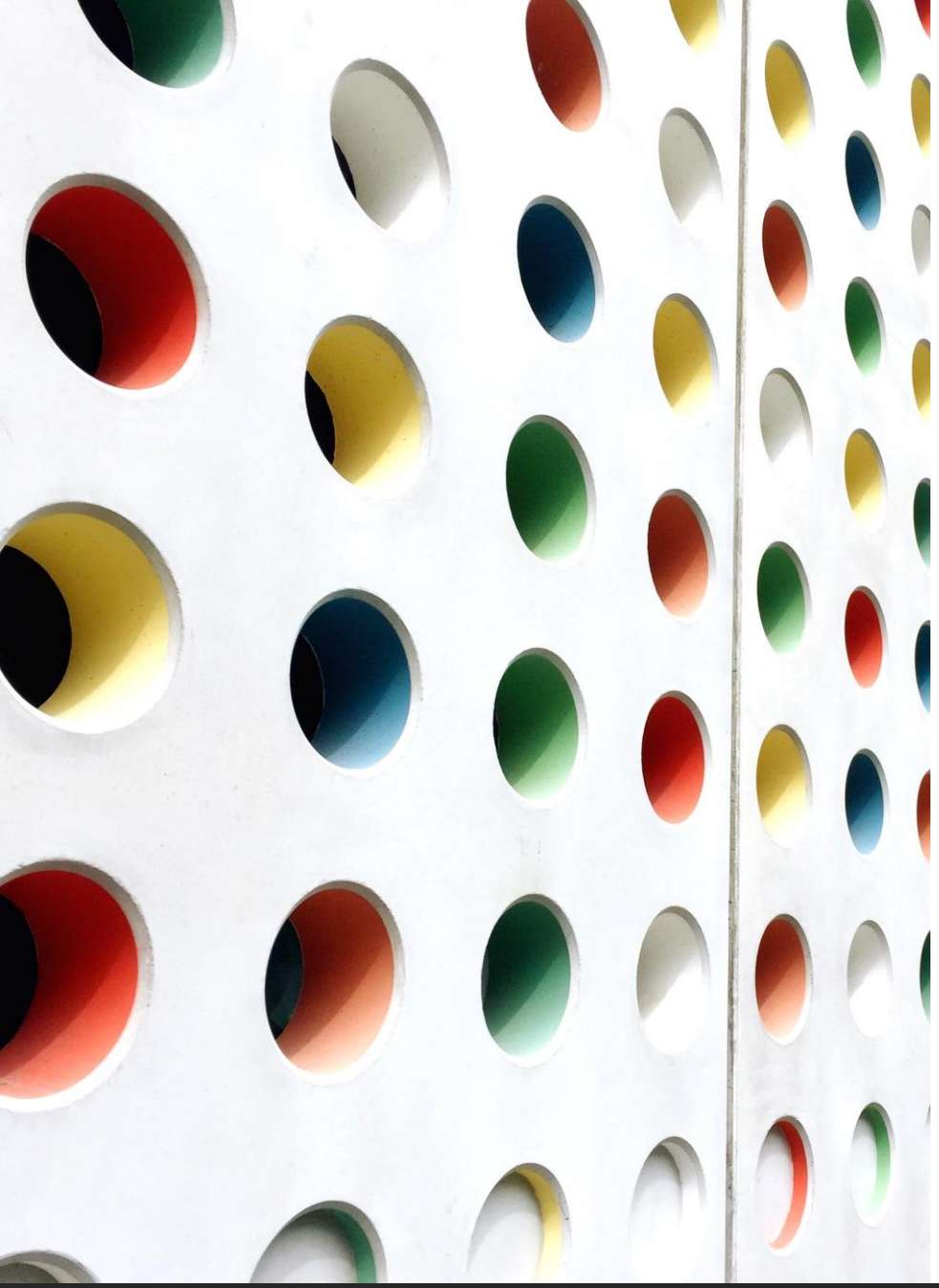


Duplex Scanning and Color Flow Imaging in Venous Evaluation

CHAPTER 30

Capabilities (Peripheral Veins)

- Identify venous thrombosis
- Differentiate acute from chronic processes
- Evaluating non-occluding/partial thrombus
- Detect calf lesions
- Distinguish between extrinsic/intrinsic compression
- Evaluate soft tissue masses (Baker's Cyst)
- Detect venous incompetence
- Document collateralization or recanalized channels

Capabilities (Perforating Veins)

- Differentiate normal from abnormal flow patterns
- Identify perforators associated with chronic venous stasis
- Document vessels marked for surgical intervention

Capabilities (Abdominal/Pelvic Veins)

- Document presence of elevated systemic venous pressures
- Identify if venous thrombosis is present
- Distinguish extrinsic from intrinsic obstruction
- Assess portocaval shunts
- Evaluate liver diseases by investigating portal venous system

Limitations (Peripheral Veins – LE)

- Difficult to thoroughly evaluate vessels due to:
  - Edema
  - Multiple veins/collaterals
  - Scarring
  - Recent surgery
  - Obesity
  - Depth/size of vessels

Limitations (Perforating Veins)

- Difficult to thoroughly evaluate vessels due to:
  - Edema
  - Recent surgery
  - Obesity
  - Non-intact skin (open sores, broken skin, etc)

Limitations (Peripheral Veins – UE)

- It is difficult to fully evaluate the subclavian, brachiocephalic/innominate veins due to the bony structure of the chest
- Immobility of the patient

Limitations (Abdominal/Pelvic Veins)

- Difficult to thoroughly evaluate vessels due to:
  - Depth/size of vessels
  - Bowel gas interference

Limitations (False Positive Studies)

- Extrinsic compression of a tumor, pregnancy, or ascites
- Peripheral Arterial Disease (PAD) decreases venous filling
- COPD
- Sonographer skill level (probe angle and pressure crucial to exam)

Physical Principles

- Vein must be identified by appropriate landmarks (i.e. accompanying artery or bone)
- Peripheral veins must be clearly visualized in transverse to ensure complete coaptation
- Velocity signals should be obtained in sagittal view to maximize Doppler shift

Physical Principles

- Maximize color flow and fill patterns:
  - Decrease color scale to detect venous flow (slower moving)
  - Decrease wall filters
  - Increase color gain
  - Steer the color box
  - Heel-toe the transducer to optimize the angle

Peripheral Veins of the Lower Extremity Exam

Peripheral Veins of LE Technique

- Patient Position:
- The head of the bed should be elevated to facilitate venous filling
  - Reverse Trendelenburg
- Hip on the symptomatic side should be externally rotated with the knee *slightly* flexed
  - Avoid venous compression behind the knee
- Keep the patient warm to promote blood flow

Peripheral Veins of LE Technique

- Transducer Frequency:
- Linear Array
- 7-12 MHz is routinely used however:
  - 15 MHz can be used for superficial veins or very thin patients
  - 5 MHz or lower may be used for obese legs or extremely deep vessels
- Alter transducer frequency to optimize your image when necessary

Peripheral Veins of LE Technique

- Facility protocols vary significantly:
  - Unilateral exam of the symptomatic leg only
  - Bilateral exam
  - Imaging calf veins may be included with either of the above exams

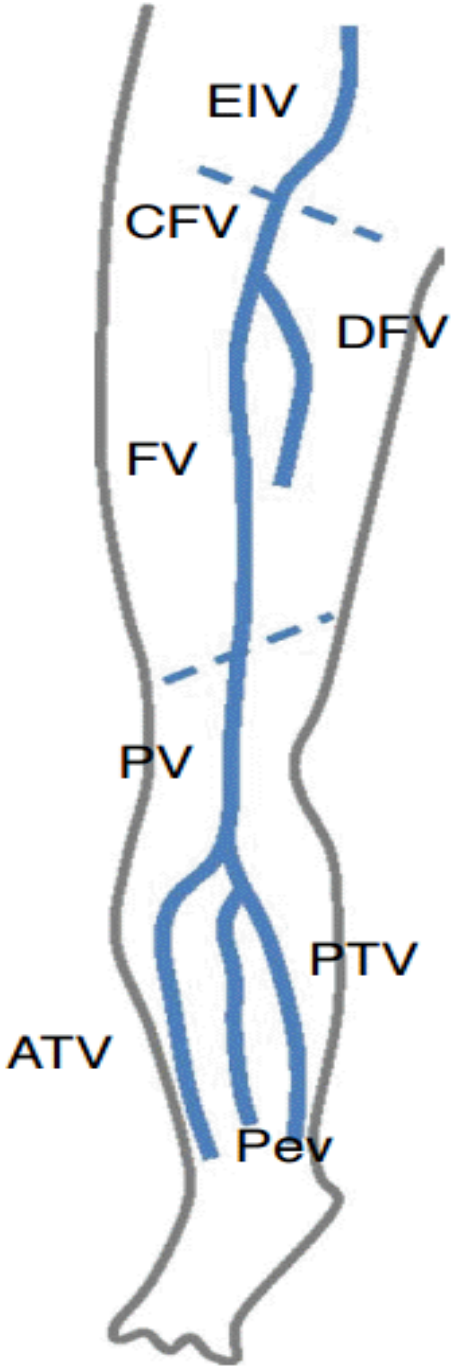
  - If only performing a unilateral exam; always check the CFV on the asymptomatic side for inflow disease!!!

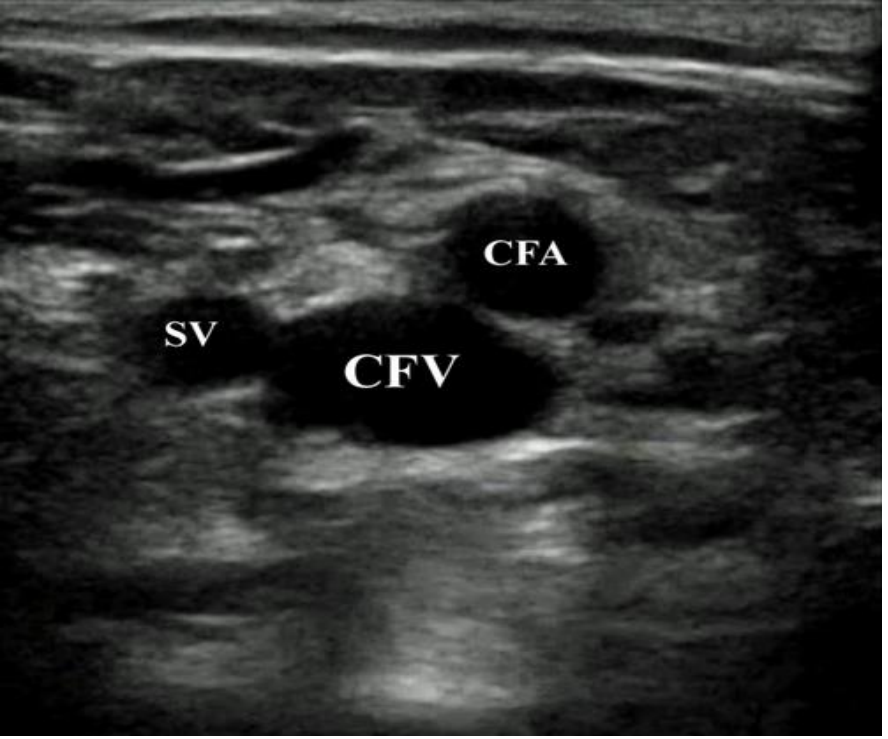
Peripheral Veins of LE Technique

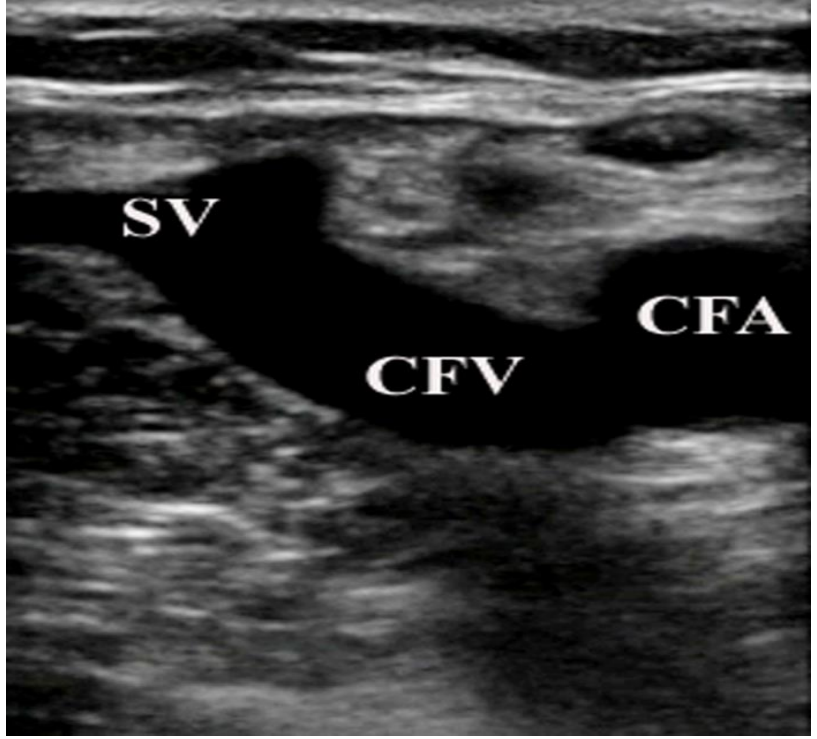
- Exam can be started in either:
  - Longitudinal
  - Transverse
- For beginning technologists, transverse may be easier to start with
- There is no wrong way to begin the exam, but be aware of facility (or reading Dr's) strict protocol's

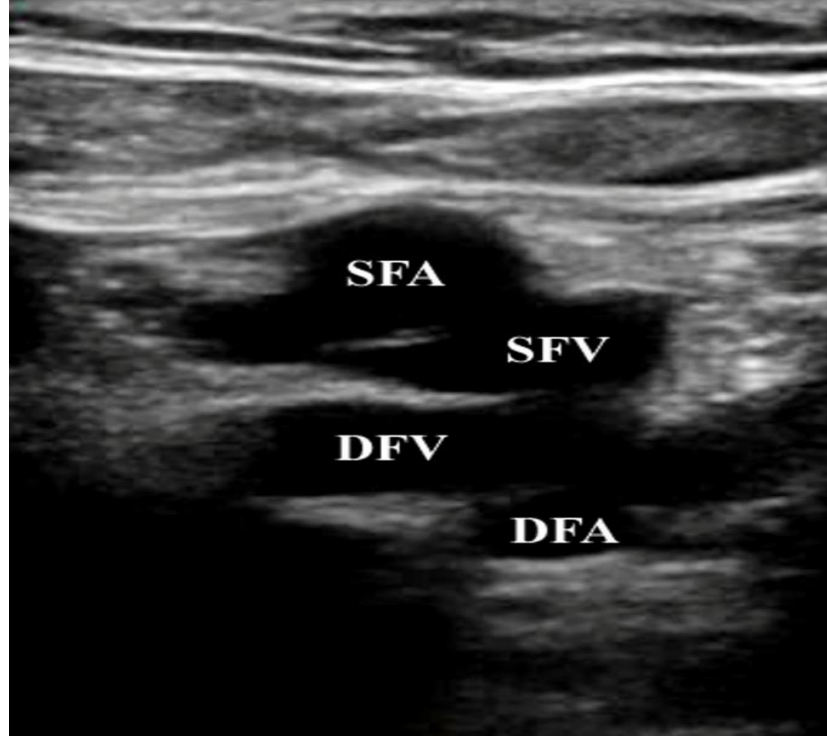
Peripheral Veins of LE Technique

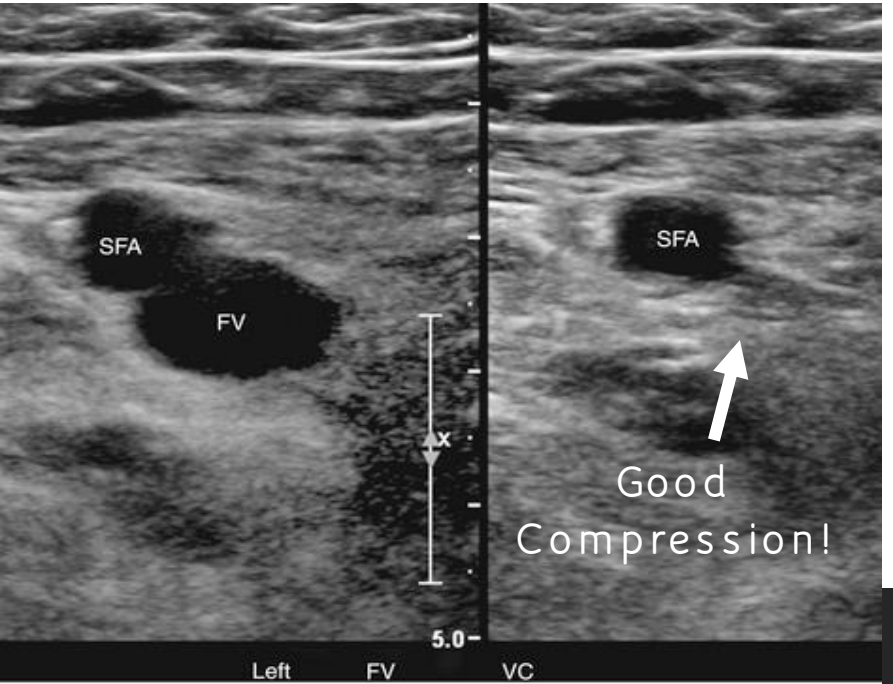
- Imaging should begin at the level of the inguinal ligament
- Transverse Imaging: (2-D)
  - Image the following vessels with and without compression of the vein to check for coaptation:
    - Common Femoral
    - Saphenofemoral Junction
    - Origin of Profunda Femoris Vein
    - Superficial Femoral Vein (Proximal & Distal)
    - Popliteal Vein
    - Small Saphenous-Popliteal Junction (not always routine)
    - Anterior Tibial, Posterior Tibial and Peroneal Veins (not always routine)

