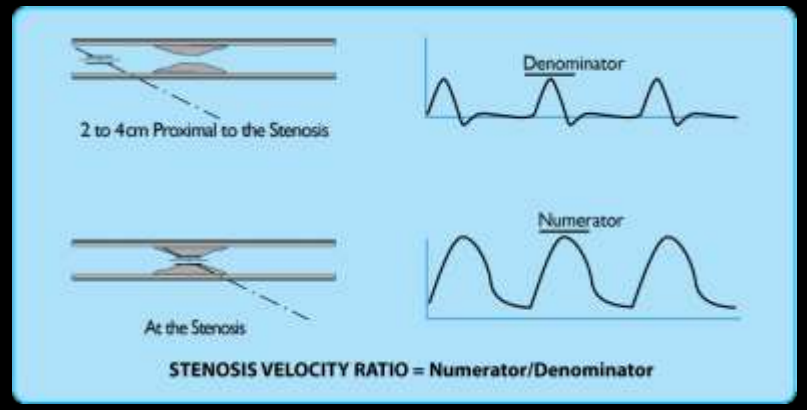
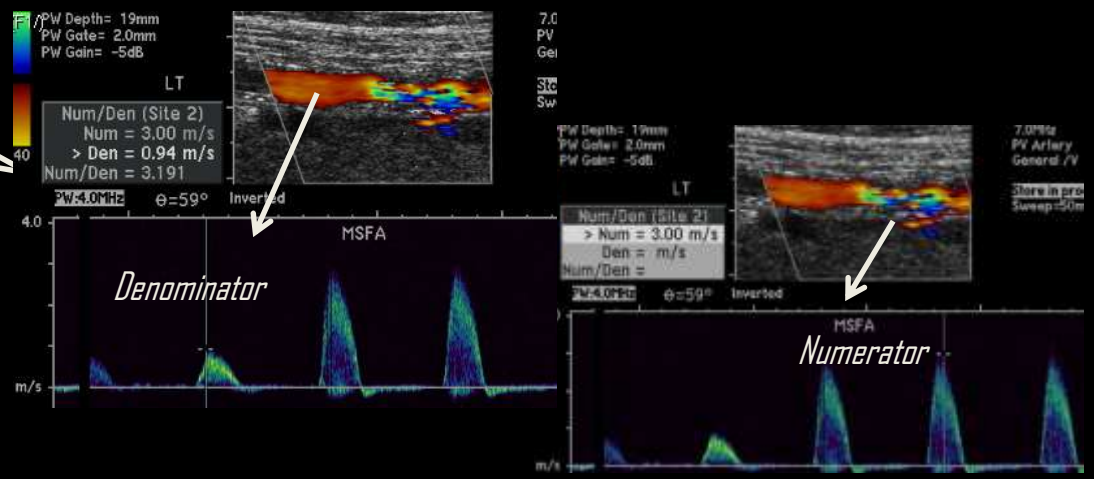
Lower Extremity Arterial Duplex Imaging for Peripheral Arterial Disease (PAD)
Abnormal Criteria "Velocity Ratios"

% STENOSIS	PEAK VELOCITY	VELOCITY RATIO
Normal	<150 cm/sec	<1.5:1
30%-49%	150-200 cm/sec	1.5:1 - 2:1
50%-75%	200-400 cm/sec	2:1 - 4:1
>75%	>400 cm/sec	>4:1
Occlusion	No Color Saturation	

JVS, 1989,10:522-529

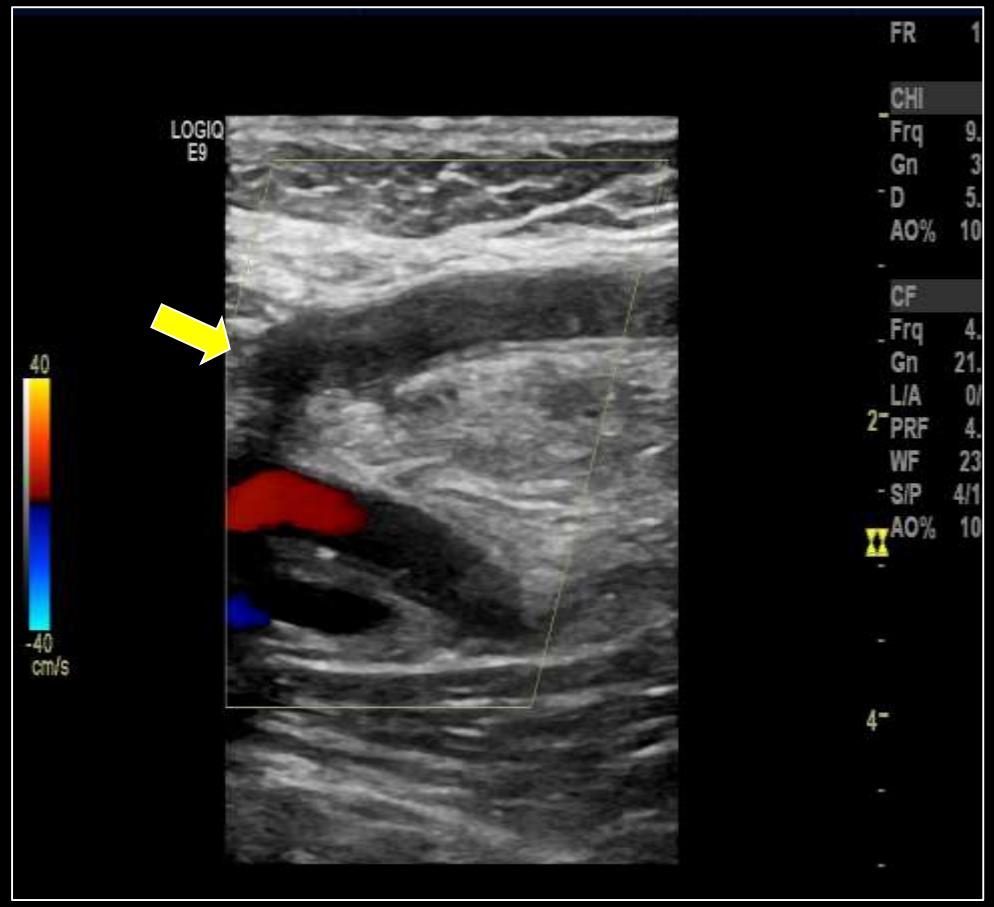




Rumack, In Diagnostic Ultrasound, 4th ed, 2011

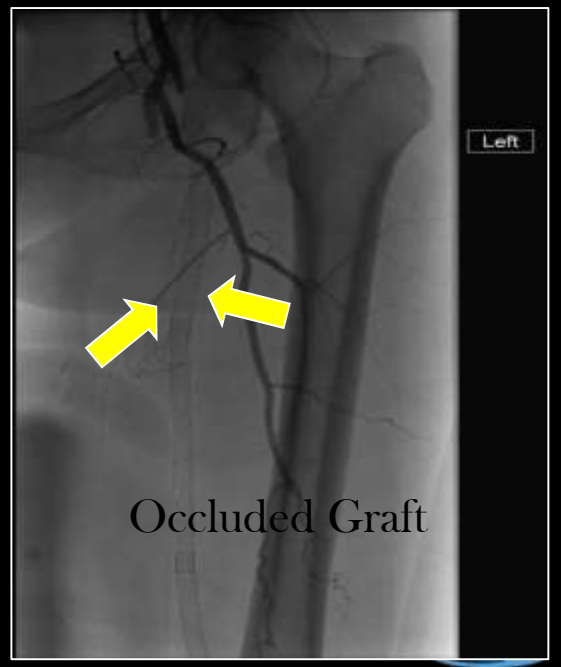
Arterial Duplex Imaging Case

History: 64 yr old female, history of CAD, PAD, + smoker
Post intervention ABI .26



What is your diagnosis?

- Thrombosed Saphenous Vein
- Occluded SFA
- AVF
- **Occluded insitu fem pop**



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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

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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

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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)

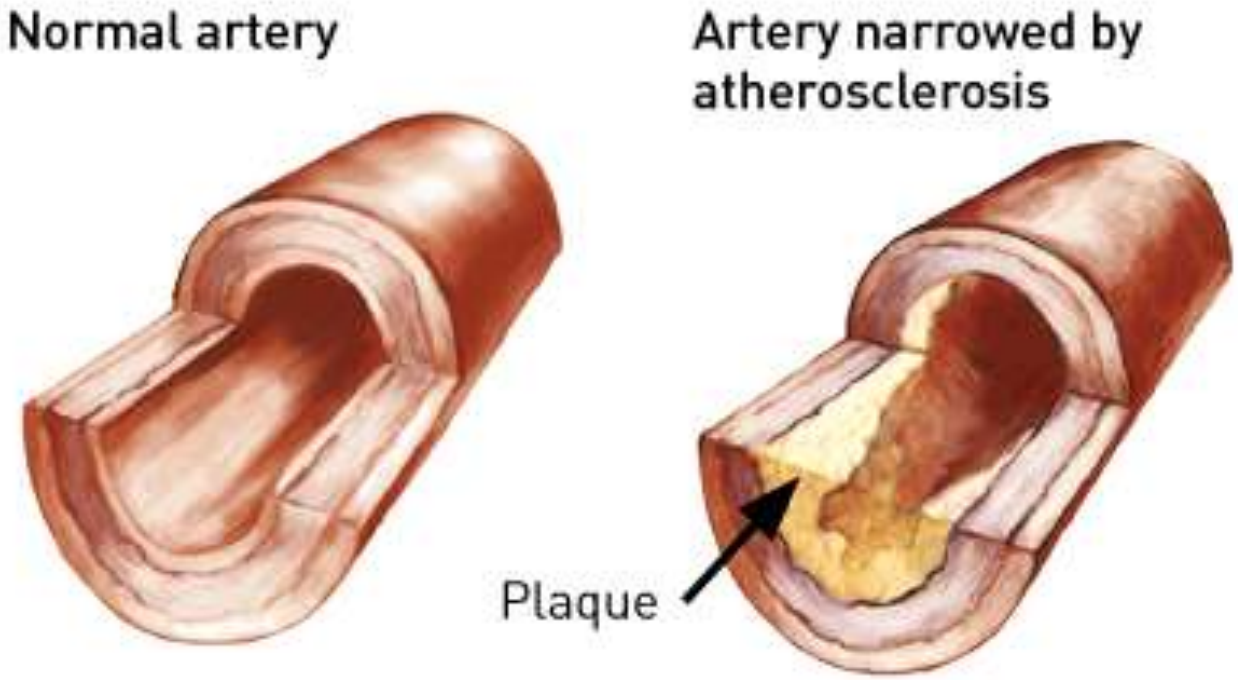
PAD Overview Continued:

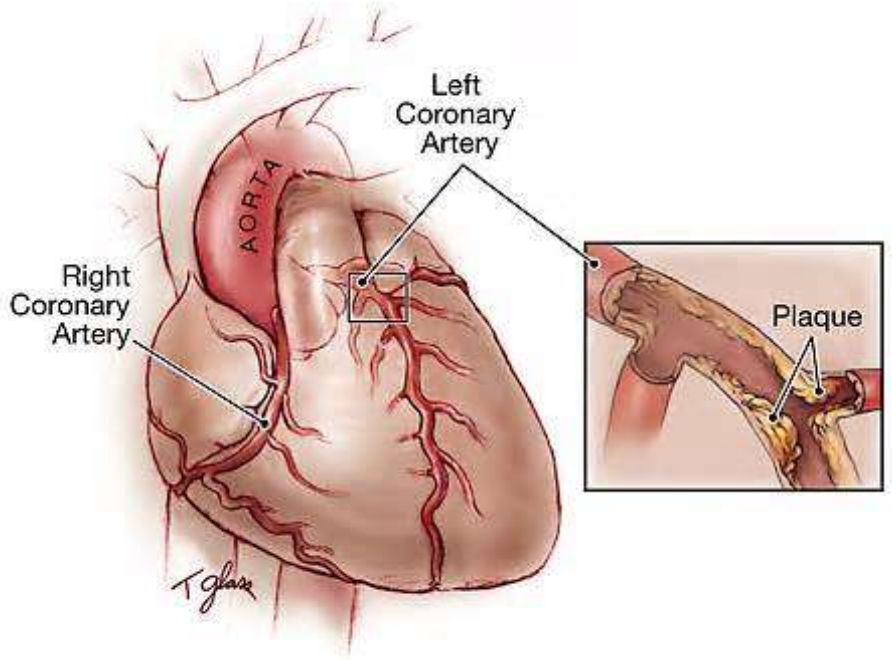
- Atherosclerosis accounts for >90% of cases
- Plaques tend to localize at the bifurcations or proximal segments, as well as in the distal femoral and adductor canal segments in the lower extremities
- Femoral/Popliteal Arteries are affected in 80%-90% of symptomatic PAD patients, the Tibioperoneal Arteries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

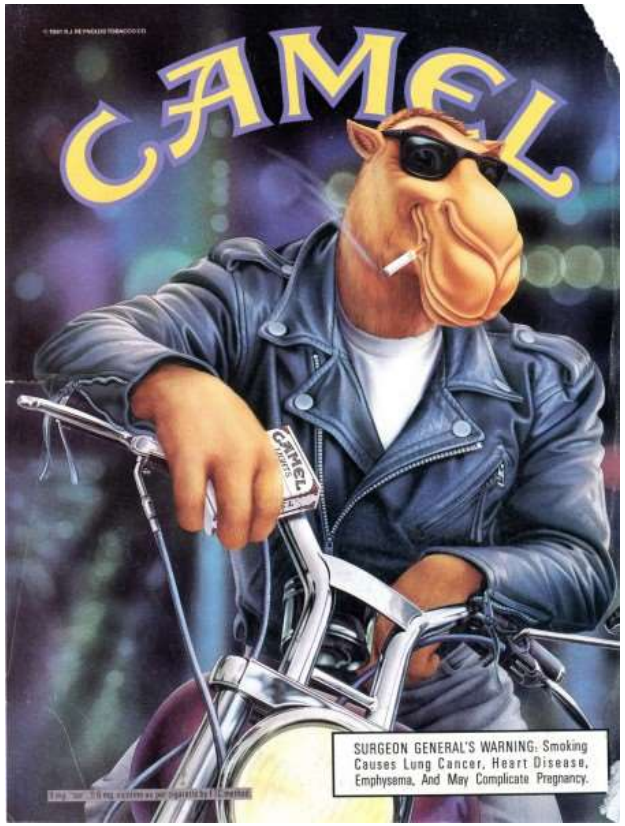
Arteriosclerosis At Junctional Regions Usually





Know Your Patient

- History
- Pathology
- Risk Factors
- Physical Signs
- Current medications or therapies
- Results of previous noninvasive studies
- Results of previous vascular interventions



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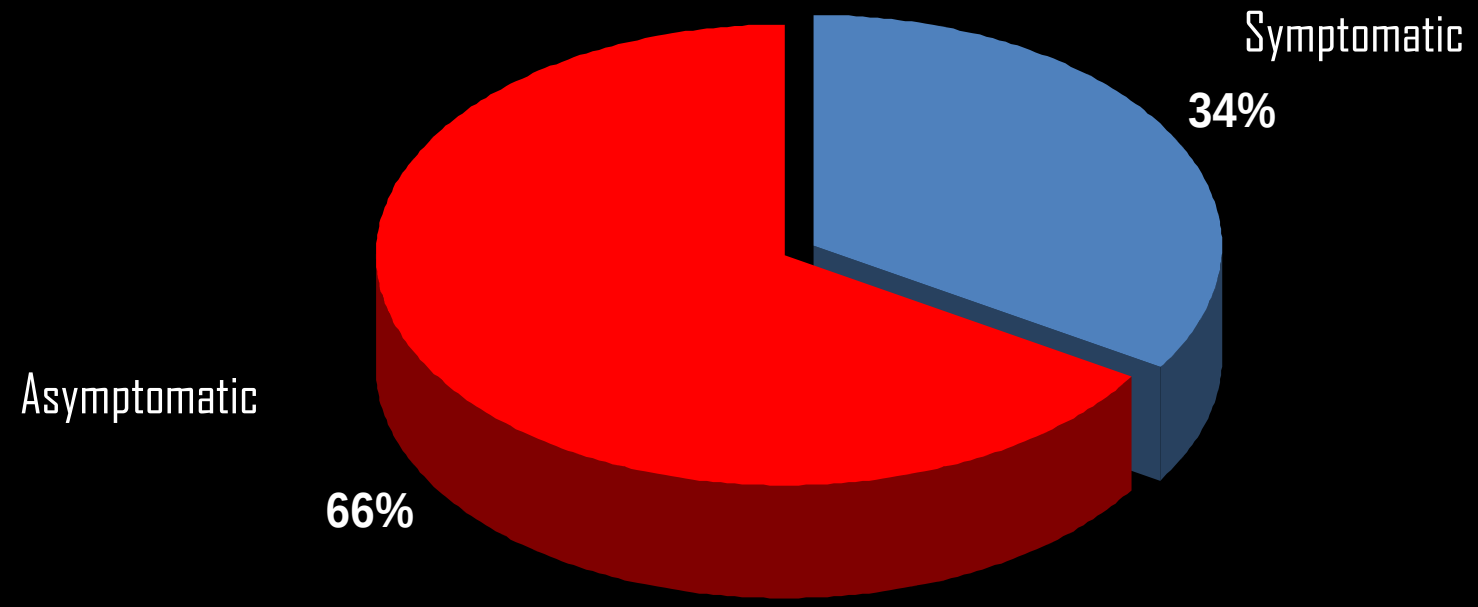
Lower Extremity Arterial Duplex Evaluation for Peripheral Arterial Disease (PAD)

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

PERIPHERAL ARTERIAL DISEASE



Hiatt WR. *N Engl J Med.* 2001;344:1608-1621.

