

OBJECTIVES OF THIS LECTURE:

UNDERSTAND VENOUS ANATOMY AND HEMODYNAMICS

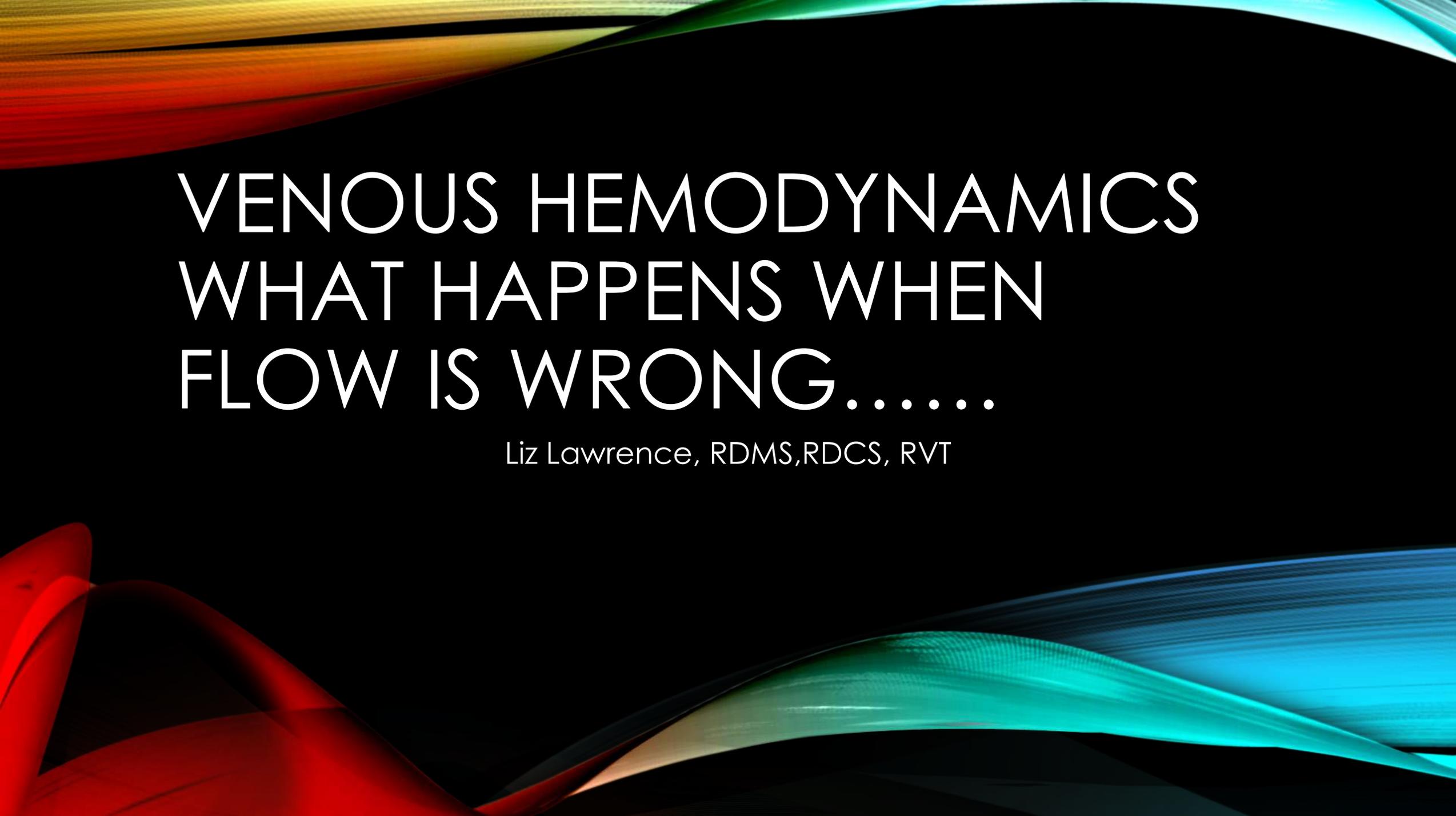
BE ABLE TO IDENTIFY NORMAL AND ABNORMAL VENOUS ANATOMY AND HEMODYNAMICS BY DUPLEX ULTRASOUND

RECOGNIZE THE CLINICAL SIGNS AND SYMPTOMS OF VENOUS HYPERTENSION

BECOME FAMILIAR WITH SUPERFICIAL VENOUS ANATOMY AND HEMODYNAMIC ABNORMALITIES

KNOWLEDGE OF THE SCANNING PROTOCOL, PATIENT POSITIONS, AND MANEUVERS TO DEMONSTRATE VENOUS INSUFFICIENCY

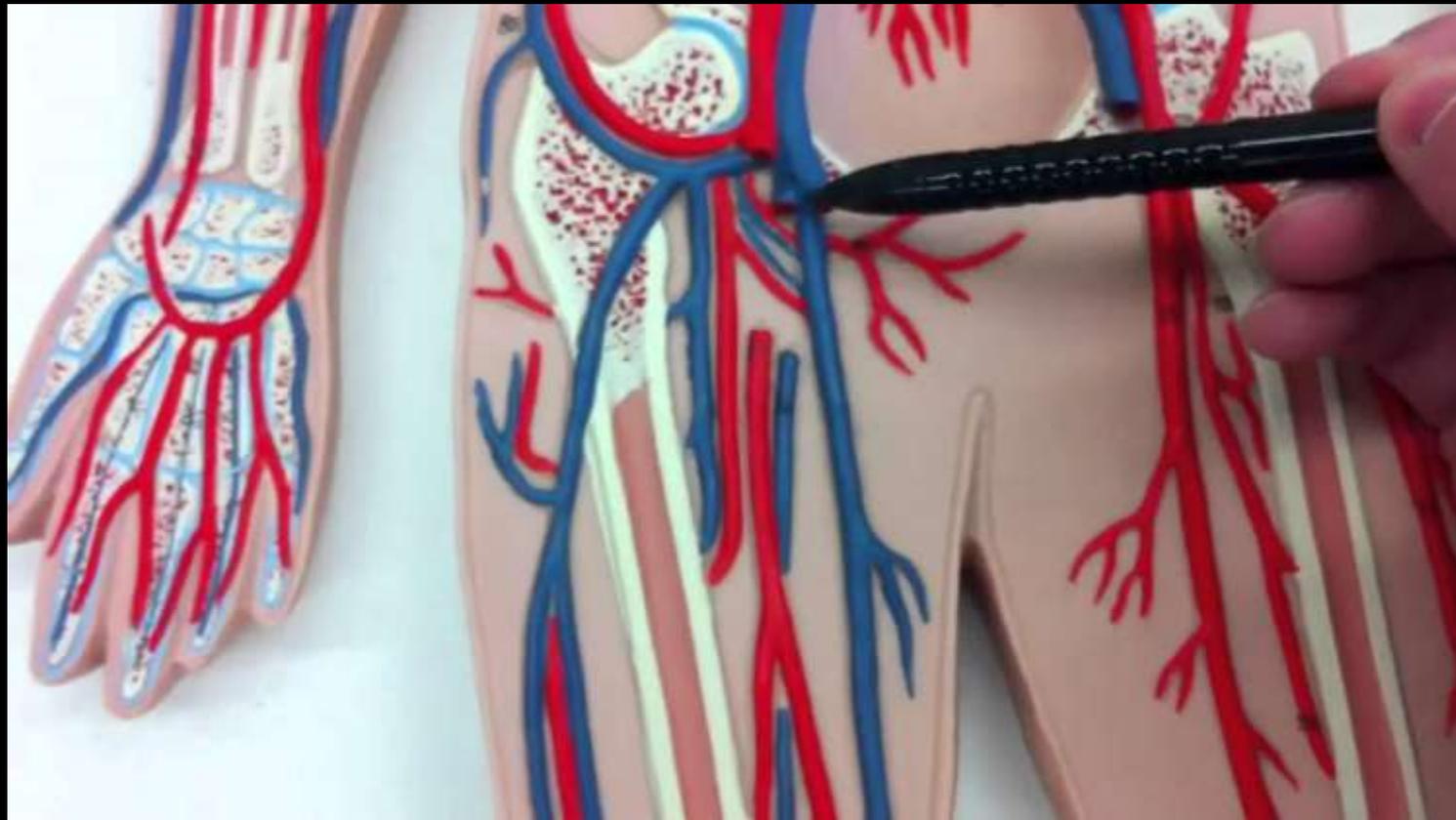
Liz Lawrence, RDMS,RDCS, RVT



# VENOUS HEMODYNAMICS WHAT HAPPENS WHEN FLOW IS WRONG.....

Liz Lawrence, RDMS,RDCS, RVT

# KNOW YOUR ANATOMY

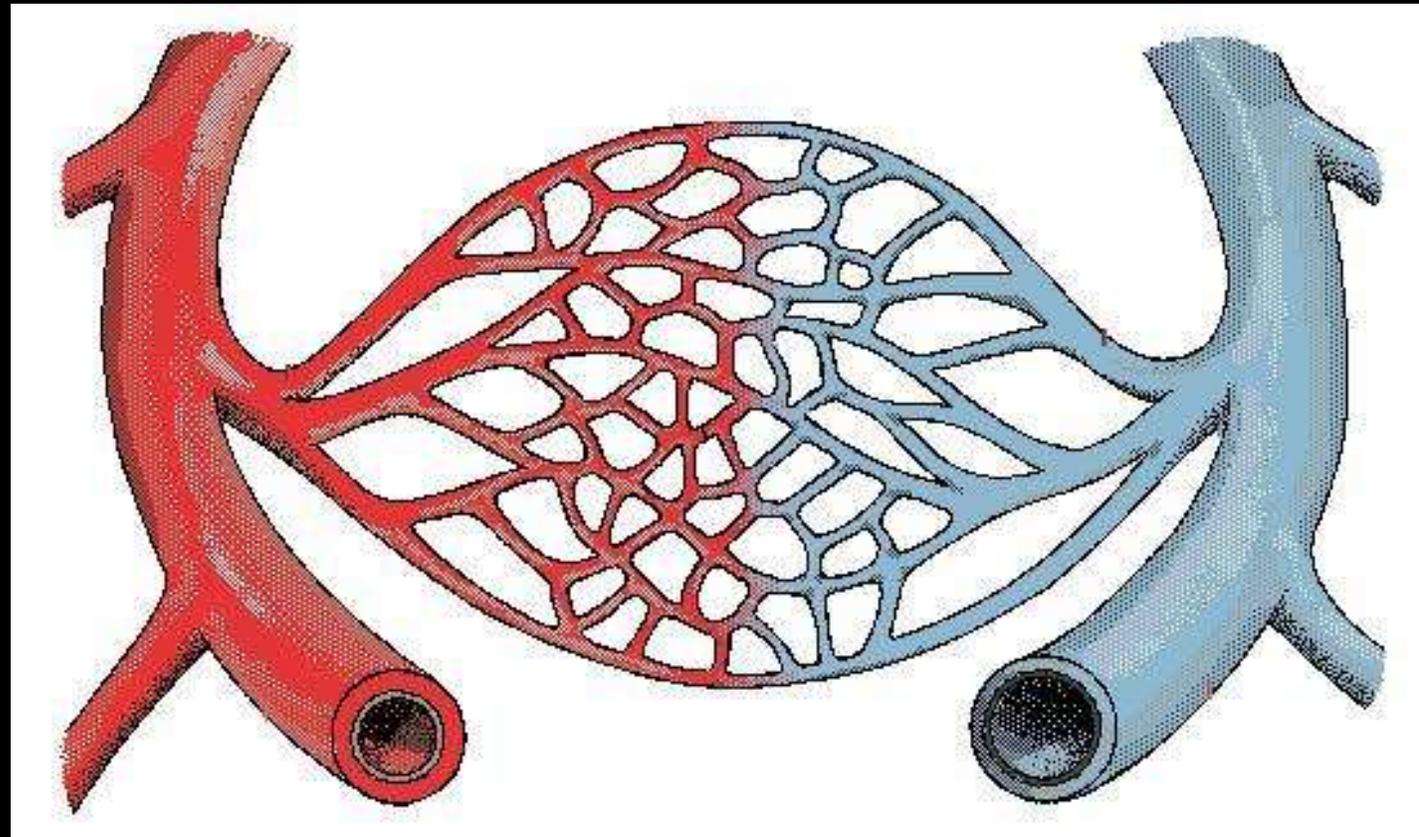


# THE START OF VENOUS ANATOMY

## The Capillary Bed

Arterioles

Size is 20-30 $\mu$ m  
Micrometer  
On millionth of a  
meter



Venules

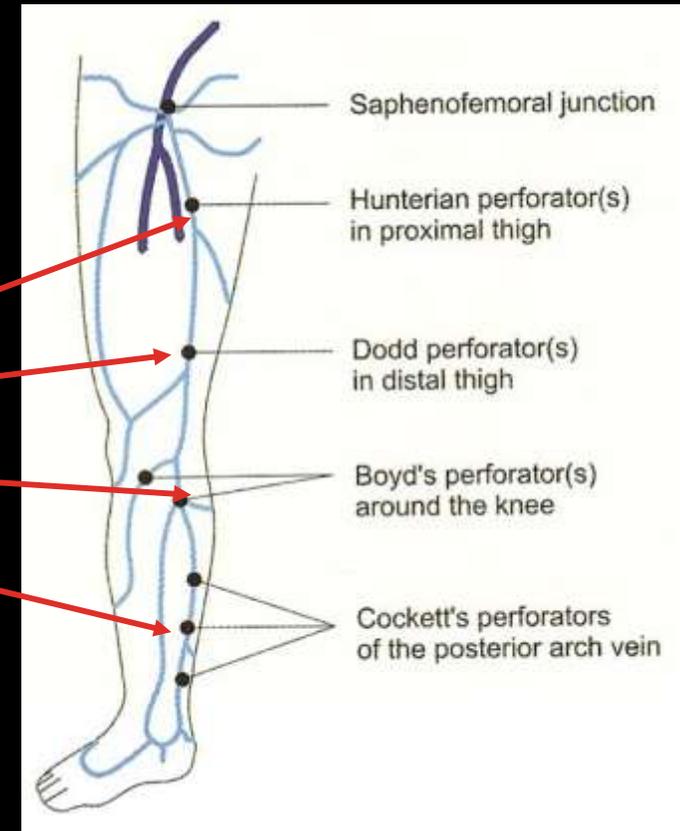
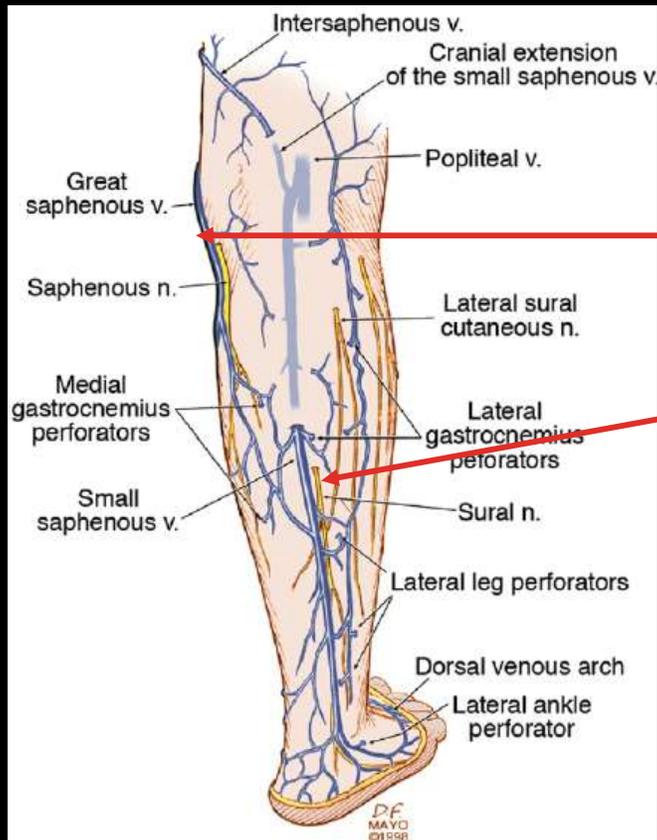
# SUPERFICIAL VENOUS ANATOMY

Superficial veins flow to the major superficial veins - Saphenous Veins:

Perforators:

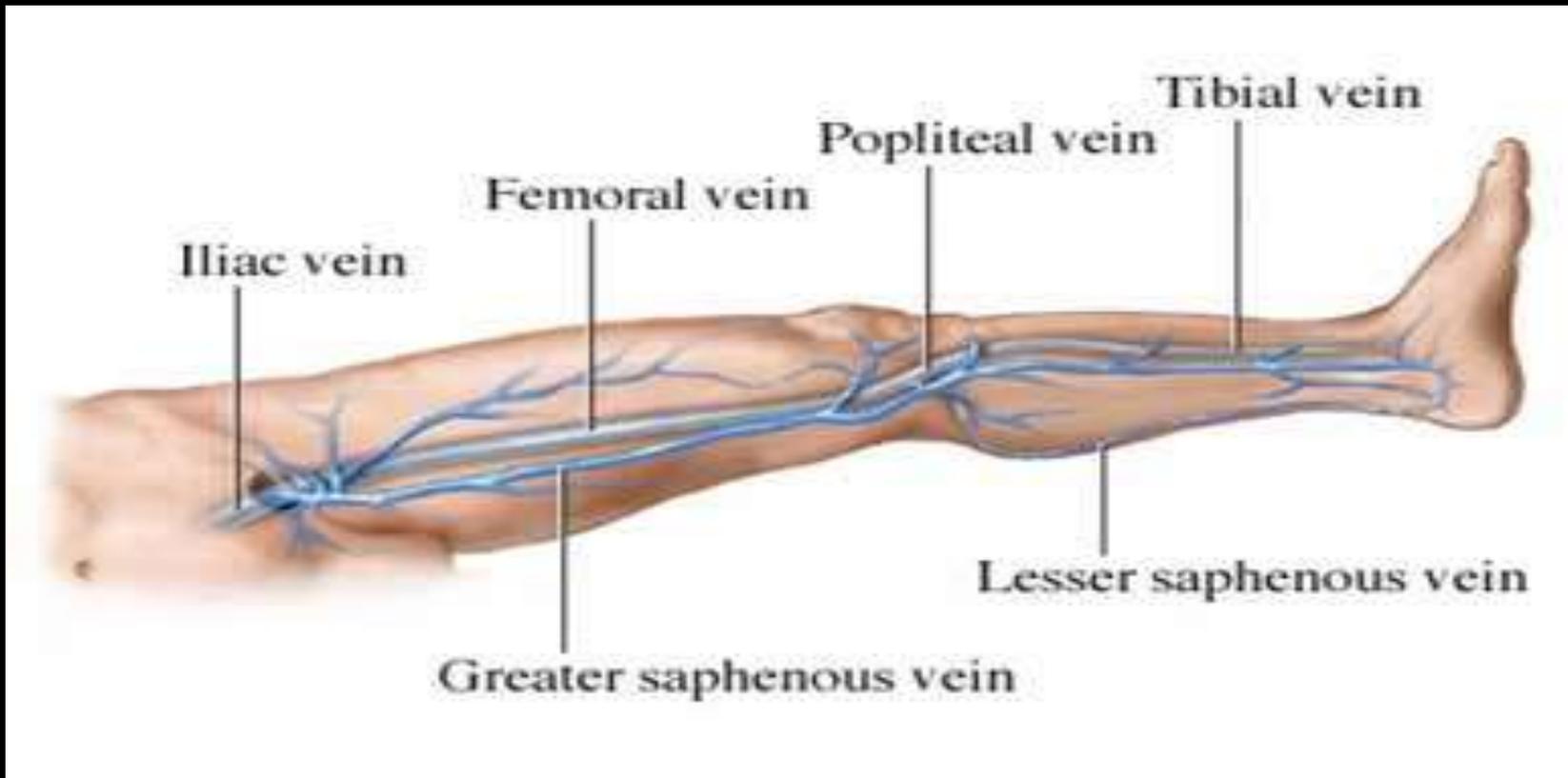
Greater  
Lessor / Small

Hunterian  
Dodd  
Boyd  
Cockett



# LOWER EXTREMITY DEEP VENOUS ANATOMY

Superficial veins flow into the Deep Veins



Common Femoral

Profunda/Deep Femoral

Femoral Vein

Popliteal Vein

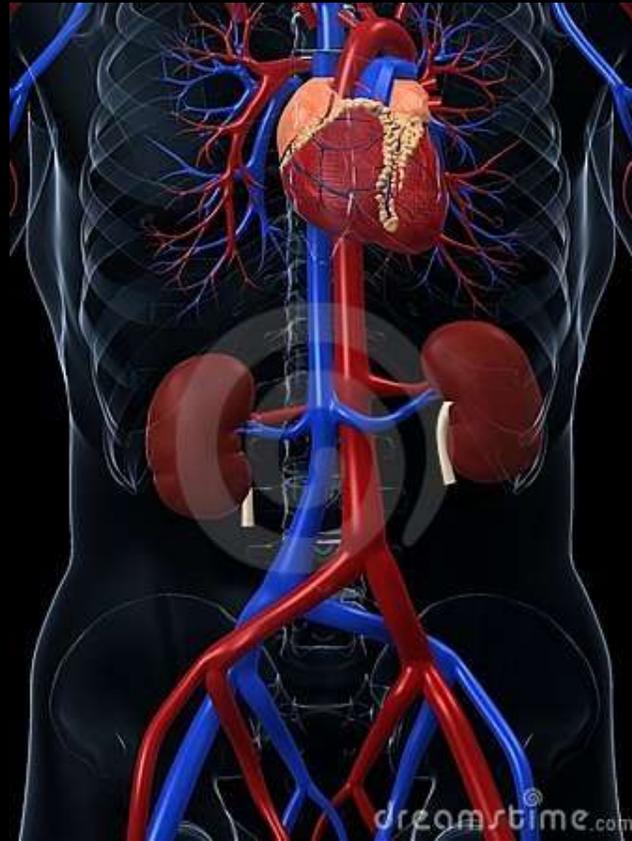
Gastrocnemius Veins

Posterior Tibial Veins

Anterior Tibial Veins

Peroneal Veins

# LOWER VEINS FLOW TO THE HEART

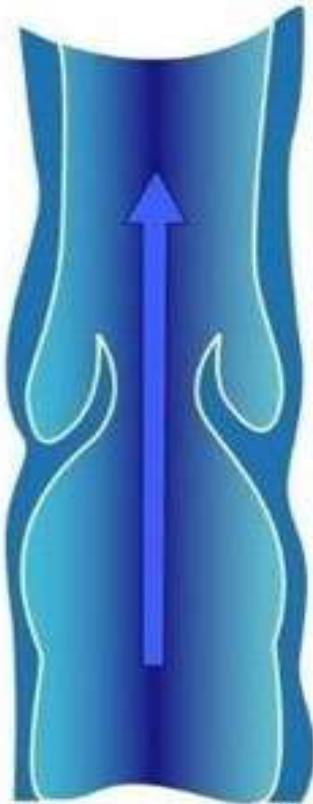


Carried to the heart by the  
Inferior Vena Cava

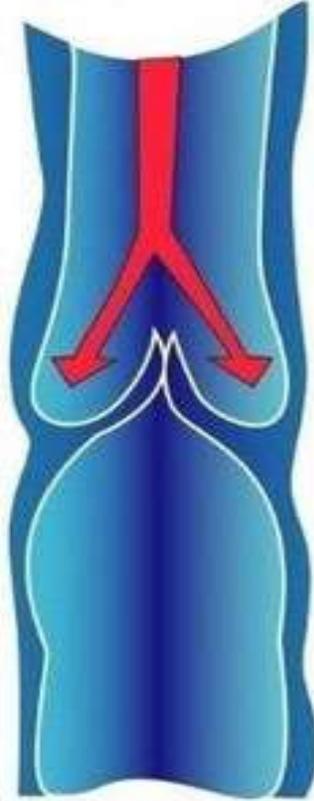
VENOUS FLOW IS EFFECTED  
BY ABDOMINAL  
AND THORACIC PRESSURE

This is important to  
remember when  
looking at venous  
flow patterns

## Normal One-Way Vein Valves



Blood flowing  
to heart



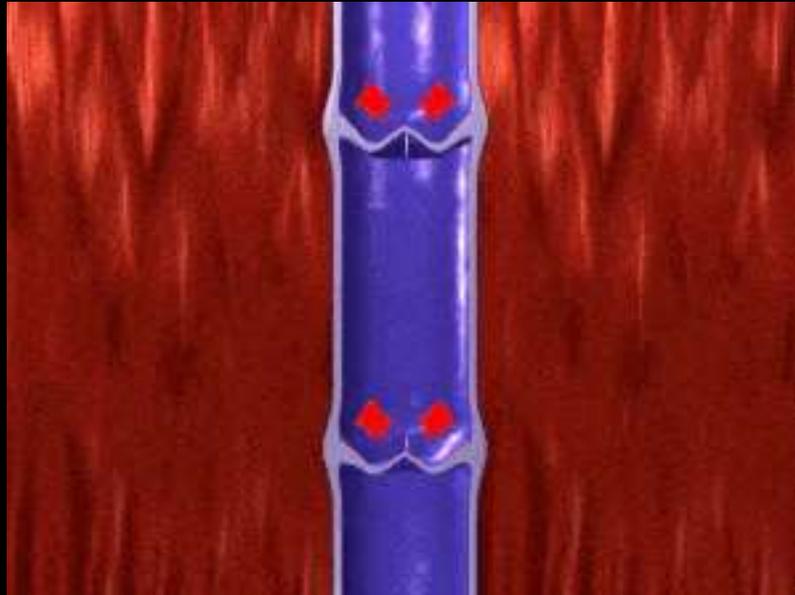
Healthy valve  
prevents reverse  
blood flow

# VENOUS VALVES

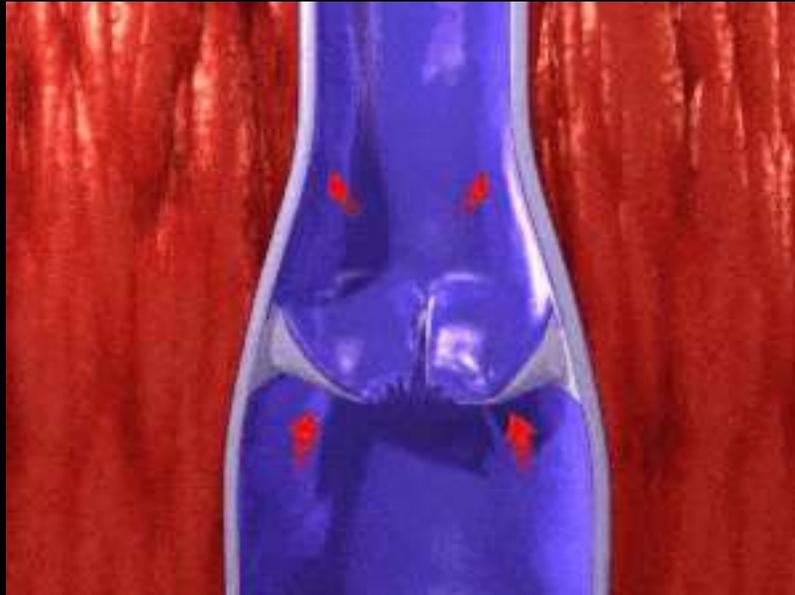
Valves are responsible for keeping flow going in the right direction – TOWARD THE HEART

When the valves fail it results in Venous Hypertension

# NORMAL VALVES

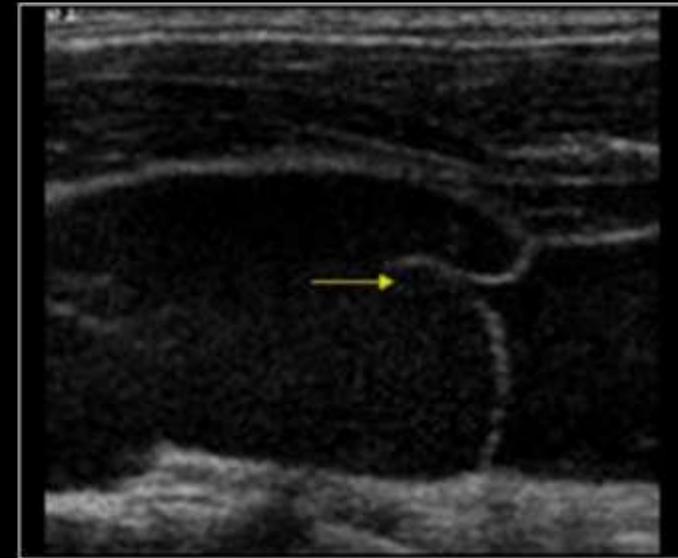


# WHEN VEIN VALVES ARE ABNORMAL



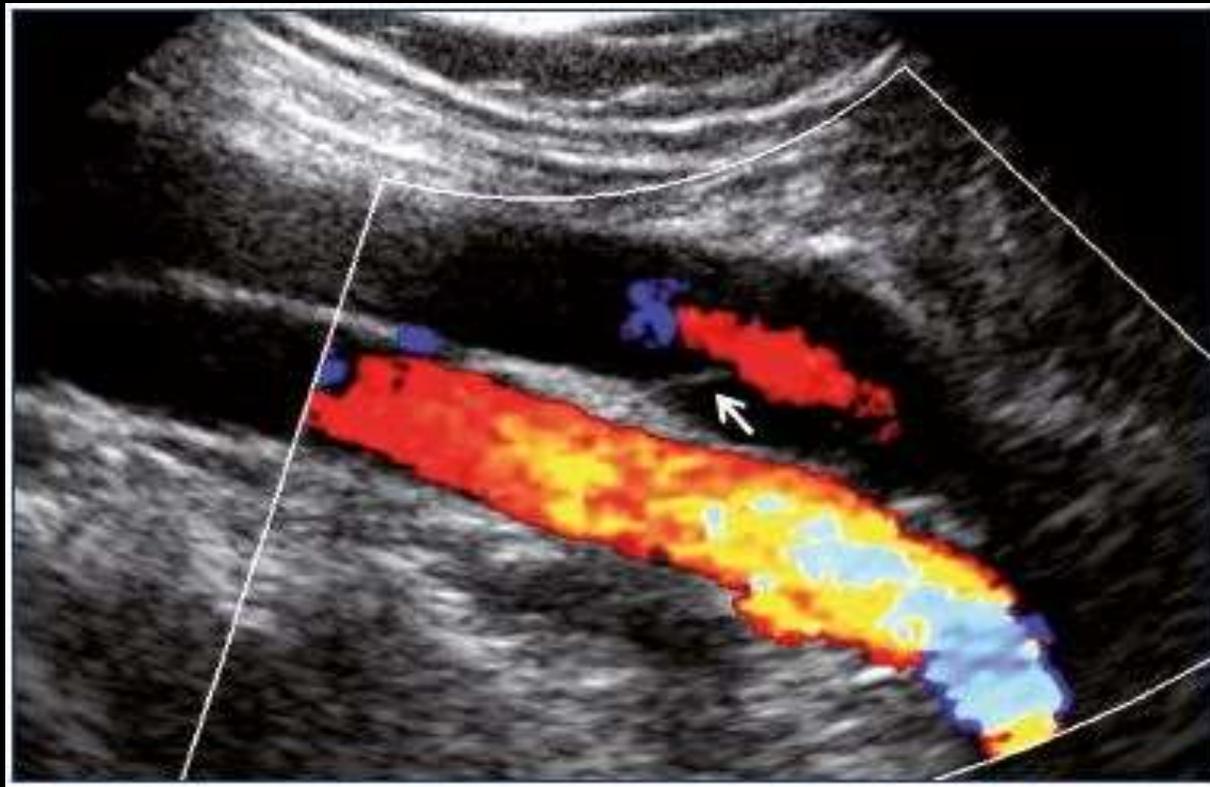
# VALVE SEEN BY ULTRASOUND

Venous Valve



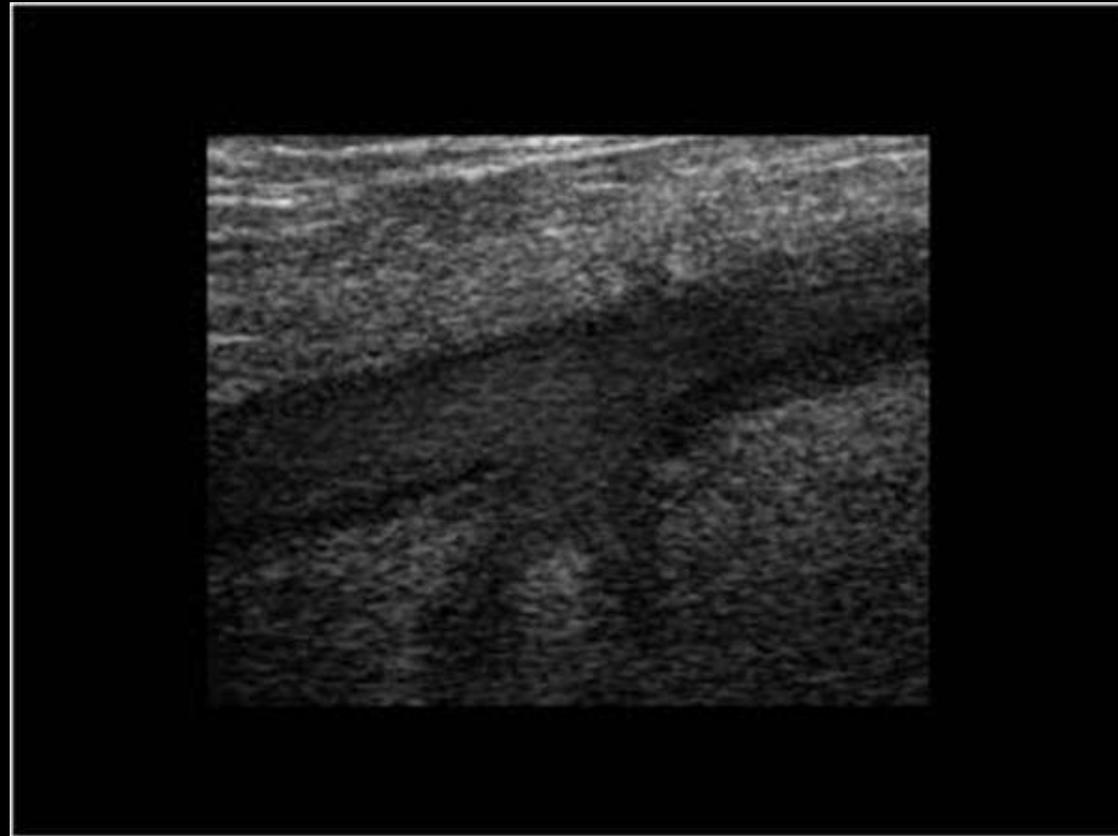
Courtesy of Dr. Taco Geertsma  
[www.ultrasoundcases.info](http://www.ultrasoundcases.info)

# INCOMPETENT VALVE BY COLOR DOPPLER



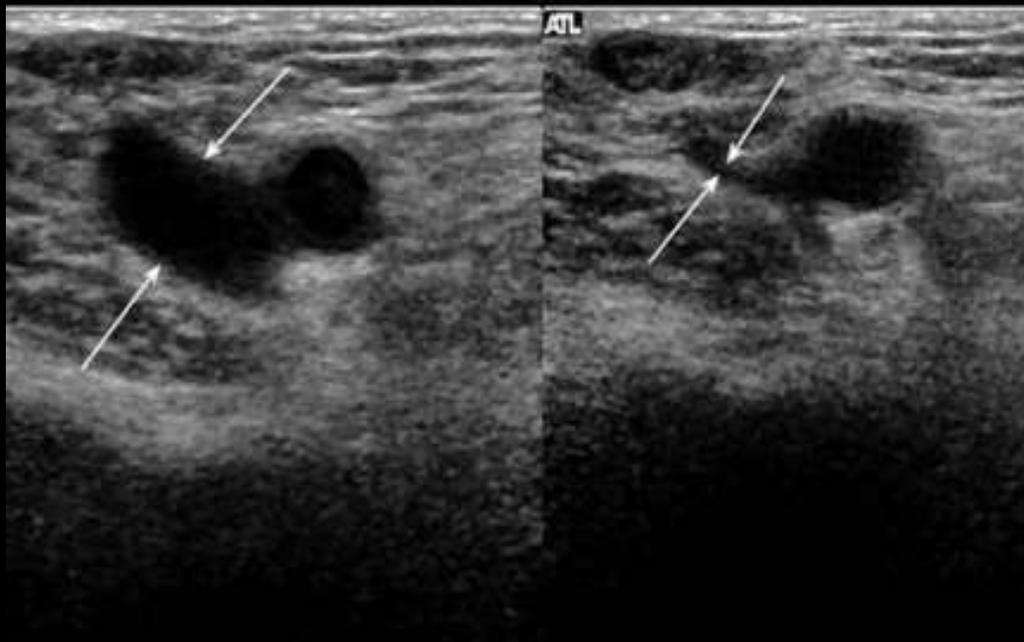
The flow color of this popliteal vein is red at a valve– the same color as the artery (which is in the direction of the foot) this is indicative of an incompetent vein valve