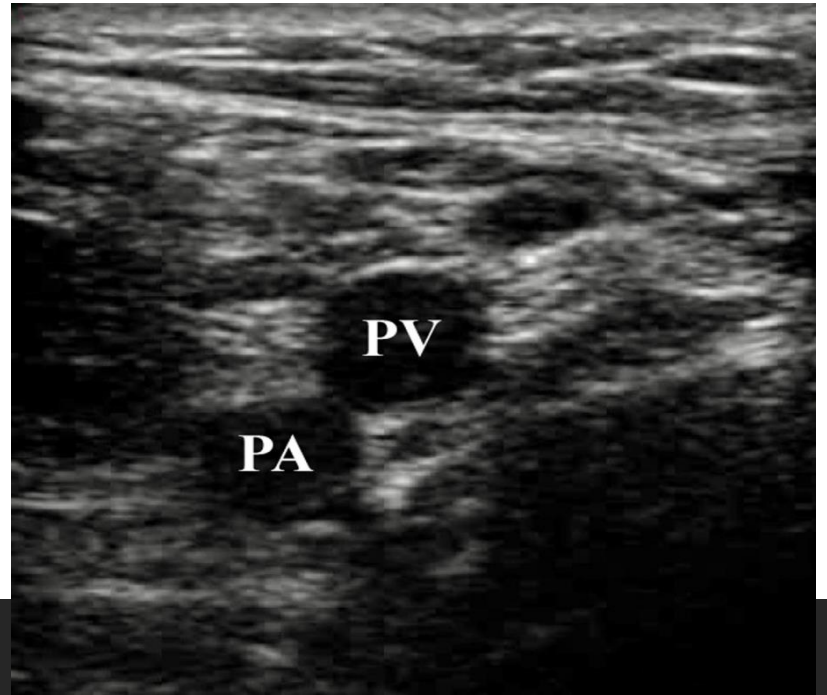

EIV
CFV
DFV
FV
PV
PTV
ATV
Pev

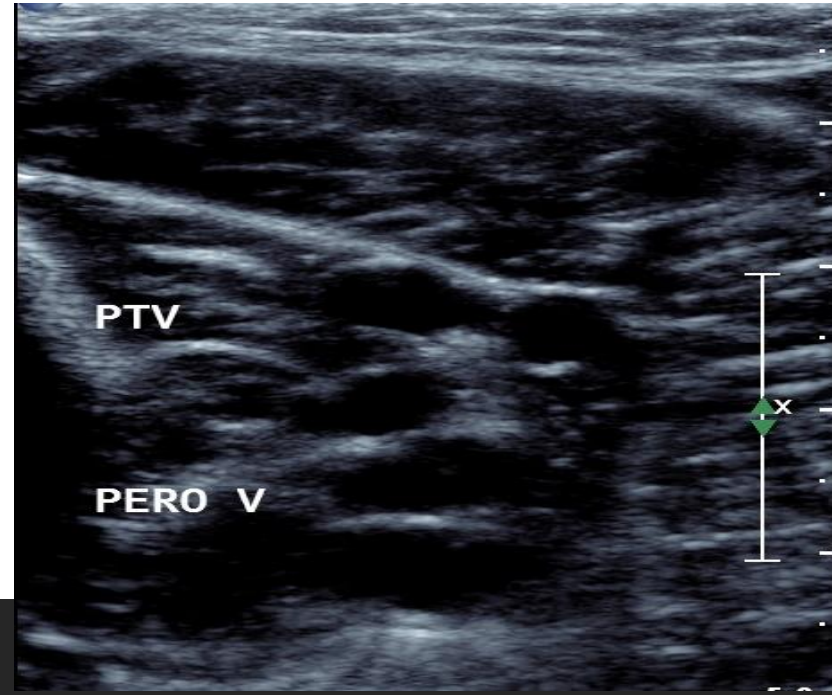

CFA
SV
CFV


SV
CFA
CFV


SFA
SFV
DFV
DFA


SFA
FV
SFA
Good
Compression!
5.0
Left
FV
VC


PV
PA

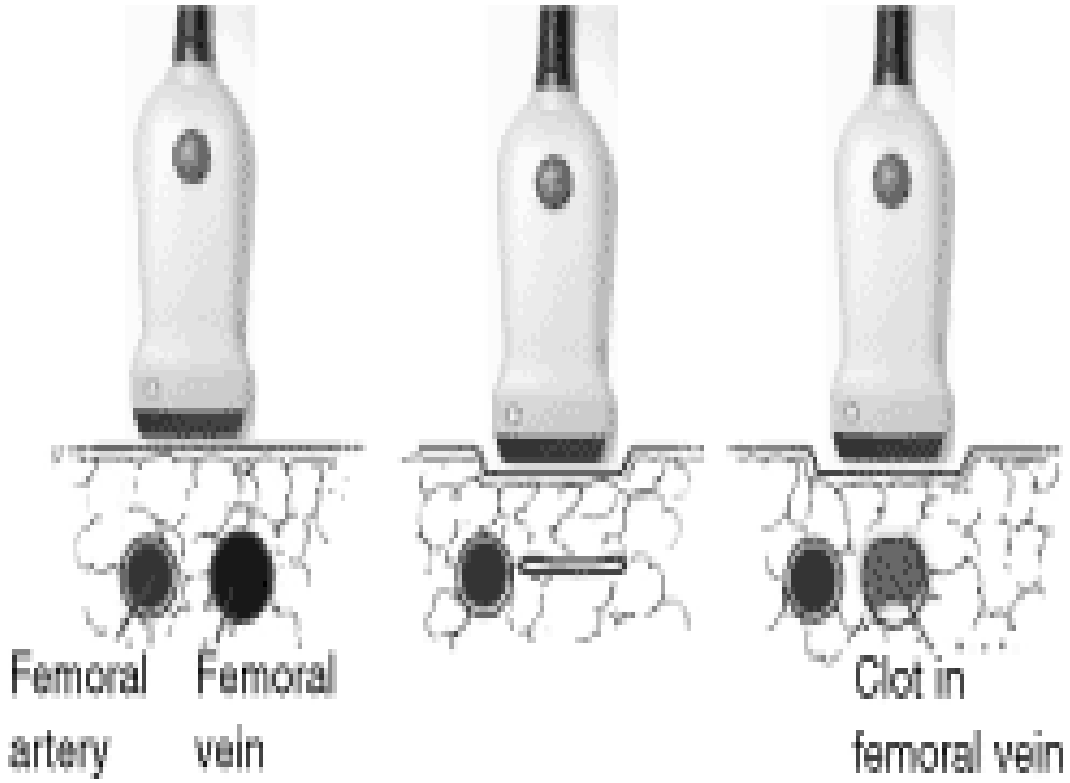

PTV
PERO V

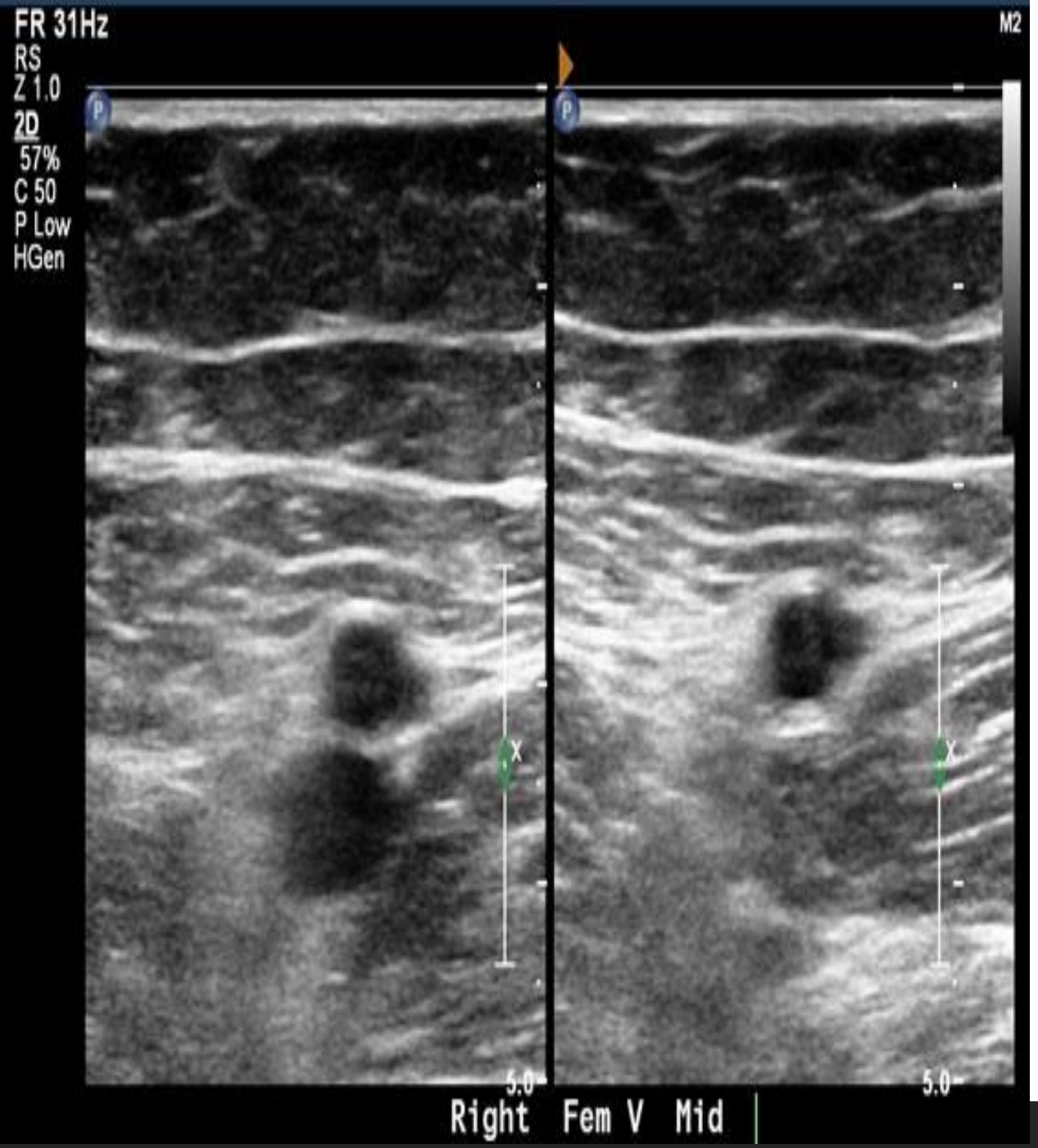
Peripheral Veins of LE Technique

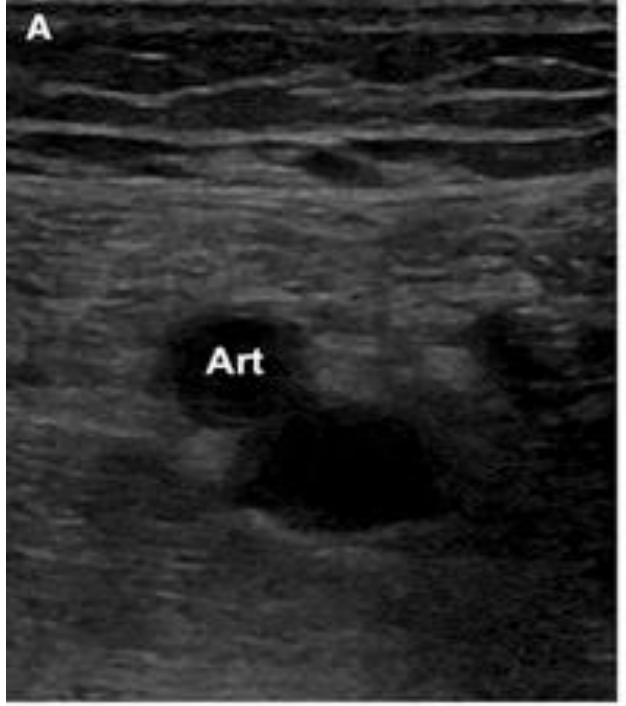
- Transverse imaging allows for direct visualization of:
  - Anatomical verification
  - Vessel wall coaptation
    - Compression should be performed every 1-2 inches along the levels of the lower extremity
  - Thrombus if present
    - Vessel should be anechoic if normal

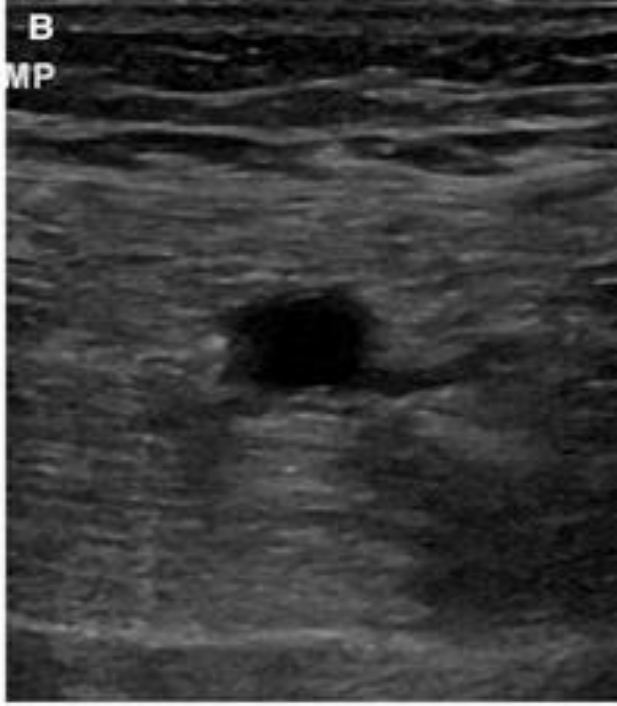
Transducer Compressions

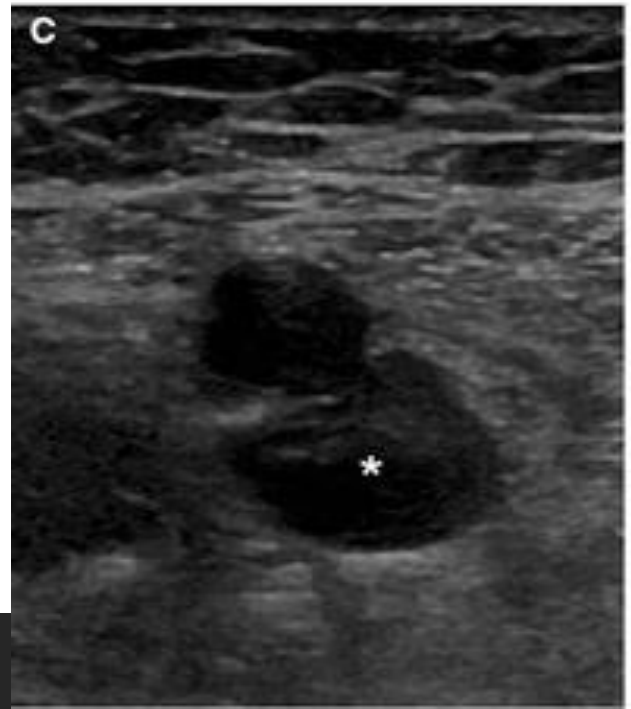
- Try to keep the transducer perpendicular to the vein for optimal imaging
- Before beginning compressions, look for intraluminal thrombus
- Use moderate probe pressure to fully coapt vein walls and release
  - A clot-free vein will collapse; thrombus will prevent the vein walls from touching
  - Distal SFV may require some extra help to collapse