Prevalence of PAD Increases with Age

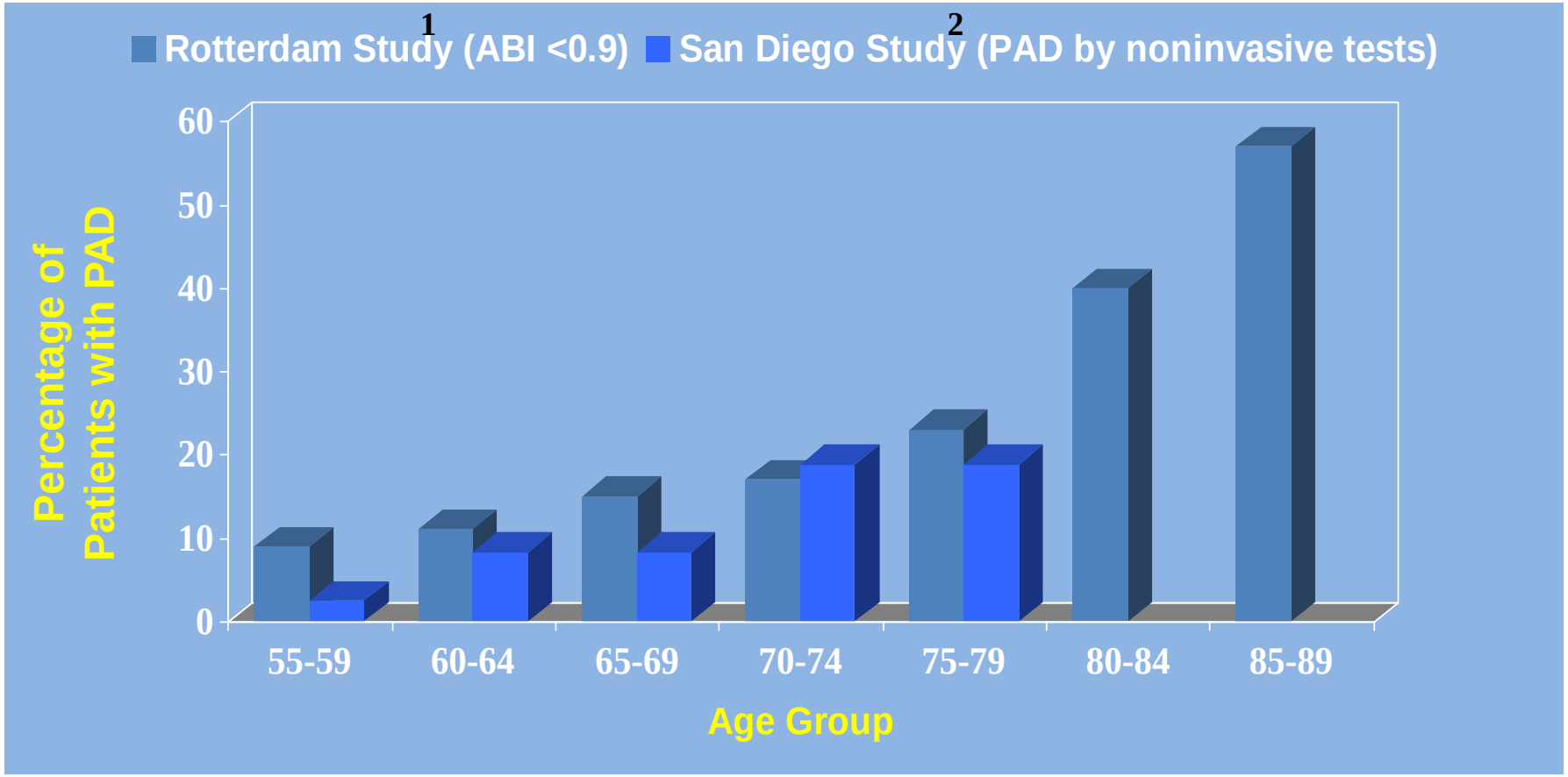


Figure adapted from Creager M. *Management of Peripheral Arterial Disease. Medical, Surgical, and Interventional Aspects.* 2000.

[1] Criqui MH, Arnost F, Barret-Connor E, et al. *Circulation*. 1985;71:510-515.

[2] Meijer WT, Hoes A, Rutgers D, et al. *Arterioscler Thromb Vasc Biol*. 1998;18:185-92.

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

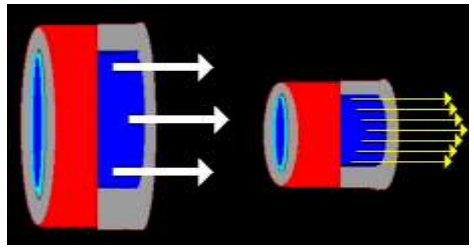
- **Remember Patients Are #1 Concern**
- Ankle brachial indices
- PVR/Segmental Pressures
- Duplex
- Level of disease
- Insonate proximal

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

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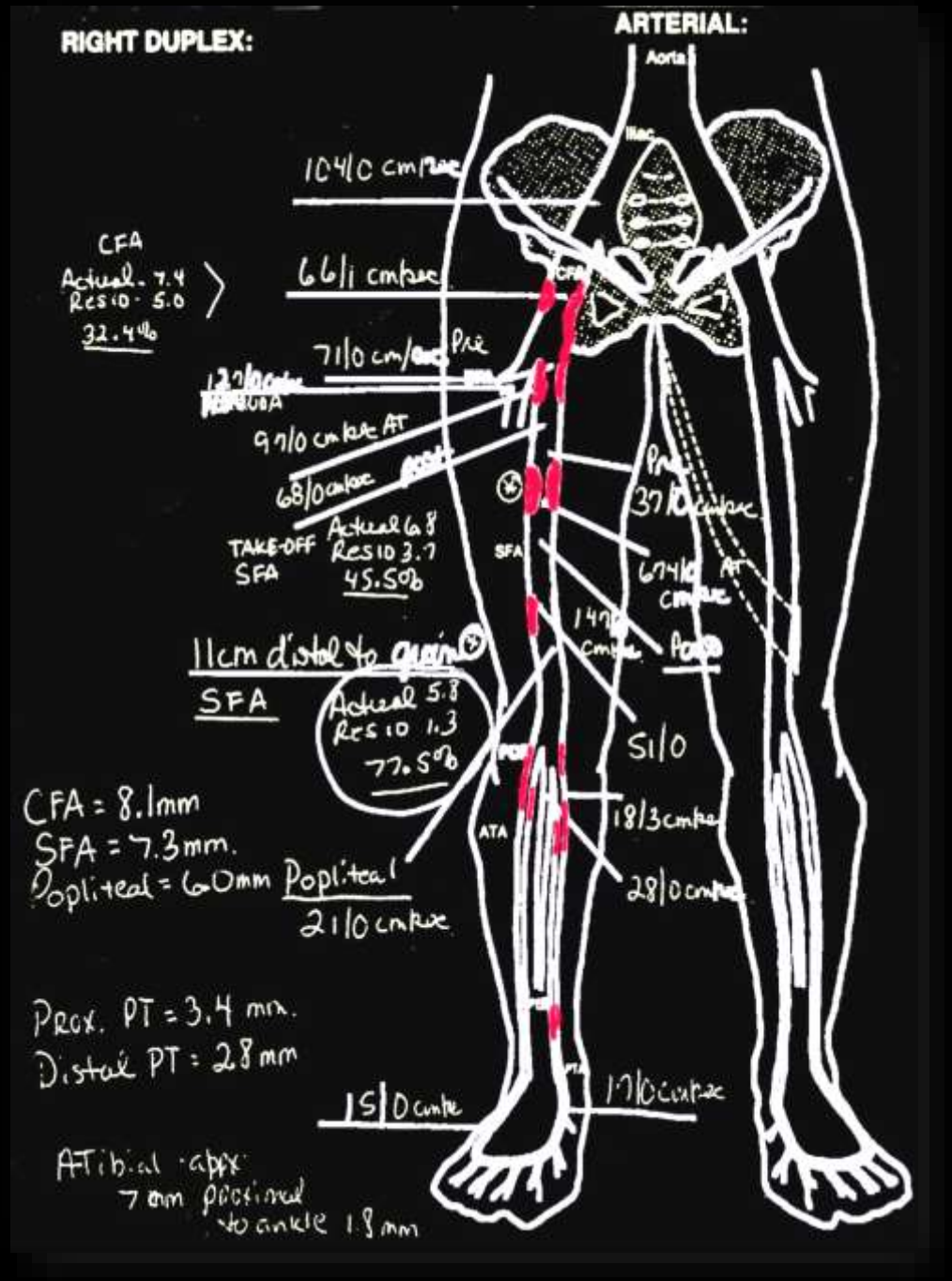

The Arterial Duplex Work Sheet
"Old School"

Communication

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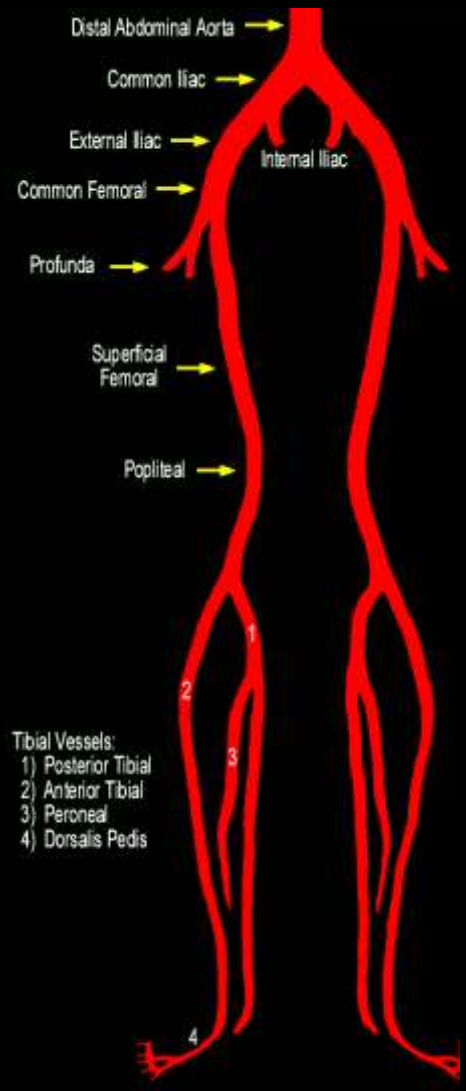
Protocol

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

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 ie.. 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

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

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

Definition of Terms Continued:

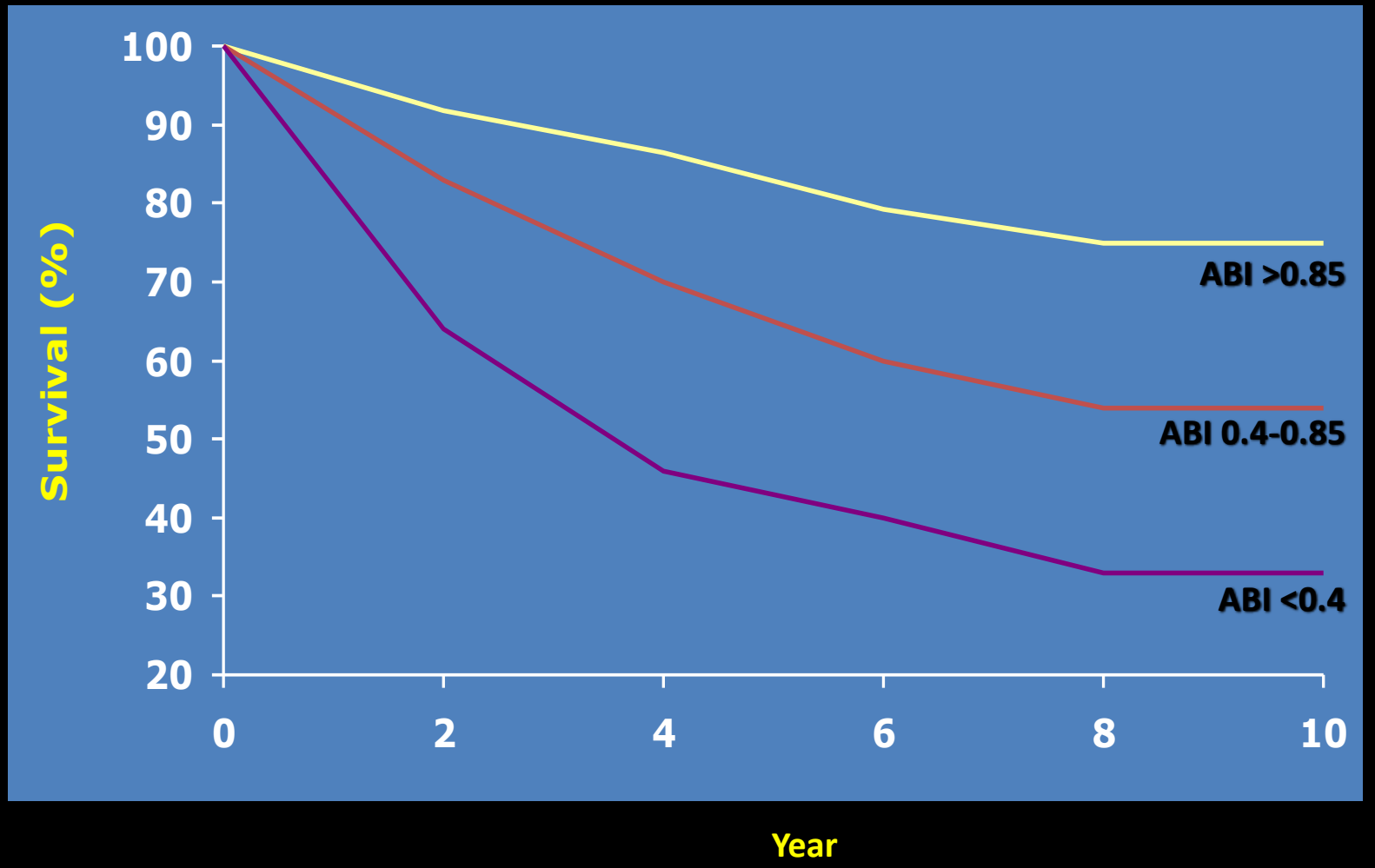
- Gangrene: Critical limb ischemia resulting in localized areas of tissue death; common sites; toes, feet, fingers, hands
- Usually appears in a toe as a focal blackened area; without treatment it may spread to other toes and eventually the foot and lower leg
- Two major types "Dry and Wet" most cases 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

Introduction to Vascular Ultrasonography, *2012*

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 ≥70 years or ≥50 years with risk factors (diabetes, smoking)

ABI: Predictor of Survival



McKenna M, Wolfson S, Kuller L. *Atherosclerosis*. 1991;87:119-128.

Go And Complete your Assessment With The Old Pocket Doppler

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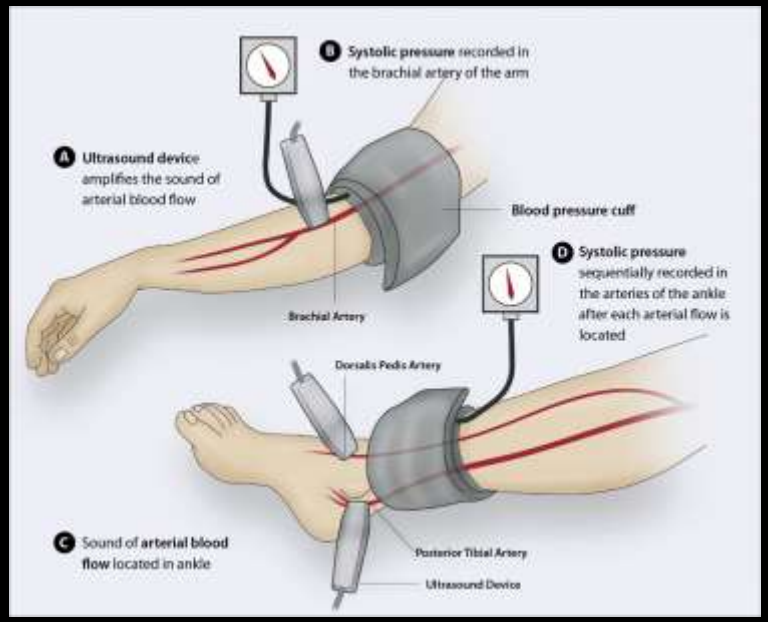
ANKLE-BRACHIAL INDEX

- 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



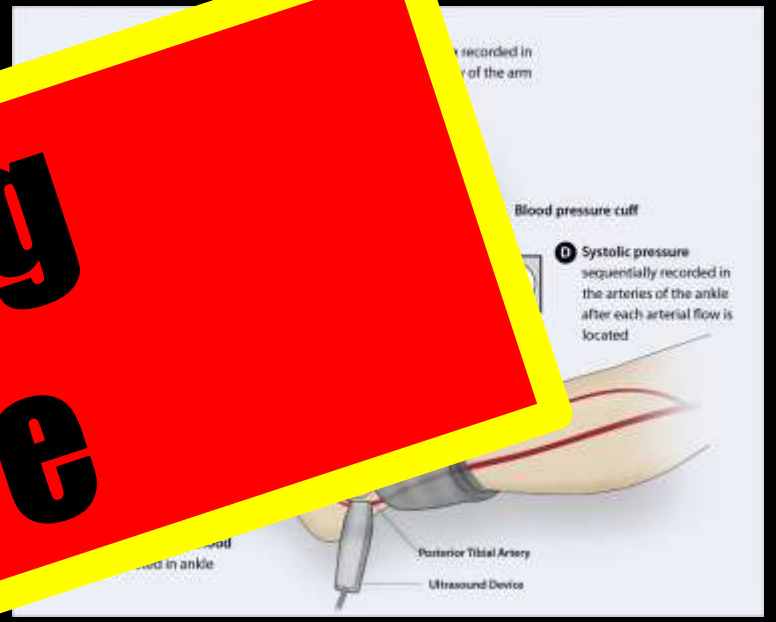
ABI Scale (resting)

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

ANKLE-BRACHIAL INDEX

- Obtain bilateral brachial systolic pre
- Acquire Doppler signals
  DP and Perc

Screening Procedure



ABI Scale (resting)

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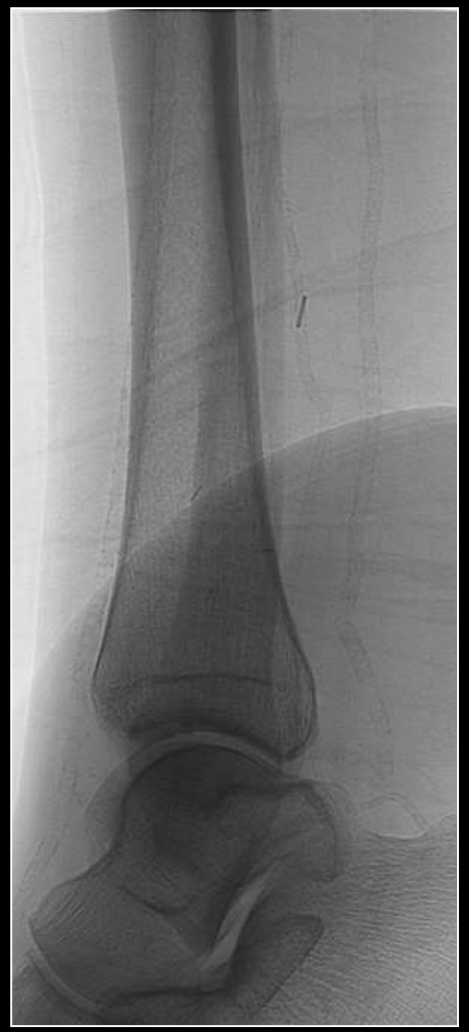
<0.8 = probable claudication
<0.5 = multi-level disease, or long segment occlusion
<0.3 = ischemic rest pain

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

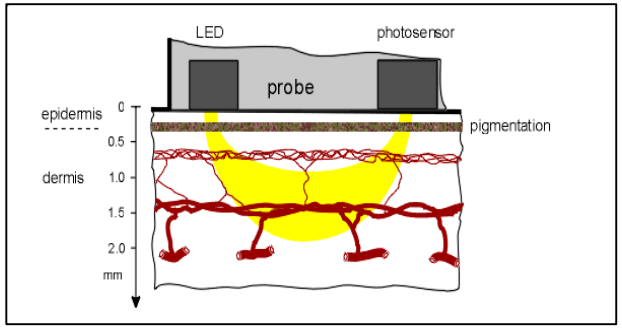
$$\text{Toe/Brachial Index (TBI)} = \frac{\text{toe pressure}}{\text{highest brachial presure}}$$

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



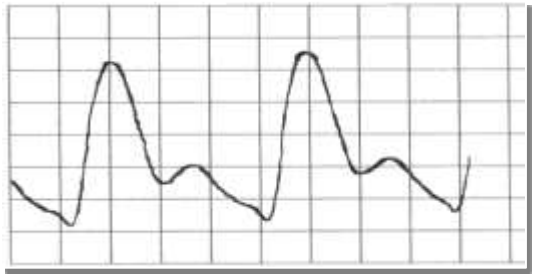
PPG

- 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.