# 2D VENOUS ULTRASOUND IMAGING



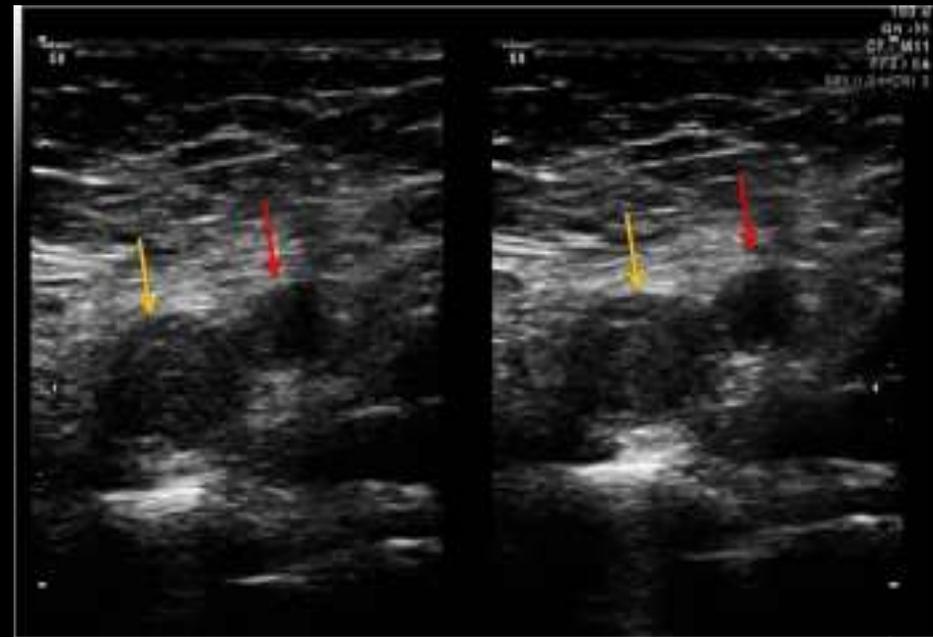
# NORMAL VEINS COMPRESS WITH PRESSURE

# VEINS WITH THROMBUS DON'T!

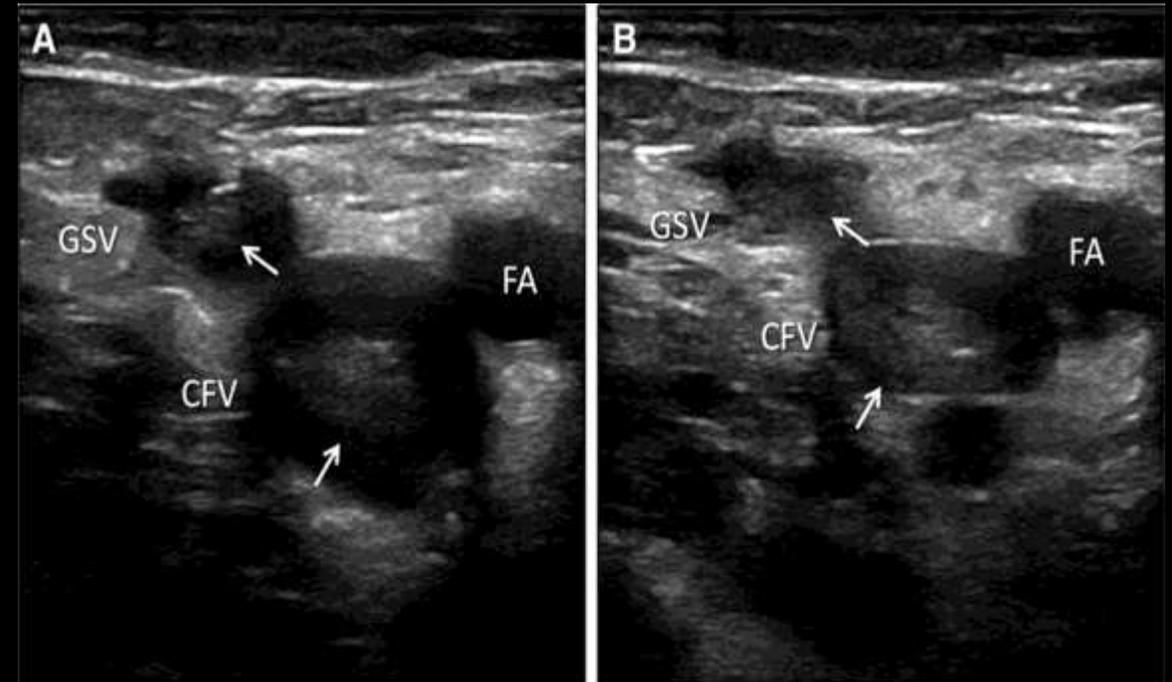
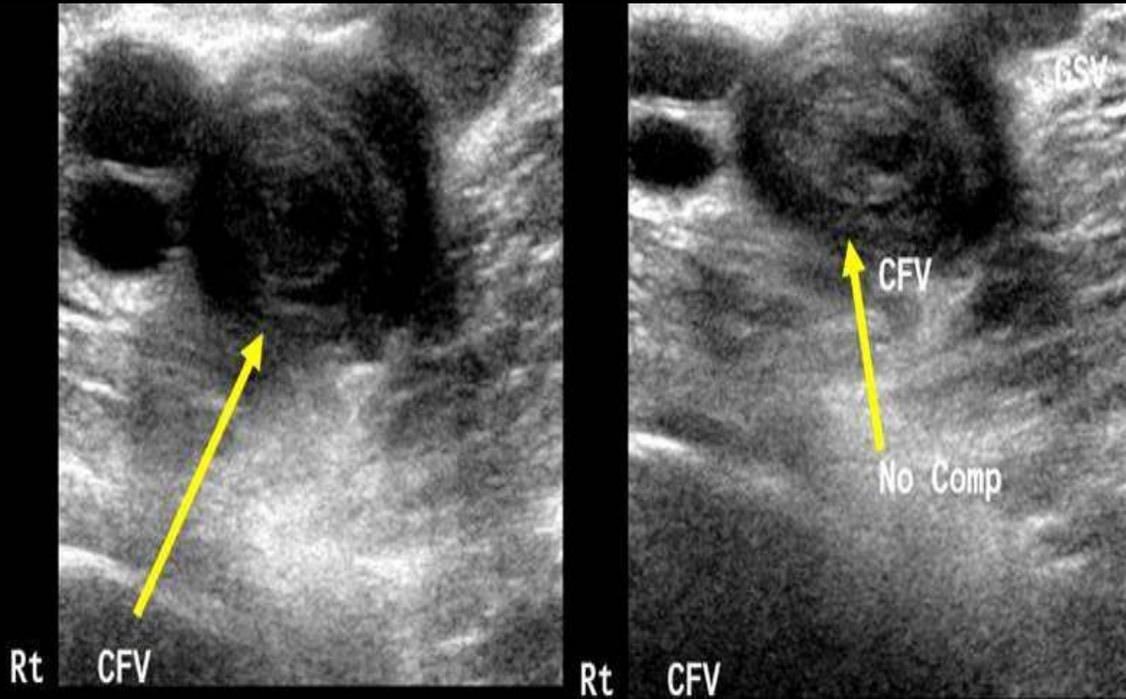


NO COMP

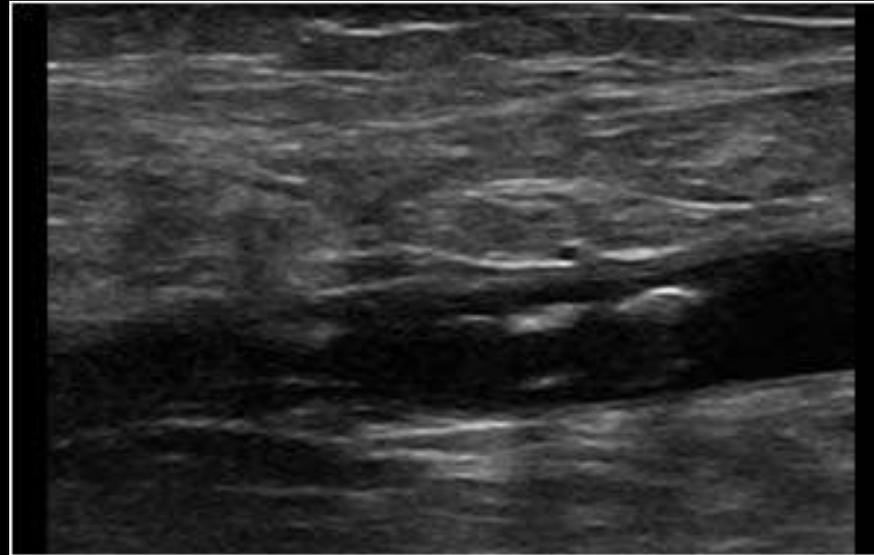
COMP



# VARIATIONS OF VEIN THROMBOSIS



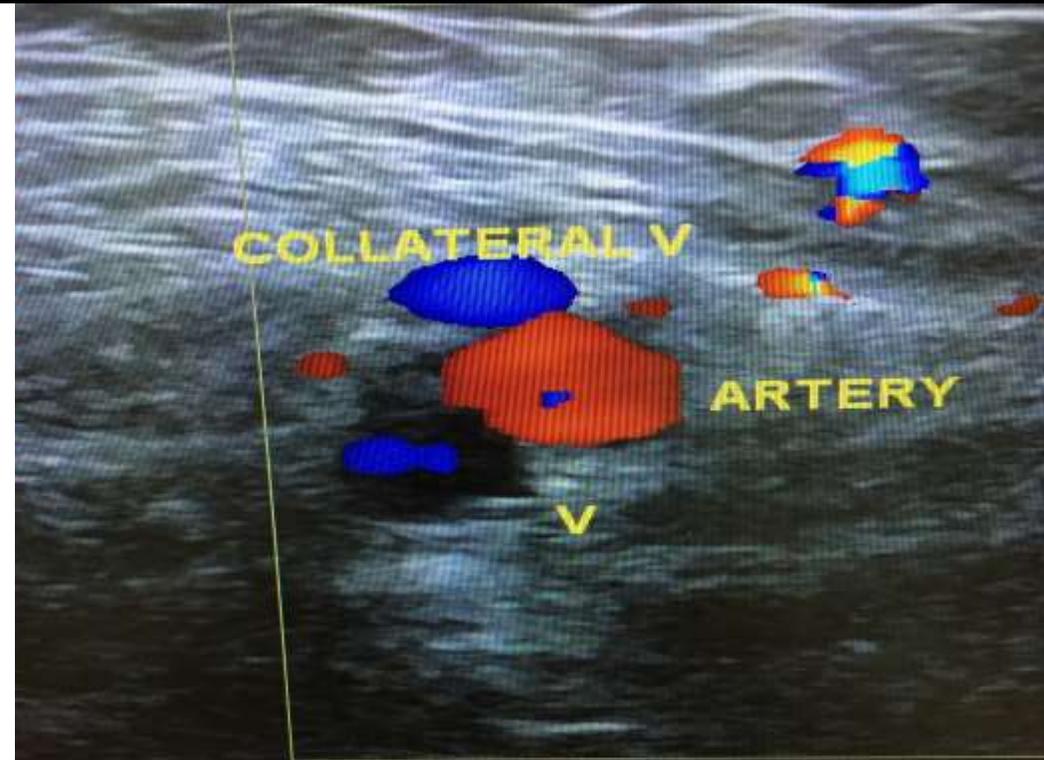
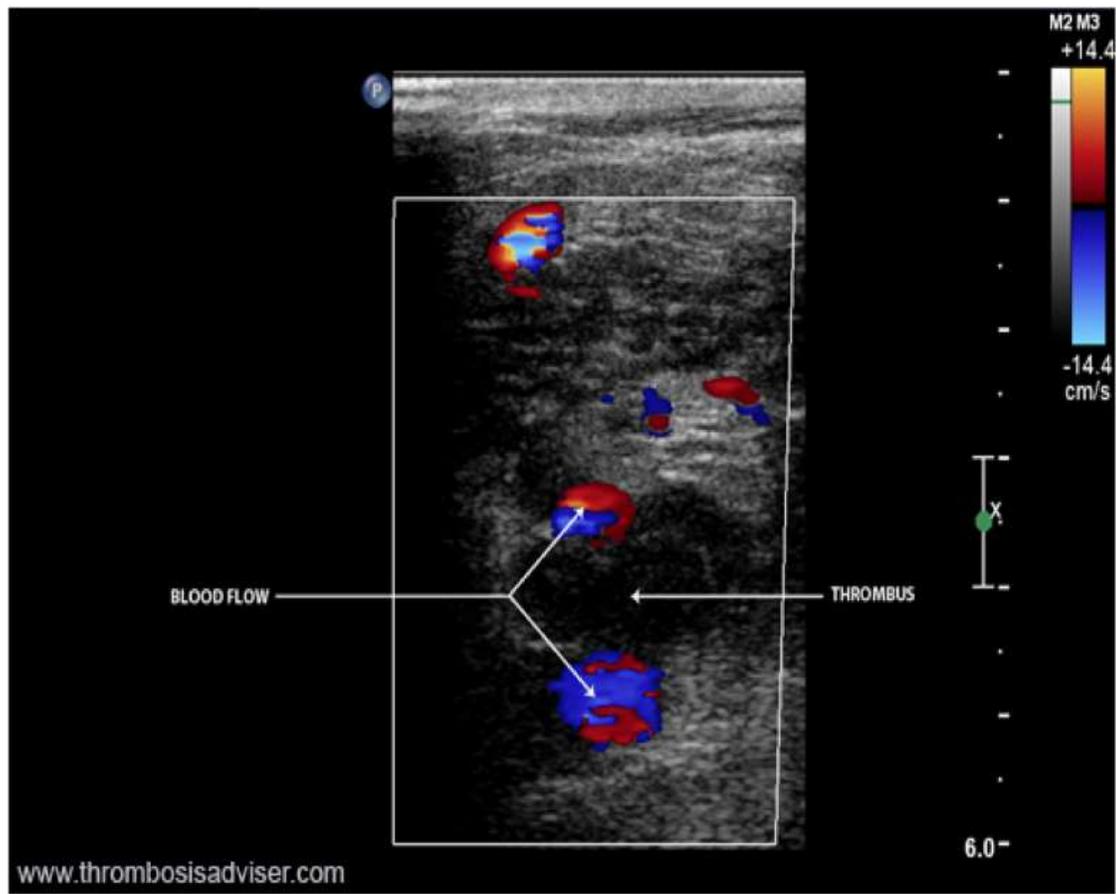
# CHRONIC VENOUS DISEASE



Veins that have residual matter left after an acute thrombus resolves.

Patients who get immediate anticoagulate therapy for DVT may not have evidence of Chronic changes – If the DVT goes undetected or untreated for a longer duration – it is more likely the vein will display chronic signs of previous clot.

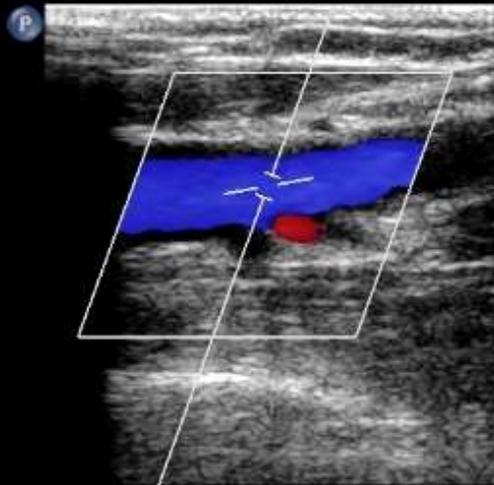
# COLLATERAL VEINS WITH CHRONIC VENOUS DISEASE



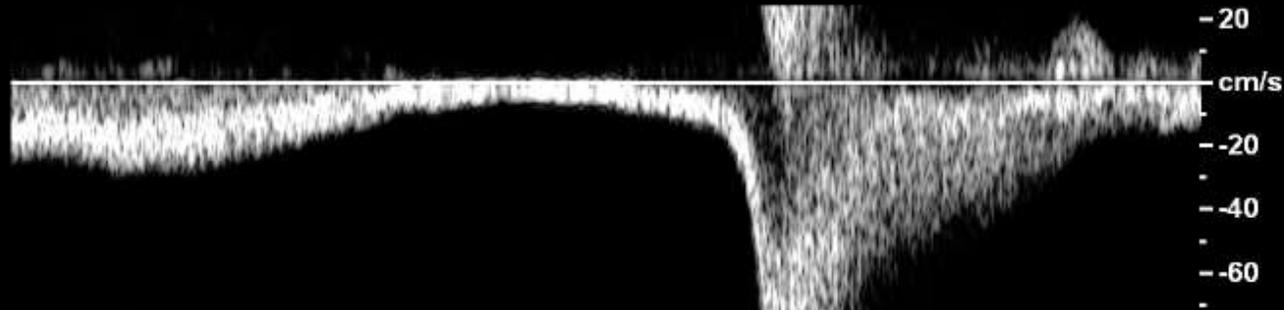
# VENOUS FLOW

P1

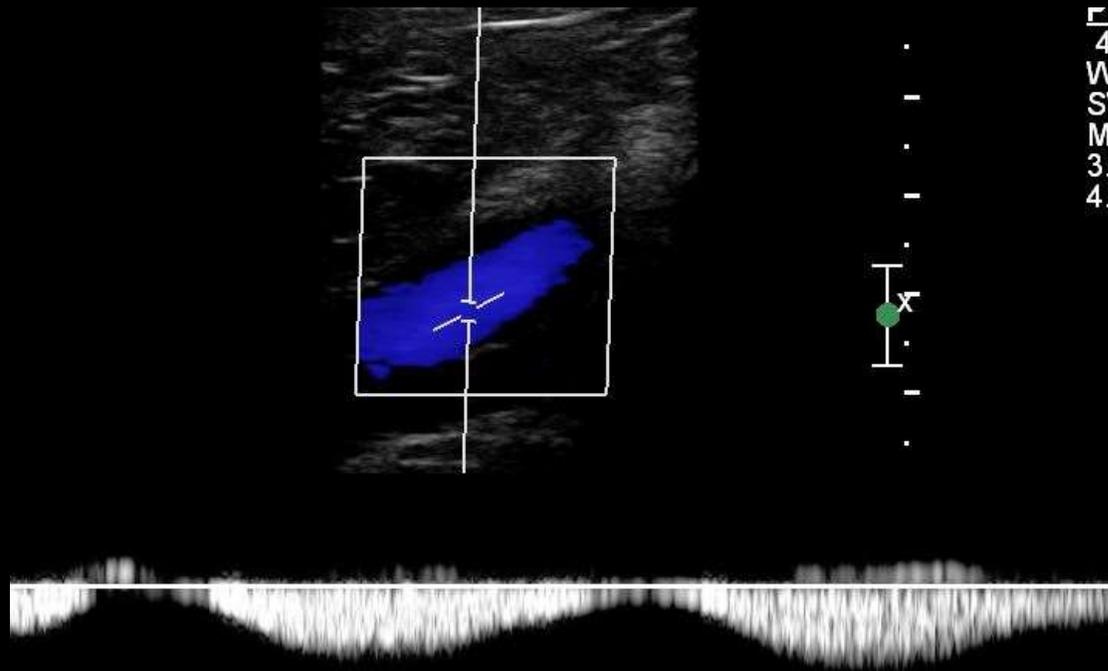
**2D**  
44%  
C 52  
P Med  
Gen  
**CF**  
58%  
1688Hz  
WF 109Hz  
Med