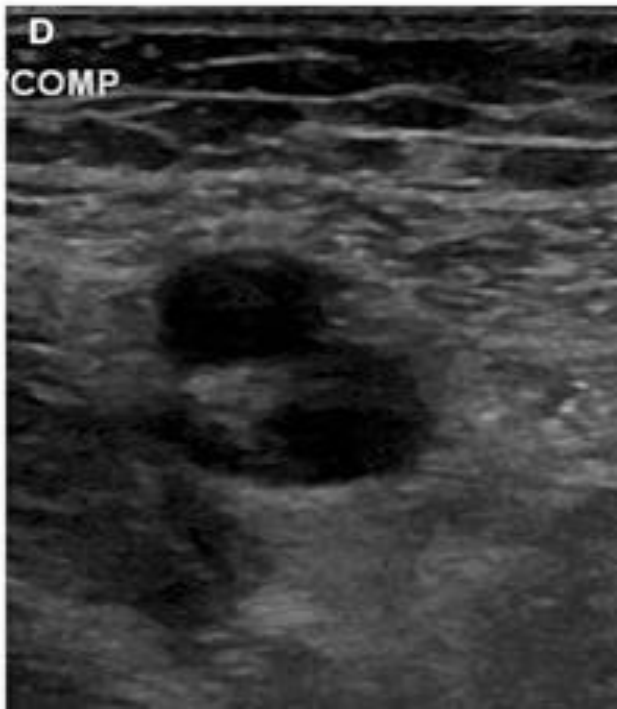



FR 31Hz
RS
Z 1.0
2D
57%
C 50
P Low
HGen
M2
5.0
5.0
Right Fem V Mid


A
Art


B
MP


C
*


D
COMP

Peripheral Veins of LE Technique

- Imaging should begin at the level of the inguinal ligament as with transverse imaging
- Longitudinal Imaging: (Color and Spectral Doppler with augmentation)
  - Common Femoral Symptomatic Side
  - Common Femoral Asymptomatic Side
  - Popliteal Vein
  - Saphenofemoral Junction
  - Origin of the Profunda Femoris Vein
  - Superficial Femoral Vein (Proximal to Distal)
  - Small Saphenous-Popliteal Junction (not always routine)
  - Anterior Tibial, Posterior Tibial and Peroneal Veins (not always routine)

Peripheral Veins of LE Technique

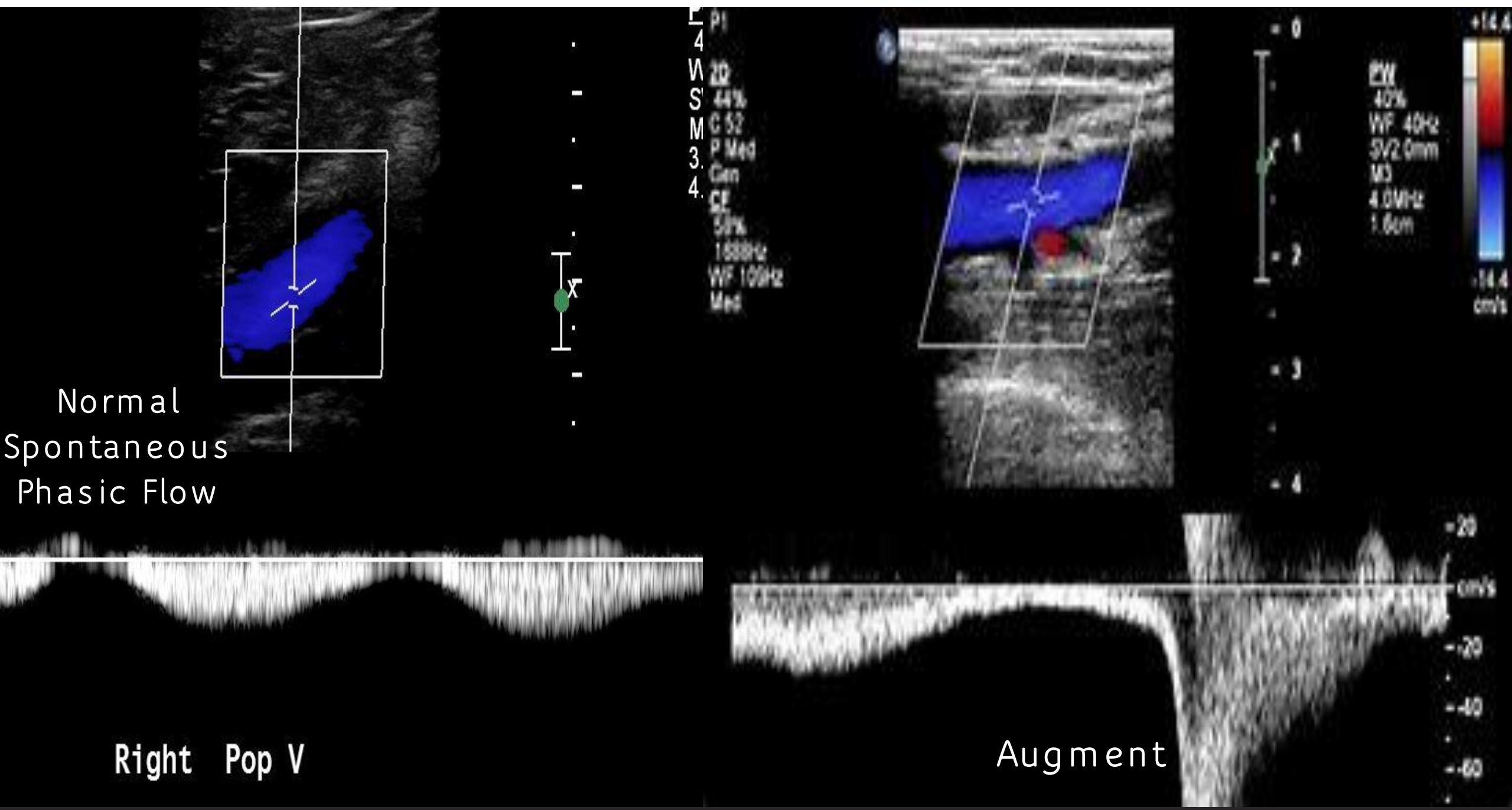
- Doppler assessment is performed in the longitudinal view
- Color flow is included to help identify:
  - Occlusion
  - Partial occlusion
  - Recanalization of thrombus
  - Verification of anatomical variant
  - Documenting venous incompetence

Interpretation of LEV Exam

- The primary criteria for detecting DVT is compression
  - Normal
    - Vein walls completely collapse
    - No visualization of intraluminal clot
  - Abnormal
    - Vein walls do not collapse with compression
    - Intraluminal clot is visible in vessel
    - Vein walls partially collapse indicating partial obstruction

Interpretation of LEV Exam

- The secondary criteria for detecting DVT is Doppler signal
  - Normal
    - Spontaneous flow
    - Phasic flow with respiration
      - Inspiration – decrease in venous flow velocity
      - Expiration – increase in venous flow velocity
    - Augmentation
      - Compression of the vein distal to the transducer will increase (augment) the venous signal

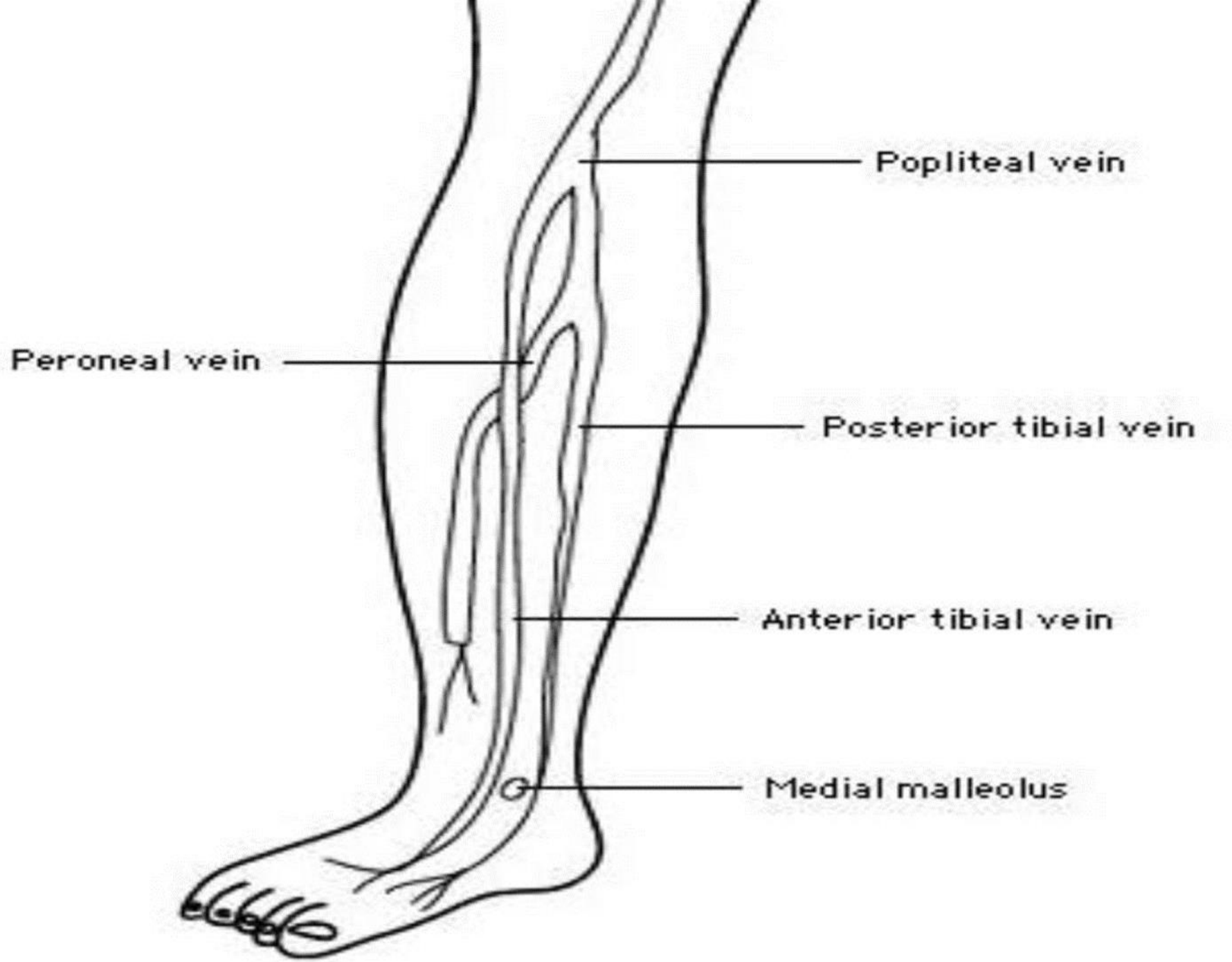

Normal
Spontaneous
Phasic Flow
Right Pop V
Augment

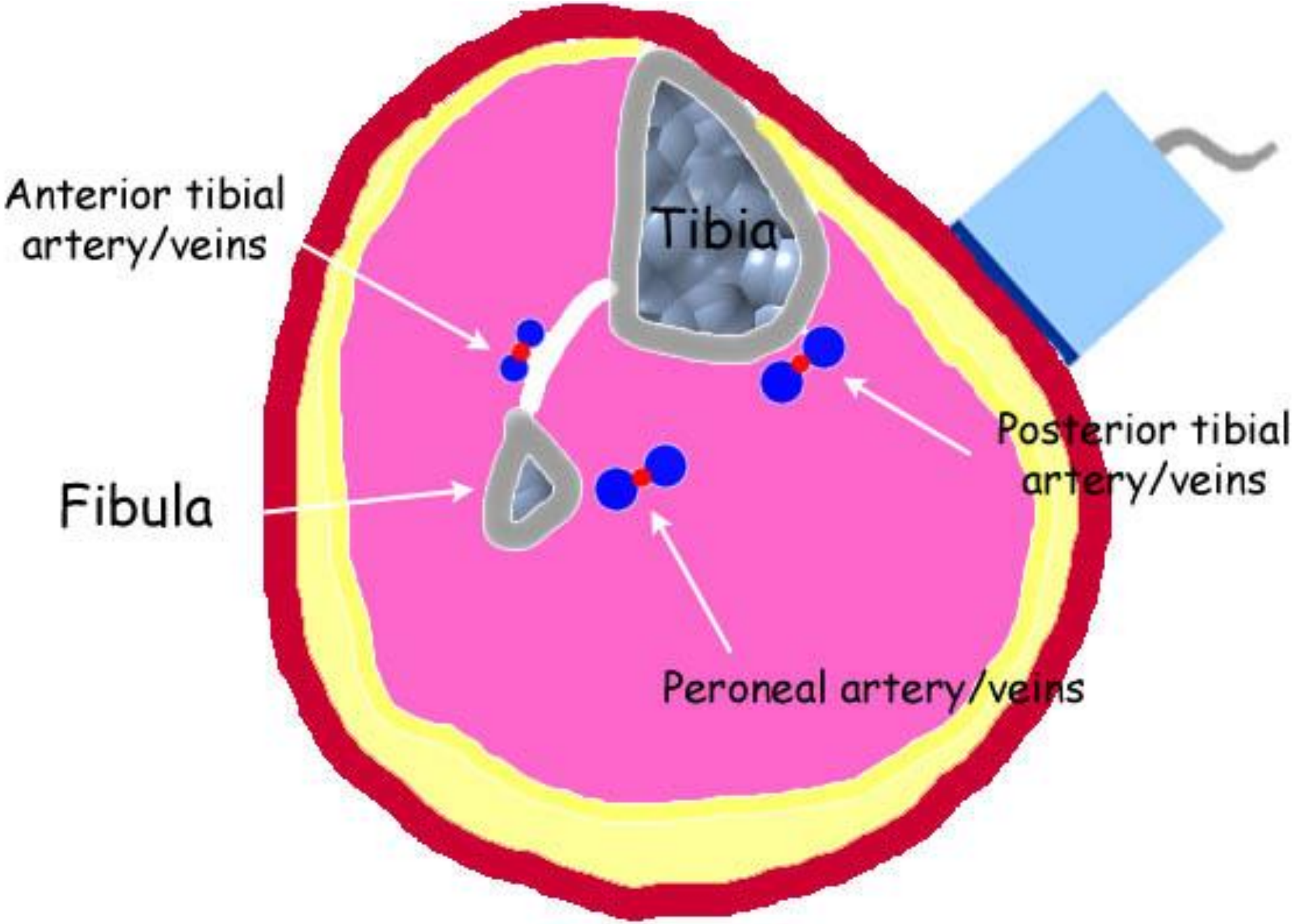
Interpretation of LEV Exam

- Use color along with spectral Doppler
- Color Doppler is helpful but be cautious – it can obscure a partial clot
  - Make sure gain/scale settings are appropriate and of diagnostic quality
  - Using 2-D and transverse views will help to aid in visualization of partial clots