PHOTOPLETHYSMOGRAPHY

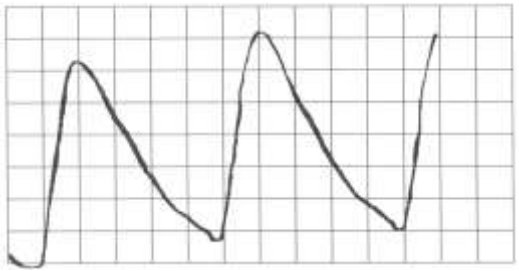
- Normal

  Steep acceleration with a notched reflected diastolic wave



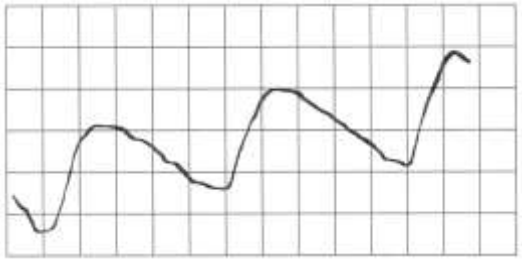
- Mild disease

  Steep acceleration but a decreased rate of fall during deceleration



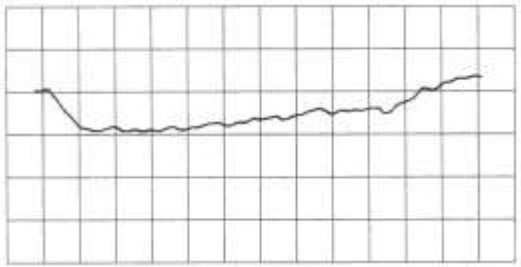
- Moderate disease

  Slower acceleration and marked slowing of deceleration



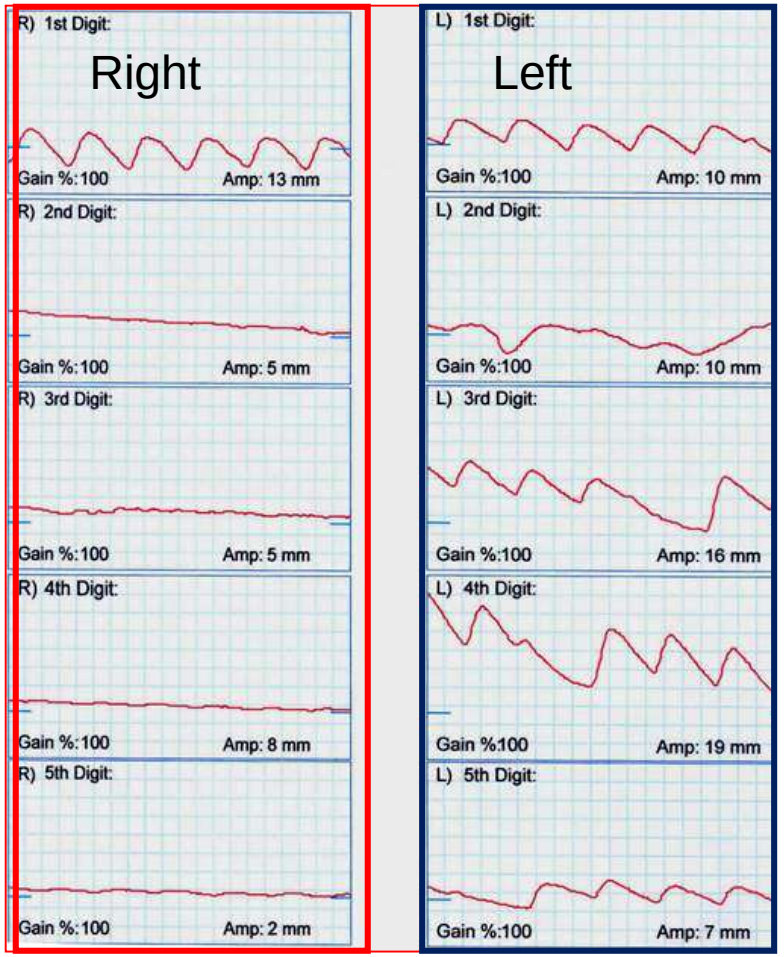
- Severe disease

  Loss of amplitude and pulsatility with no definable configuration



PPG

- Always compare contralateral flow parameters in any form of duplex when questions exist!
- Any difference on right?
- Is this normal?



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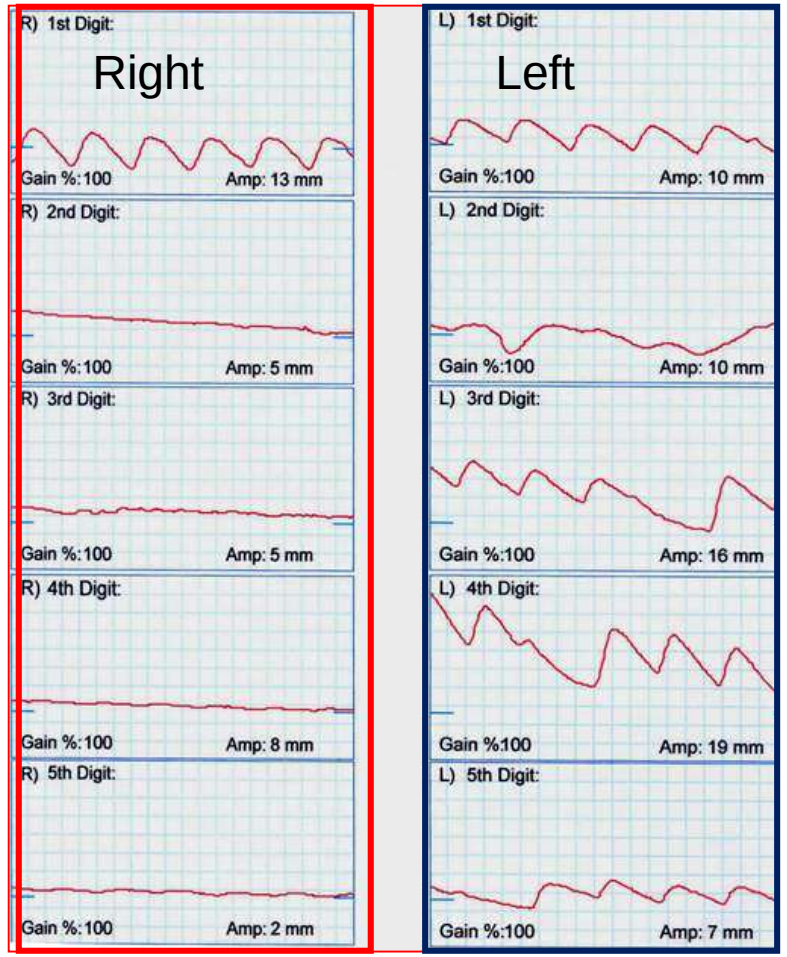
PPG

- NO!
- Note the abnormal perfusion seen bilaterally
- Minimal to no flow was seen in the right 2nd,3rd,4th and 5th digits



Toe/Brachial Indices

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

- Absolute Toe (%)Probability of healing

Pressure (mm Hg)	No diabetes	Diabetes
Below 20	29	25
20 to 30	73	40
30 to 55	100	85
Above 55	100	97

Relationship to Peripheral Vascular Disease

Ankle / Brachial Index (ABI)

Normal: 0.97 to 1.25

Mild: 0.75 to 0.96

Moderate: 0.50 to 0.74

Severe : < 0.50

Critical: < 0.30

Toe / Brachial Index (TBI)

Normal: > 0.80

Claudication:

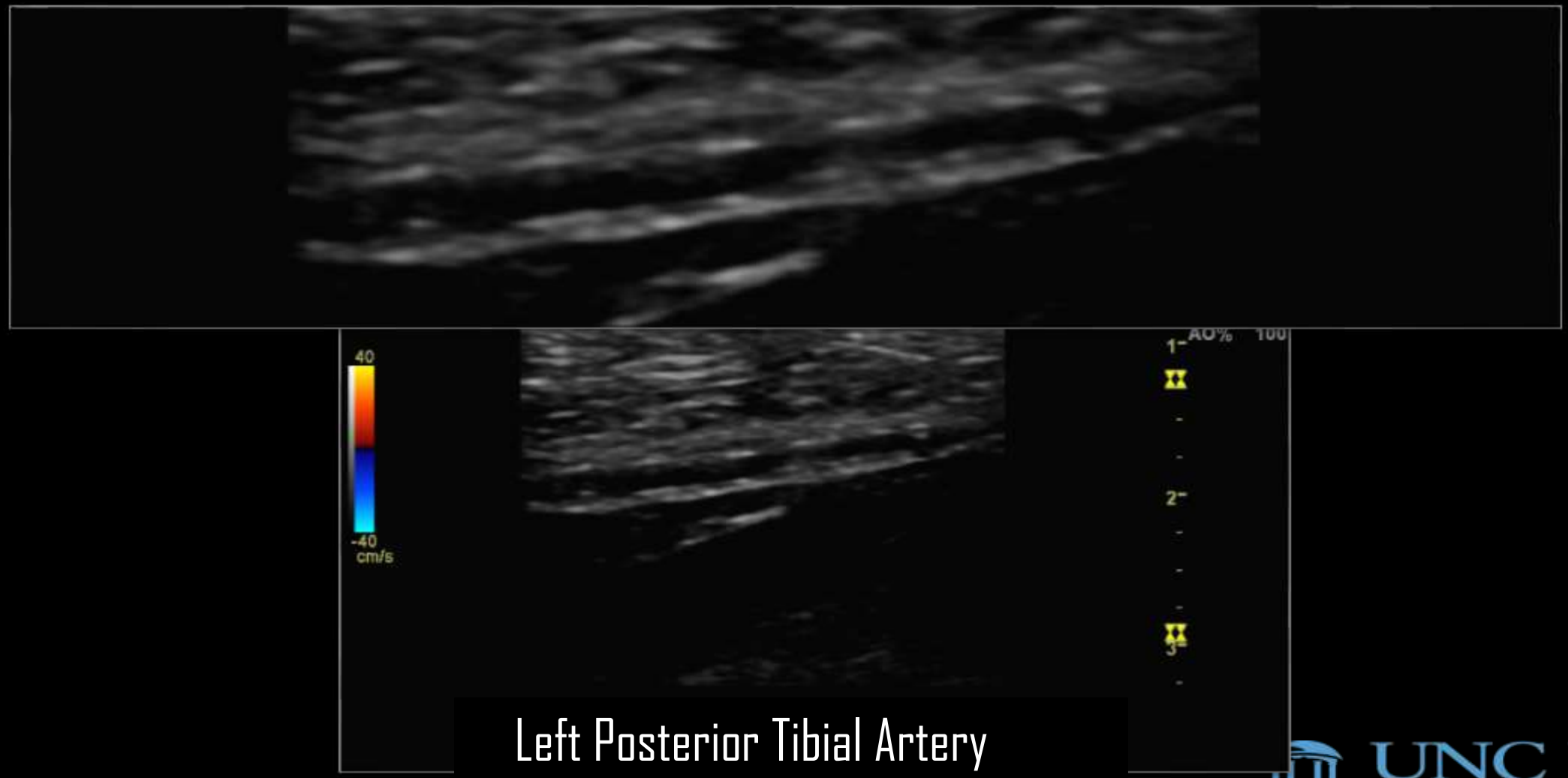
0.20 to 0.50

Rest Pain: < 0 .20

Run-off Disease

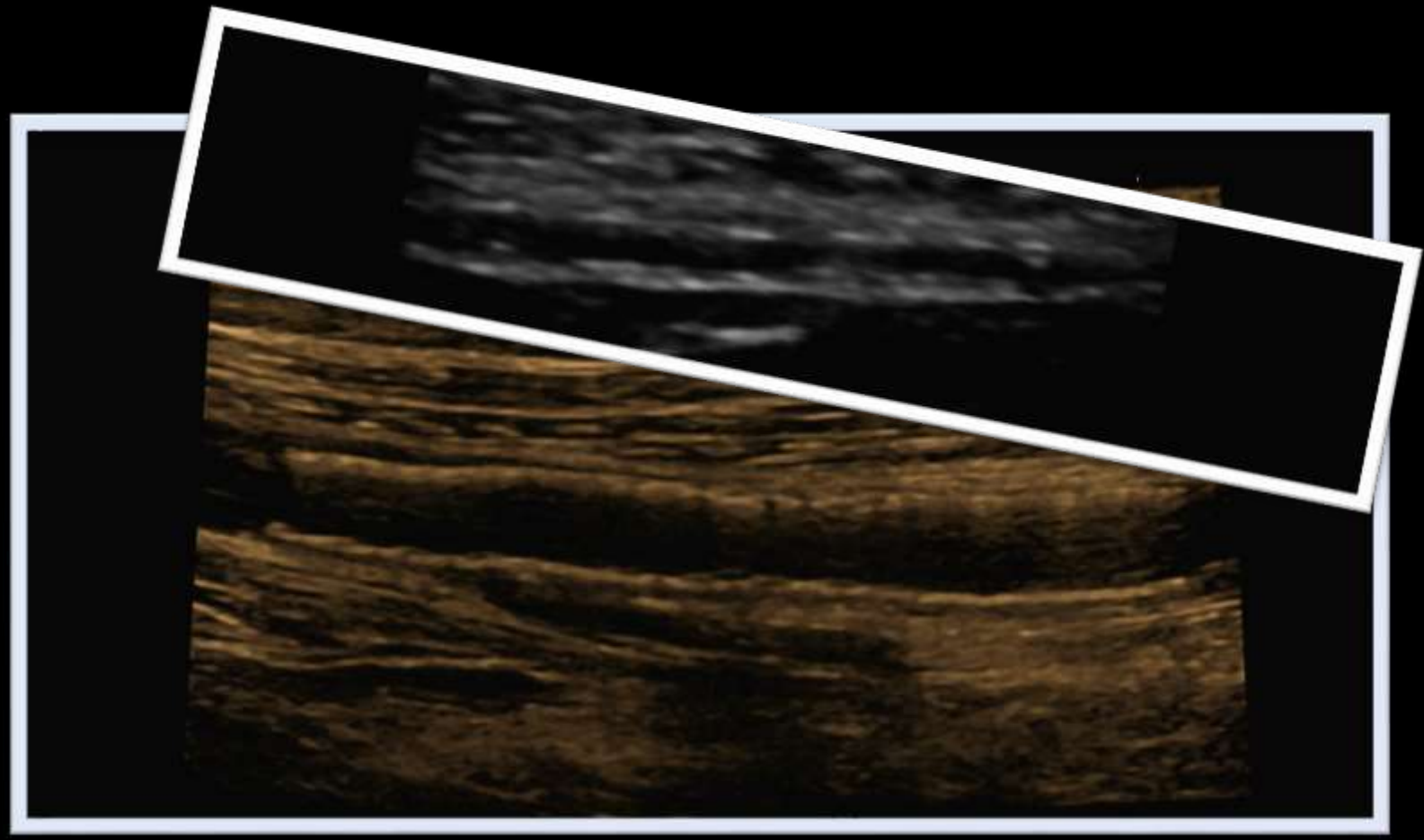
- Tibial vessels
  - —Anterior Tibial Artery (Dorsalis Pedis)
    - Anterior and lateral to tibia
  - —Posterior Tibial Artery
    - Posterior to medial malleolus
  - —Peroneal Artery
    - Lateral calf
- Non-healing ulcers (foot or lower leg)
- Diabetic patients

Run Off Calcification



Left Posterior Tibial Artery

Rigidity Of Calcified Wall vs Peripheral Stenting



Right SFA Stent

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

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REX
UNC HEALTH CARE

UNC REX
HEALTHCARE

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

Arterial Ulcer

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

Physical Signs Acute

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 ?

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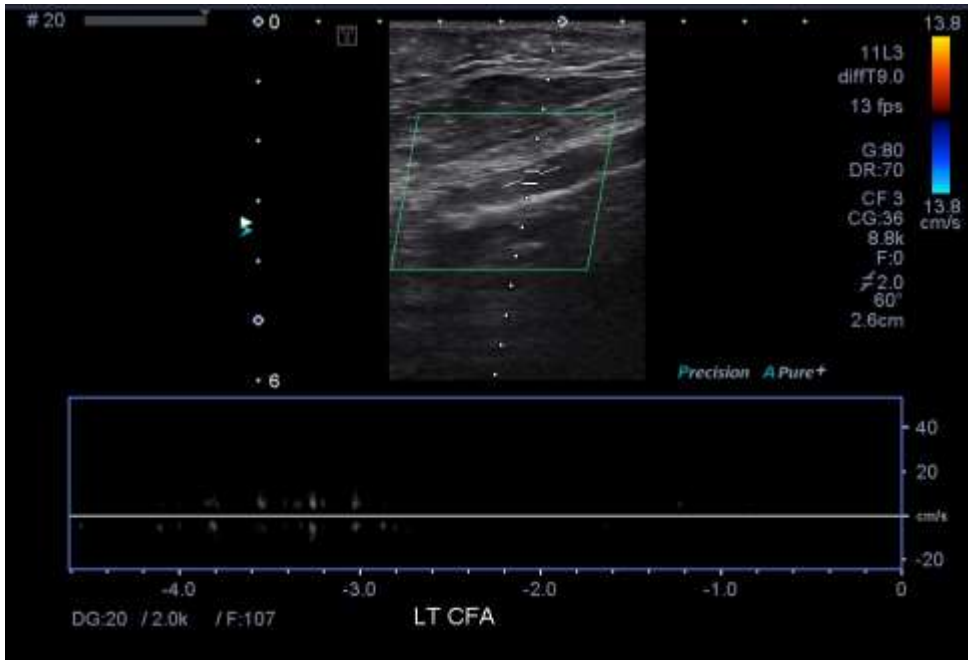
Left External Iliac Artery


11L3
diffT9.0
13 fps
G:80
DR:70
CF 3
CG:36
8.8k
F:0
2.0
60°
2.6cm
Precision A Pure+
40
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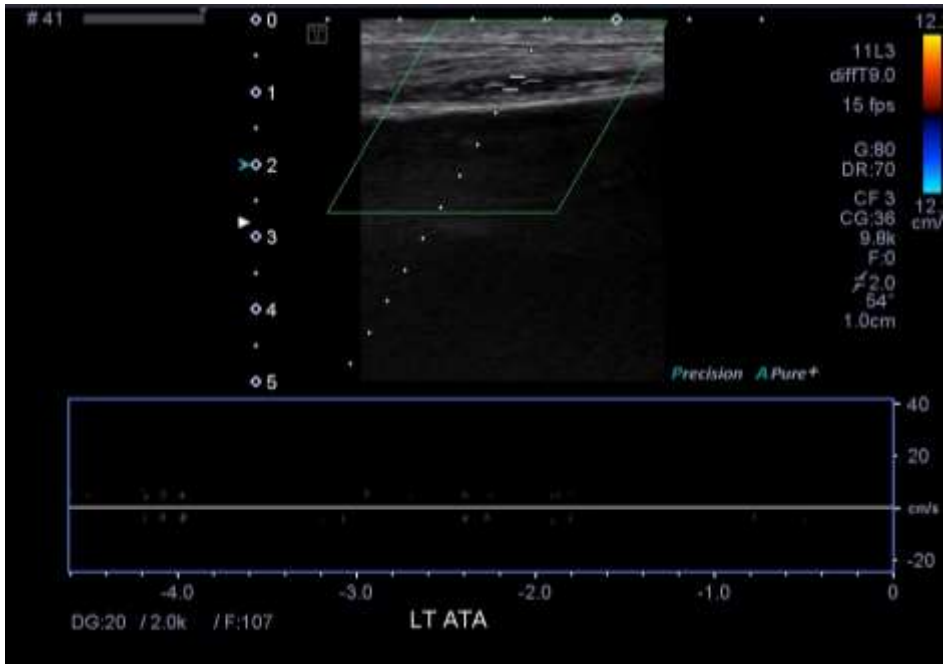
0
DG:20 / 2.0k / F:107
LT CFA