**PW**  
40%  
WF 40Hz  
SV 2.0mm  
M3  
4.0MHz  
1.6cm



# PARAMETERS OF NORMAL VENOUS FLOW



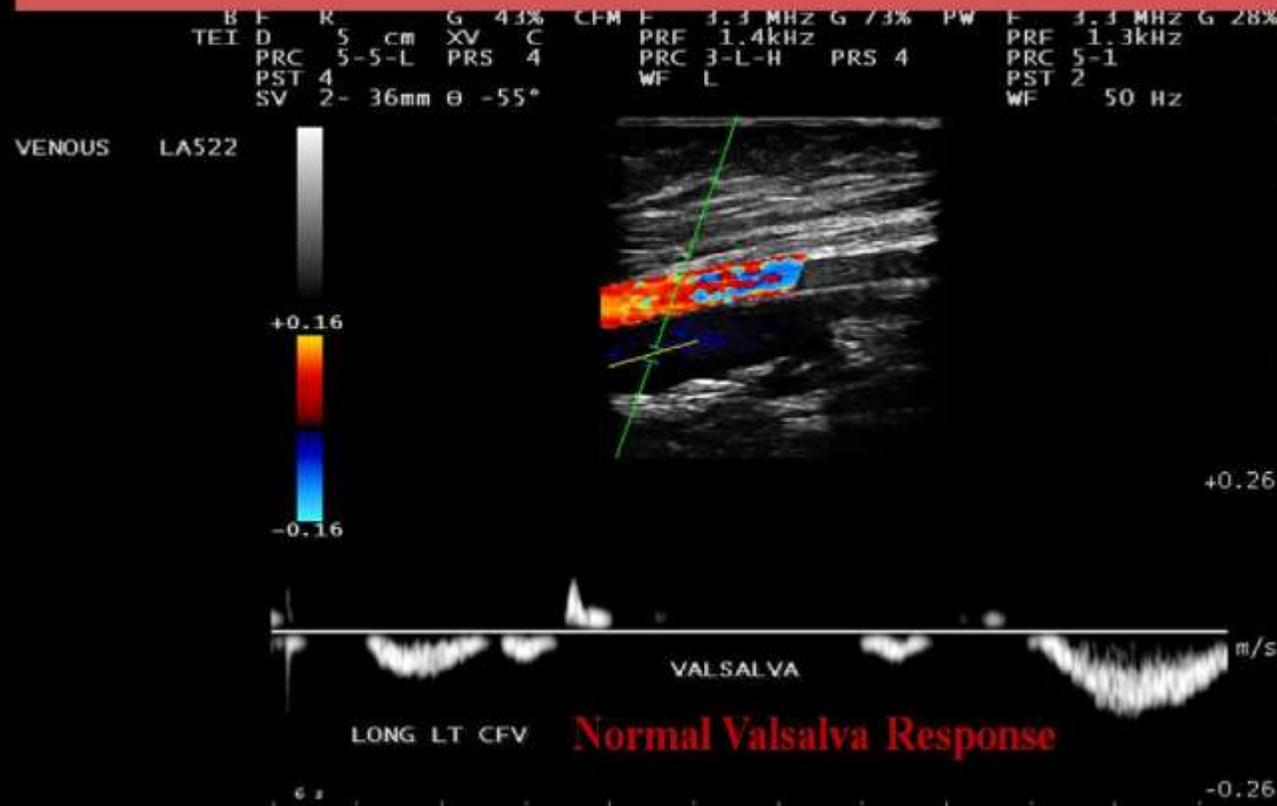
SPONTANEOUS  
PHASIC FLOW

Venous flow  
responds to  
respiration

Right Pop V

# PARAMETERS OF NORMAL VENOUS FLOW

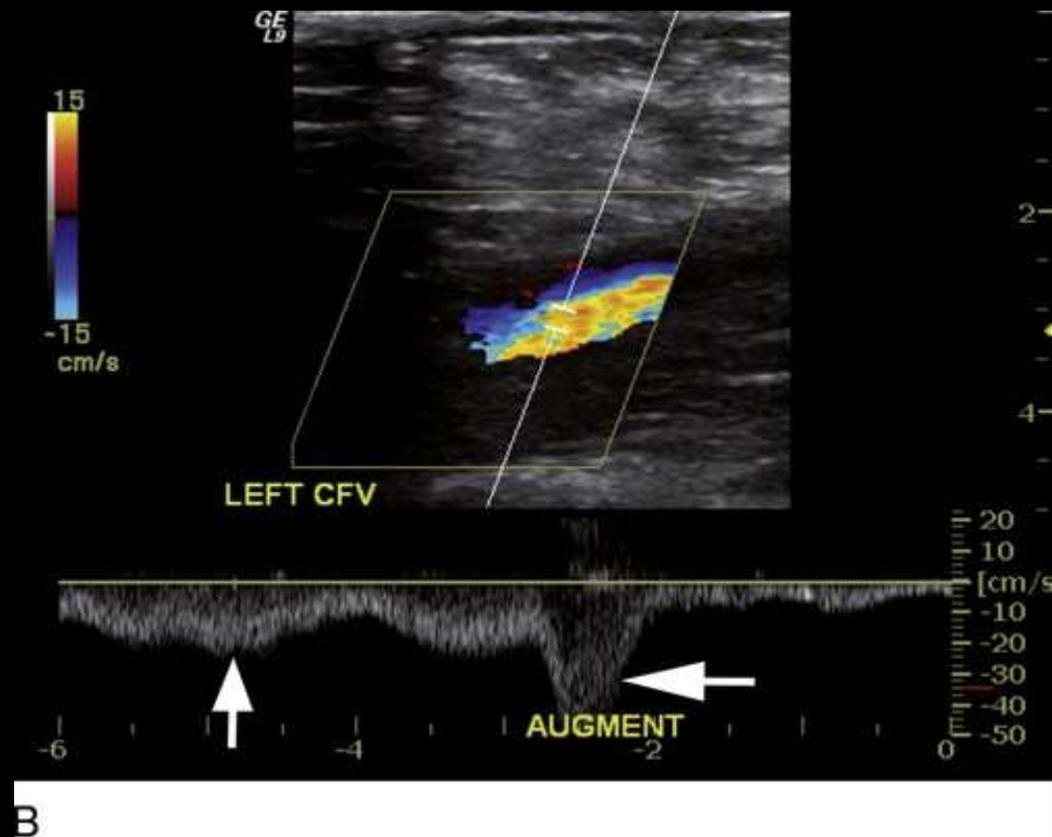
## Doppler Exam



Venous flow  
responds to  
Valsalva  
Maneuver

Normal  
response will be  
absent flow

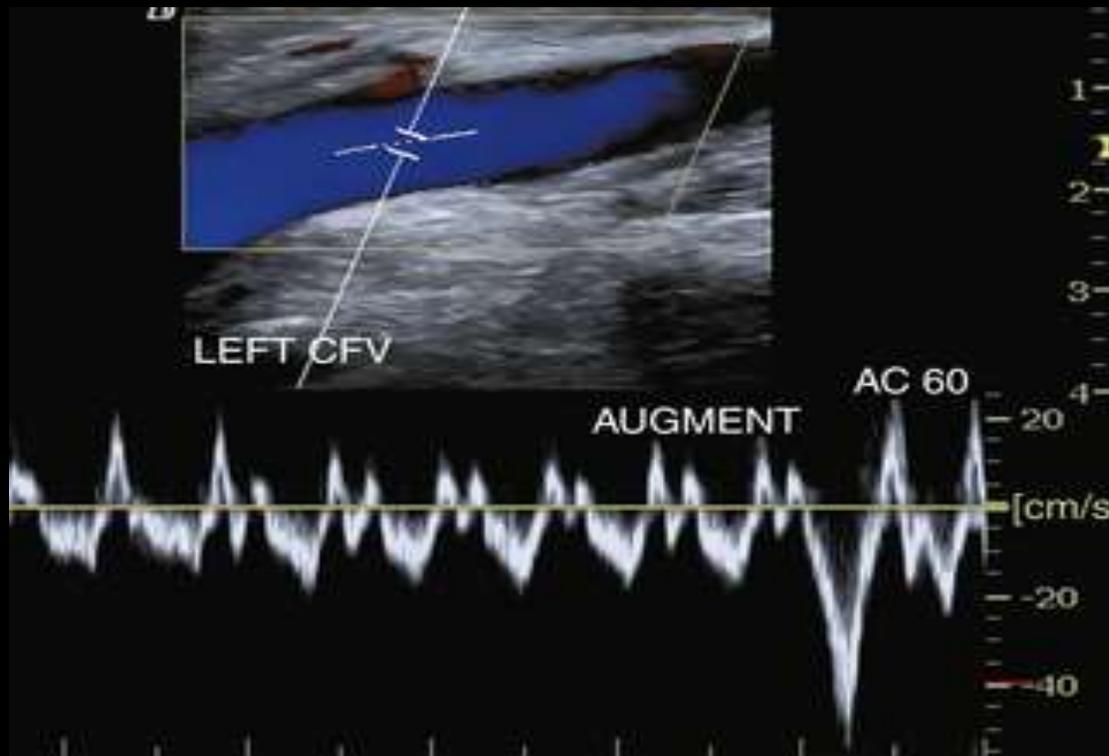
# PARAMETERS OF NORMAL VENOUS FLOW



AUGMENTATION  
FLOW

Venous flow  
responds to  
Distal  
Augmentation

# WHEN VENOUS FLOW IS ABNORMAL



## PULSITILE FLOW

Is due to right sided heart volume overload.

The Vein may be completely normal

Causes are:

Pulmonary Hypertension

Atrial Fib

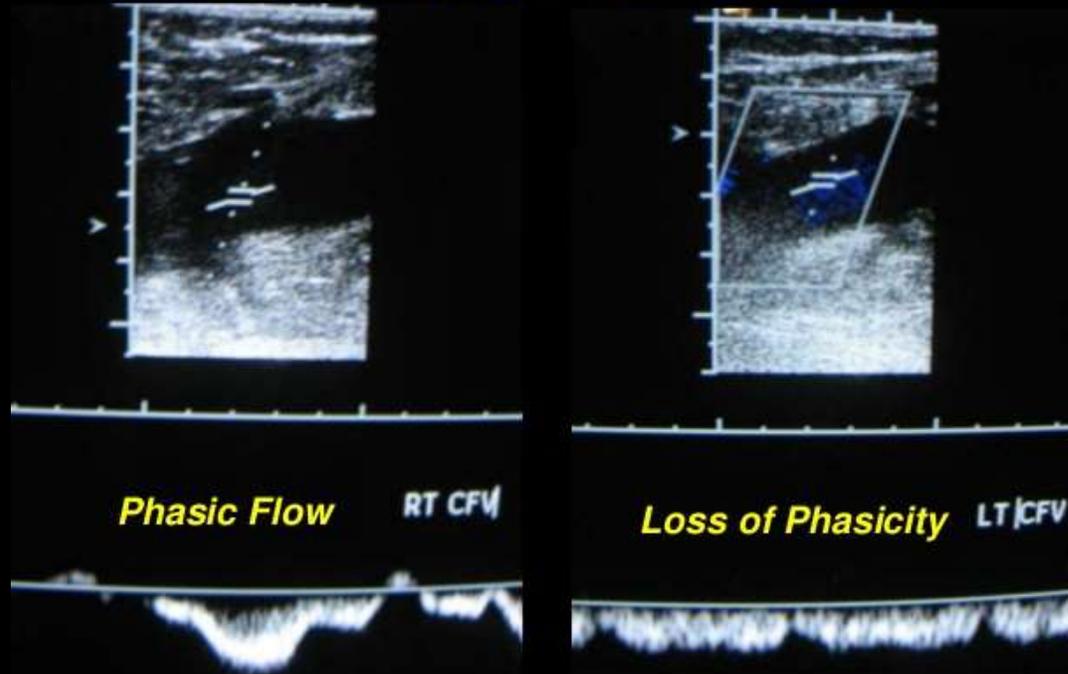
Congestive Heart Failure

Significant Tricuspid Valve Regurgitation

These conditions can cause BILATERAL leg Swelling – especially beginning at the ankles

# WHEN VENOUS FLOW IS ABNORMAL

## CFV flow pattern on admission



## CONTINUOUS FLOW

Can be due to proximal venous obstruction

Causes are:

May-Turner syndrome

Proximal Venous Obstruction

Post-Thrombotic syndrome

Have the patient take a deep breath –  
Make sure it is TRUE continuous flow

# WHEN VENOUS FLOW IS ABNORMAL

## REFLUX FLOW

When Valves are damaged – flow moves forward then backwards

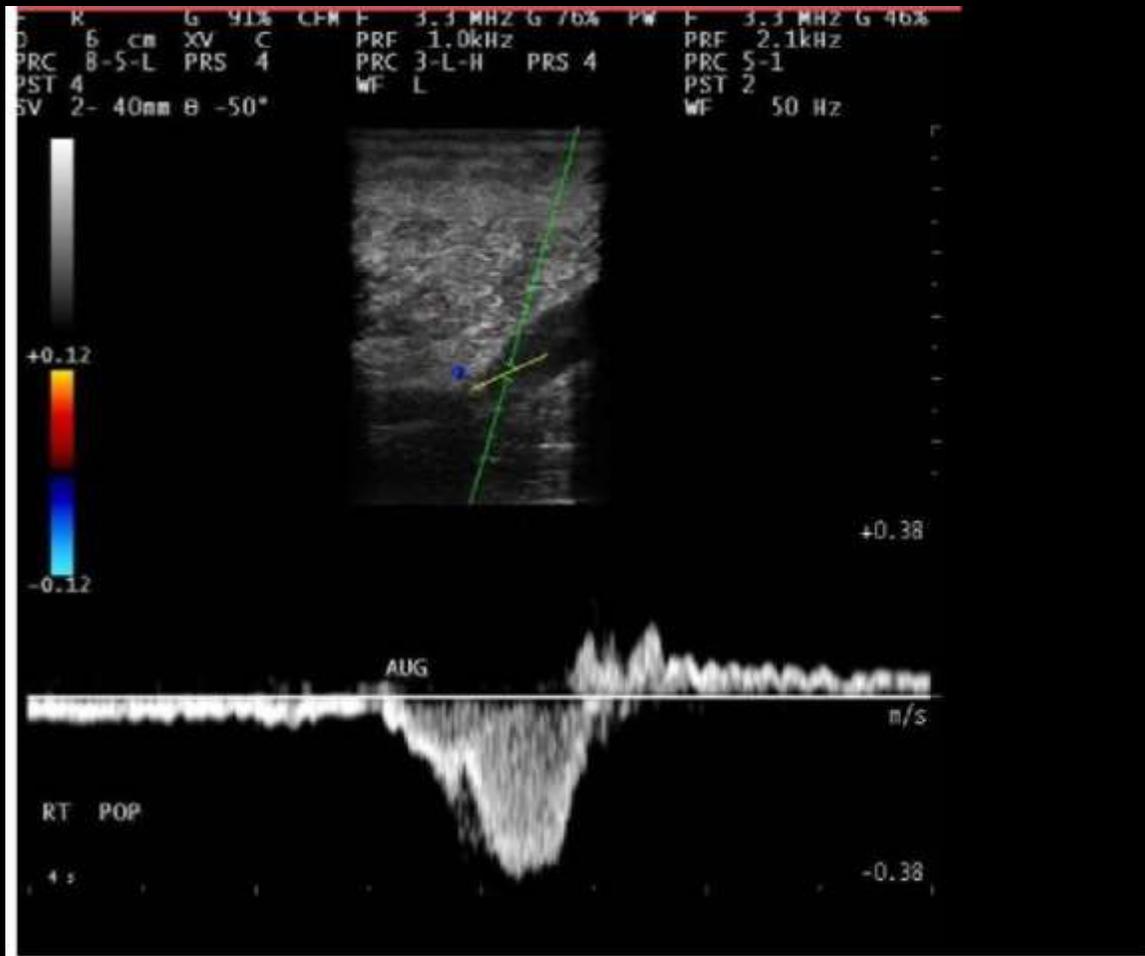
Causes are:

Post-Thrombotic syndrome

Obesity

Heredity- Family History of Venous Insufficiency

Reversed flow in the lower extremity veins is called **VENOUS INSUFFICIENCY**



# DIAGNOSTIC CRITERIA

## **Acute DVT**

Thrombus float in vessel  
Composed of RBC and fibrin  
  
Low level echogenicity  
Acoustically homogenous  
Thrombus expands diameter  
of veins  
Collaterals absent  
Vein non-compressible  
No evidence of recanalization  
within vessel

## **Chronic DVT**

Thrombus adherent to vessel wall  
Composed of fibrin and covered  
with endothelium  
Enhanced echogenicity  
Acoustically heterogenous  
Diameter of vein decreases with  
time  
Collaterals present  
Partially compressible  
Recanalization within vessel

DVT=Deep vein thrombosis, RBC=Red blood cell

# CLINICAL SIGNS OF DEEP VENOUS INSUFFICIENCY

## Postthrombotic syndrome



Postthrombotic pigmentation



Healed skin ulcer and postthrombotic pigmentation



Chronic (left) leg swelling, skin hardening, and postthrombotic pigmentation

# CLINICAL SIGNS OF SUPERFICIAL VENOUS INSUFFICIENCY

VARICOSE VEINS	CHRONIC VENOUS INSUFFICIENCY		
Bulging veins	Leg swelling	Skin color and texture changes	Venous ulcers
			

CVI and Post Thrombotic Syndrome present the same clinically.

The ultrasound exam can determine which venous system (deep or superficial) is the cause of the problem.

# SYMPTOMS OF VENOUS INSUFFICIENCY



Some Patients will have toned legs without Large Varicose Veins– but will have symptoms of Venous Insufficiency:

Swelling at the end of day  
Itching  
Heavy feeling  
Night cramps  
Aching

# SUPERFICIAL VENOUS DUPLEX EXAM PATIENT POSITION



# THERE ARE DIFFERENT APPROACHES



Patient Standing



Reverse Trendelenburg



Patient Supine

# THE STANDING POSITION



## Advantages:

Veins will be at their maximum diameter.