Peripheral Veins of LE Technique

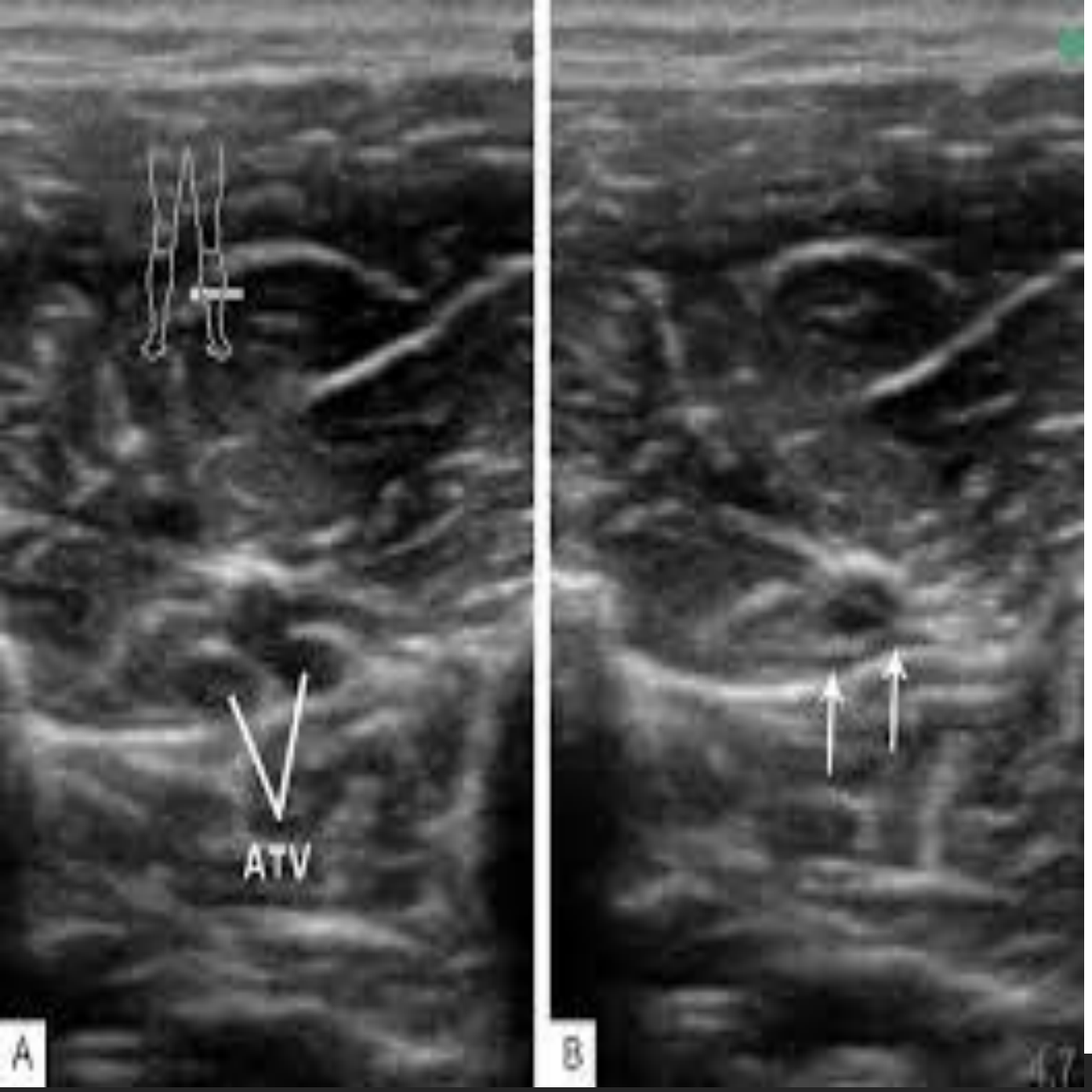
- Calf veins:
  - Not all facilities image the calf veins
  - To adequately examine the calf veins, the sonographer should scan through the entire length of the veins
    - Visualization of the calf veins in one area is not sufficient and is not a complete examination of the calf veins

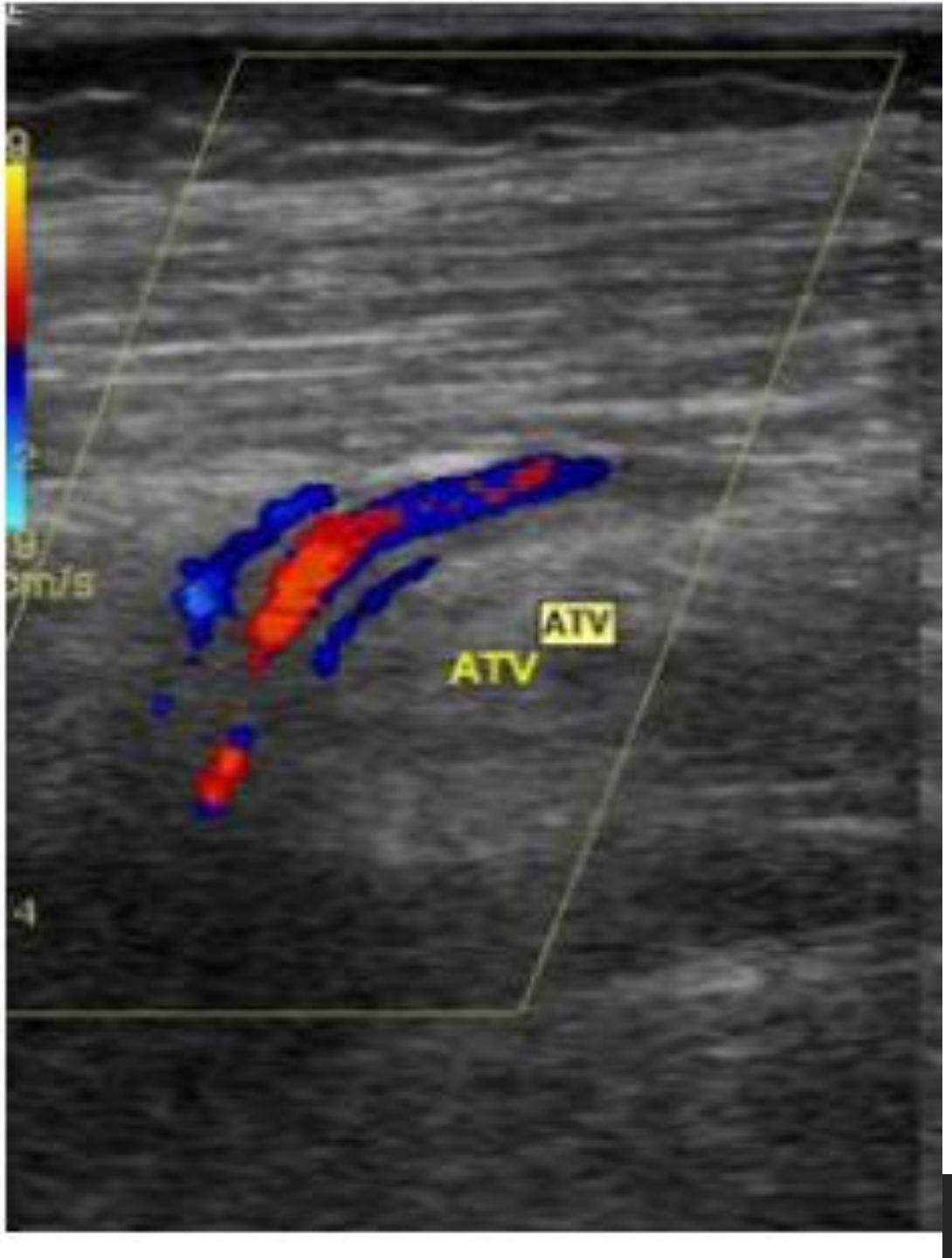

Popliteal vein
Peroneal vein
Posterior tibial vein
Anterior tibial vein
Medial malleolus


Anterior tibial artery/veins
Tibia
Fibula
Posterior tibial artery/veins
Peroneal artery/veins

Anterior Tibial Veins

- Lie along the anterolateral surface of the tibia, running alongside the interosseous membrane
  - Look for accompanying Anterior Tibial Artery
- Begin scanning in the proximal calf and follow distally, coursing with the tibia
  - If unable to visualize, begin at the distal portion of the lower leg (top of the foot) and scan more proximally up the calf


ATV
A
B

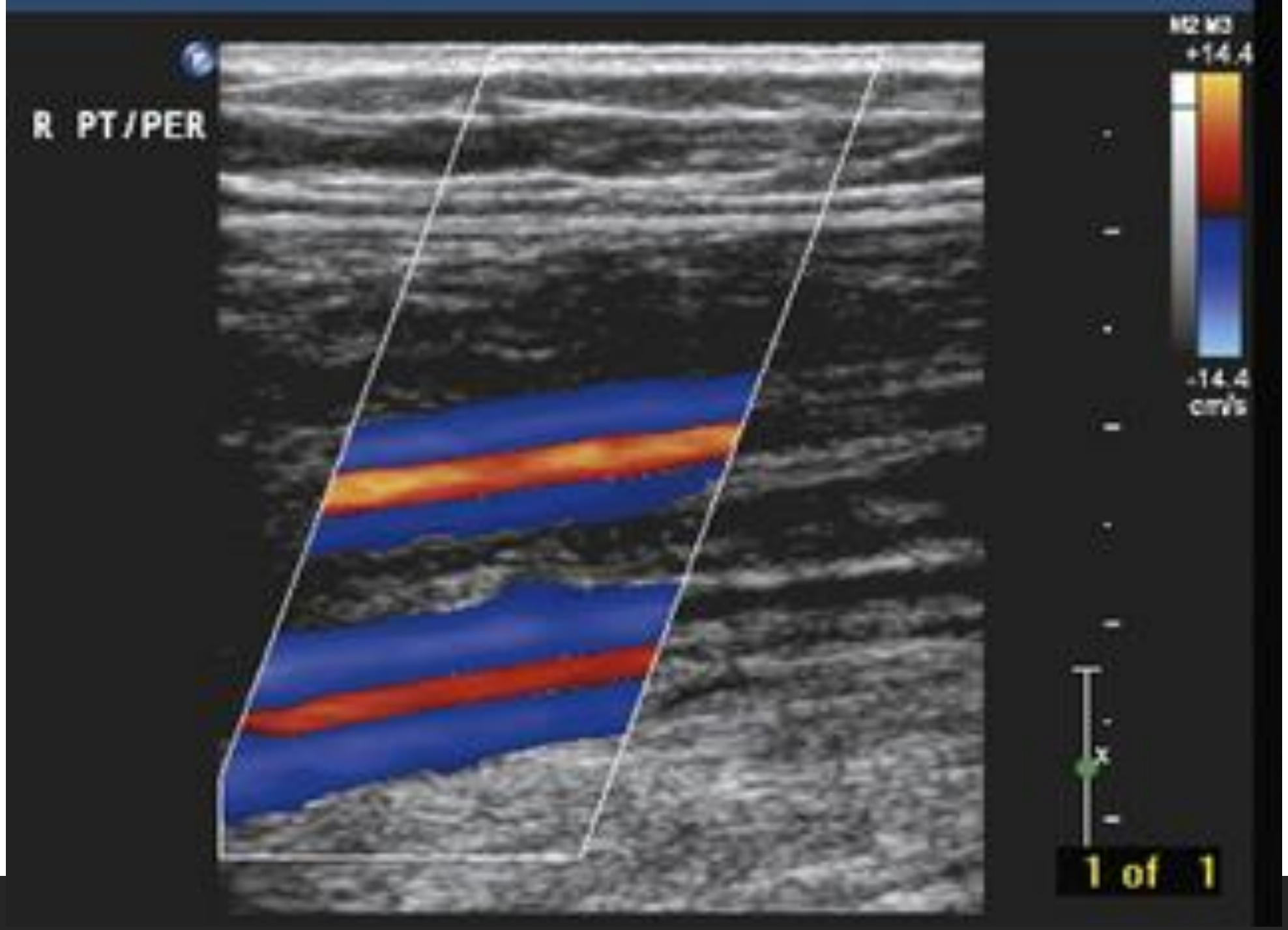

ATV
ATV

Posterior Tibial Veins

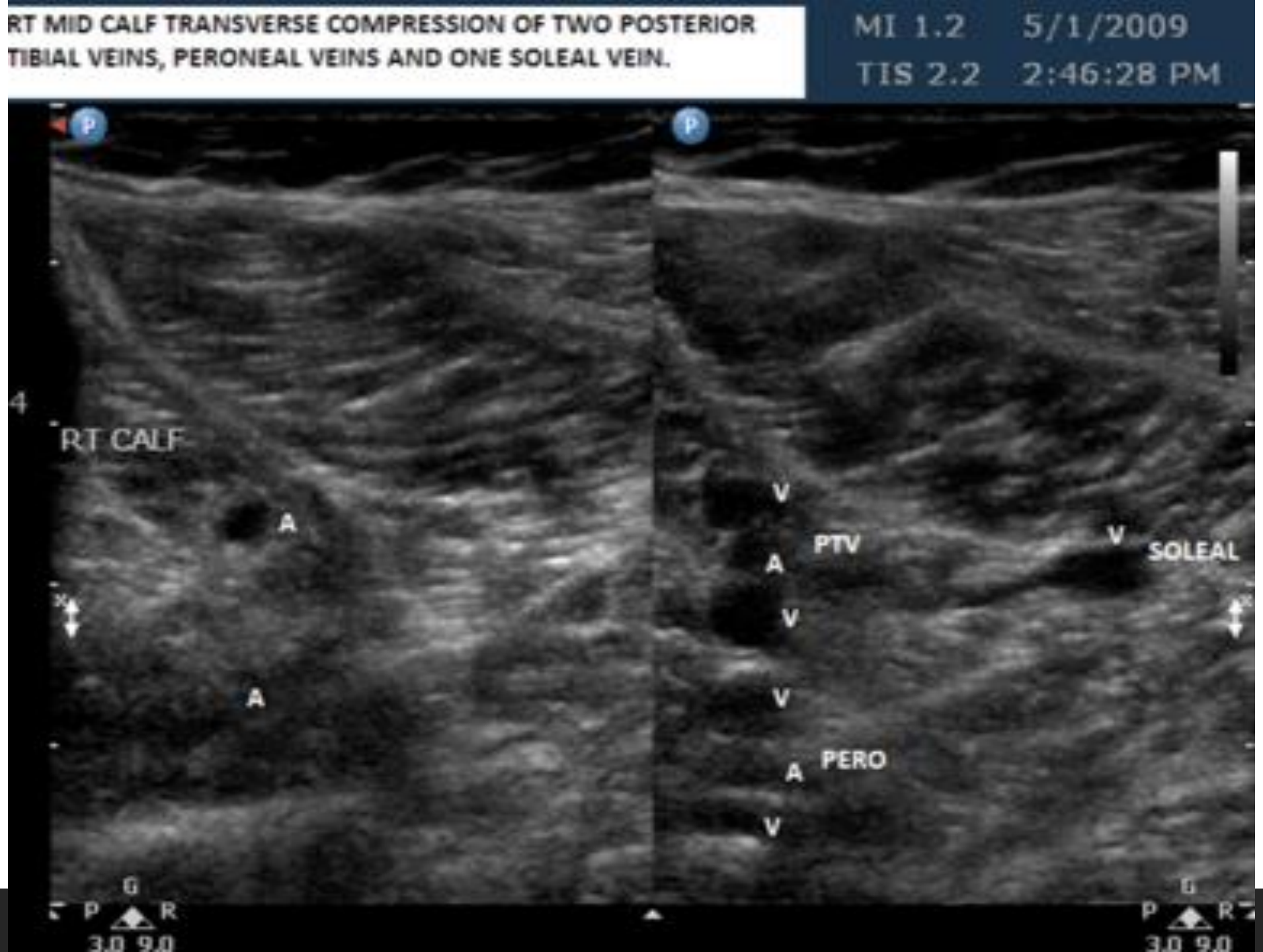
- Lies posteromedial to the tibia
- Can also scan posteriorly if medial approach does not work
- Begin scanning at the level of the ankle
  - Visualize the PTV's between the medial malleolus and the Achille's Tendon
  - Follow PTV's up the medial aspect of the calf
    - Evaluate Doppler flow and compressibility

Peroneal Veins

- Lie posteromedial to the tibia
  - Best approach posteromedial
  - Scan posteriorly if medial approach does not work
- Begin scanning a few centimeters up from the medial malleolus
  - Peroneals are deeper than the PTV's
  - Follow Peroneals up the medial side of the calf while also evaluating the PTV's


R PT/PER
M2 M3
+14.4
-14.4
cm/s
1 of 1

RT MID CALF TRANSVERSE COMPRESSION OF TWO POSTERIOR TIBIAL VEINS, PERONEAL VEINS AND ONE SOLEAL VEIN.