11L3
diffT9.0
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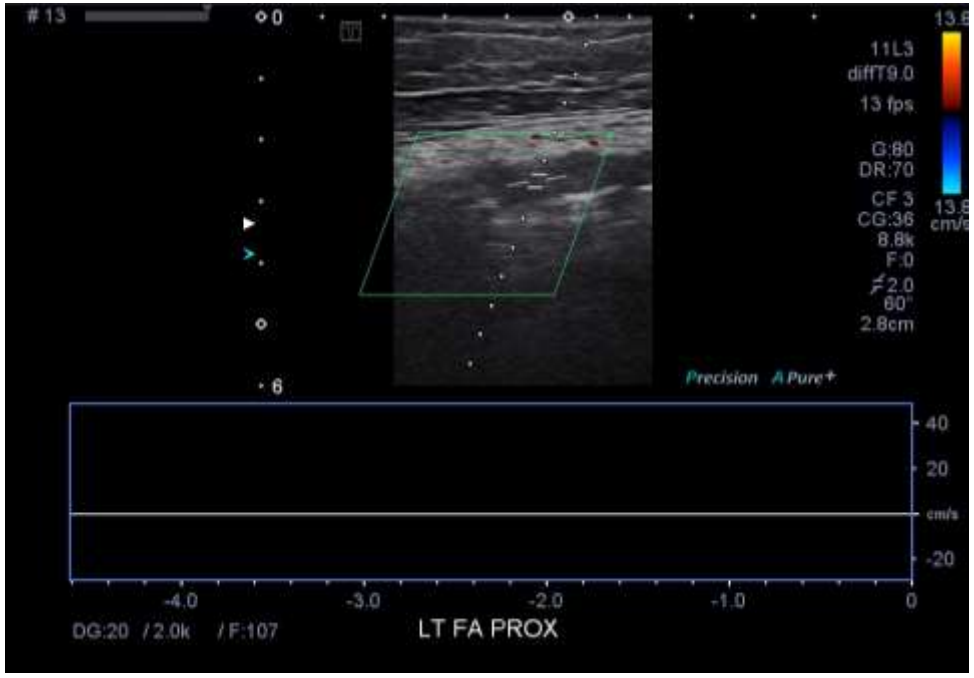
G:80
DR:70
CF 3
CG:36
9.8k
F:0
2.0
64°
1.0cm
Precision A Pure+
40
20
cm/s
-20
-4.0
-3.0
-2.0
-1.0
0
DG:20 / 2.0k / F:107
LT ATA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G:80
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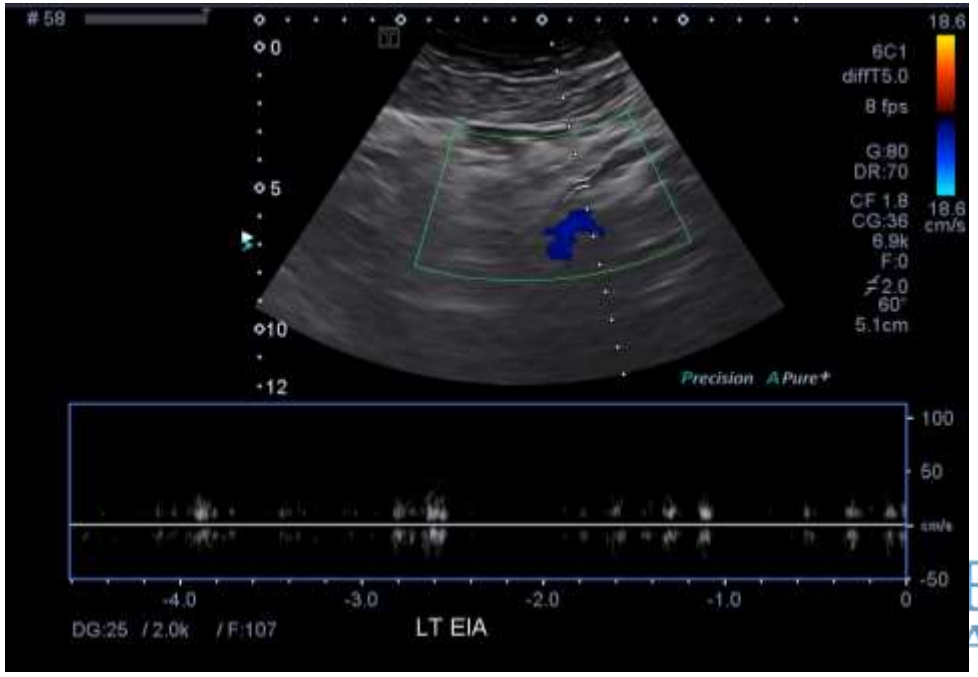
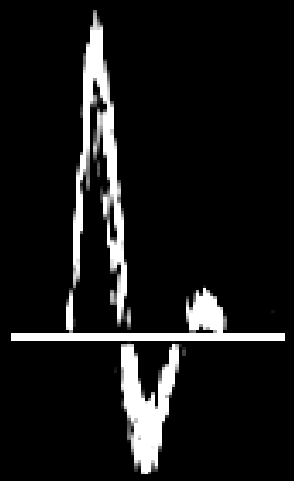
CF 3
CG:36
8.8k
F:0
2.0
60°
2.8cm
Precision A Pure+
40
20
cm/s
-20
-4.0
-3.0
-2.0
-1.0
0
DG:20 / 2.0k / F:107
LT FA PROX

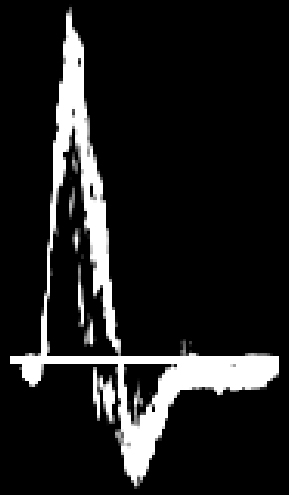

6C1
diffT5.0
8 fps
G:80
DR:70
CF 1.8
CG:36
6.9k
F:0
2.0
60°
5.1cm
Precision A Pure+
100
50
cm/s
-50
-4.0
-3.0
-2.0
-1.0
0
DG:25 / 2.0k / F:107
LT EIA

Basic LE Hemodynamics (Normal)

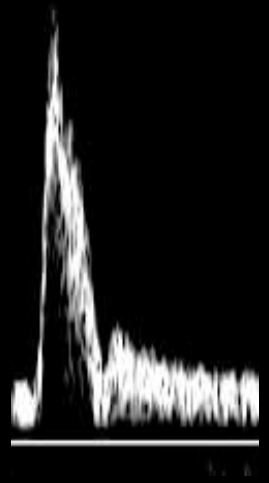
Triphasic



Biphasic



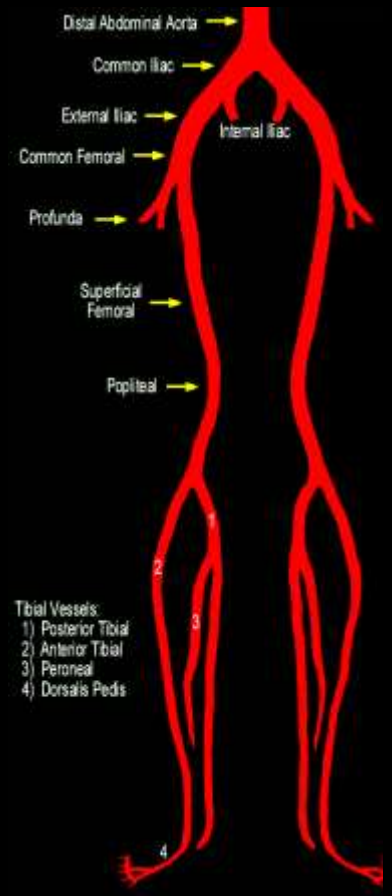
Biphasic, Hyperemic



- 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



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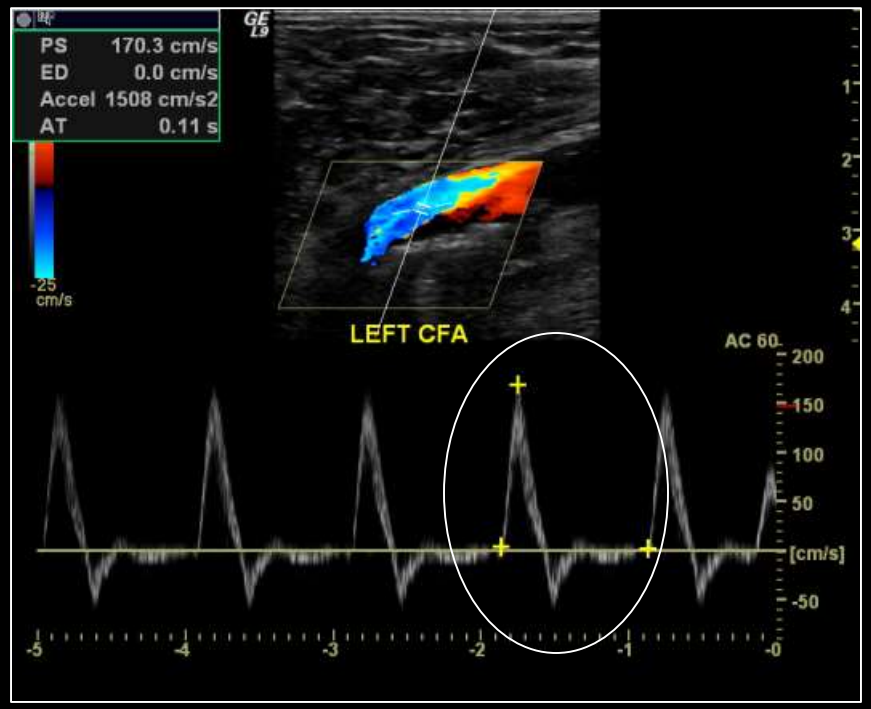
What is Normal?

- 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

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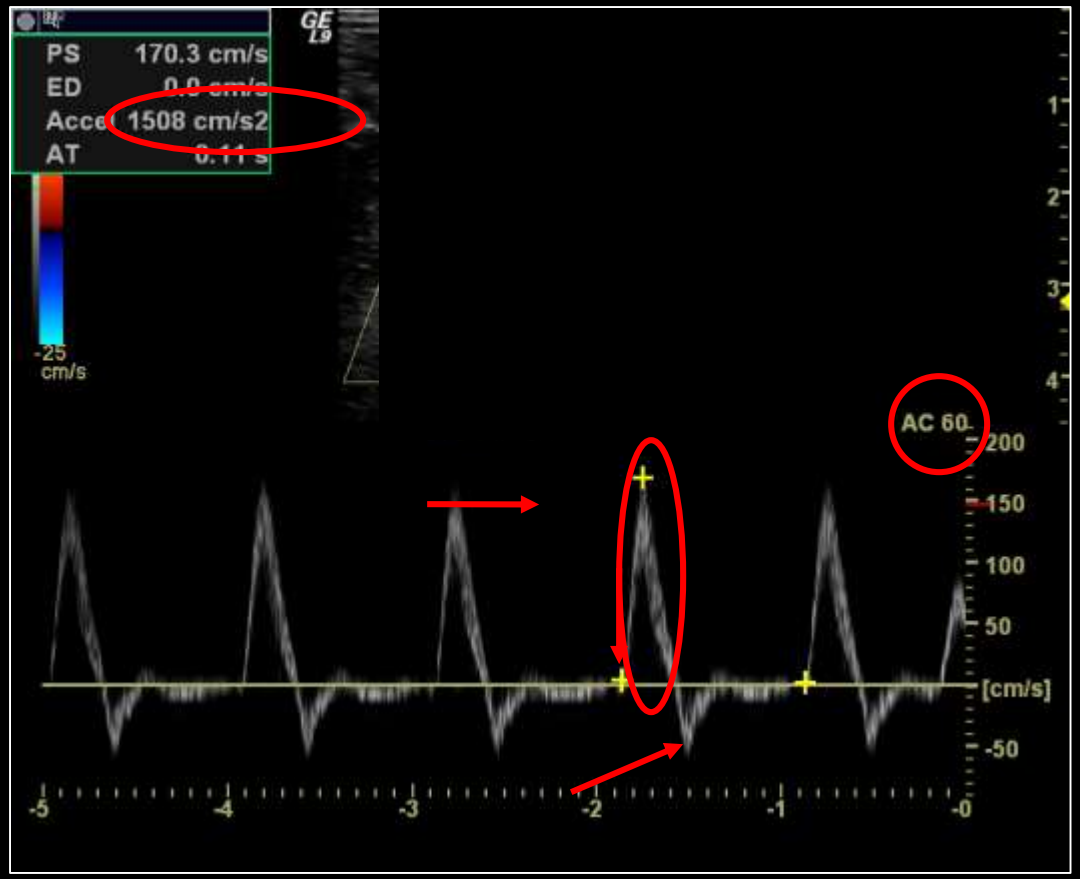
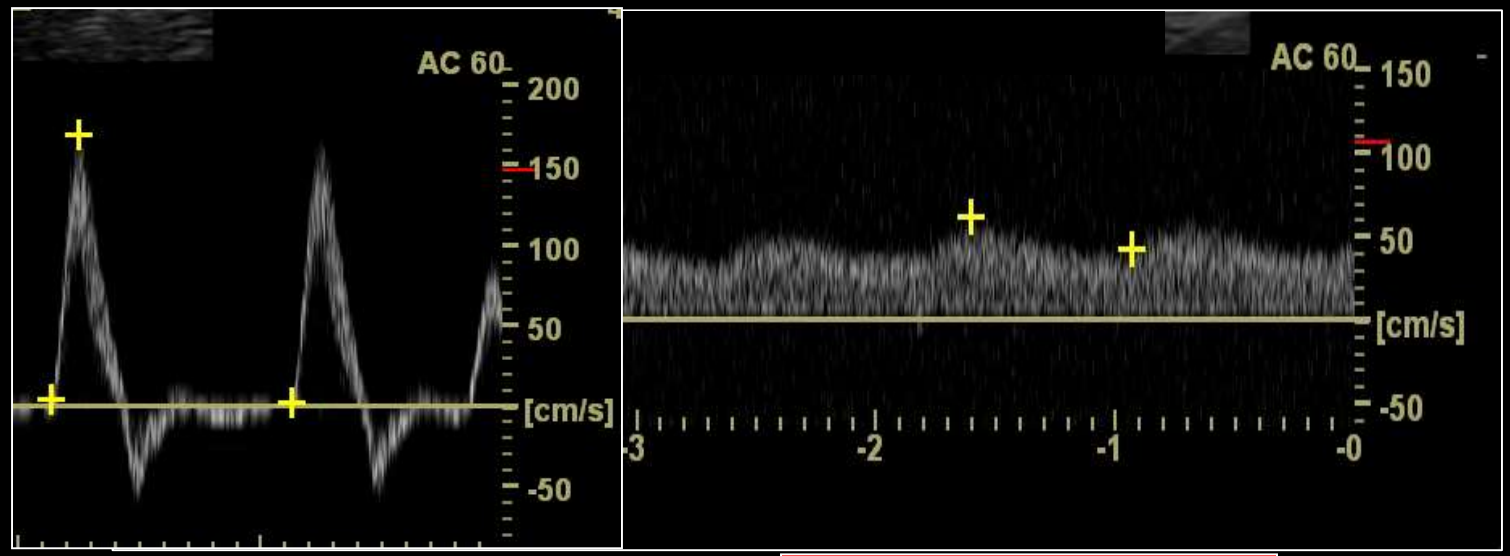
Normal Waveform



Minimal Plaque In Lower Arterial System

Left CFA



Normal

Abnormal

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Clinical Correlation

- Secondary imaging does not always provide significant insight
- Sometimes it does!!!
- Keep a folder of such events
- Q.A.
- Departmental education

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Left Foot

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Closer Look

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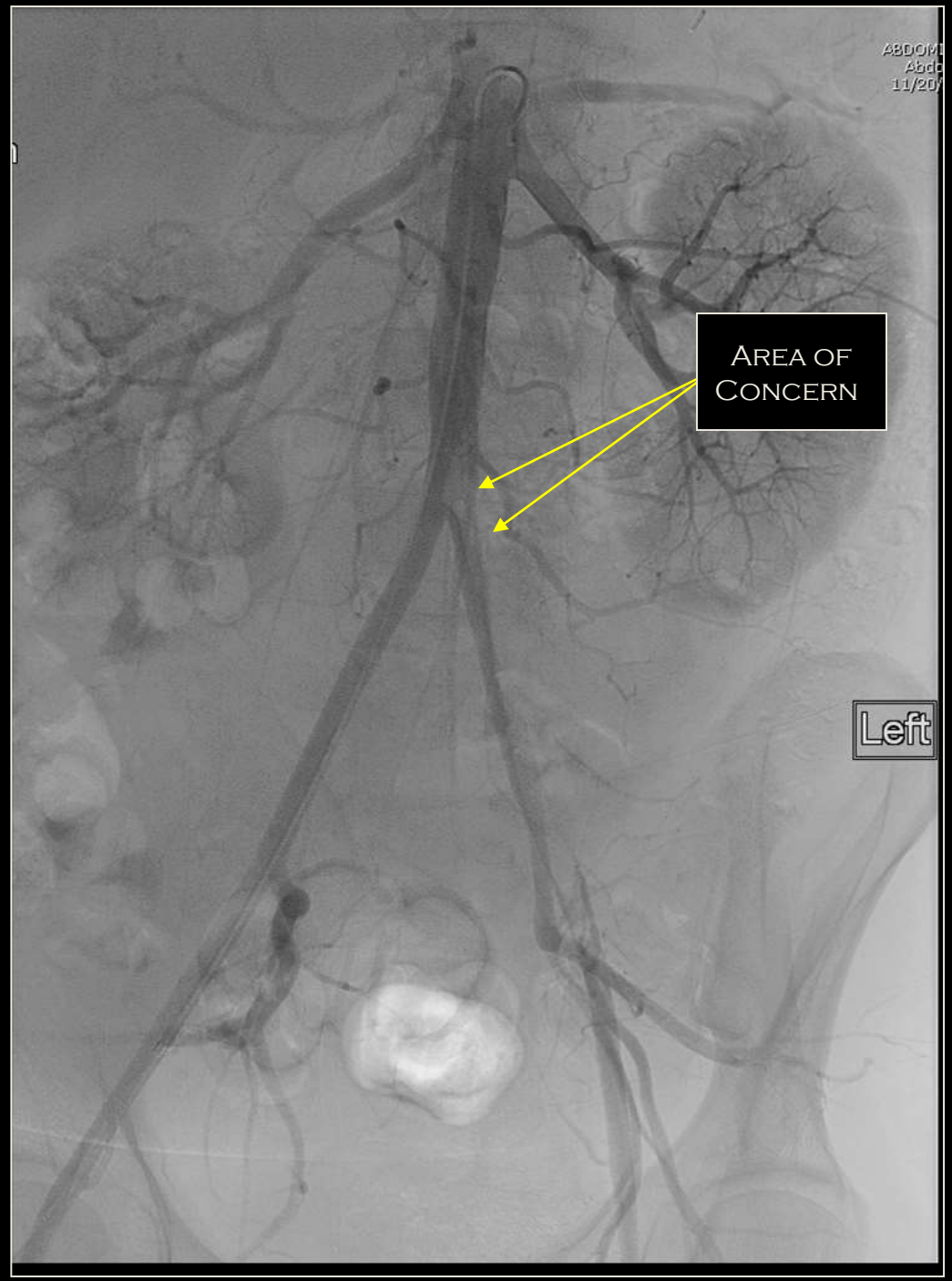
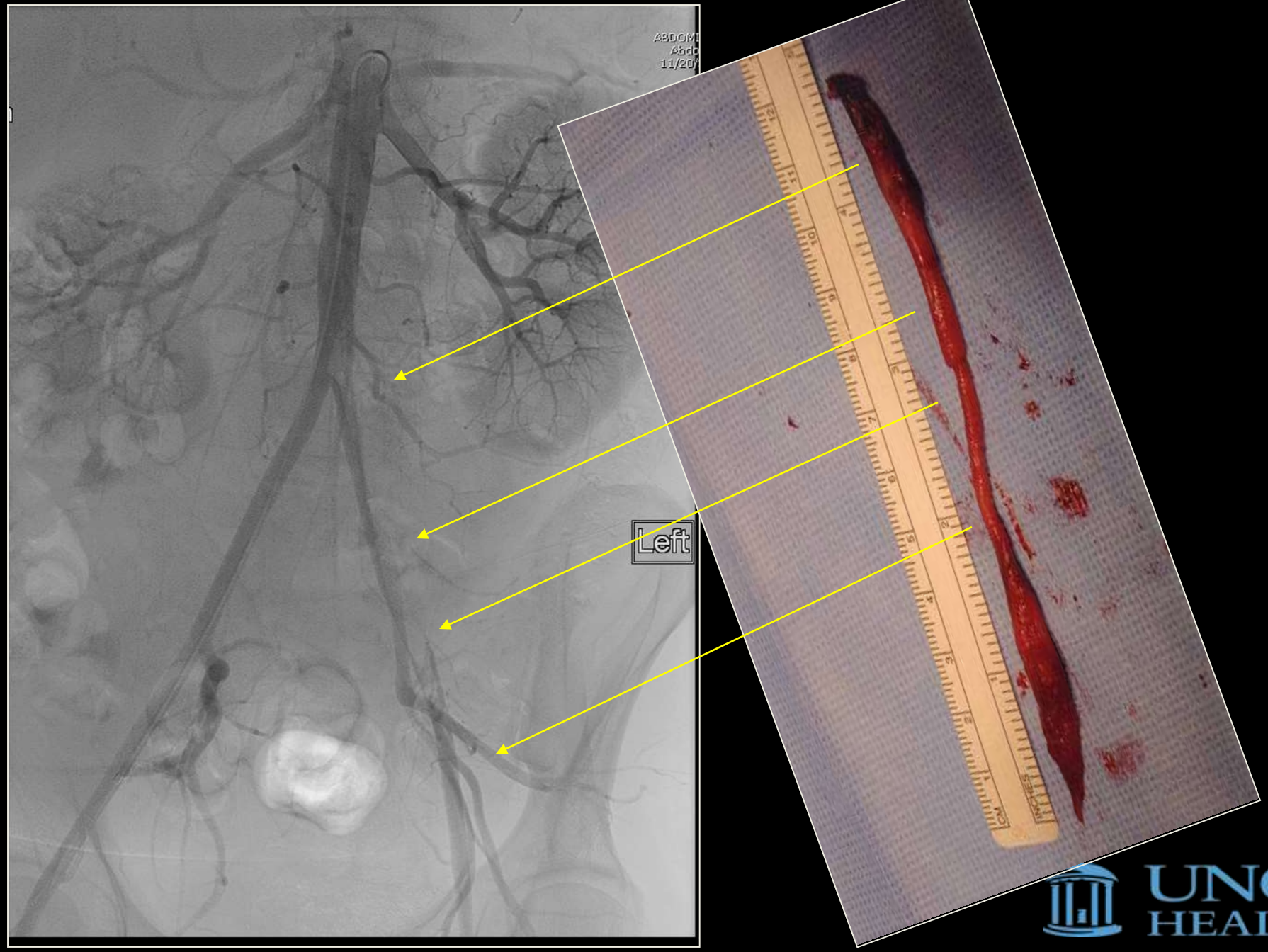