## Disadvantages:

Poor ergonomics for the sonographer

Patients often pass out after several valsalva events



## Opinion:

If venous insufficiency is demonstrated in the supine position, the exam can be performed with comfort for the sonographer and patient.

IF venous insufficiency is NOT demonstrated, then it is worthwhile to have the patient stand at the end of the exam to demonstrate Reflux

# REVERSE TRENDENDLEBERG

## Advantages:

Ergonomics for the sonographer can be optimized while increasing the venous pressure to help demonstrate presence or absence of abnormal venous flow.

## Disadvantages:

This type of exam table can cost up to \$7,000



# PATIENT SUPINE



## Advantages:

Ergonomics for the sonographer can be optimized  
Patient can be comfortable

## Disadvantages:

Minimal reflux may be missed in the supine position



## Opinion:

80-90% of patients with venous insufficiency can be demonstrated in the supine position. If Reflux can NOT be demonstrated, then stand the patient up to determine competency of valves.

# POSITIONING FOR THE SMALL SAPHENOUS VEIN



Right Leg



Left Leg

The most optimal visualization of the small saphenous vein is when the leg is in a dependent position.

Standing is difficult for the sonographer and patient.

Having the patient 'dangle' the leg provides vein enlargement.

The sonographer's arm is rested for ergonomics and helps with better control of the Transducer.

# SUPERFICIAL VENOUS PARAMETERS



Some describe scanning the superficial venous system like scanning a plate of spaghetti

# THE SAPHENOFEMORAL JUNCTION

***Anatomy of the saphenofemoral junction:***

***AL- anterolateral tributary,***

***FV- femoral vein,***

***IL- inguinal ligament,***

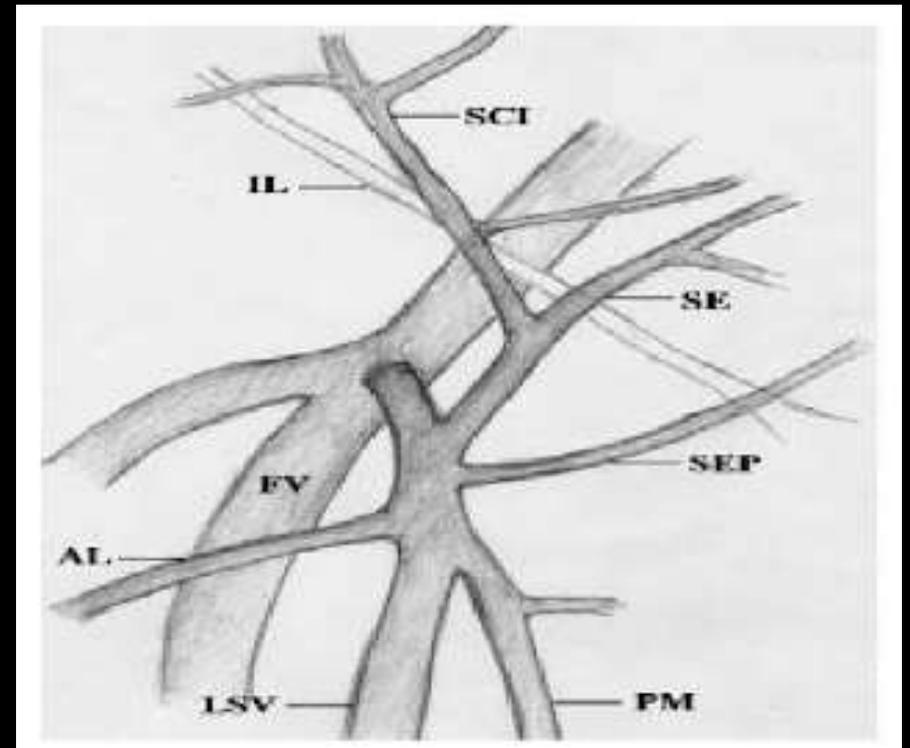
***PM- posteromedial tributary,***

***SCI- superficial circumflex iliac vein,***

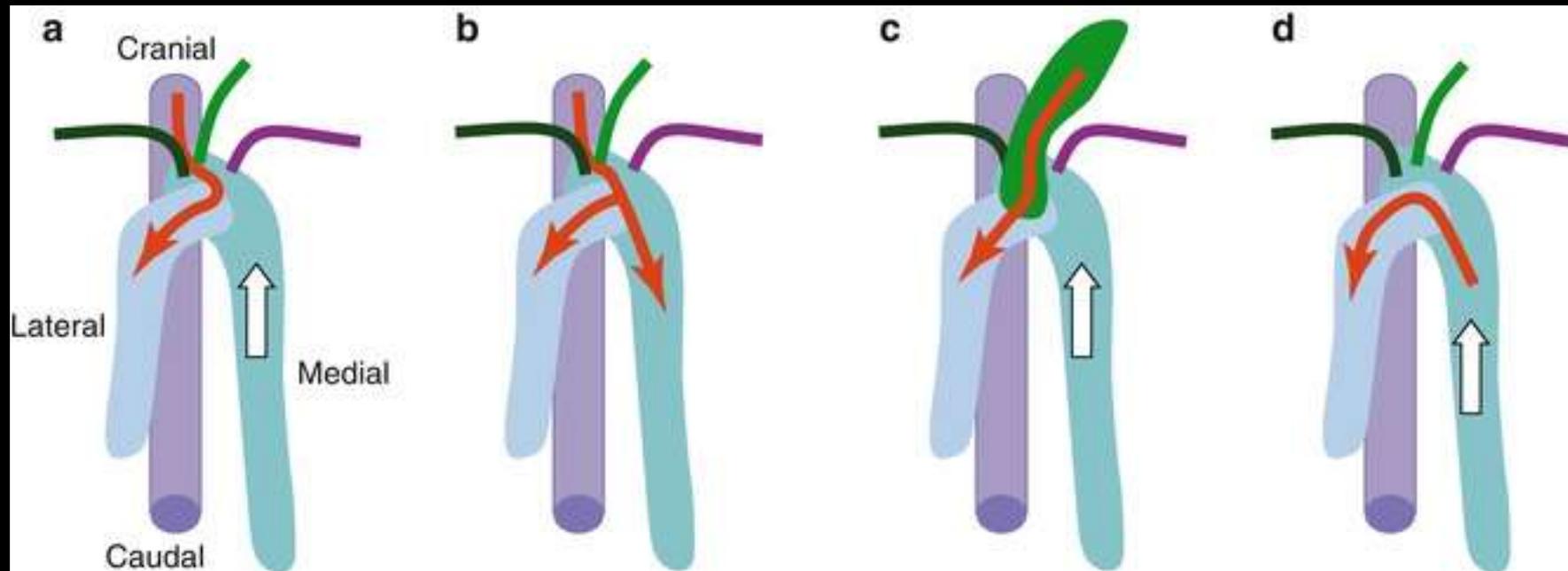
***SE- inferior superficial epigastric vein,***

***SEP- superficial external pudendal vein.***

***LSV- long saphenous vein ( GSV )***



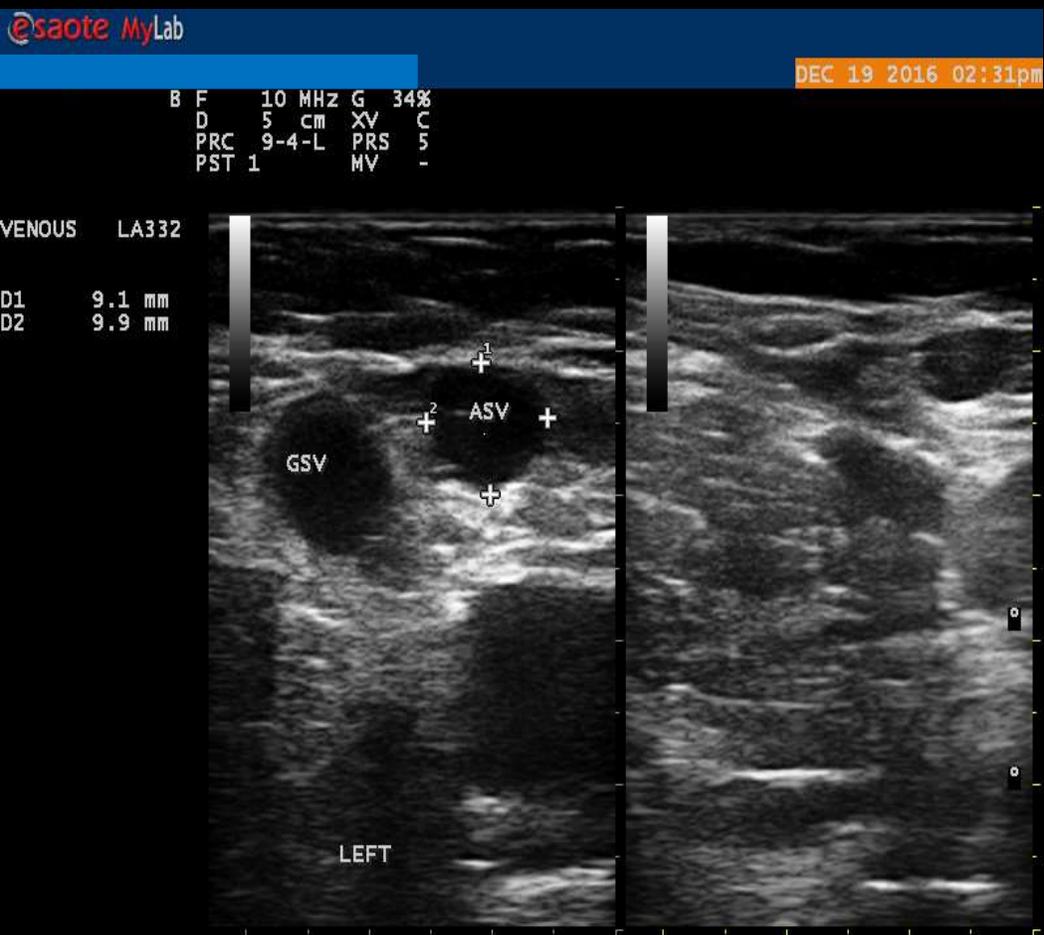
# POSSIBLE FLOW DIRECTIONS IN REFLUX



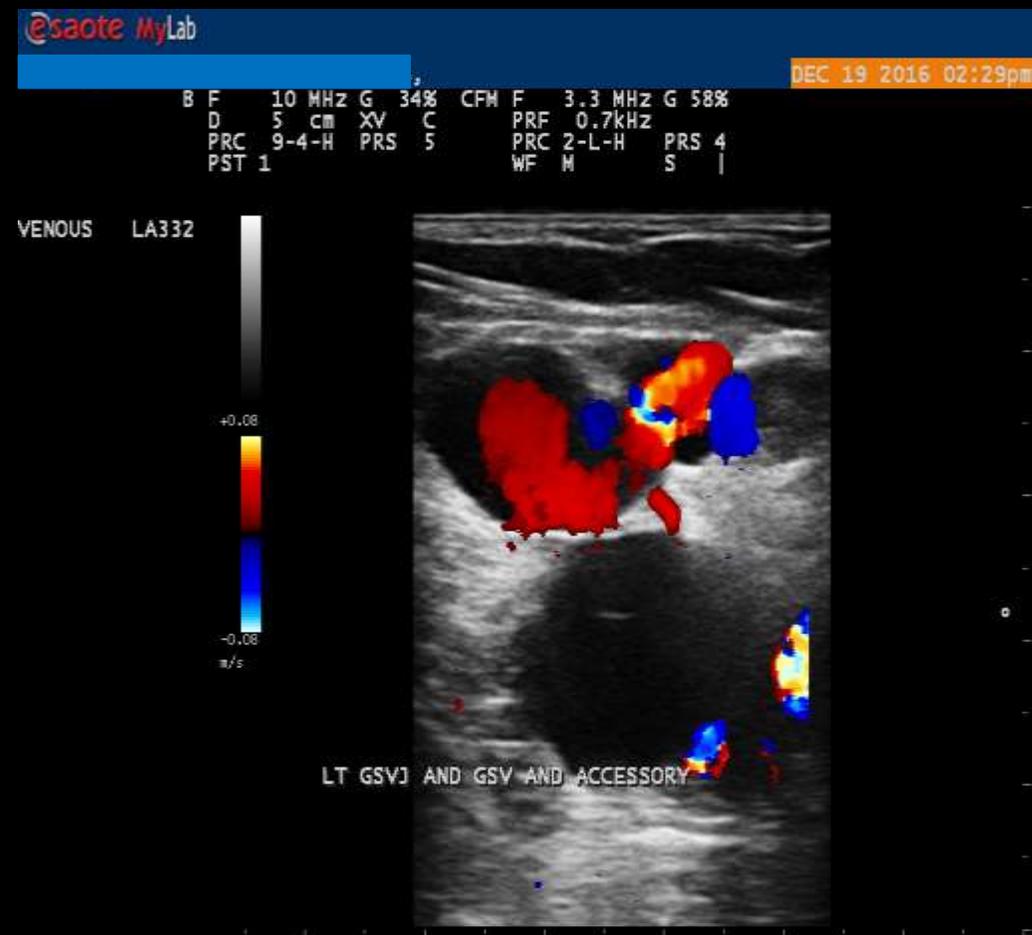
# GSV JUNCTION



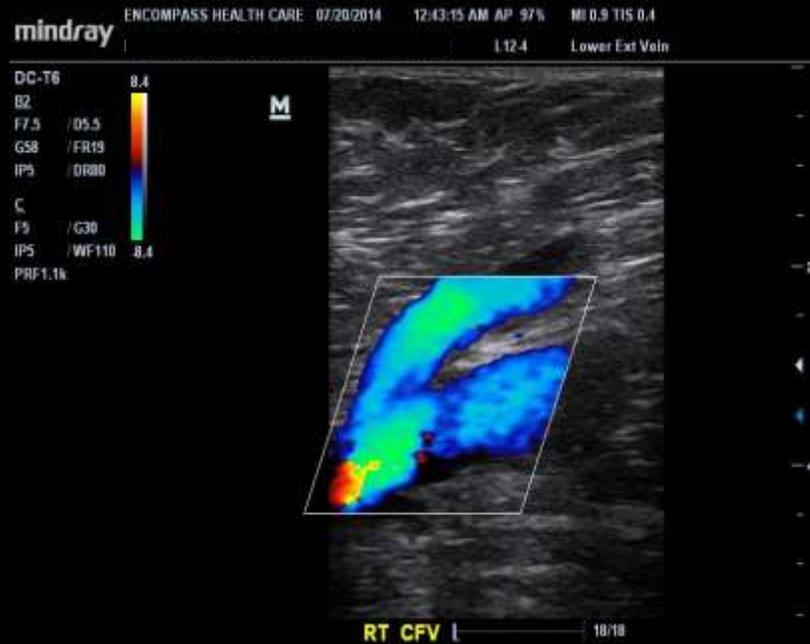
# ACCESSORY / ANTERIOR SAPHENOUS VEIN



The vein that is Medial is the 'main' or GSV.  
The vein that travels anterior is the ASV



# SCANNING APPROACHES TO GSVJ



## Sagittal

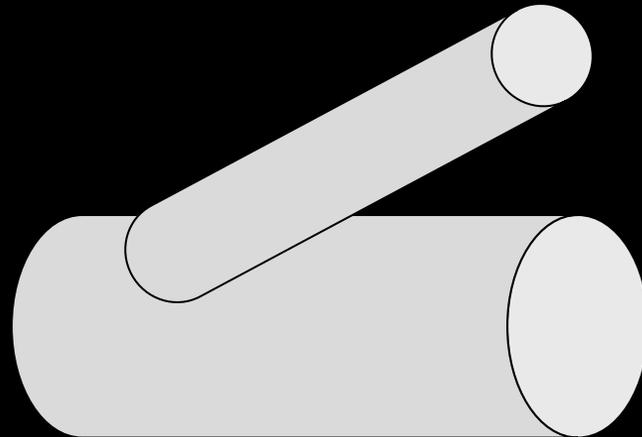
This is what is reported in most of the literature



## Transverse Coronal

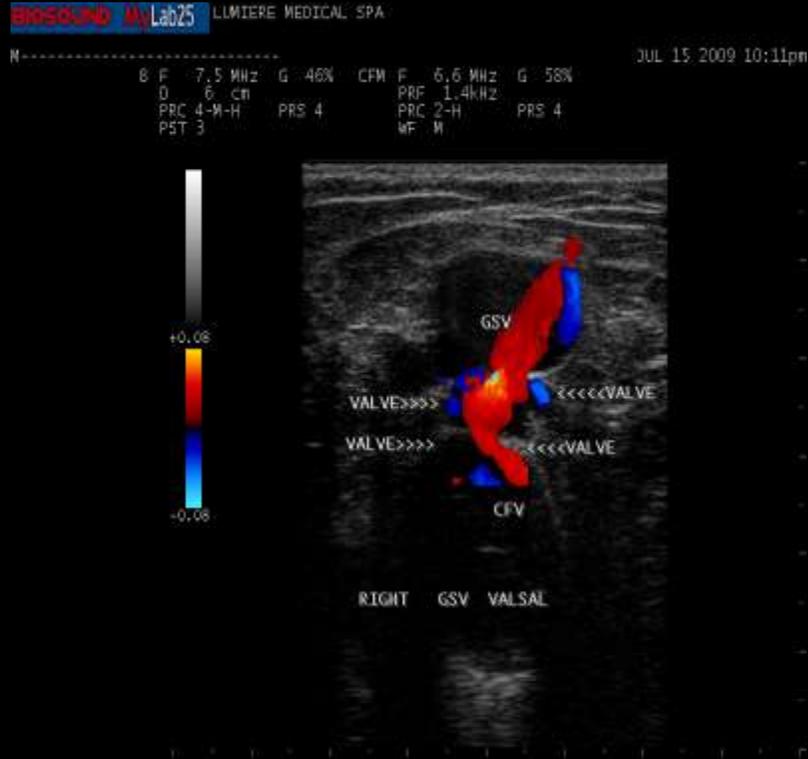
A more accurate approach to scanning this area

# WHY TRANSVERSE CORONAL WORKS

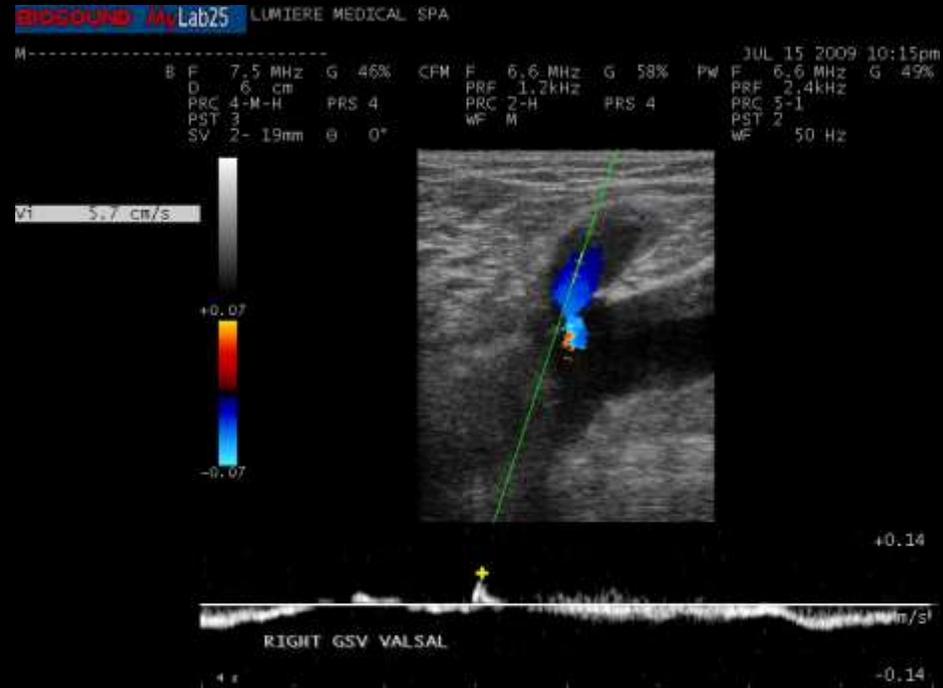


By positioning the transducer in a way to 'look down the barrel' of the vein, the ultrasound color and Doppler angle is better aligned with flow and if the reflux flow is eccentric, this position will detect and determine the angle of the reflux.