Peripheral Veins of the Lower Extremity – Venous Reflux

Venous Reflux Testing

- Used to identify *CVI – Chronic Venous Insufficiency*
- Checks competency of venous valves and identifies areas of reflux
  - Reflux – venous blood escapes from its normal antegrade flow path; instead reverses course and pools in the veins of the legs
- Valves no longer function as they should
  - Hereditary, Trauma, DVT

Venous Reflux Testing

- Two part testing:
  - 1. Normal venous duplex exam – patient supine
    - Head of the bed should be elevated to facilitate venous filling
  - 2. Reflux exam – patient standing
    - Elevated platform or step stool is used to help with ergonomics
- Keep the patient warm to promote blood flow and avoid vasoconstriction

Venous Reflux Testing

- Follow protocol for venous duplex exam with compressions, grayscale, color, and spectral imaging first
  - Identify if reflux is present in the deep venous system

- Have the patient stand so they are elevated 1-2 steps off the ground
  - The leg to be examined is not to be bearing weight
  - Toes should be pointed laterally, allows better access of GSV
  - For Small Saphenous Vein Imaging, have patient turn around and scan the back of their calf from popliteal fossa to ankle

Venous Reflux Testing

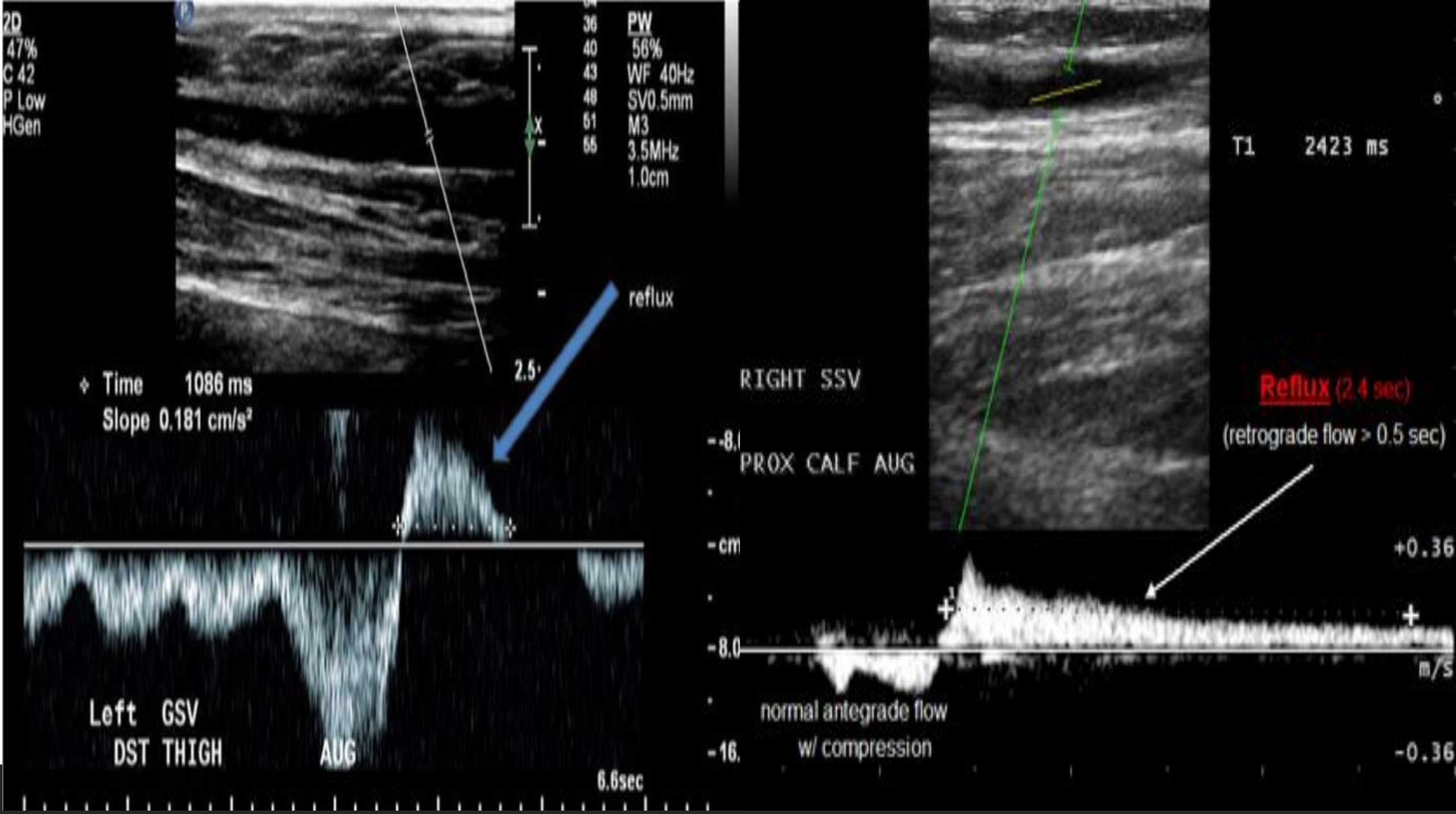
- Images of the GSV and SSV are documented in transverse and longitudinal planes at various levels to perform a complete exam
- Transverse diameter measurements are obtained of the GSV and SSV
  - Begin at the vessel junction and end in the distal leg
- In cases of positive reflux, duration of the flow reversal should also be measured

Venous Reflux Testing

- Patients tend to get lightheaded when standing for the exam
  - Make sure they have something to hold on to
  - Give them breaks when necessary
- Ergonomics are key
- For patients who are unable to stand, a steep reverse Trendelenburg positioning may work

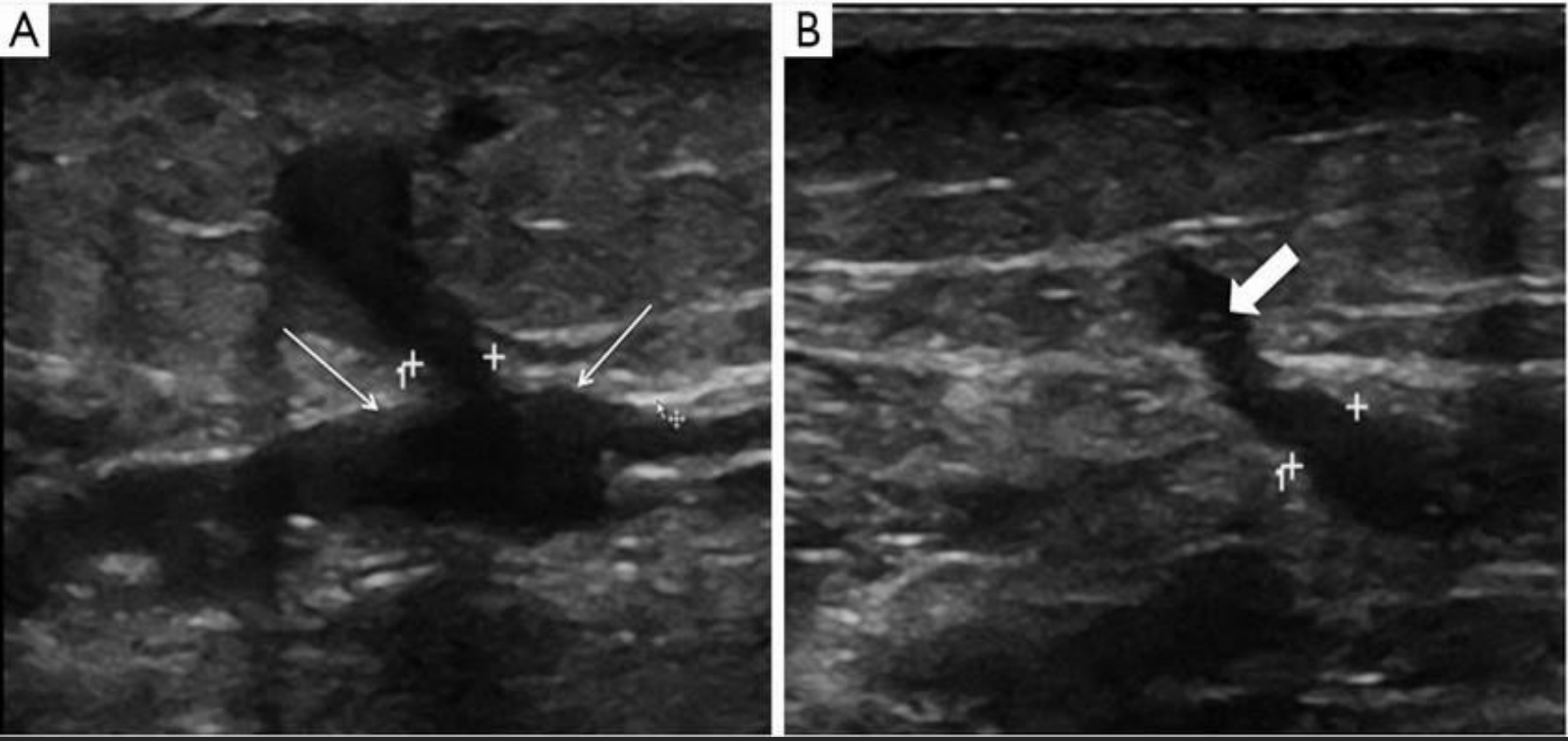
Venous Reflux Testing Interpretation

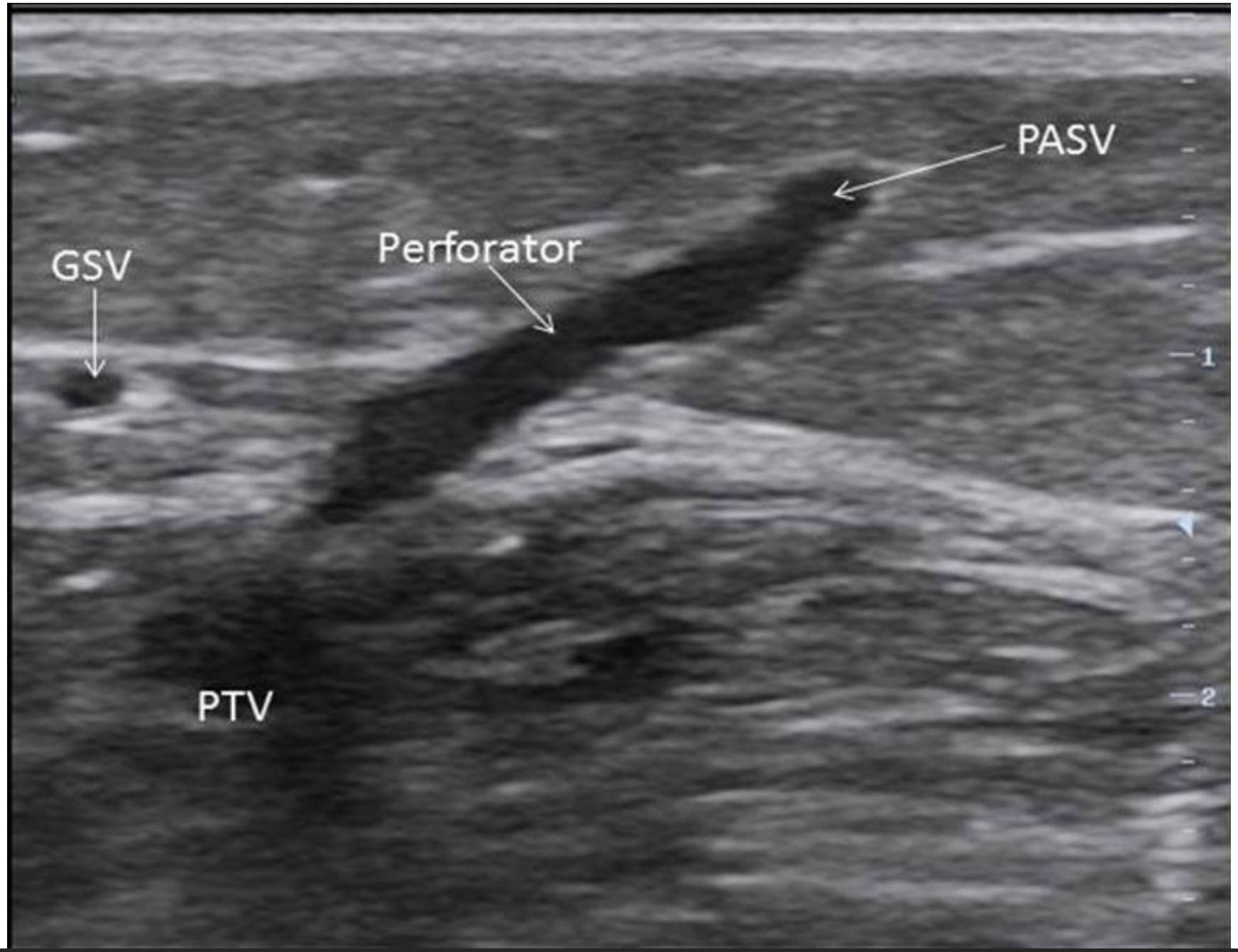
- Positive reflux segment:
  - >500 ms for superficial or perforating veins
  - >1000 ms for deep veins
- Document continuity of vessels and any anatomical variables (i.e. tortuosity, multiple branches, visible perforators)
- Diameter measurements in transverse: (measured A-P)
  - GSV 4mm – normal limit
  - SSV 3mm – normal limit
  - Perforators <3mm – normal limit


2D
47%
C 42
P Low
HGen
PW
56%
WF 40Hz
SV0.5mm
M3
3.5MHz
1.0cm
reflux
Time 1086 ms
Slope 0.181 cm/s²
Left GSV
DST THIGH
AUG
6.6sec
RIGHT SSV
PROX CALF AUG
T1 2423 ms
Reflux (2.4 sec)
(retrograde flow > 0.5 sec)
+0.36
-8.0
m/s
-0.36
normal antegrade flow
w/ compression

Perforating Veins

- Normal perforators <3mm
- Connect the superficial venous system to the deep venous system
- Optimize your system settings for low-flow detection (decrease scale, decrease wall filters, increase color gain)
- Patient should be standing to image perforators
  - Allows blood pooling in the lower extremity to assess size and movement of blood flow


A
B

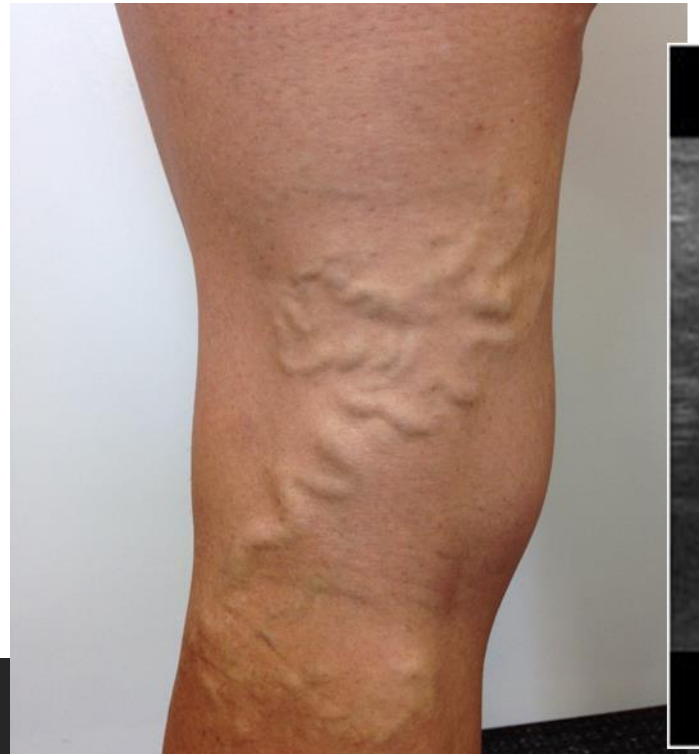


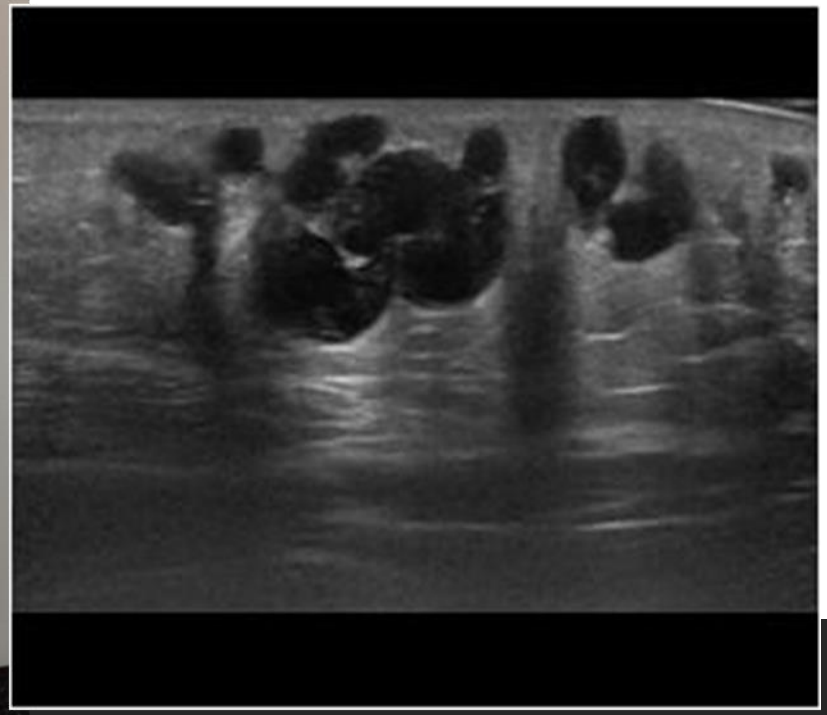
The perforator passes through the fascial place from the superficial system to the deep system