UNC REX HEALTHCARE



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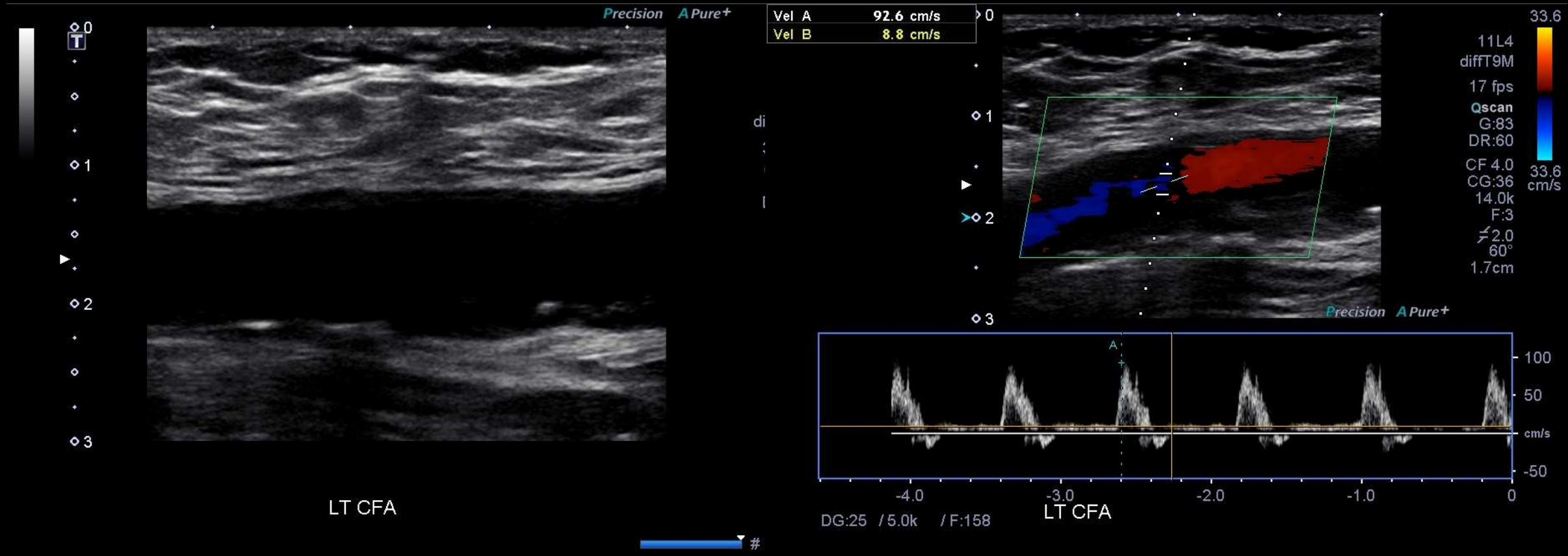
UNC REX HEALTHCARE

UNC REX HEALTHCARE

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 Common Femoral Artery



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Left Deep Femoral Artery (Profunda)

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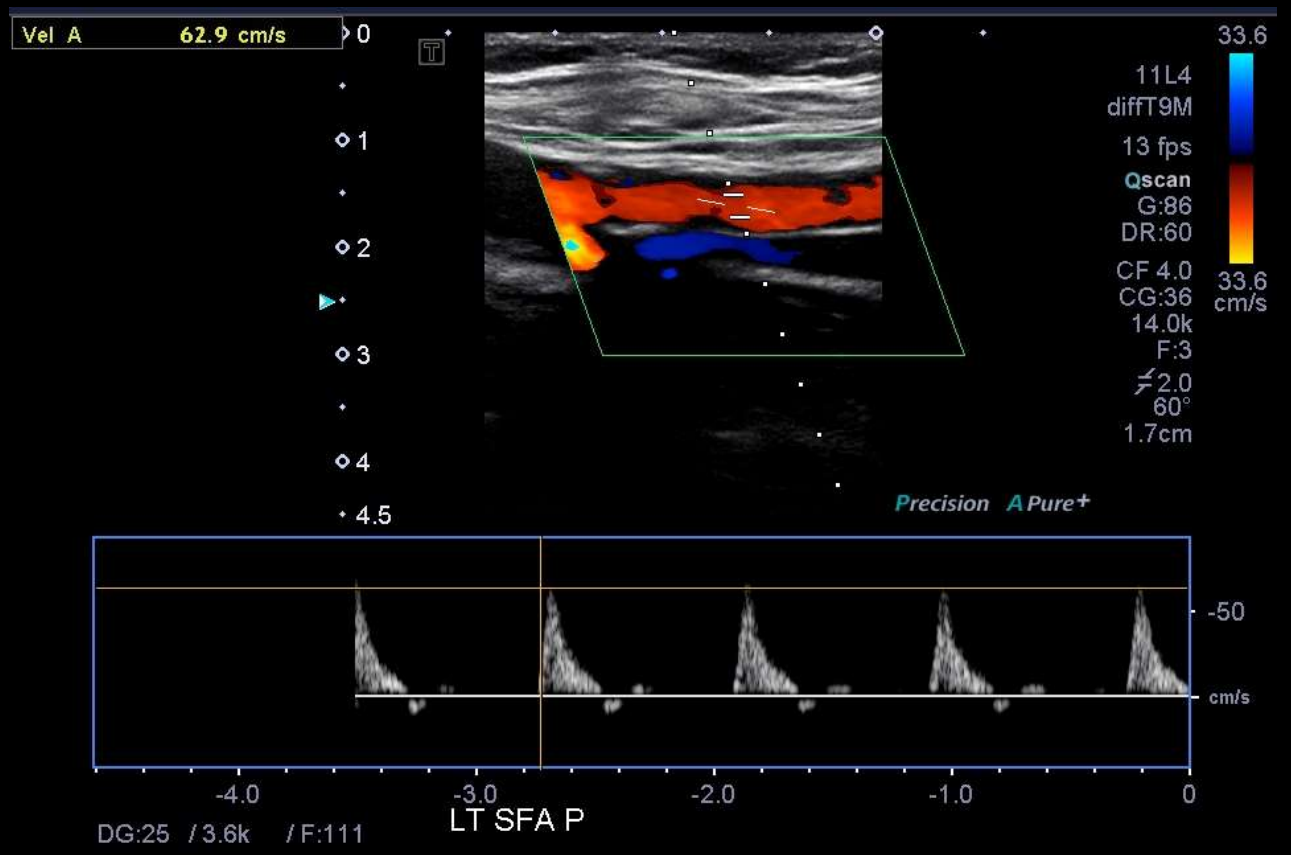
Left SFA Proximal Aspect



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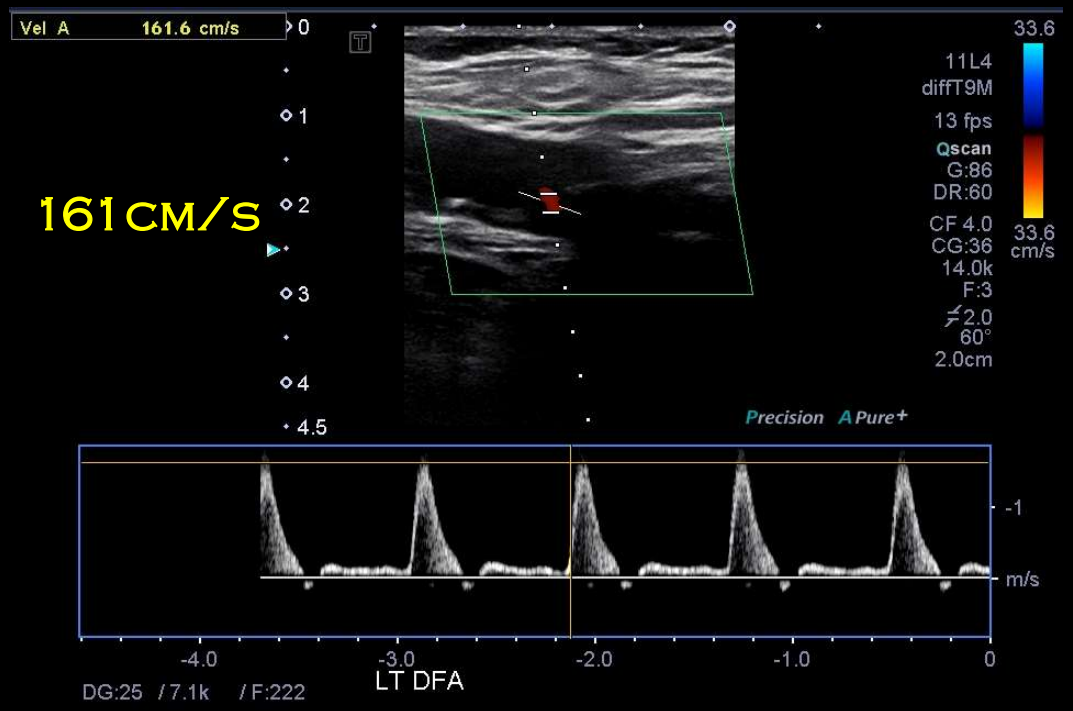
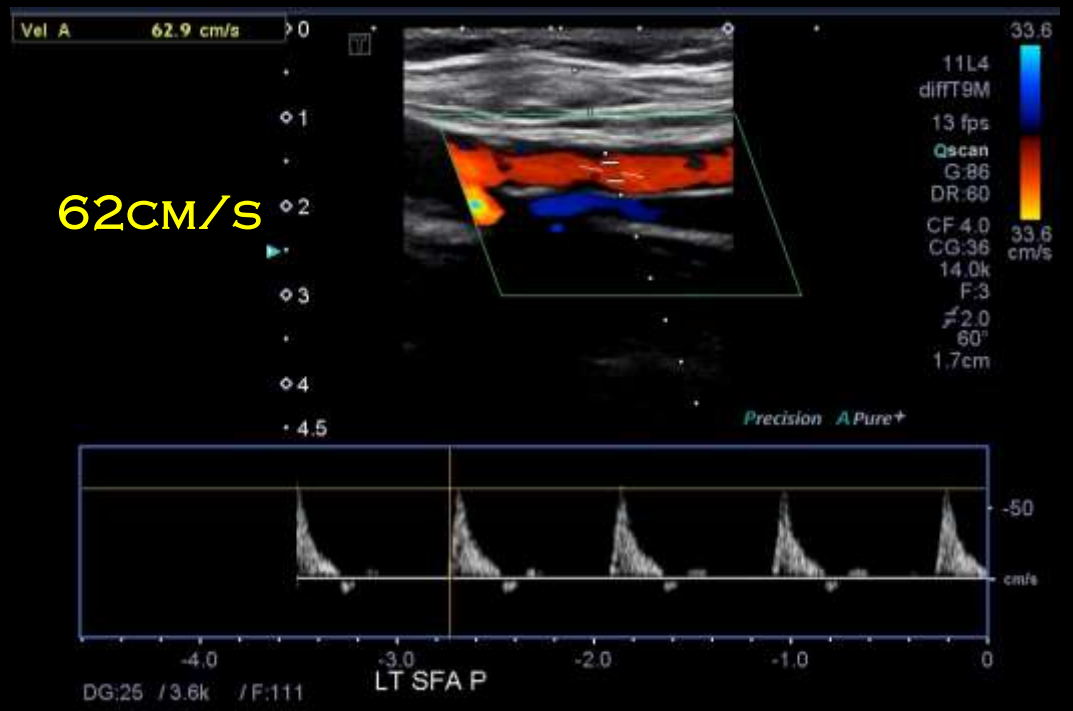
Arterial Duplex Pearl





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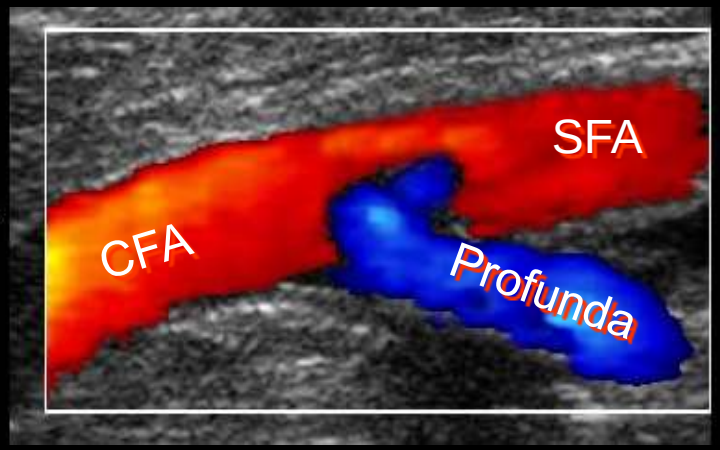
CFA-SFA–DFA (Profunda)



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.