# LOOK AT THESE EXAMPLES:

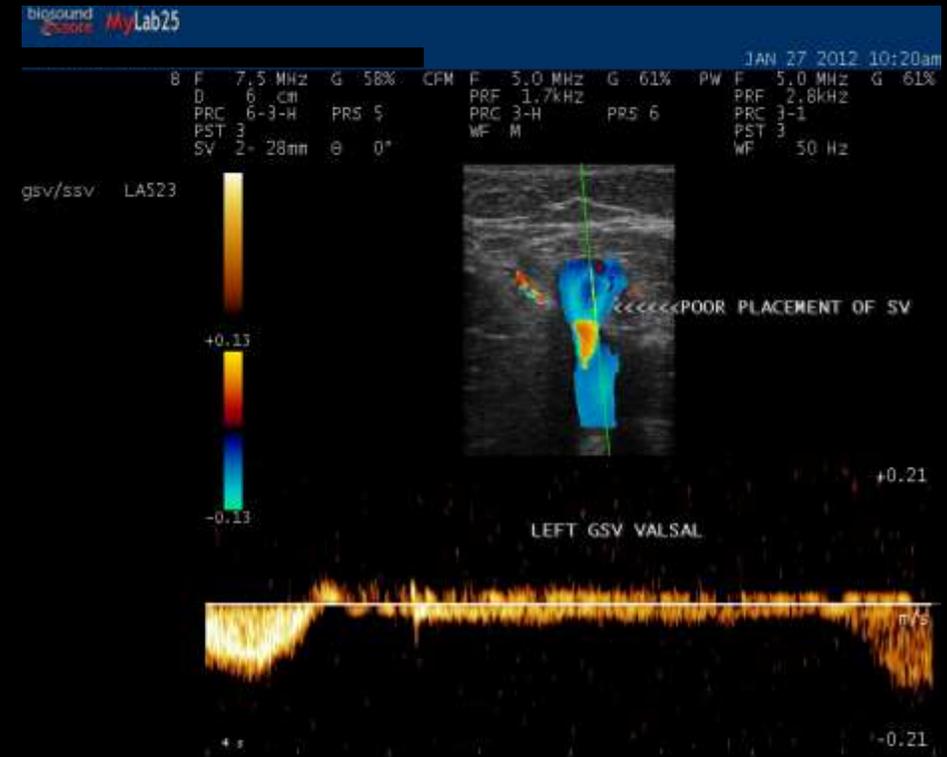


In the Transverse Coronal View: eccentric flow of GSVJ reflux



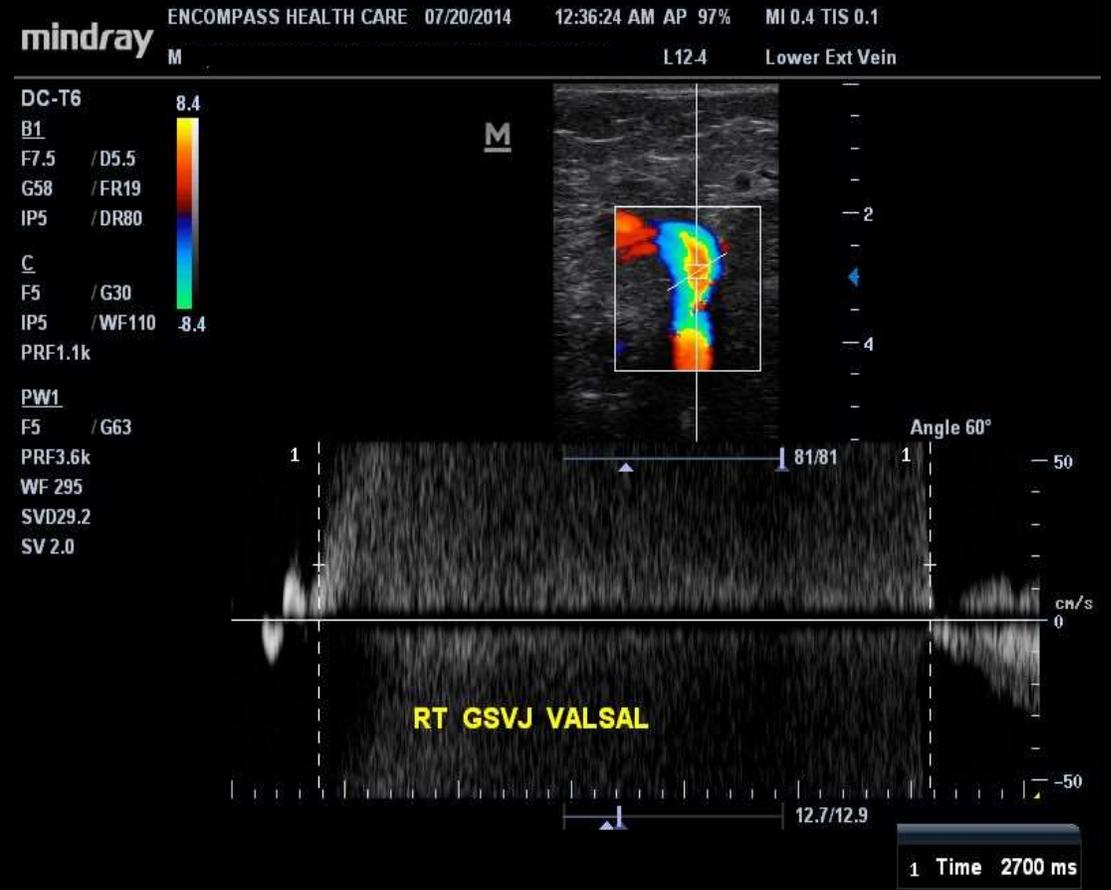
In the sagittal view, the Doppler is not aligned in the reflux jet and GSVJ insufficiency goes undiagnosed.

# DOPPLER PLACEMENT

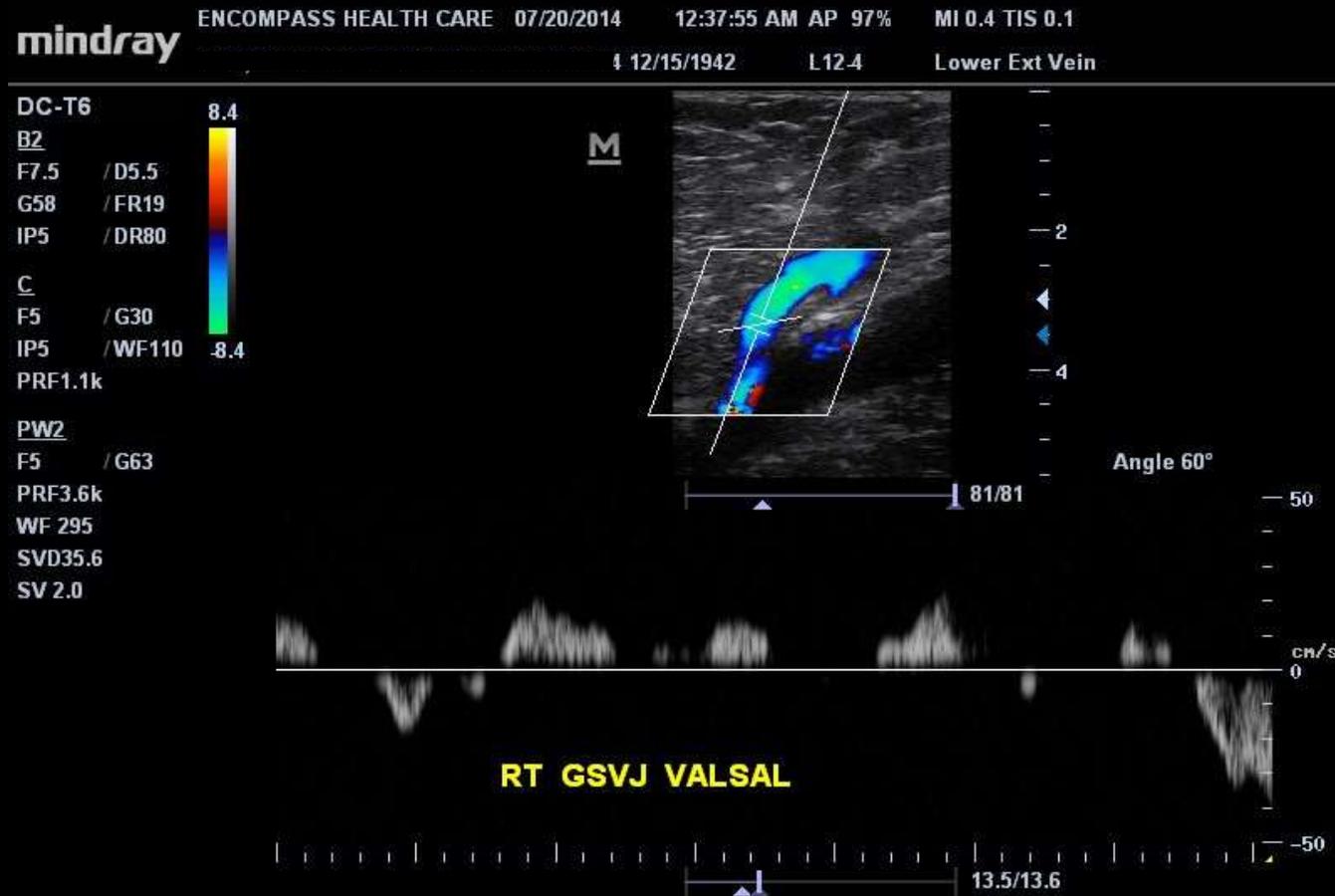


The difference between good and bad Doppler placement can be a matter of sub-millimeters!

# TRANSVERSE CORONAL APPROACH



# OR.... SAGITTAL APPROACH

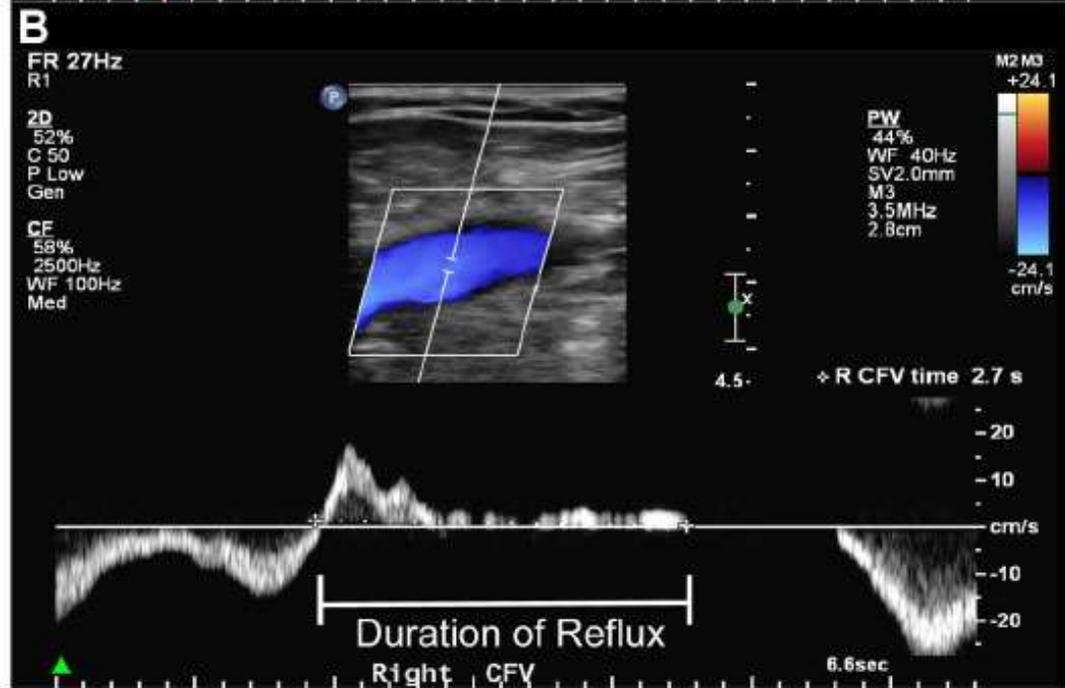
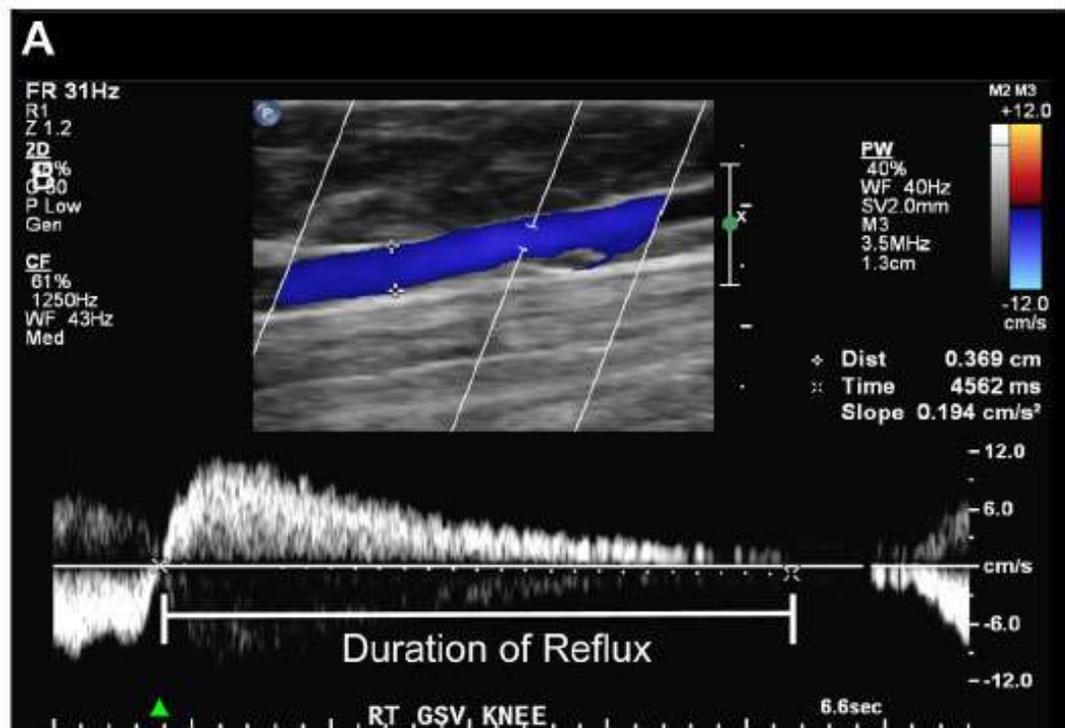


Same patient –  
There is a hint of  
Reflux.... But this  
image does not  
show with certainty  
the extent of  
retrograde flow

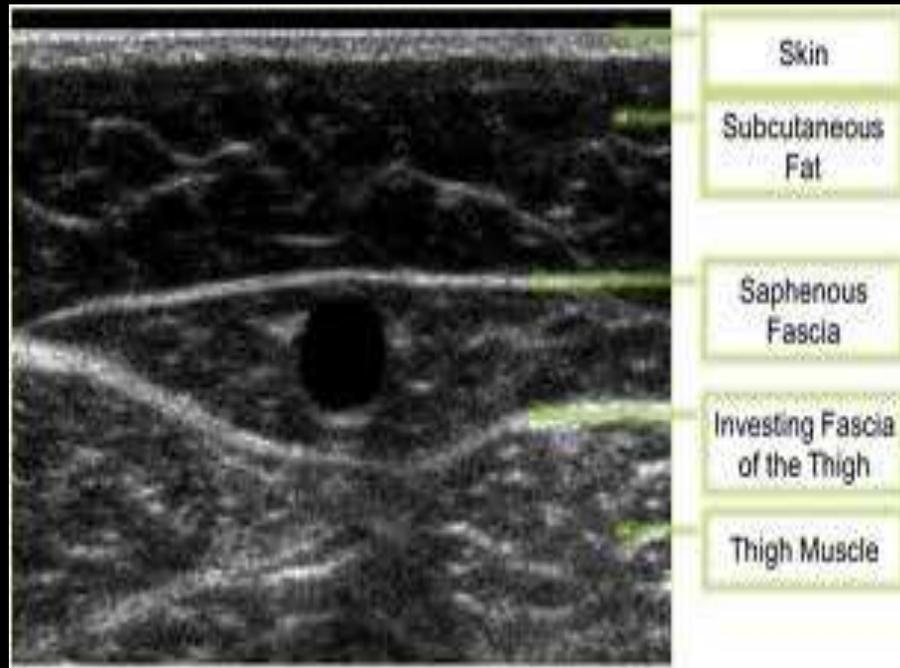
# MEASURING REFLUX TIME

Superficial vein flow is considered abnormal when reflux time is greater than .5 seconds

Deep vein flow is considered abnormal when reflux time is greater than 1.0 seconds

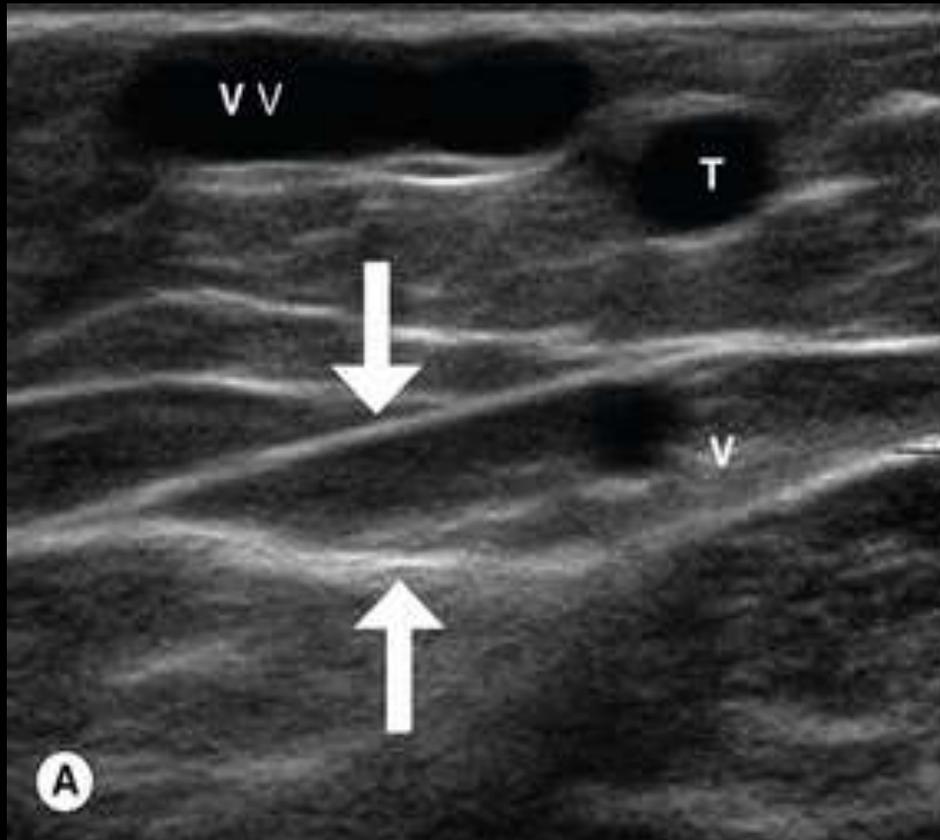


# SAPHENOUS VEIN VS TRIBUTARIES



Do not measure a large Tributary and call it a GSV or SSV  
– this is misleading when the physician plans for ablation.