PASV = posterior accessory saphenous vein

Varicosities

- Varicose veins arise from an increase in pressure of the veins
- Attributed to standing or walking for long periods of time
- Also caused by:
  - Age
  - Gender (pregnancy)
  - Family history
  - Obesity
- Concerning for:
  - Ulcer formation
  - Bleeding





Peripheral Veins of the Upper Extremity Exam

Peripheral Veins of UE Technique

- Patient Position:
- Patient is in a supine or Low Fowler's position
  - While scanning their neck, have the patient turned their head slightly away from you
- Make sure the stretcher is wide enough to comfortably support the upper arm
- Keep the patient warm

Peripheral Veins of UE Technique

- Transducer Frequency:
- Linear Array
- 7-12 MHz is routinely used however:
  - 15 MHz can be used for superficial veins or very thin patients
  - 5 MHz or lower may be used for obese legs or extremely deep vessels
- Alter transducer frequency to optimize your image when necessary

Peripheral Veins of UE Technique

- Facility protocols vary significantly:
  - Unilateral exam of the symptomatic arm only
  - Bilateral exam
  - Imaging of lower arm veins may be included with either of the above exams

  - If only performing a unilateral exam; if there is a question about "normal" flow for the patient, compare it to the asymptomatic side

Peripheral Veins of UE Technique

- Imaging should begin at the internal jugular vein
- Transverse images: (2-D Imaging)
  - Image the following vessels with and without compression:
    - Internal Jugular Vein
    - Peripheral Subclavian Vein
    - Axillary Vein
    - Brachial Veins in the upper arm
    - Cephalic Vein in the upper arm**
    - Basilic Vein in the upper arm**
    - Focal symptomatic areas, if present

** Superficial Veins

Peripheral Veins of UE Technique

- Additional transverse images:
  - Radial (if clinically indicated)
    - Paired veins that travel along the lateral aspect of the arm
  - Ulnar (if clinically indicated)
    - Paired veins that travel along the medial aspect of the arm

Peripheral Veins of UE Technique

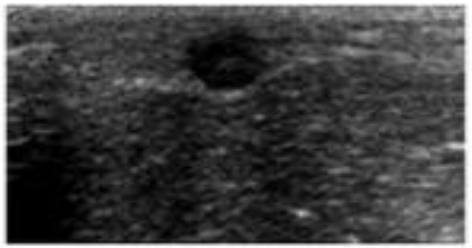
- Transverse imaging allows for direct visualization of:
  - Anatomical verification
  - Vessel wall coaptation
    - Compression should be performed every 1-2 inches along the levels of the lower extremity
  - Thrombus if present
    - Vessel should be anechoic if normal

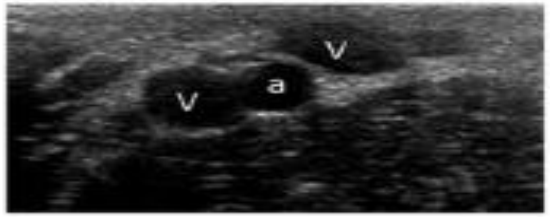
Peripheral Veins of UE Technique

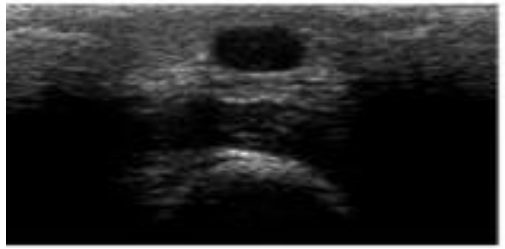
- Imaging should begin at the level of the internal jugular vein
- Longitudinal Imaging: (Color and Spectral Doppler)
  - Internal Jugular Vein
  - Subclavian Vein
  - Axillary Vein
  - Brachial Veins
  - Radial Veins (if clinically indicated)
  - Ulnar Veins (if clinically indicated)
  - Cephalic Vein
  - Basilic Vein

Peripheral Veins of UE Technique

- Doppler assessment should be performed in the longitudinal view
- Color flow Doppler should be included to help identify:
  - Occlusion
  - Partial occlusion
  - Recanalization of thrombus
  - Verification of anatomical variations
  - Documenting venous incompetence







Internal jugular v.

Subclavian v.

Brachiocephalic v.

Axillary v.

UPPER ARM
Cephalic v.

UPPER ARM
Basilic v.

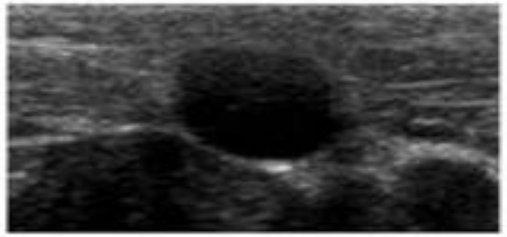
Brachial v.
(x 2, deep)

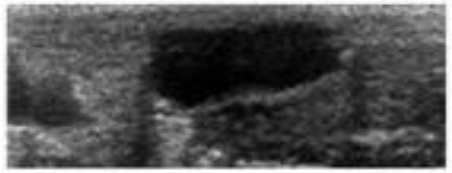
Median cubital v.

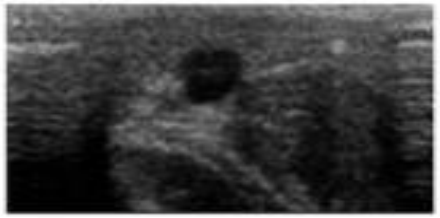
FOREARM
Cephalic v.

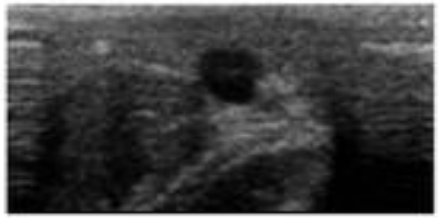
FOREARM
Basilic v.

Median vein
of the forearm









Interpretation of UEV Exam

- The primary criteria for detecting DVT is compression
  - Normal
    - Vein walls completely collapse
    - No visualization of intraluminal clot
  - Abnormal
    - Vein walls do not collapse with compression
    - Intraluminal clot is visible in vessel
    - Vein walls partially collapse indicating partial obstruction

Interpretation of UEV Exam

- The secondary criteria for detecting DVT is Doppler signal
  - Normal
    - Spontaneous flow
    - Phasic flow with respiration
      - Inspiration – decrease in venous flow velocity
      - Expiration – increase in venous flow velocity
    - Augmentation
      - Compression of the vein distal to the transducer will increase (augment) the venous signal

Interpretation of UEV Exam

- Use color along with spectral Doppler
- Color Doppler is helpful but be cautious – it can obscure a partial clot
  - Make sure gain/scale settings are appropriate and of diagnostic quality
  - Using 2D and transverse views will help to aid in visualization of partial clots

Abdominal and Pelvic Vein Exam

Abdominal and Pelvic Vein Technique

- Patient Position:
  - One or more of the following positions may be used for image optimization of all exams:
    - Supine with head slightly elevated
    - Left and/or right lateral decubitus position
    - Reverse Trendelenburg position

Abdominal and Pelvic Vein Technique

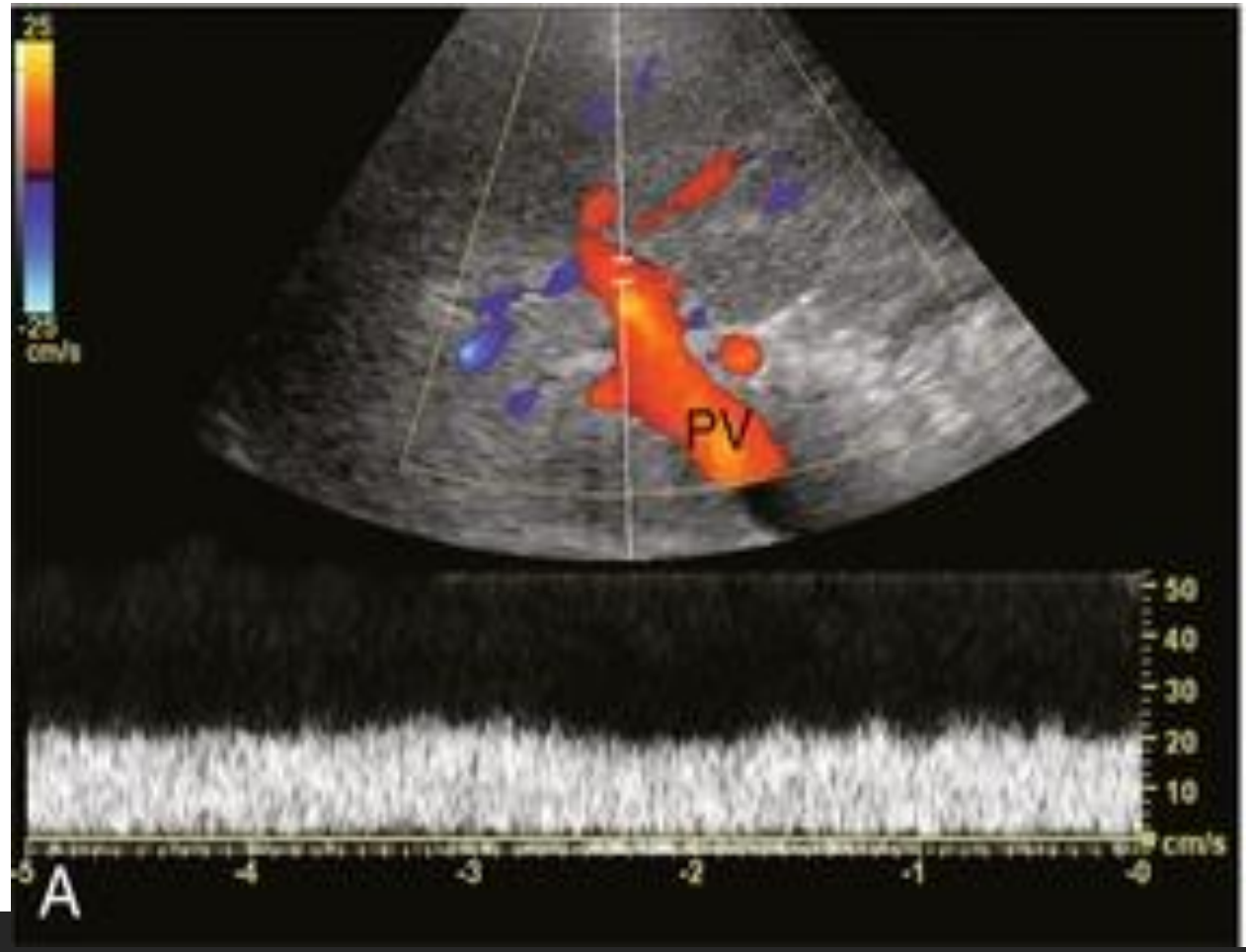
- Evaluation of the IVC and pelvic veins begins in the transverse view at the level of the umbilicus
- Evaluation of other abdominal vessels begins in the transverse view at the level of the xiphoid process
- Accurate identification of the vessels is reliant on the sonographer's knowledge and skill set (i.e. pulsating Aorta vs. IVC)

Abdominal and Pelvic Vein Technique

- Because compressibility of the abdominal and pelvic veins is not possible, respiratory changes can be evident in the IVC and iliac veins
- Evaluate patency
- Venous Doppler signals should be spontaneous
- Know your anatomy and the *normal* direction blood flow should be moving

Abdominal and Pelvic Vein Technique

- Portal vein – *hepatopetal*
  - Brings blood flow into the liver sinusoids from the SMV and Splenic Vein
  - Continuous flow, minimally affected by respirations (if pulsatile, consider congestive heart failure or fluid overload)

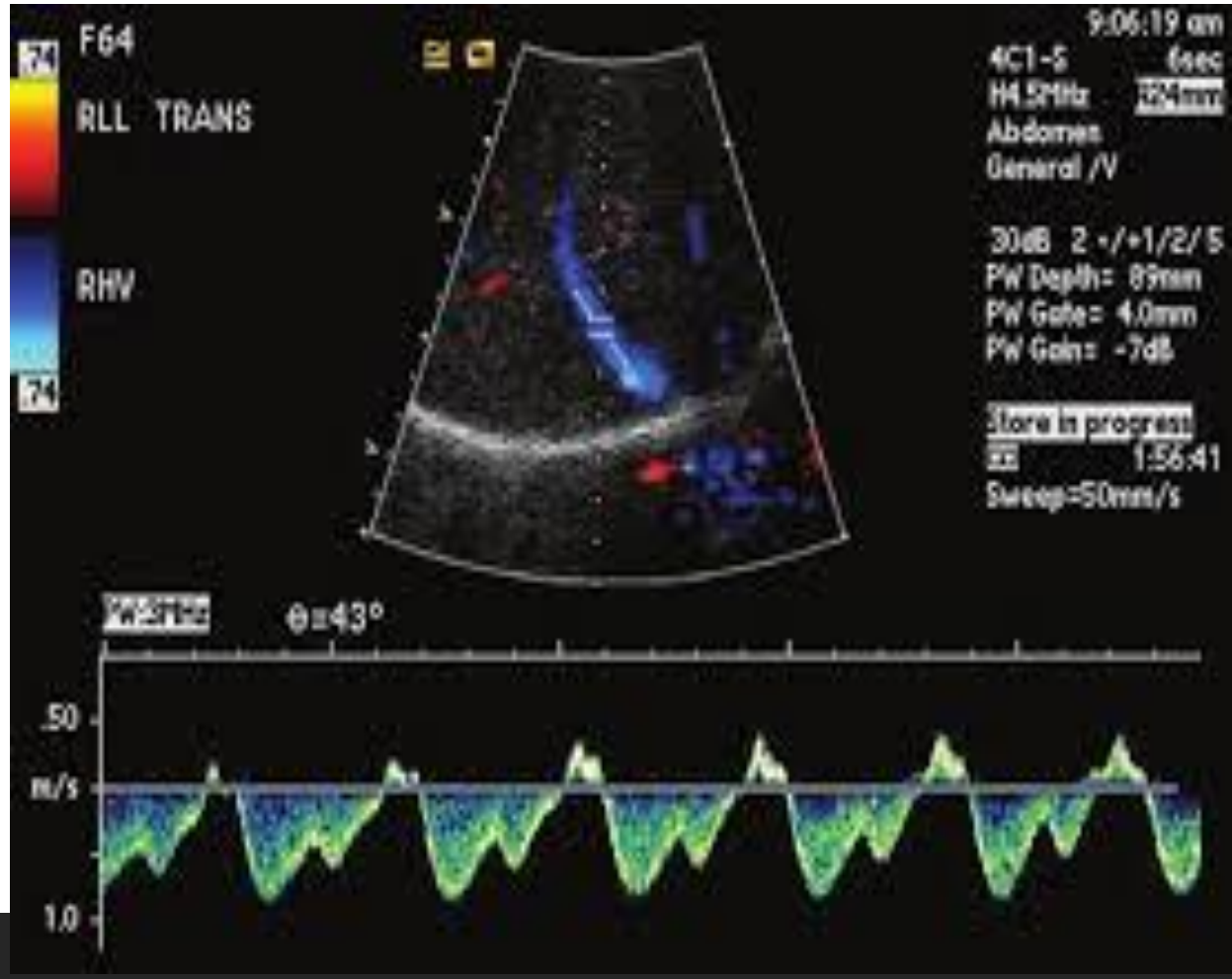


Abdominal and Pelvic Vein Technique

- Portal vein – *hepatopetal*
  - Part of a liver Doppler exam to R/O abnormalities:
    - Direction of flow
    - Thrombus
- Doppler samples are taken at the longitudinal aspect of the:
    - Main Portal vein
    - Right Portal vein
    - Left Portal vein

Abdominal and Pelvic Vein Technique

- Hepatic veins – *hepatofugal*
  - Brings blood flow from the liver into the IVC
  - Minimally phasic, bidirectional, or pulsatile signal may be demonstrated



Abdominal and Pelvic Vein Technique

- Hepatic veins – *hepatofugal*
  - Part of a liver Doppler exam to R/O abnormalities:
    - Direction of flow
    - Thrombus
- Doppler samples are taken at the longitudinal aspect of the:
    - Middle Hepatic vein
    - Right Hepatic vein
    - Left Hepatic vein