Right Lower Digits

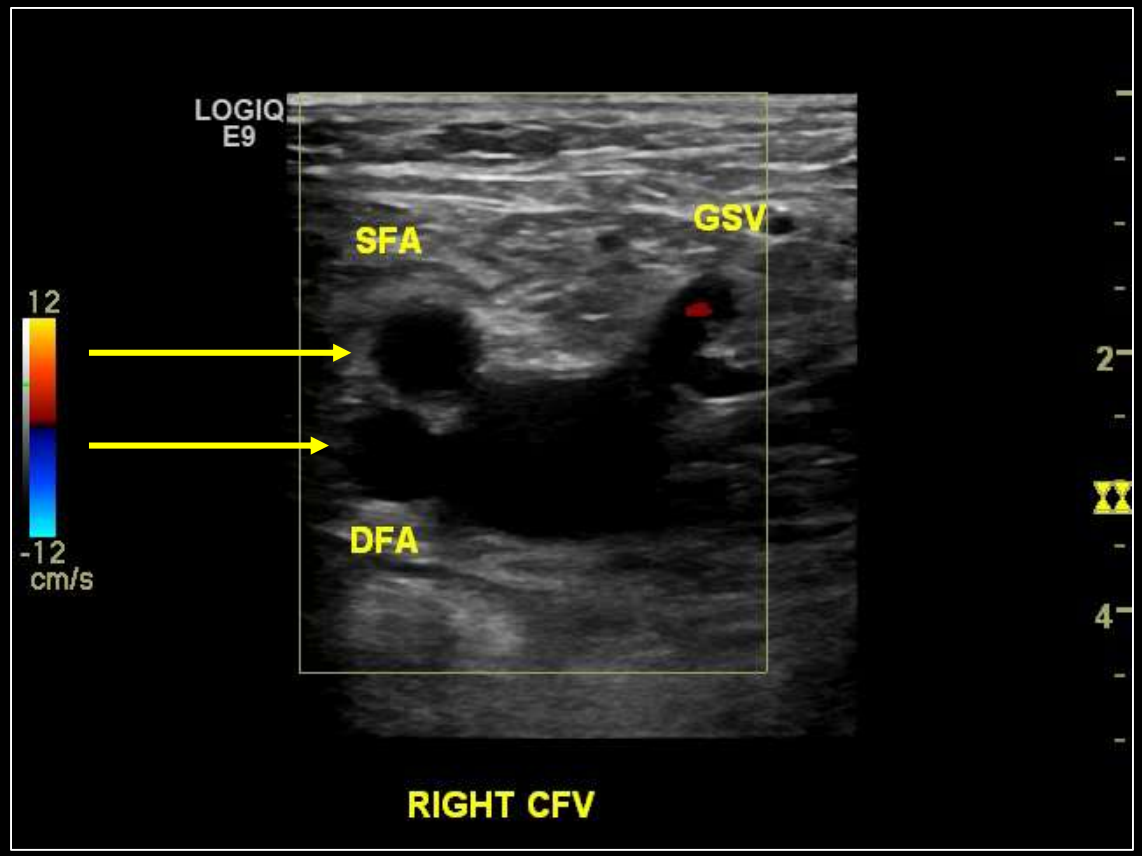
Left Lower Digits

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

Basics-Basics-Basics



Arteries Bifurcate Before Veins

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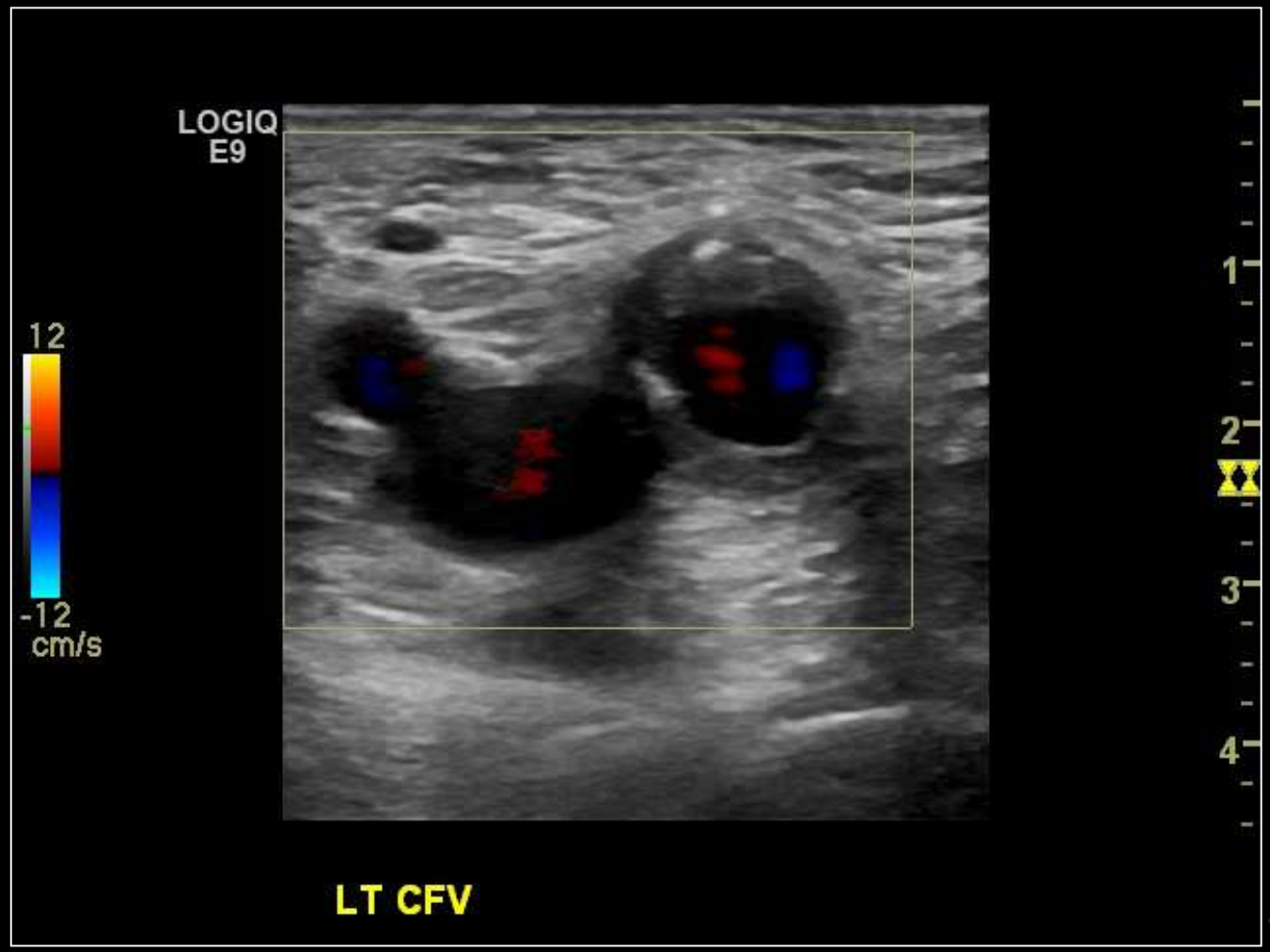
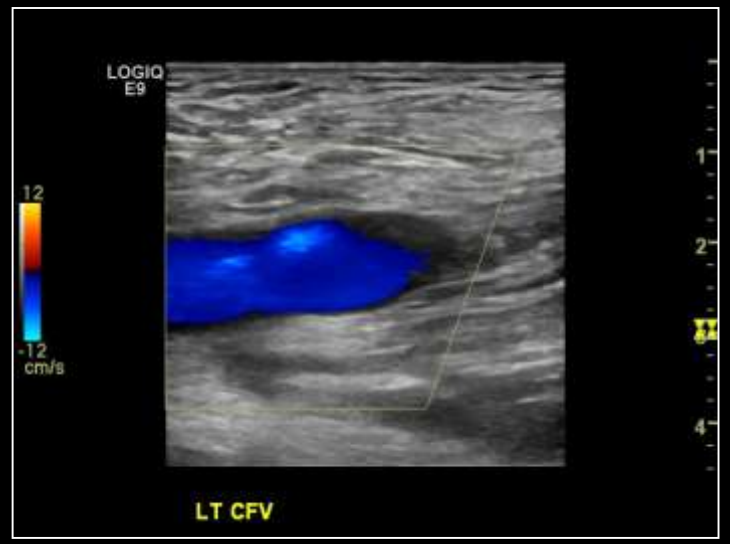
Left Common Femoral Vein

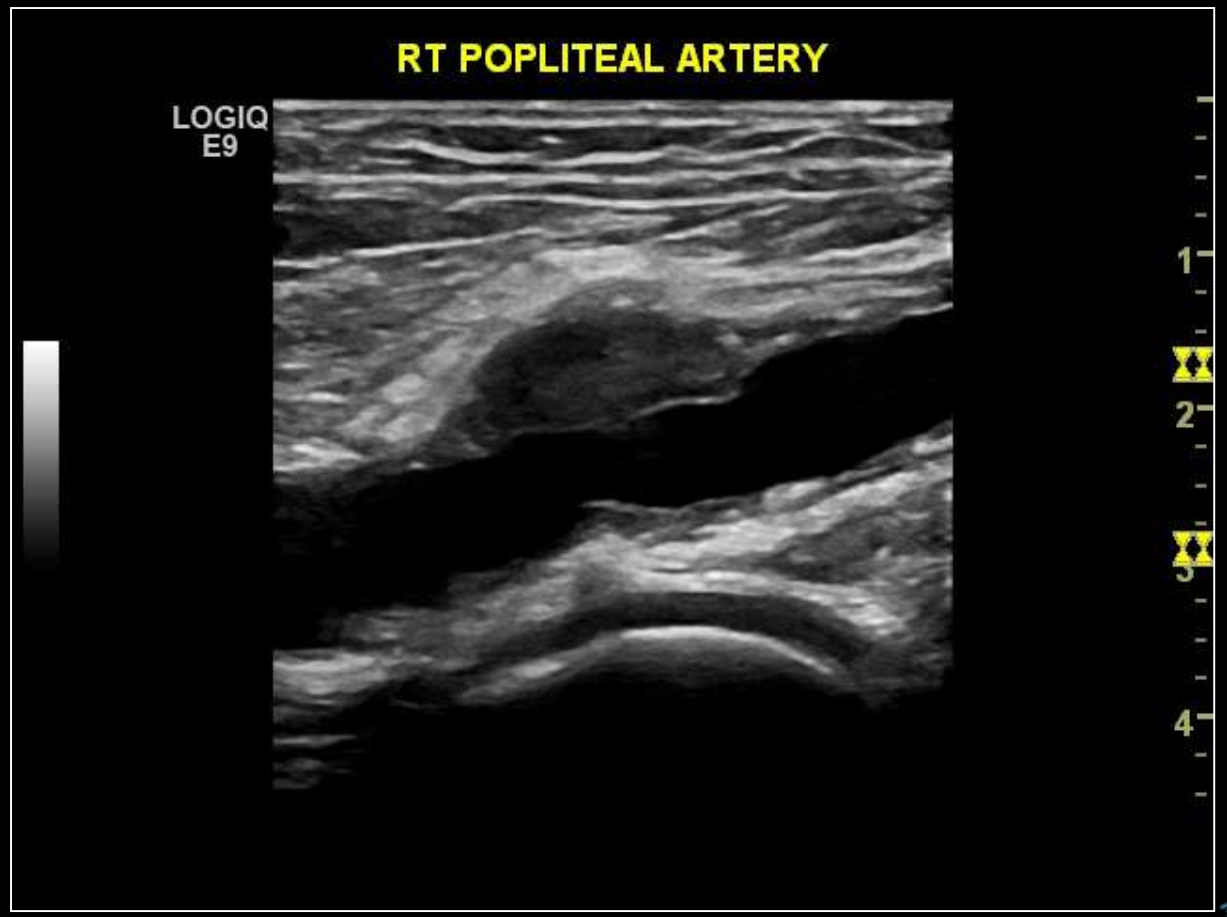



LOGIQ
E9
12
-12
cm/s
1
2
3
LT CFV


LOGIQ
E9
12
-12
cm/s
1
2
3
4
LT CFA

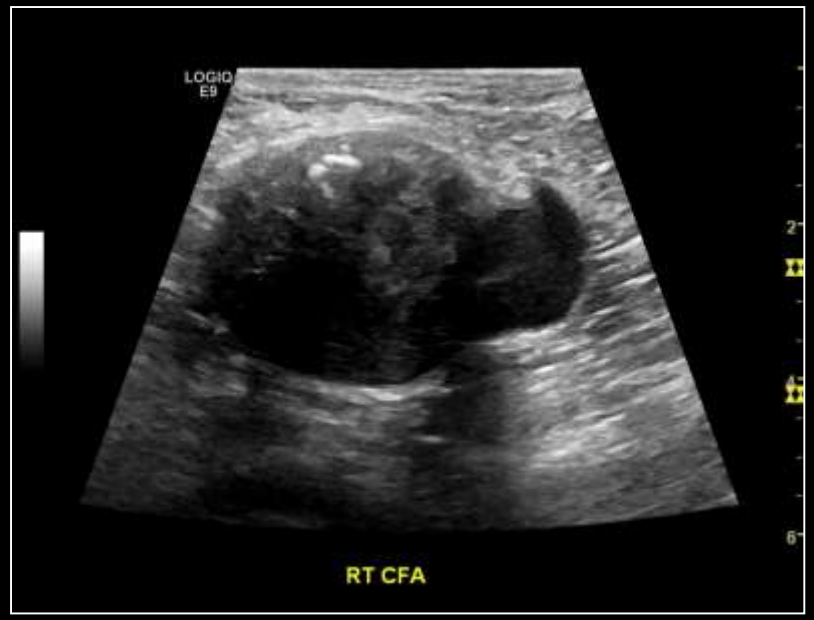

LOGIQ
E9
12
-12
cm/s
1
2
3
4
LT CFV

Popliteal Artery Aneurysm



What Else Should One Always Insonate ?

Contralateral Arterial System



Always check the contralateral CFA, ,Popliteal, Iliac and Abdominal Aorta

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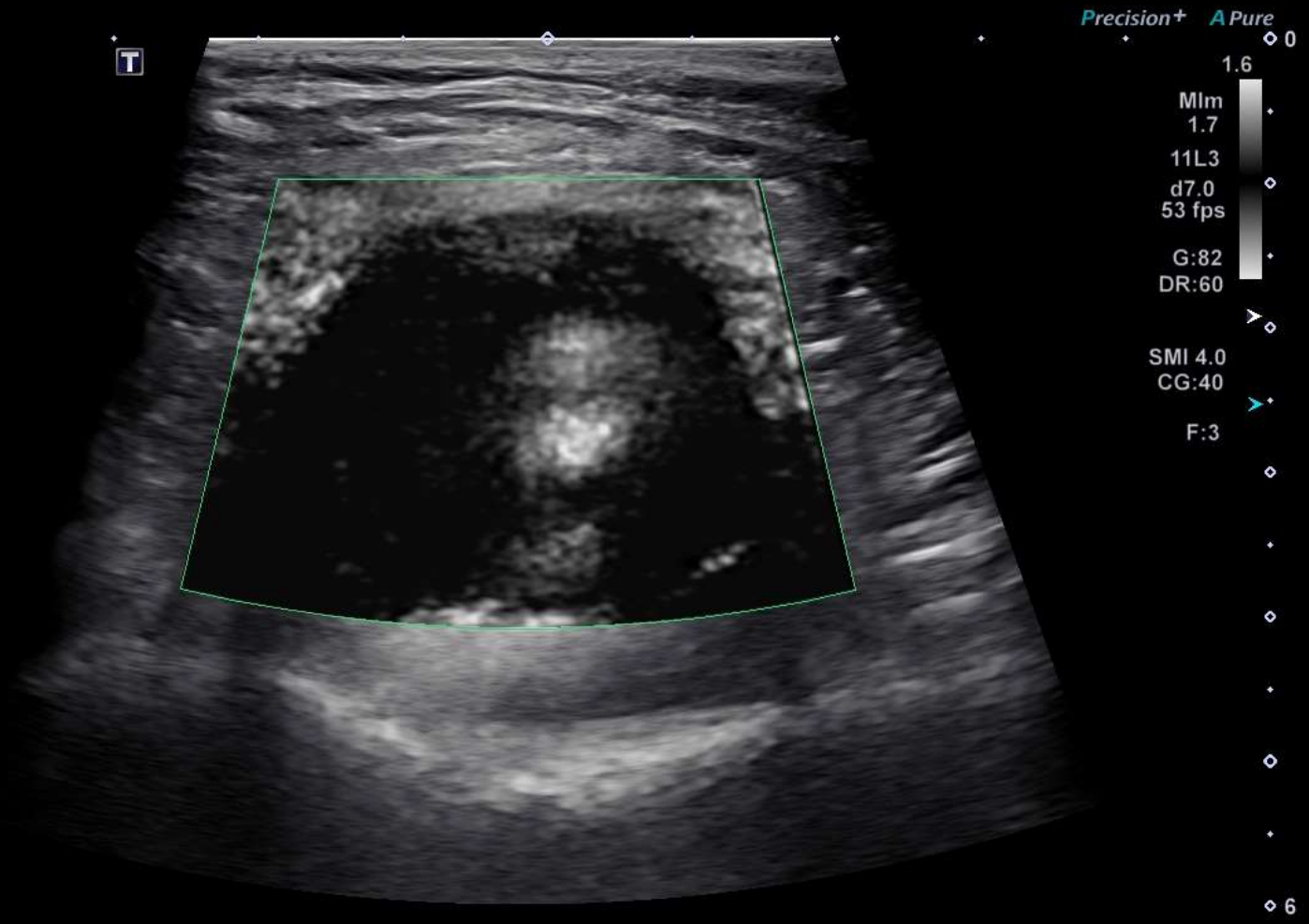
Right Common Femoral Artery



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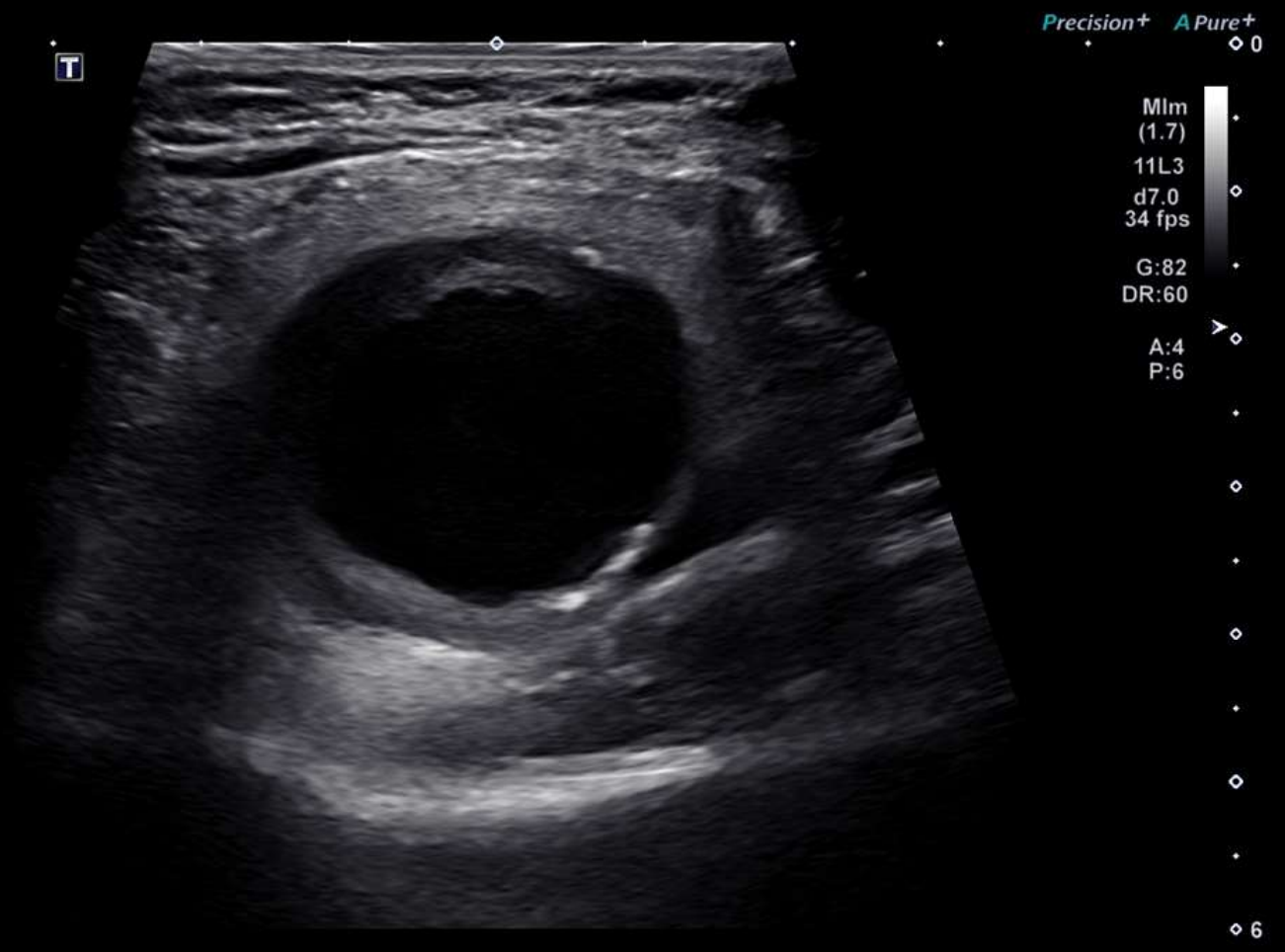
Right Common Femoral Artery