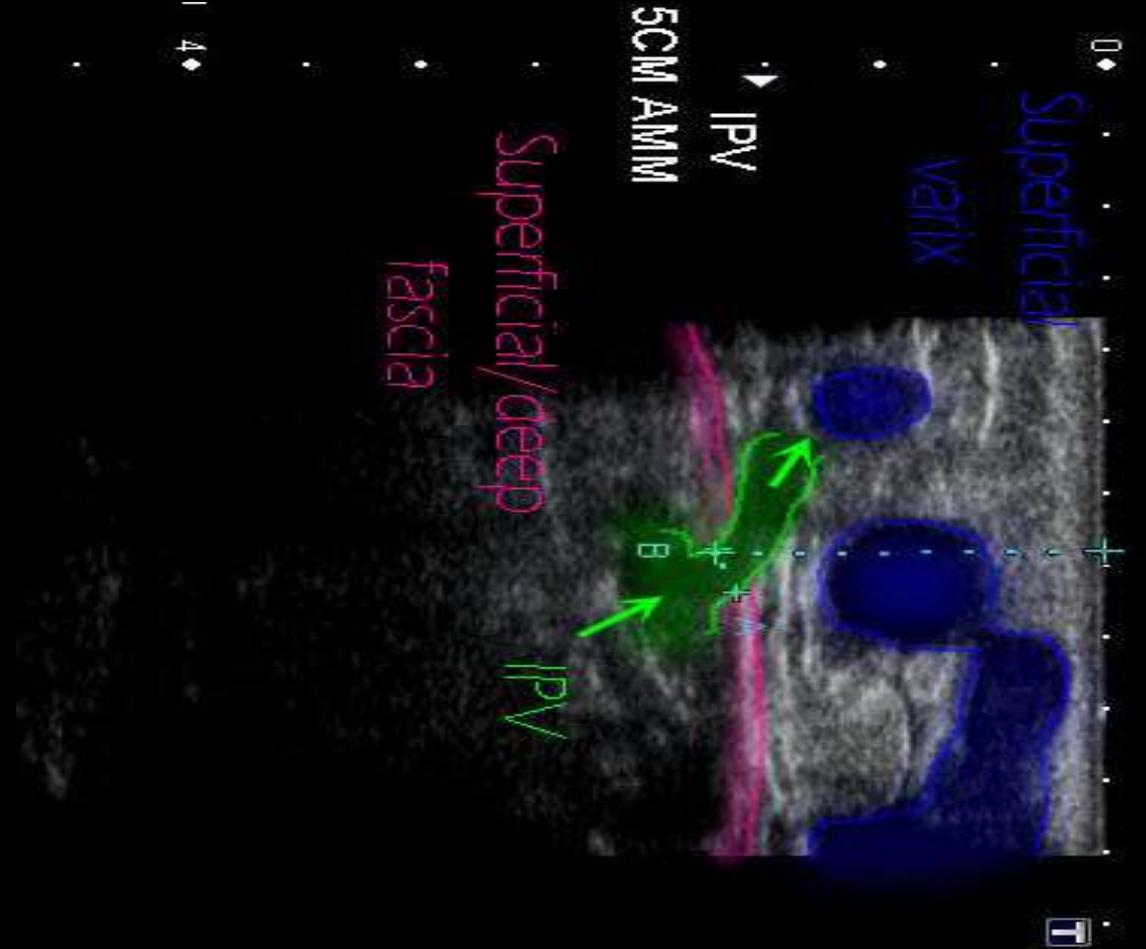
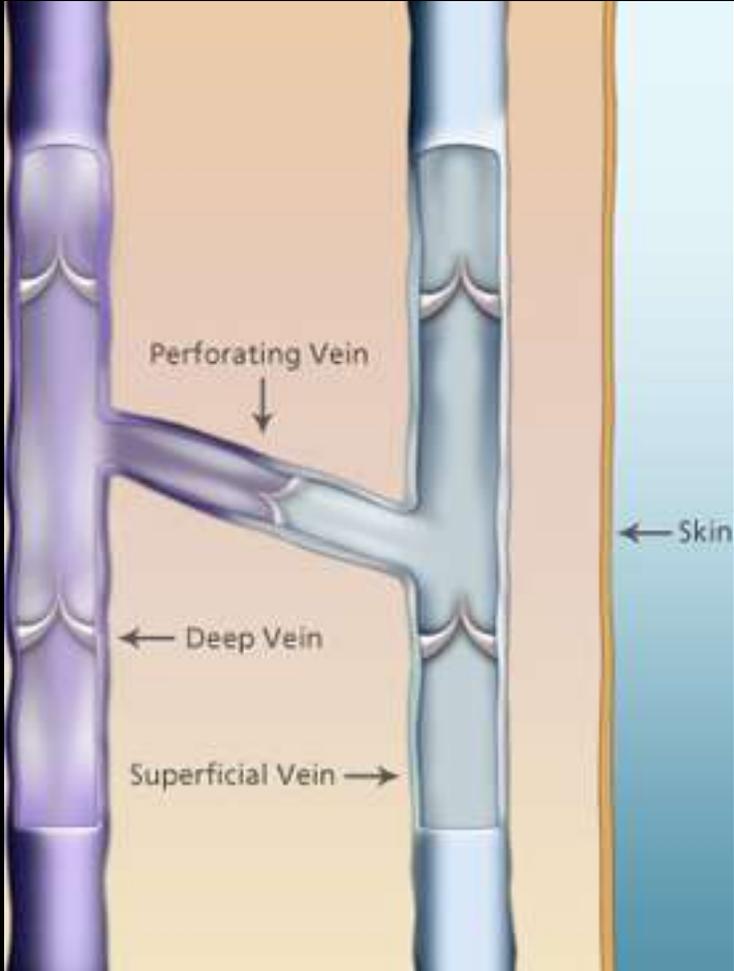
# SAPHENOUS 'COMPARTMENT'



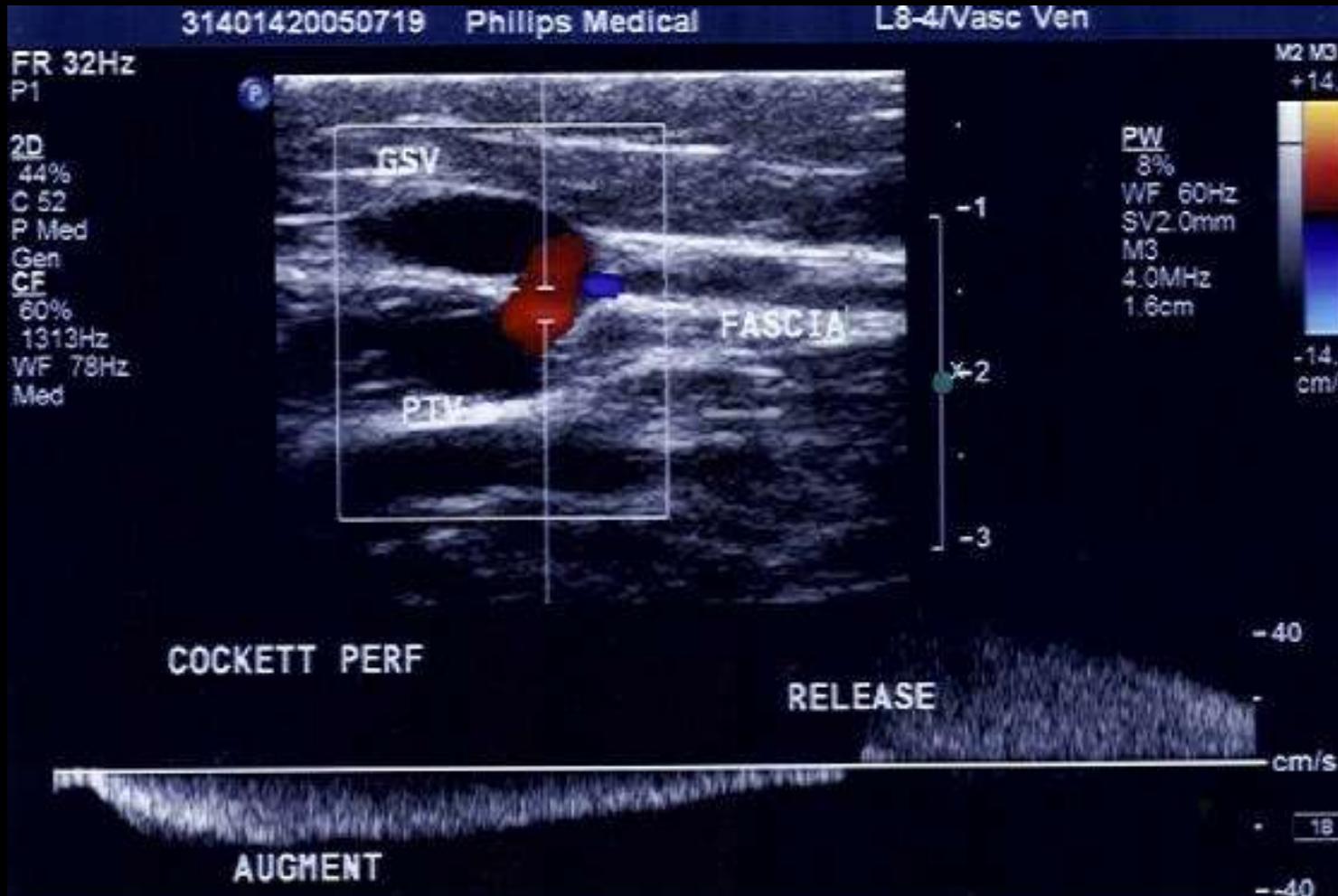
Another example of saphenous vein and other veins.

REMEMBER: It is a saphenous vein ONLY when it is located in the saphenous compartment- If the saphenous vein is out of the fascial compartment – state it on the tech sheet

# PERFORATORS



# PERFORATORS



Veins that 'PERFORATE' the fascia. The valves in the perforator vein can fail and have reflux.

mindray

ENCOMPASS HEALTH CARE 01/09/2017

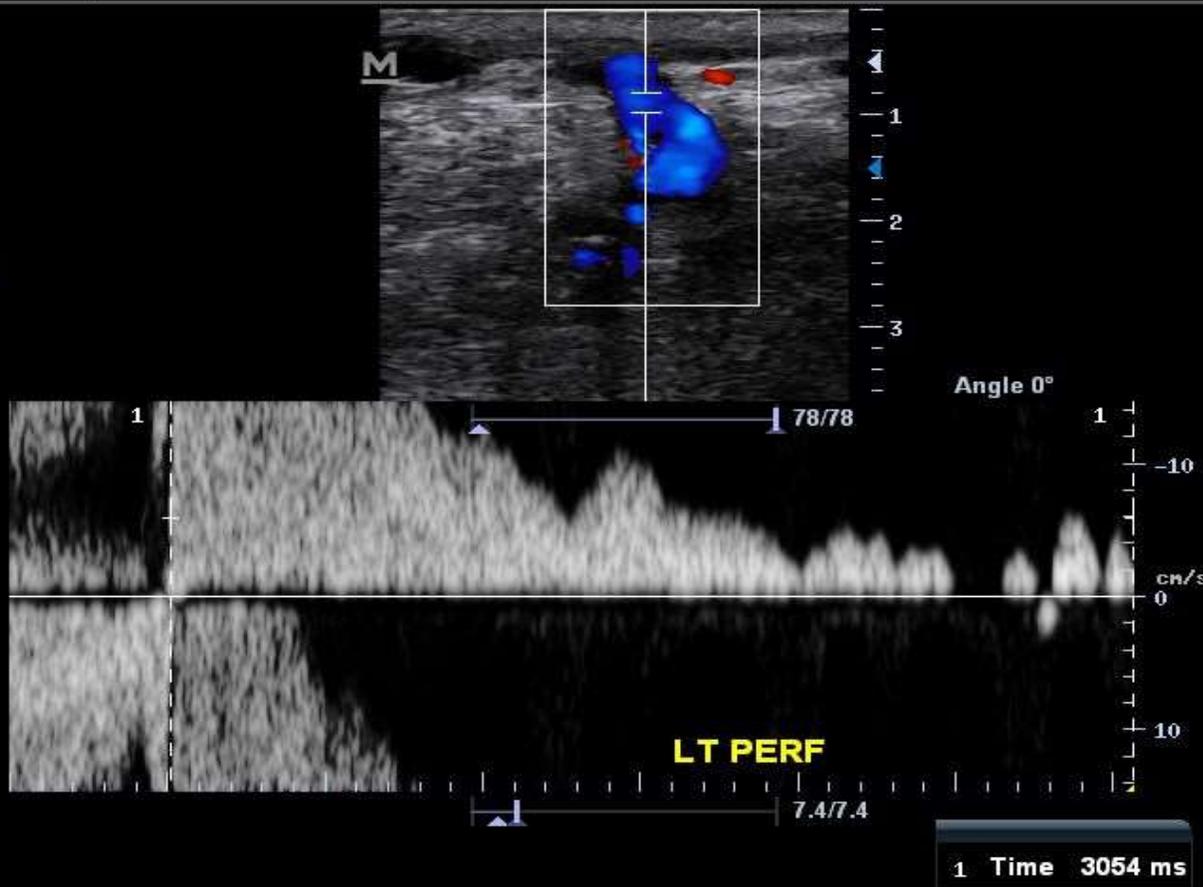
12:54:31 PM AP 97%

MI 0.6 TIS 0.0

L12.4

Lower Ext Vein

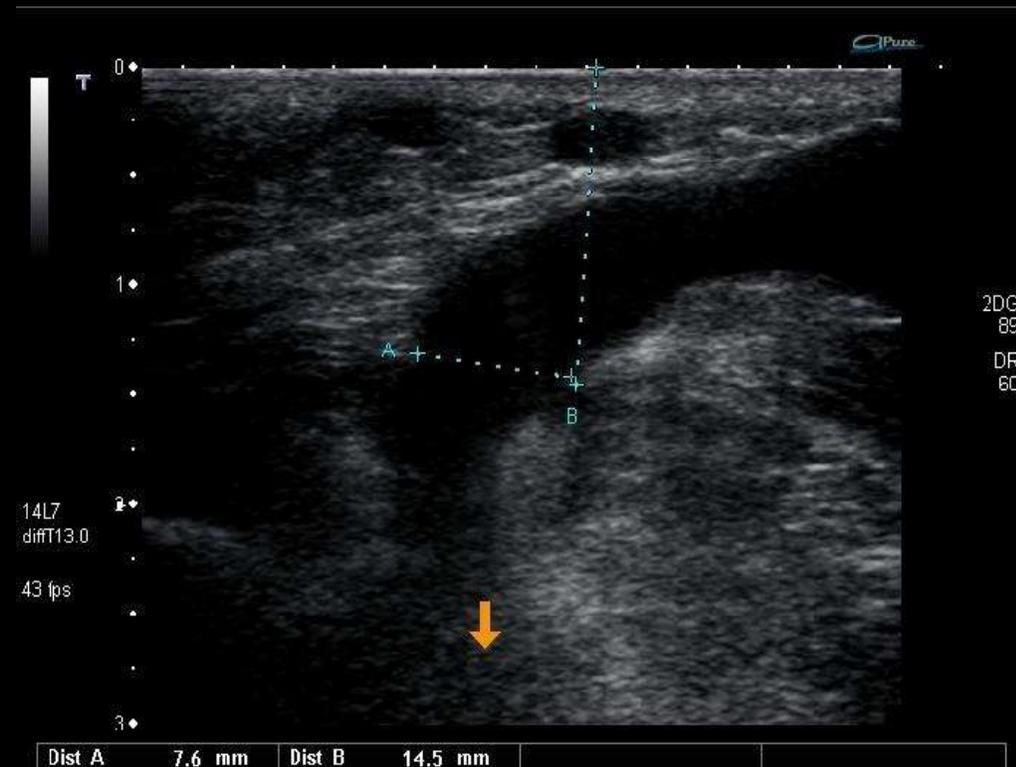
DC-T6  
B2  
F6.0 / D3.7  
G52 / FR25  
IP5 / DR80  
C  
F5 / G30  
IP5 / WF135  
PRF1.3k  
PW2  
F5 / G50  
PRF1.9k  
WF 155  
SVD8.9  
SV 2.0