Abdominal and Pelvic Vein Technique

- Splenic vein -
- Part of a liver Doppler exam to R/O abnormalities:
  - Direction of flow
  - Thrombus
- Doppler samples are taken at the longitudinal aspect of the:
  - Vein exiting the splenic hilum
  - Near the SMV confluence posterior to the body of the pancreas

Abdominal and Pelvic Vein Technique

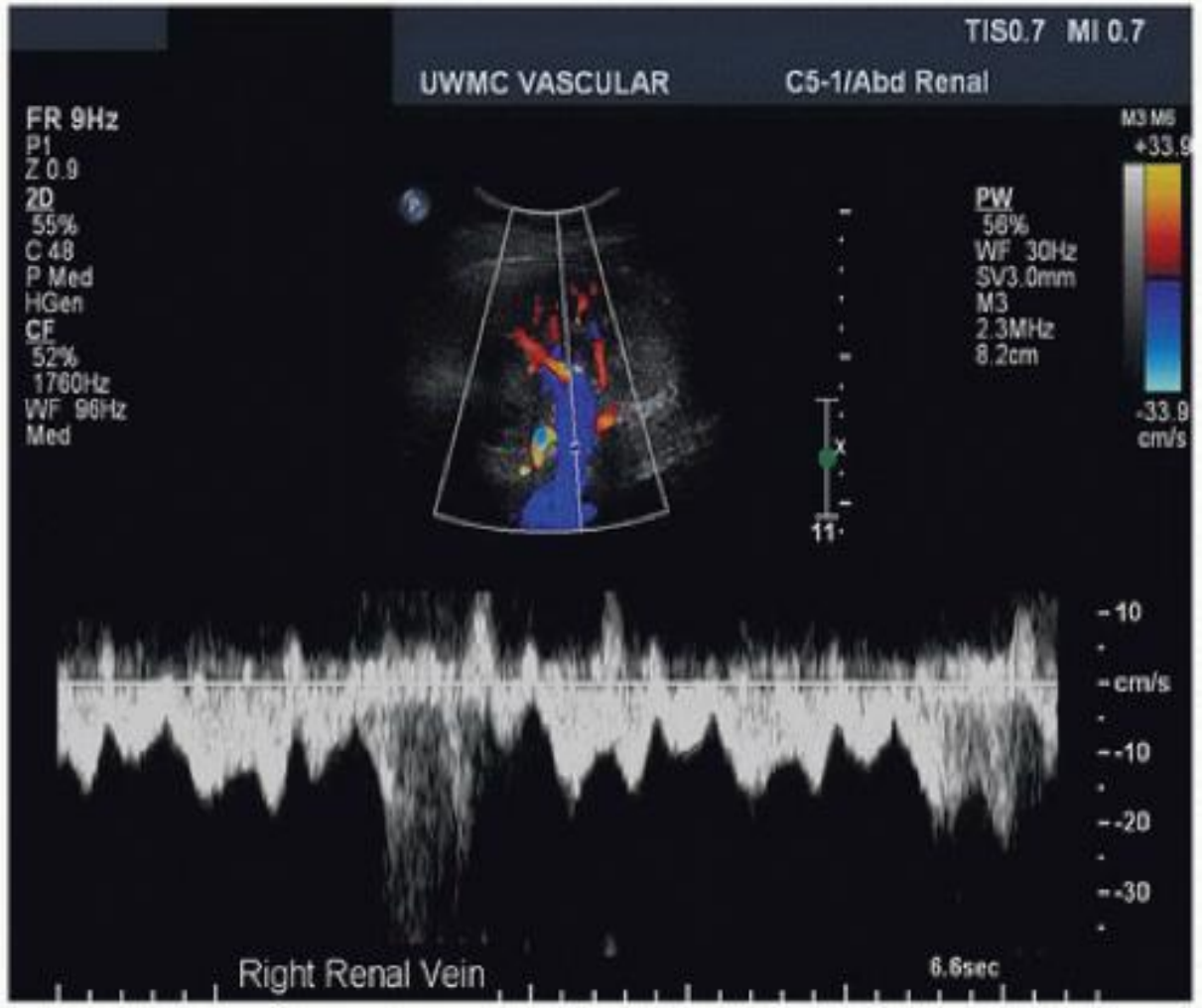
- Inferior Vena Cava-
- Part of a liver Doppler exam to R/O abnormalities:
  - Disturbance of flow
  - Thrombus
  - Doppler samples are taken at the longitudinal aspect of the:
  - Intrahepatic IVC

Abdominal and Pelvic Vein Technique

- Liver Doppler Exam:
  - Includes evaluation of the following vessels:
    - Portal veins
    - Hepatic veins
    - Splenic vein
    - Inferior Vena Cava
    - Hepatic artery
      - Imaged in its longitudinal axis near the porta hepatis

Abdominal and Pelvic Vein Technique

- Renal veins -
  - Carries blood from the kidneys into the IVC
  - Minimally phasic, bidirectional, or pulsatile signal may be demonstrated
  - Evaluated as part of a renal Doppler exam



Abnormalities of the Venous System

Thrombosis

- Intraluminal thrombi frequently begins at:
  - Valve cusps
  - In soleal sinuses
    - Secondary to stagnation
  - Thrombi resulting from trauma can occur at any site

Acute Thrombosis

- Refers to approximately the first 14 days after thrombus forms
  - The vein wall is inflamed
  - Thrombus is loosely attached
- Thrombus within the venous system is hypoechoic during the first few days after its formation but becomes more echogenic with time

Acute Thrombosis

- Recently formed thrombus has low-level echoes and may be virtually anechoic
- Small thrombi may be difficult to visualize (hypoechoic)
- As thrombus ages during the acute phase, echogenicity increases
  - Intensity of the echoes is still low and is less than the surrounding muscle
- Blood flow persists in veins that are incompletely filled with acute thrombus

Acute Thrombosis

- Most lower extremity DVT's start in the deep veins of the calf
  - Can originate anywhere in the venous system
  - Soleal Sinuses - most common site
    - Progress into the Popliteal and Femoral veins
      - At this point it is necessary to anti-coagulate the patient to prevent the risk of Pulmonary Emboli (PE)

Acute Thrombosis

- Recently thrombosed veins are generally distended to an abnormally large size
  - Normally larger than adjacent artery
    - The exception:
      - When the thrombus is small and non-occlusive
      - If the vein is scarred and incapable of dilation

Acute Thrombosis - Compressibility

- Thrombus of any age:
  - The vein lumen cannot be obliterated with compression
- Lack of compressibility of the vein is perhaps the single most reliable finding for differentiating between thrombosed and normal veins
- Thrombus can be excluded only when compression causes the vein to disappear completely

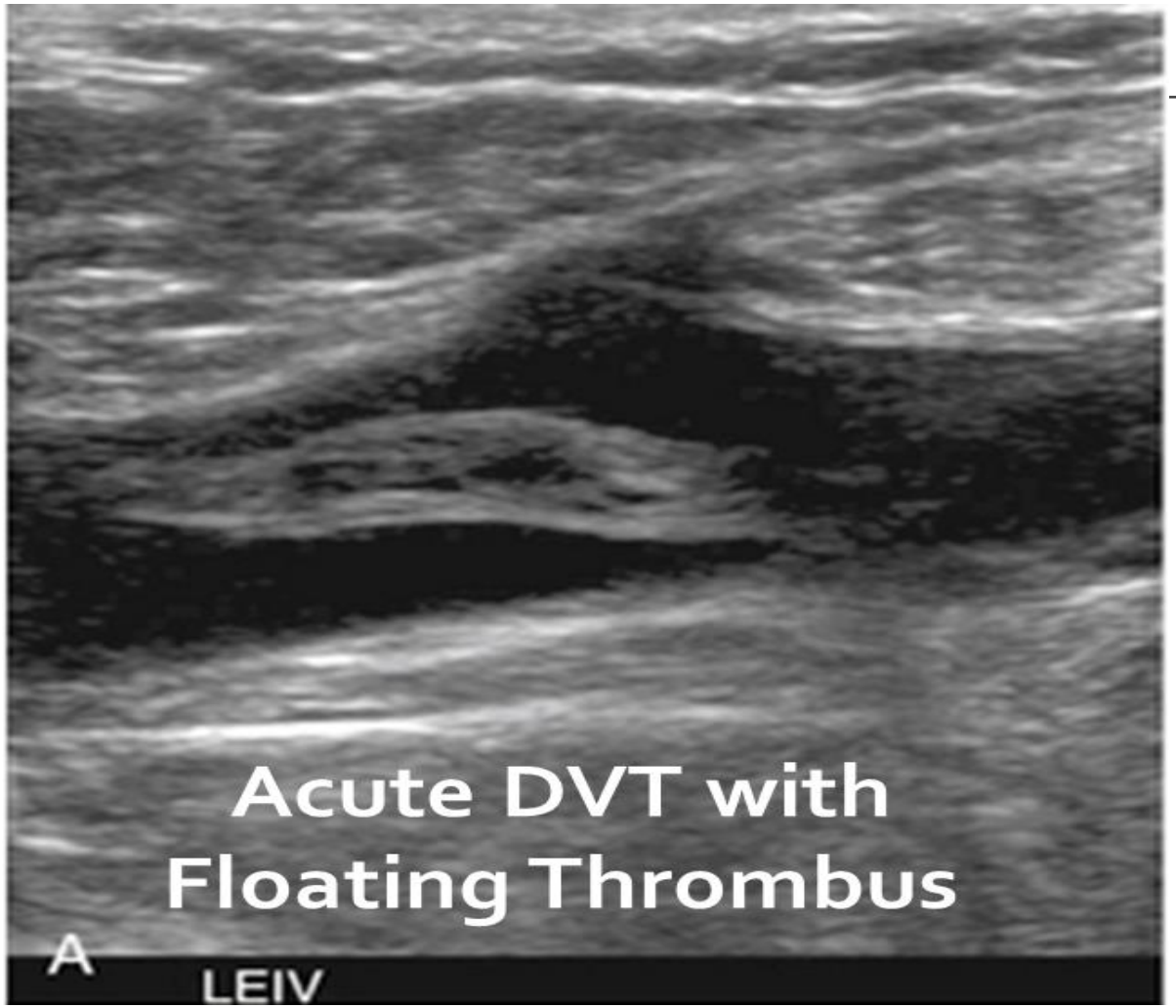
Acute Thrombosis - Compressibility

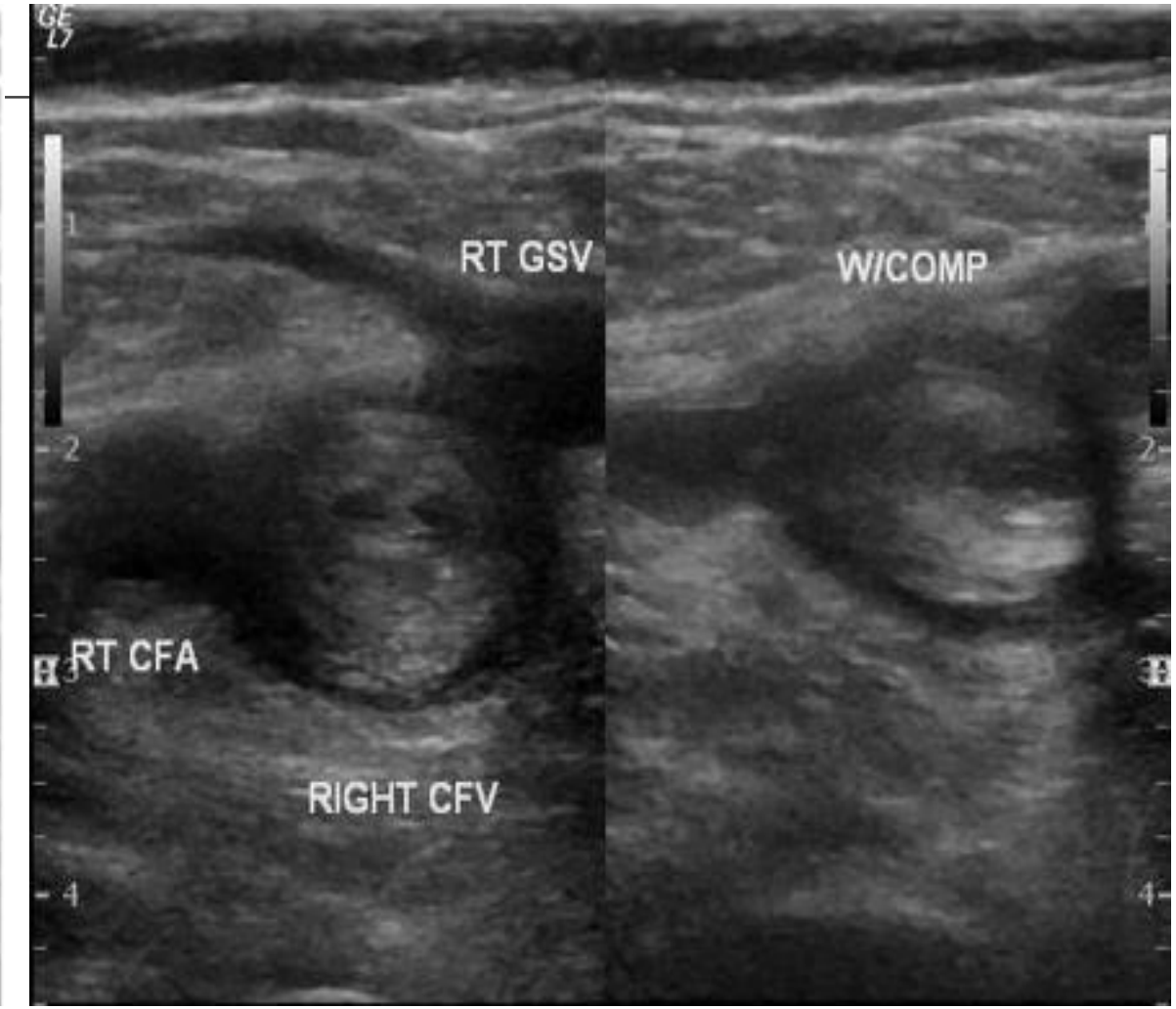
- Lumen may be partially filled with thrombus if the vein does not completely collapse
- Resistance from surrounding muscle may prevent adequate compression of the vein (normally seen in the distal thigh, at the adductor canal)
  - Attempt compression from another position
  - Check for flow voids in the vein using color Doppler

Acute Thrombosis – Floating Thrombus

- Floating thrombus seen at the proximal end of an acute thrombus
  - It represents the most recently formed coagulum and may not attach to the vein wall
- Free-floating thrombus is dramatic - depicts the potential for embolization to the pulmonary circulation
- Do not dislodge floating thrombus by unnecessary manipulation
  - You may need to discontinue compressions and augmentations
- Patient should be kept on the litter and not allowed to walk

Acute Thrombosis





Acute Thrombosis – Doppler Signals

- Doppler signals will be abnormal:
  - If flow is not spontaneous in the CFV, SFV, and/or popliteal veins, there may be an obstruction (DVT or extrinsic compression) distally
    - Spontaneous flow is not expected in the tibial vessels, where flow is normally reduced
  - If flow is continuous instead of phasic in the CFV, SFV, and/or popliteal veins, the obstruction may be more proximal in location

Acute Thrombosis – Doppler Signals

- Doppler signals will be abnormal (continued):
  - If there is no demonstrable augmentation with distal compression, then the obstruction may be located between the level of augmentation and where the transducer is located
  - If there is no augmentation with proximal release, then the obstruction is more proximal in location
  - If flow increases during proximal compression, there may be venous reflux

Acute Thrombosis

- Color flow imaging may demonstrate only partial filling or absence of color in the vessel
- Thrombus is usually poorly attached to the wall
- Thrombus appears spongy
- *Rouleau flow*, represents very sluggish flow – may indicate proximal issues
  - https://www.youtube.com/watch?v=IG7QQu-Ee_c

Chronic Thrombosis

- Normally refers to thrombus 6 months after the acute episode
- Thrombus has been invaded by fibroblast and in the process of becoming organized as fibrous tissue that will persist indefinitely
- Wall thickening is common, leaving the vein size reduced in caliber

Chronic Thrombosis – Echogenicity

- Chronic thrombosis produces focal plaque-like areas along the vessel wall
  - Can project into the lumen
  - Are increased in echogenicity
  - Calcifications may be visible with shadowing
- Web-like synechiae may be present from venous scarring
  - Attached only along one side of the vein