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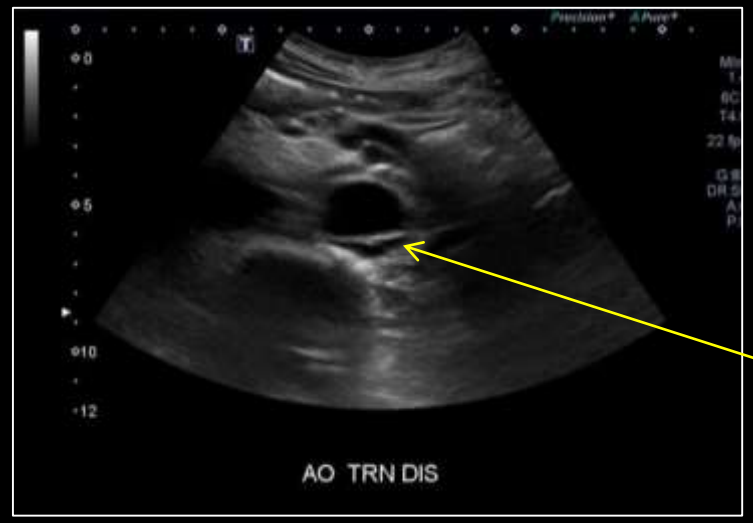
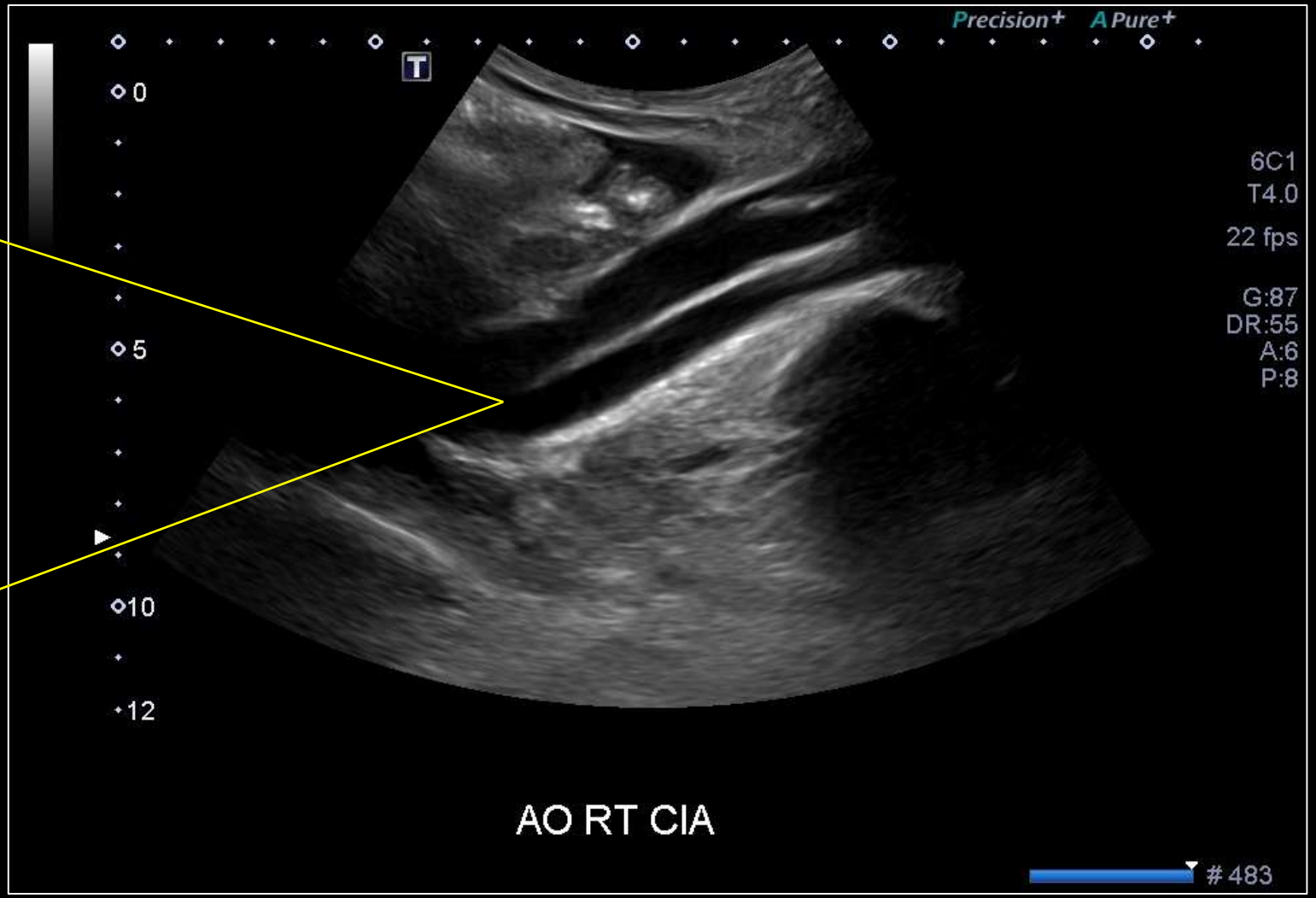
Right CFA Dissection

Type B Dissection





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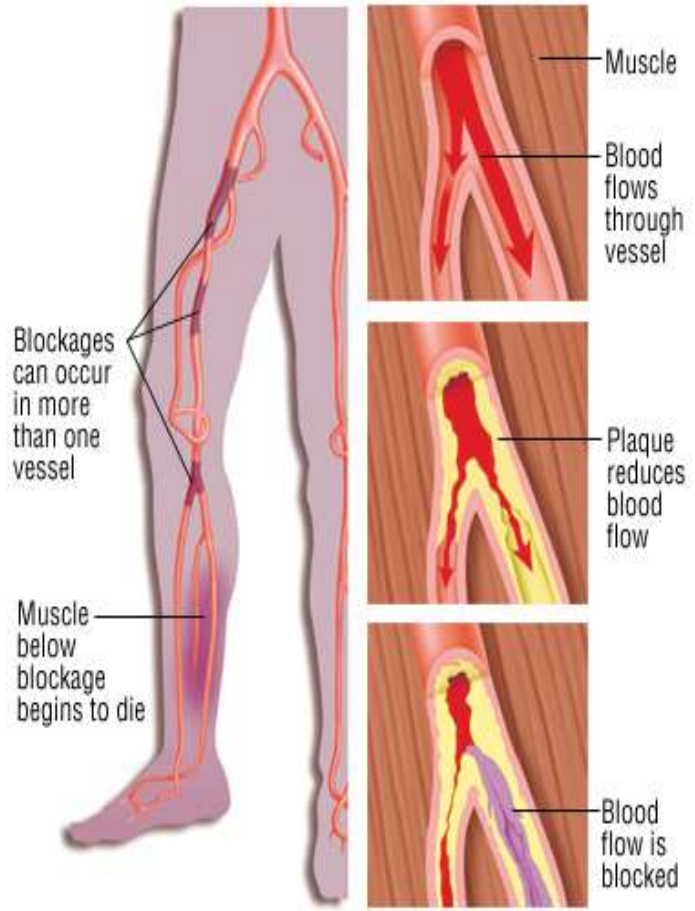
Arterial Disease
If present must be characterized by:

- Severity*
- Location*

  (Inflow - -Outflow - Run-off- Multilevel)
- Extent
- Etiology, when possible



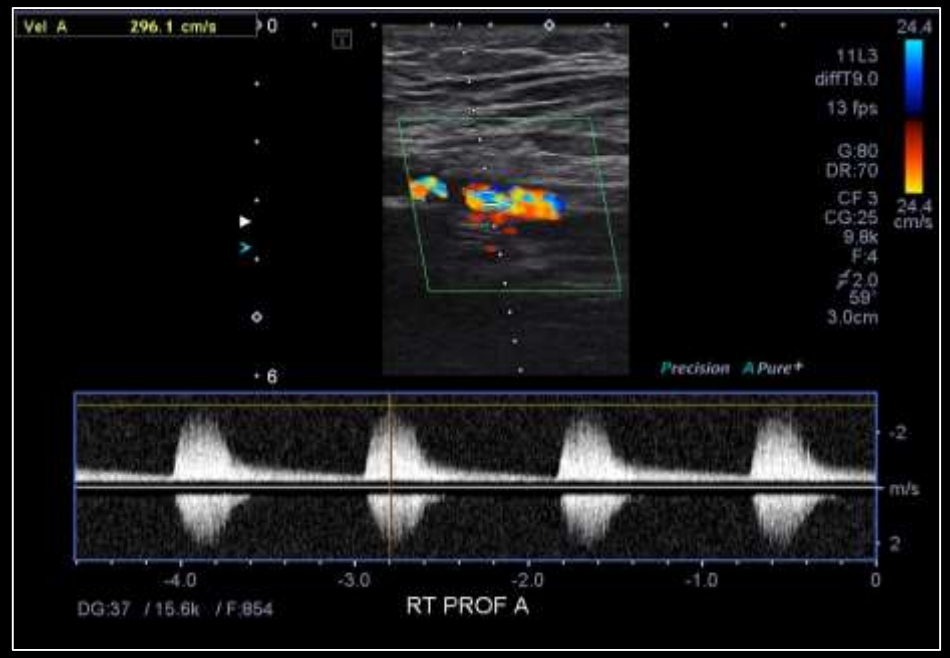
Visual Break

Everything Is Not Always at Is Appears....

43 YEAR OLD MALE

This Past Week

Run Off and Popliteal



No Color Flow
Proximal SFA

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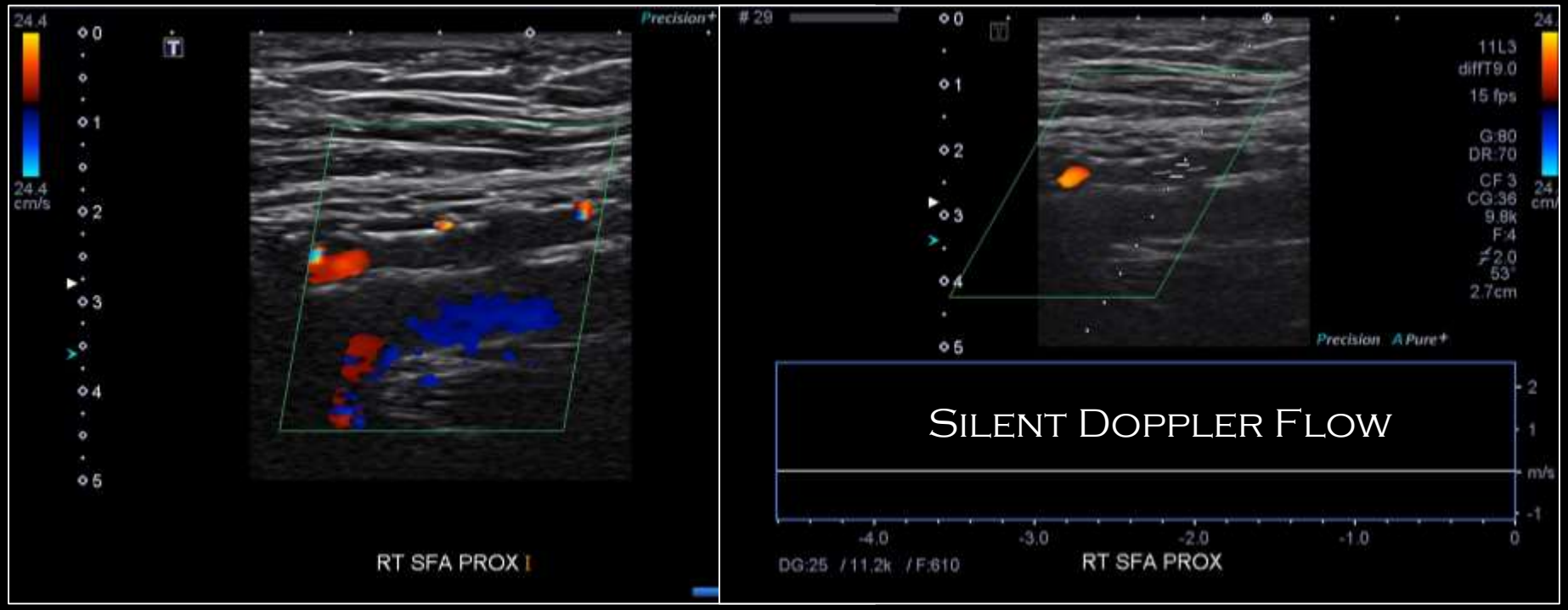

Silent Doppler Flow

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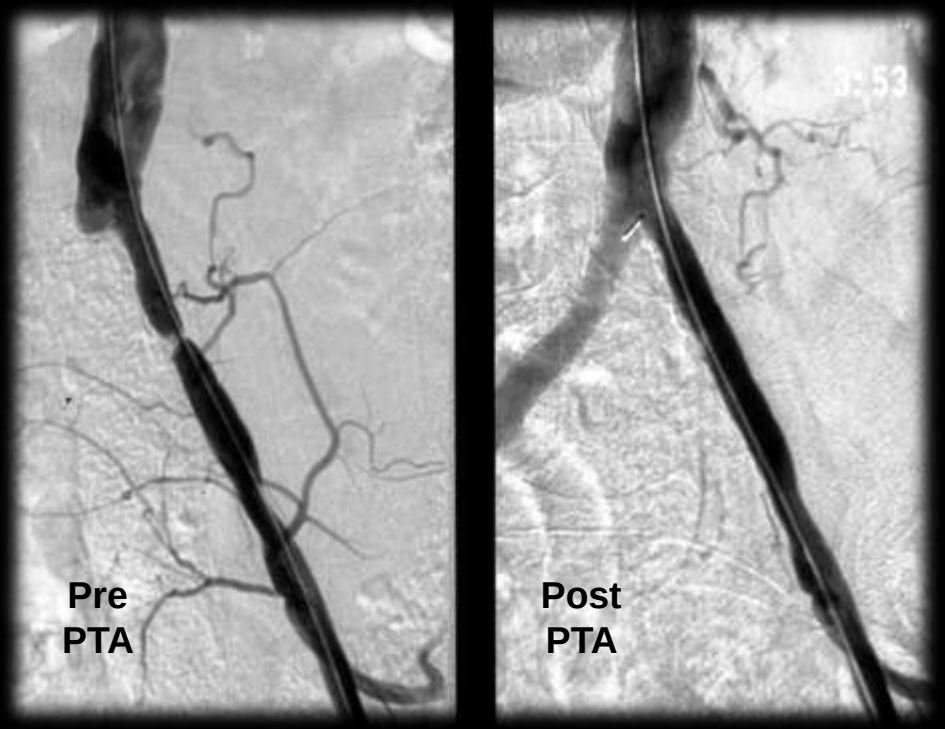
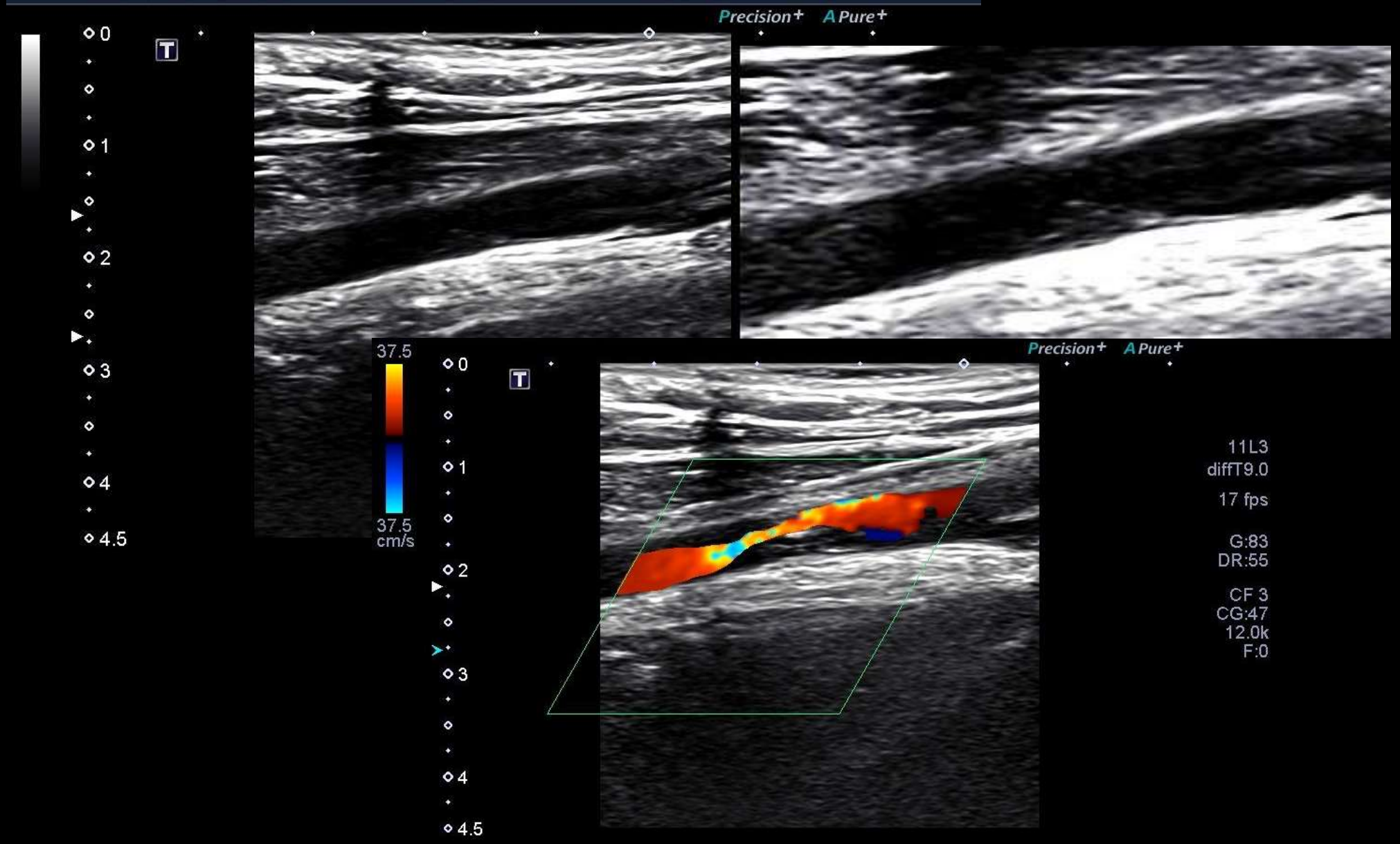
Arteriography



Traditional gold standard for LE-PAD assessment

However: expensive, invasive, poor screening tool and provides only anatomic (no hemodynamic) data



LT BRACH A PROX

9

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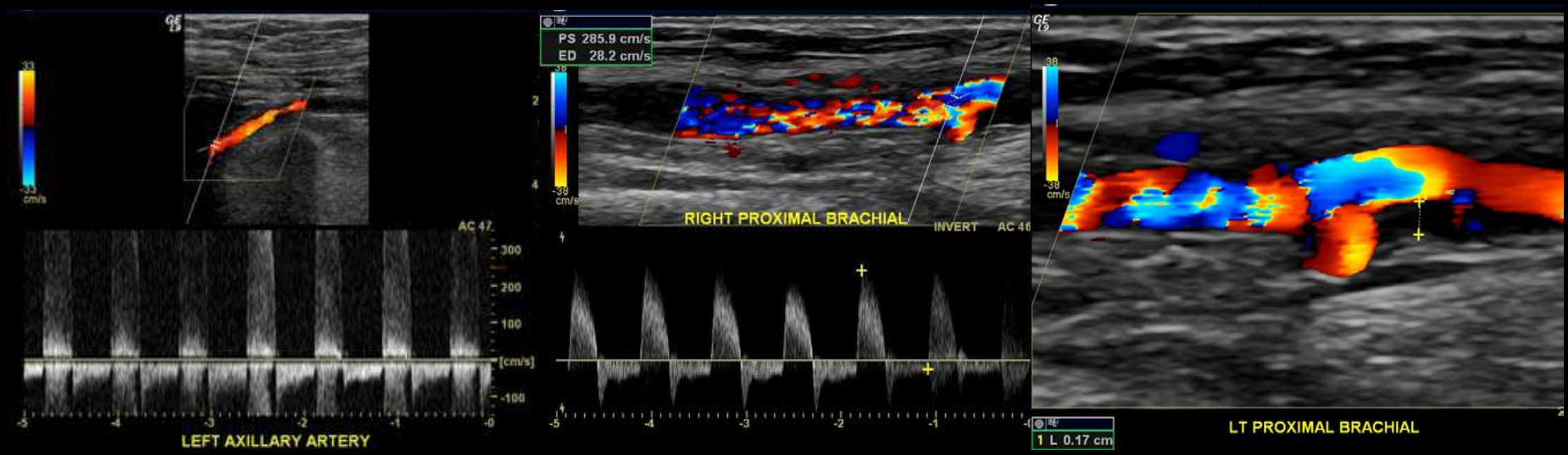
Giant Cell Arteritis

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.



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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

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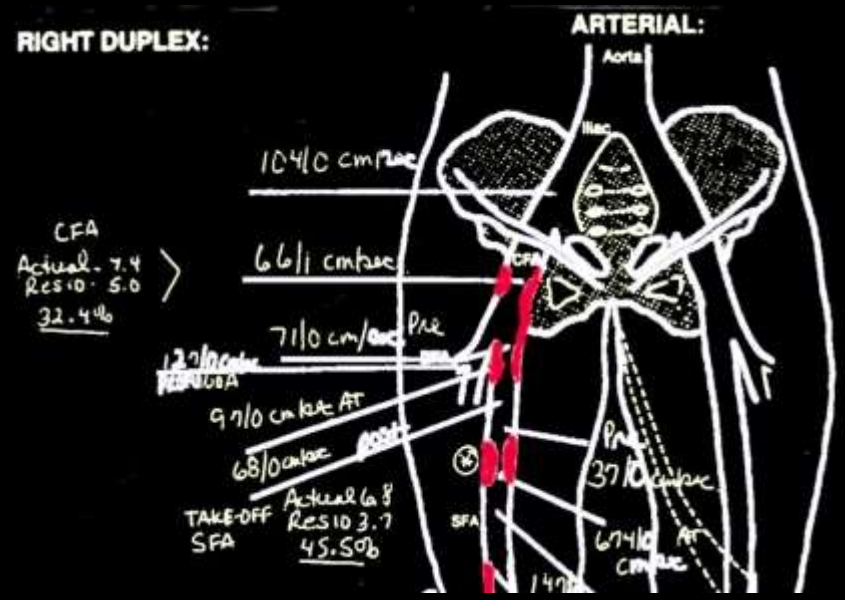
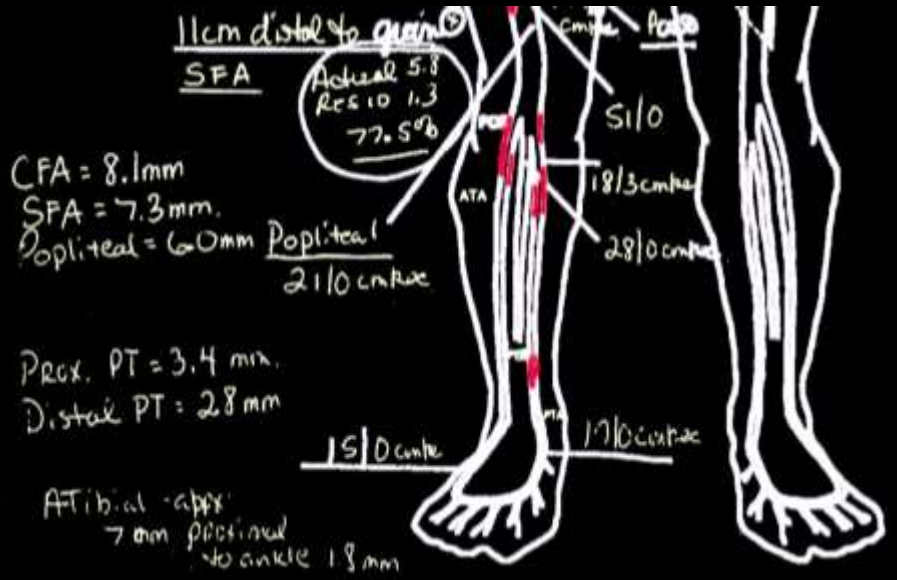


LE Arterial Duplex Imaging: Invaluable Assets



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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:

3 Cuff: Thigh (22 cm)
Calf and Ankle – PT / DP (10-12 cm)

4 Cuff: Upper/Lower Thigh Cuffs (11 cm)
Calf and Ankle – PT / DP (10-12 cm)

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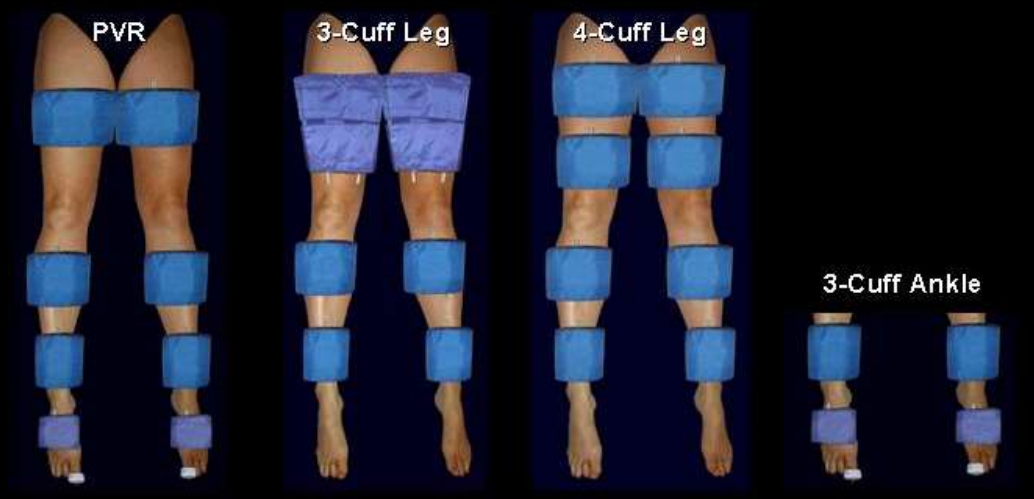
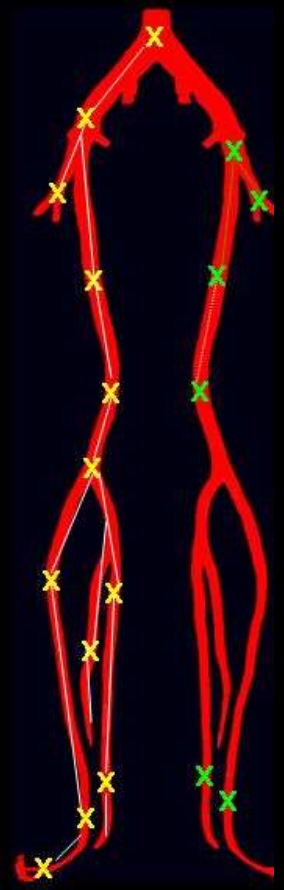
PVR vs. Duplex

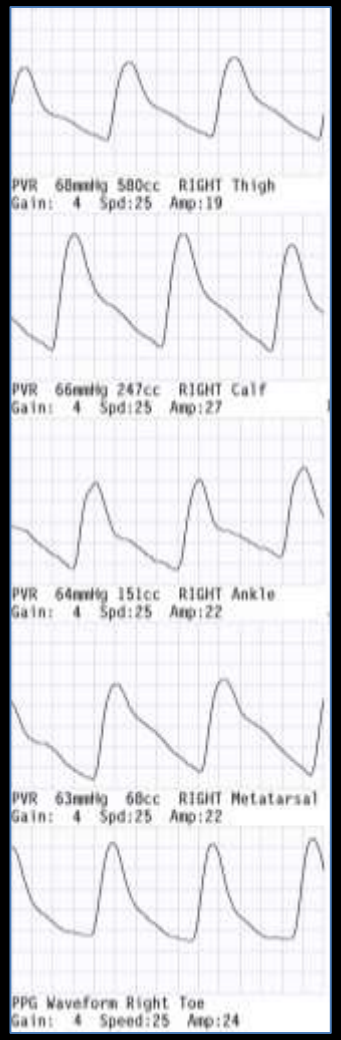


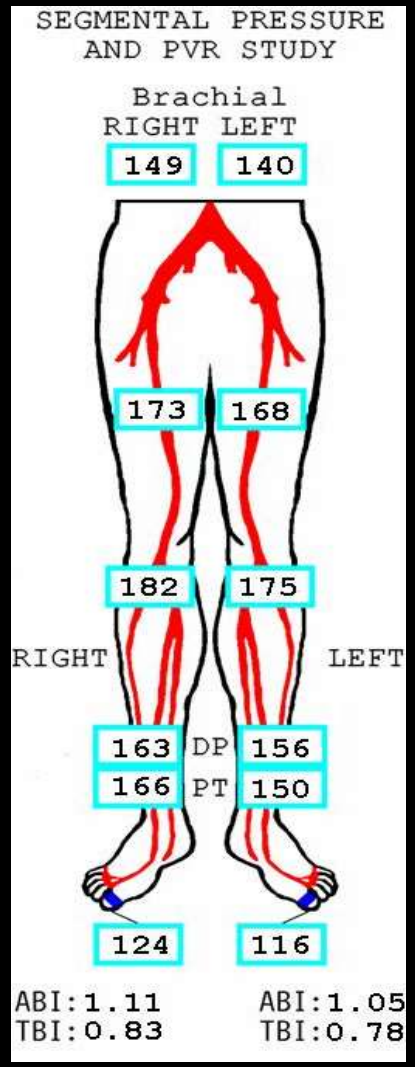


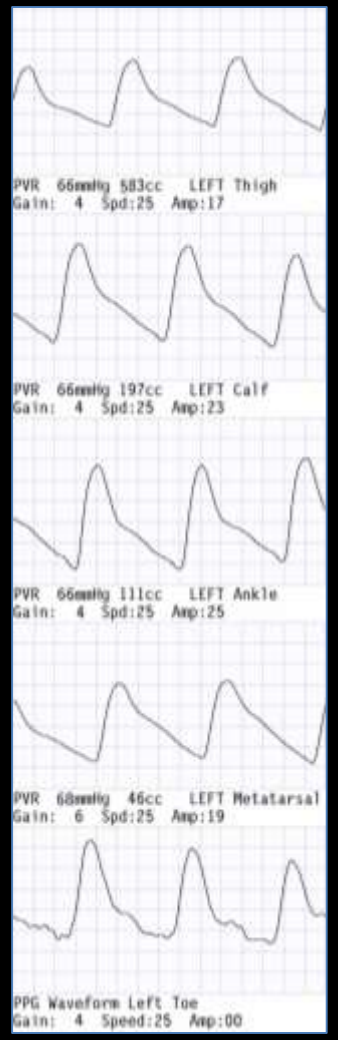
- CFA to Ankle Waveforms + ABI
  -- CW or PW or PVR
- Ankle + TM + Toe Waveforms + TBI
- SegPres + SegWave + ABI and/or TBI

- Aorto-Iliac to Ankle: Gray scale + Doppler
- FemPop + PT / AT: Gray scale + Doppler

Normal Bilateral







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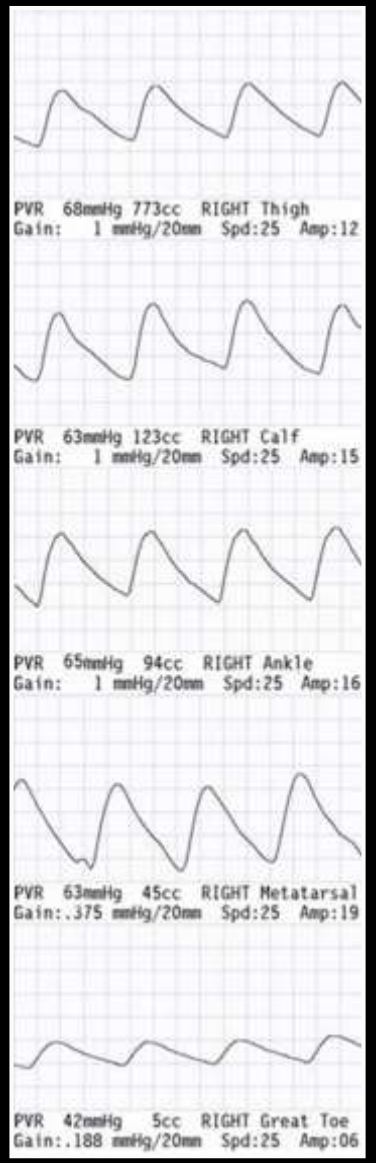
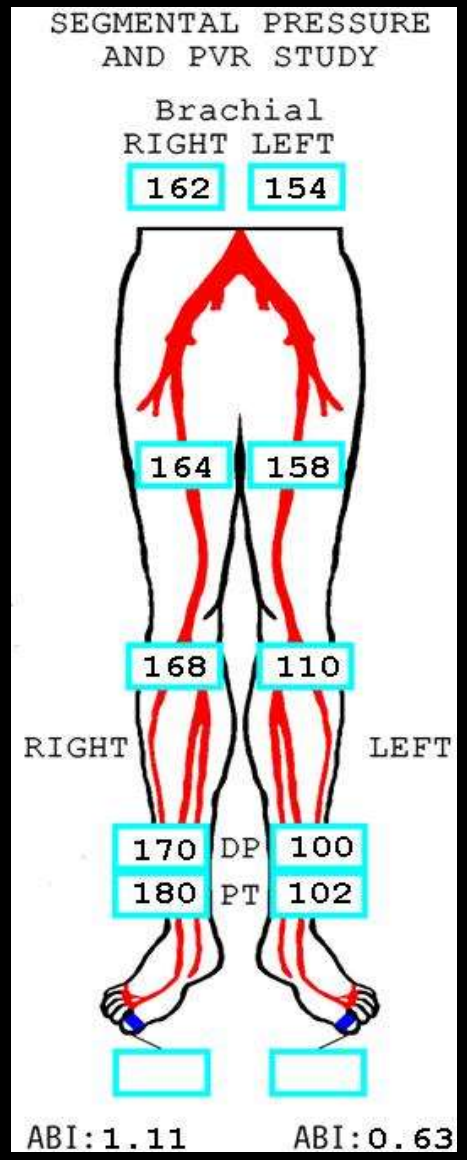
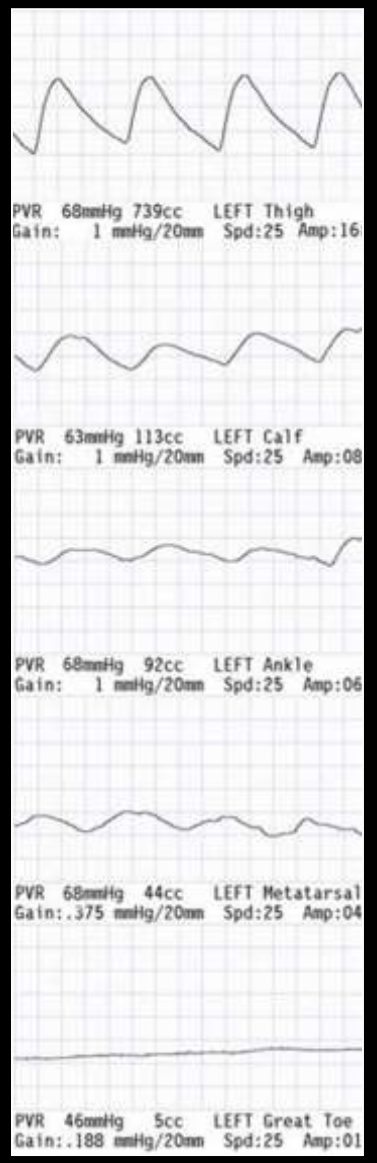
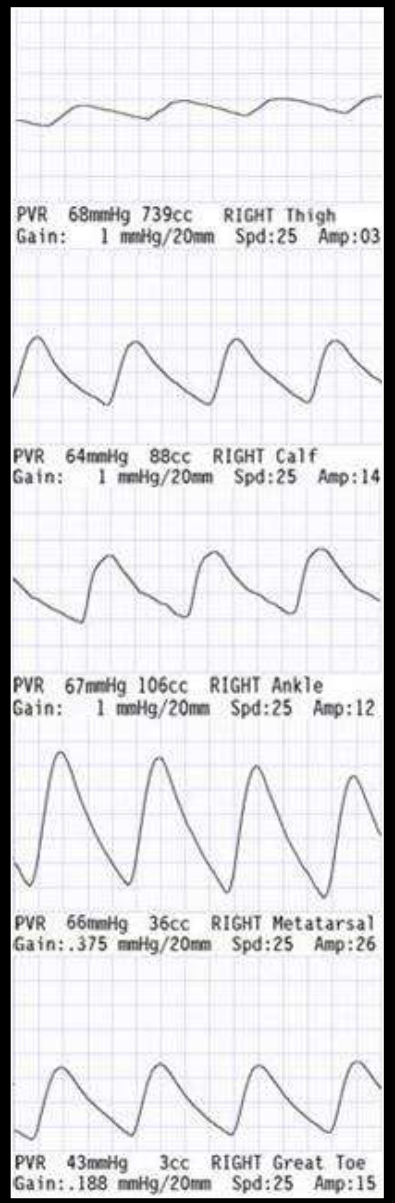
Normal–Right
Fem-Pop–Left

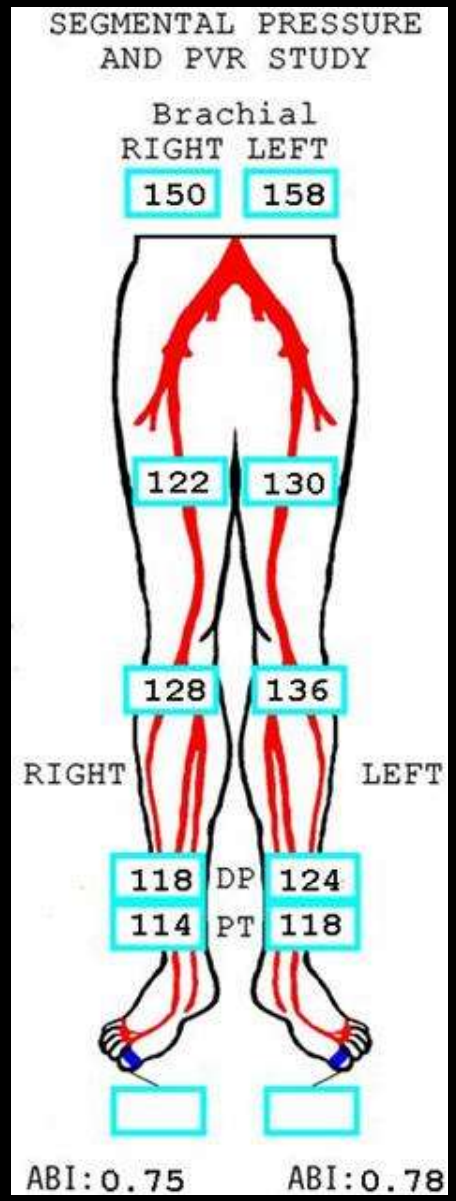


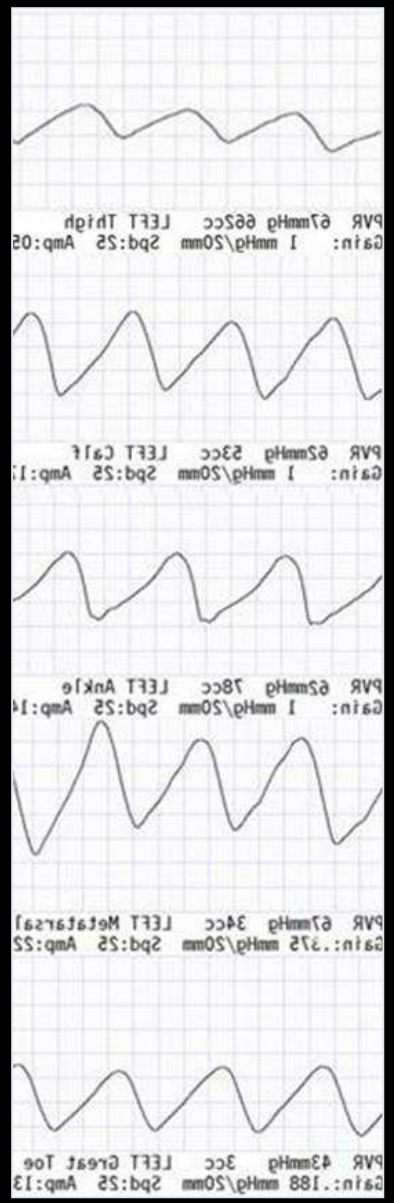




Inflow Bilateral







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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....

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Thank You

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