Chronic Thrombosis - Recanalization

- Recanalization may occur to different degrees:
  - Thrombus around its entire circumference
    - Recanalization occurs in the center of the vessel
  - Thrombus attached only along one side
    - Lumen is more readily re-established
      - Thrombus is converted to fibrous tissue only along the side where the thrombus adheres

Chronic Thrombosis – Valve Abnormality

- Valve damage is a frequent outcome of chronic DVT
- The valve cusps thicken and adhere to the vessel wall, restricting movement
  - This prevents the valves from meeting in the center of the vessel
- Valve damage will result in:
  - Reflux
  - Persistent venous stasis

Chronic Thrombosis – Valve Reflux

- Is evident on:
  - Color Doppler (will see one color traveling cephalad and then it reverses flow to travel caudal)
  - Audible Doppler
  - Spectral Doppler (will see spectral waveform below the baseline, then it will be above the baseline)
- Is very evident with augmentation
- Reflux may result in varicosities, chronic edema, skin thickening, discoloration and ulcerations

Chronic Thrombosis – Doppler Signal

- Lack of spontaneous flow
- Lack of phasicity
- Absence of the Valsalva response
- Subnormal or absent augmentation

Pulmonary Embolism

- Detached intravascular solid, liquid, or gaseous mass that travels from the systemic circulation into the pulmonary circulation
- A "PE" can be a complete or partial obstruction of the pulmonary circulation
- DVT is a serious and potentially lethal disorder

Chronic Venous Insufficiency

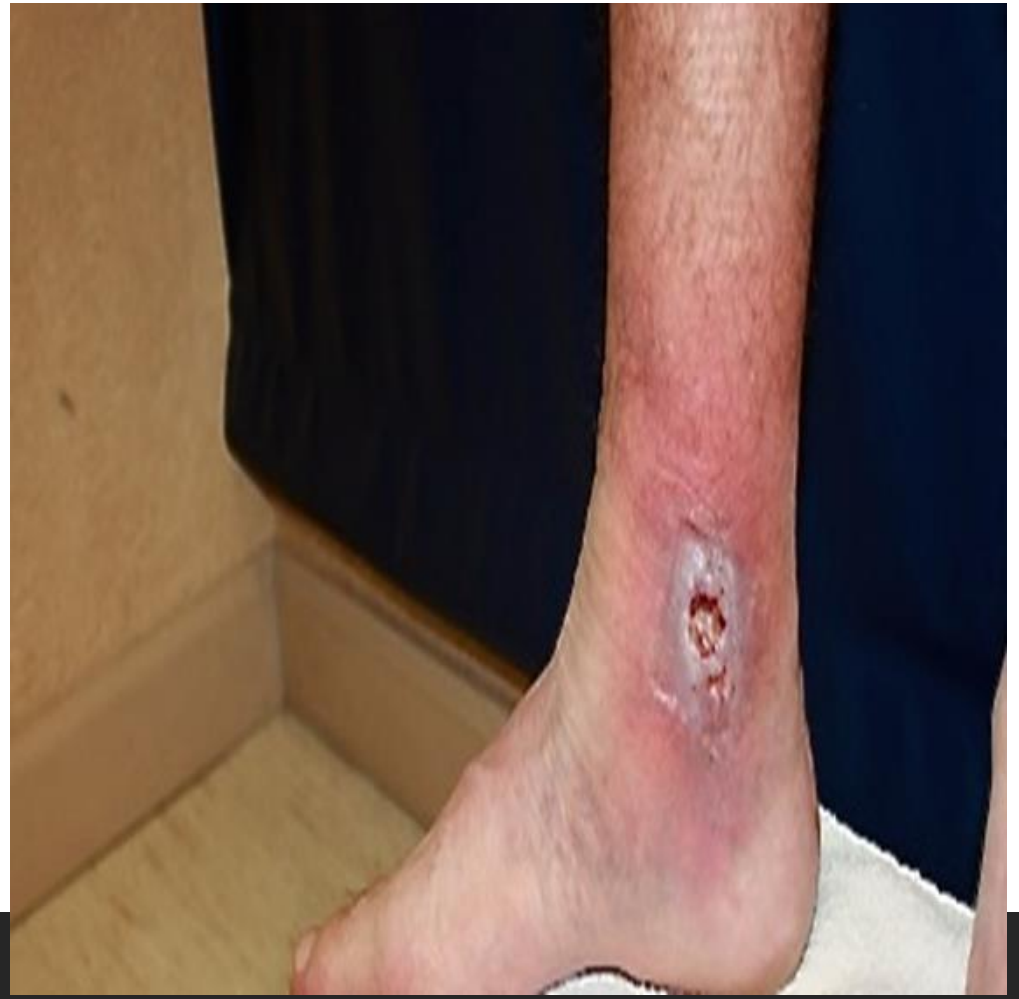
- Valve leaflets are immobile and fixed to the vein wall
  - Incompetence of the system results
  - Reflux occurs when standing
- In some patients the thrombosed veins do not recanalize resulting in chronic obstruction to venous return
- Venous hypertension occurs regardless of whether the cause is proximal obstruction, reflux, or both

Chronic Venous Insufficiency

- Is caused by venous obstruction and/or venous reflux with resulting dilation of the capillaries with an increased leakage of plasma, plasma protein and RBC
- Oxygen transport is impaired with eventual hypoxia, ischemia, fat necrosis, skin pigmentation and ulceration

Chronic Venous Insufficiency

- Presents clinically:
  - Chronic leg swelling
  - Ankle pigmentation or discoloration
  - Ankle ulceration in the “gaiter zone”



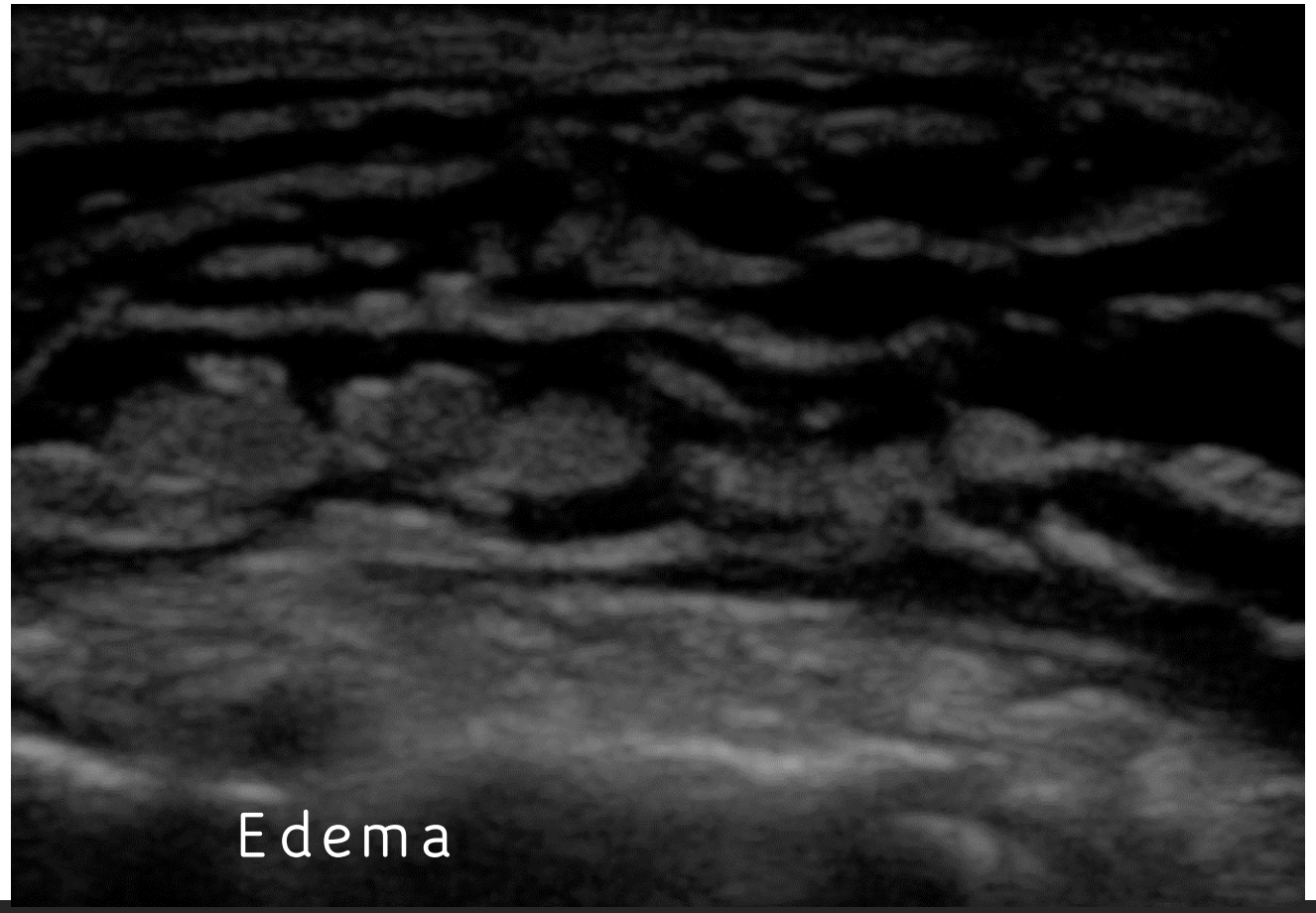
Chronic Venous Insufficiency

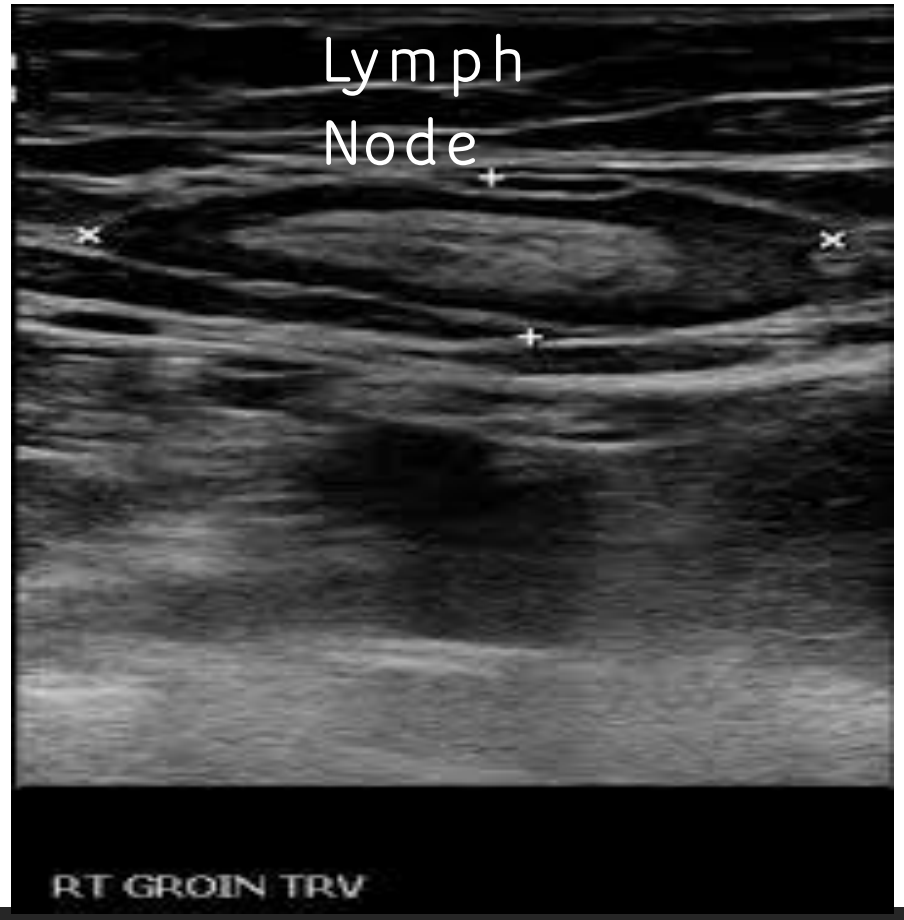
- If reflux is visualized on spectral Doppler that is <0.5 seconds, this is considered to be normal valve closure time
- True reflux is >0.5 (superficial system) or >1 second (deep system) depending on the location
- Color flow imaging will demonstrate a directional shift in color flow during compression

Miscellaneous Findings in the Extremities

- Edema – excessive fluid in the body tissues
- Lymph nodes – bright central sinus echo with hypoechoic outer cortex
- Baker's cyst – cystic structure located in the popliteal fossa, comprised of synovial fluid and may cause pain and/or swelling

Miscellaneous Findings in the Extremities

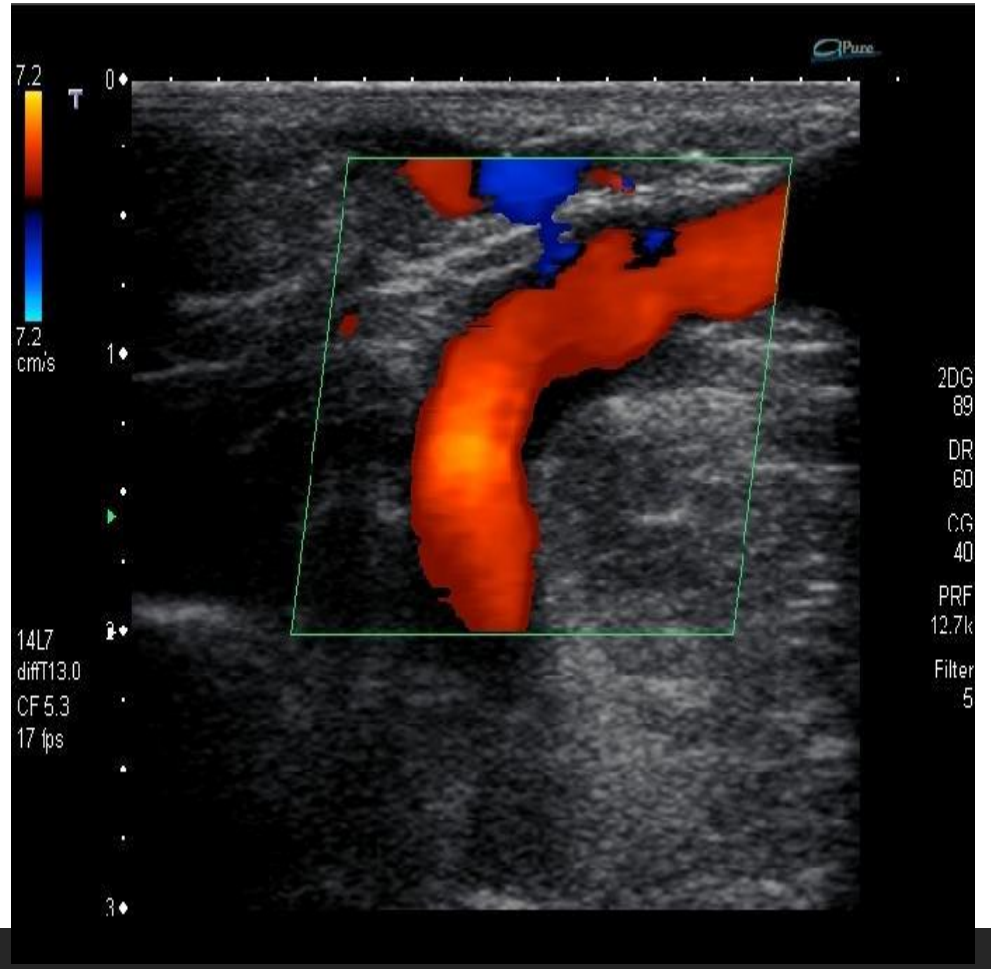





LONGITUDINAL
TRANSVERSE
POSTERIOR MEDIAL KNEE BAKER'S CYST
6.0 cm
2D: G: 34
DR: -1
MB
6.0 cm
2D: G: 34
DR: -1
MB
SonoSite
HFL50xp/15-6 MSK
MI: 0.6 TIS: 0.2

Incompetent Perforating Veins

- Associated with reflux in the superficial venous system
- Perforator measures >3.5mm, reflux is typically found
- Patient with stasis changes at the ankle (skin discoloration, ulceration, etc), the incompetent perforator lie posterior to the affected skin area



Miscellaneous Findings in the Abdomen

- IVC Filter
  - Often found below the level of the renal veins
- Portal hypertension
  - Increased resistance to flow results in retrograde (hepatofugal) flow within the portal system
- Budd-Chiari syndrome
  - Hepatic vein occlusion