# PERFORATORS

Abnormal Perforators are very easy to find; they are large and have abnormal flow

# PERFORATOR IMAGES



Measure the size of the perforator at the level of the fascia This one measures 7.6mm

# DOCUMENTATION OF LOCATION



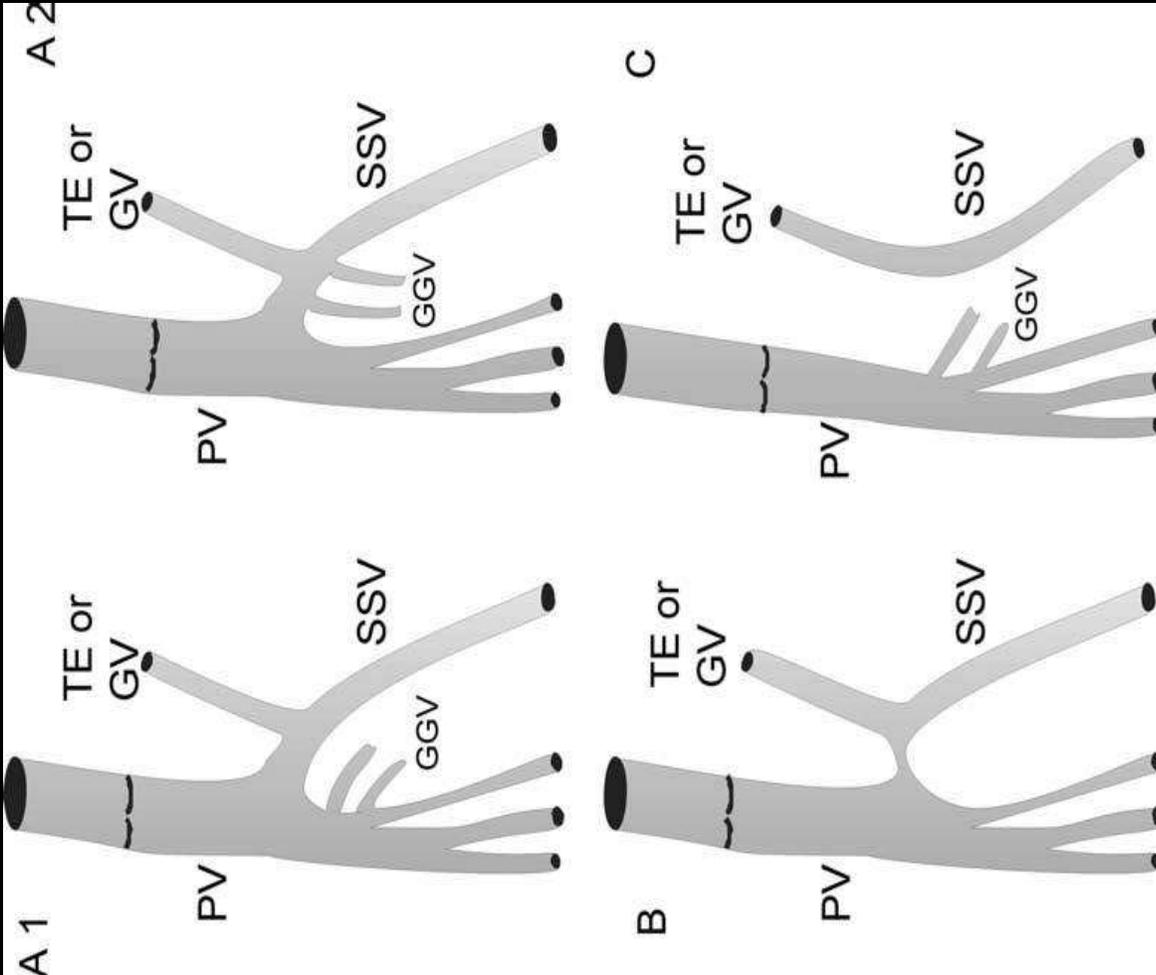
You will need to document the location of all ABNORMAL perforators using the Medial Malleolus as reference. The annotation would read something like this:

**Rt perf 7cm from MM**

**TIP:**

Use a tape measurer OR know the length of the ultrasound transducer; use it as a measuring device.

# SAPHENOPOPLITEAL JUNCTION



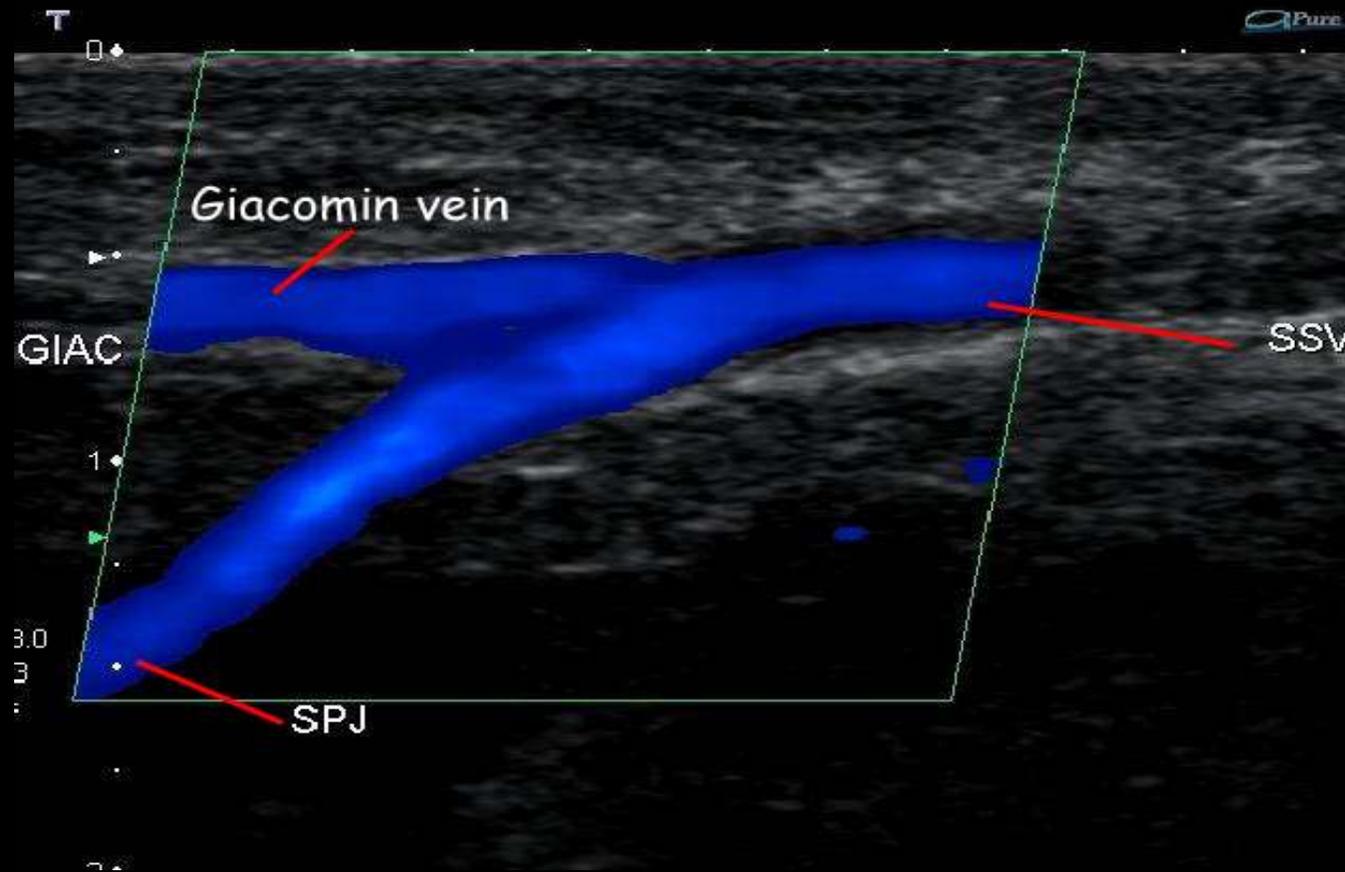
The Short Saphenous vein is located slightly lateral of midline at the posterior calf.

A thigh vein called: Vein of Giacomini Or Thigh Extender Vein joins the SSV and can have communication with the GSV

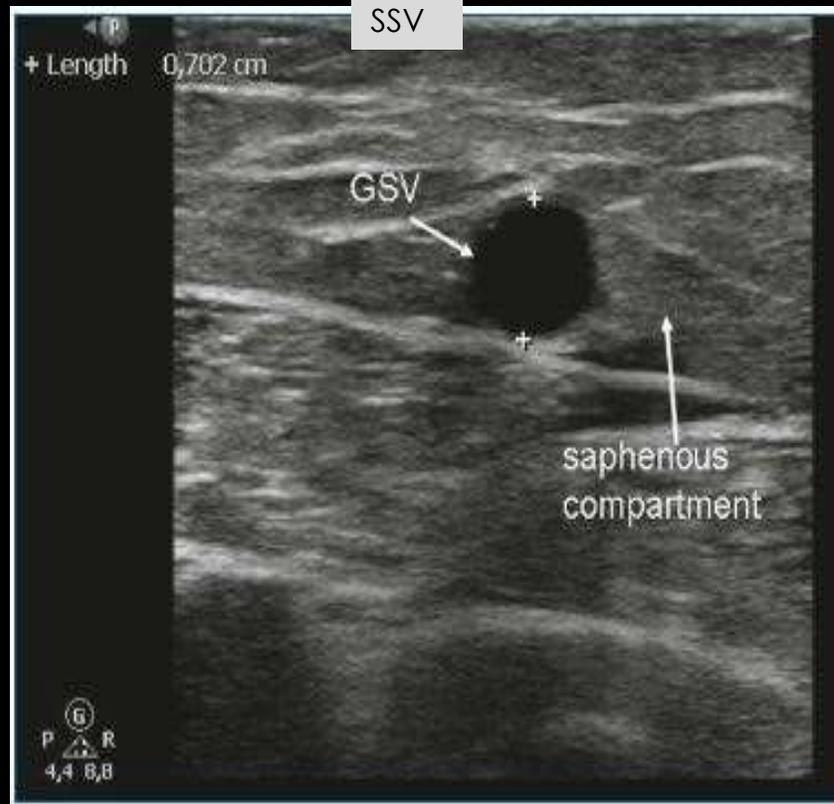
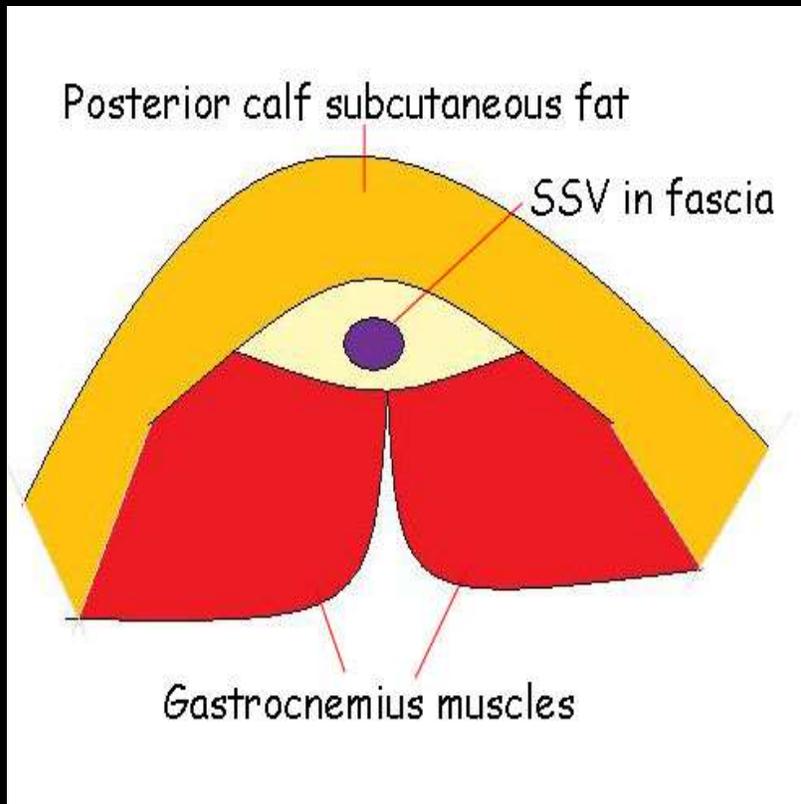
These are some variations of the anatomy

Also notice how the Gastroc Veins have many variations – and can communicate with the SSV at any level.

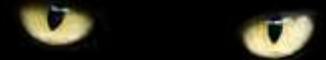
# SAPHENOPOPLITEAL JUNCTION



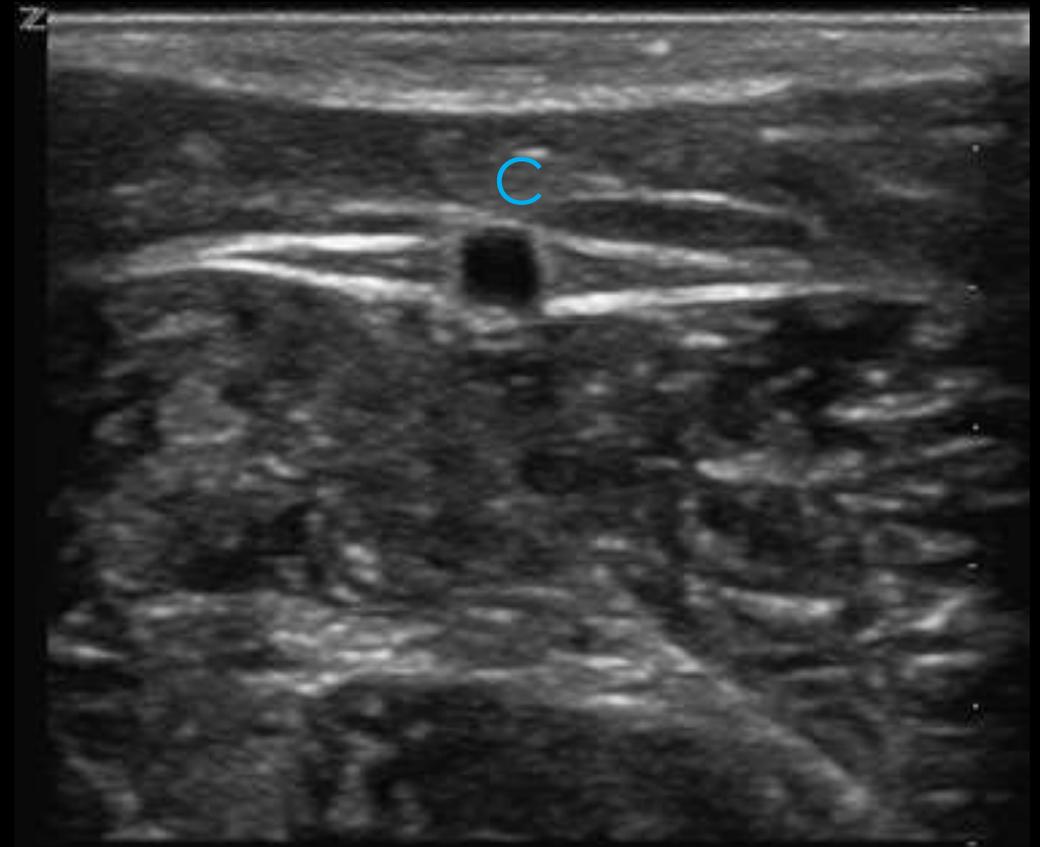
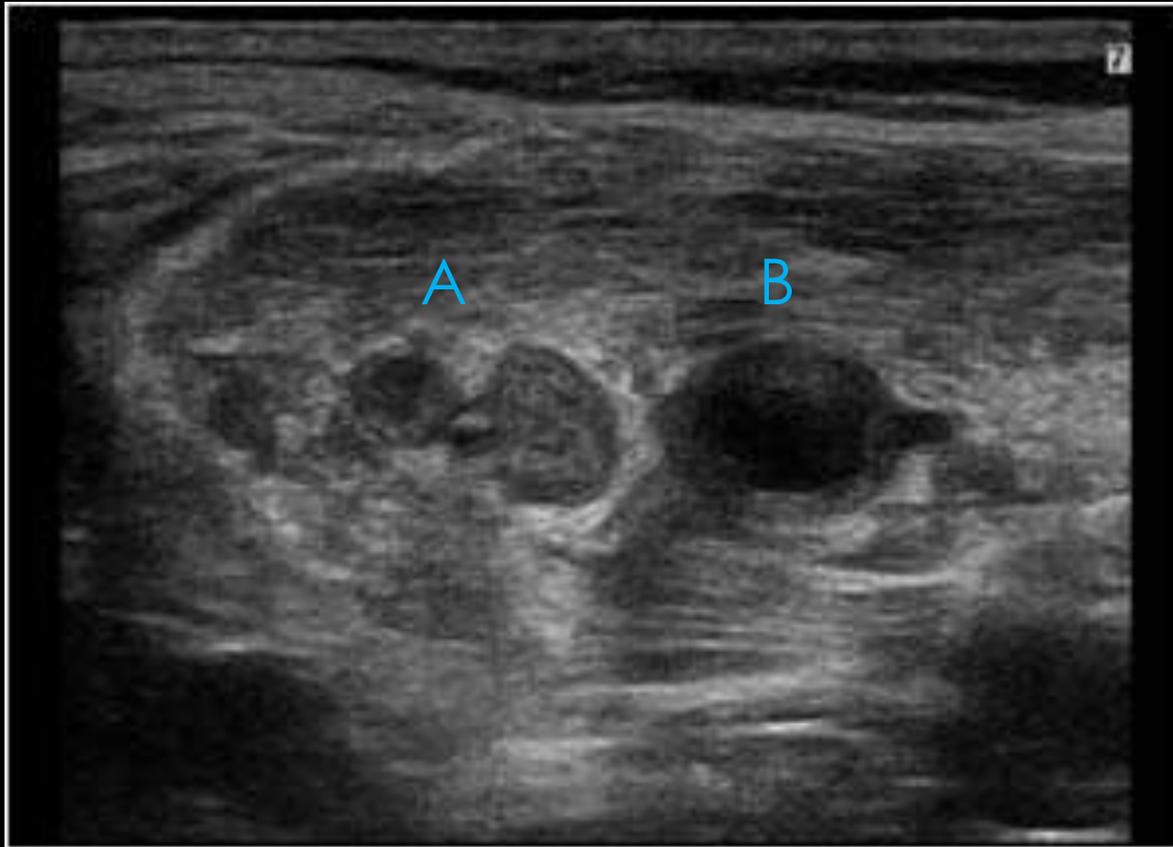
# SMALL SAPHENOUS VEIN FACIAL COMPARTMENT



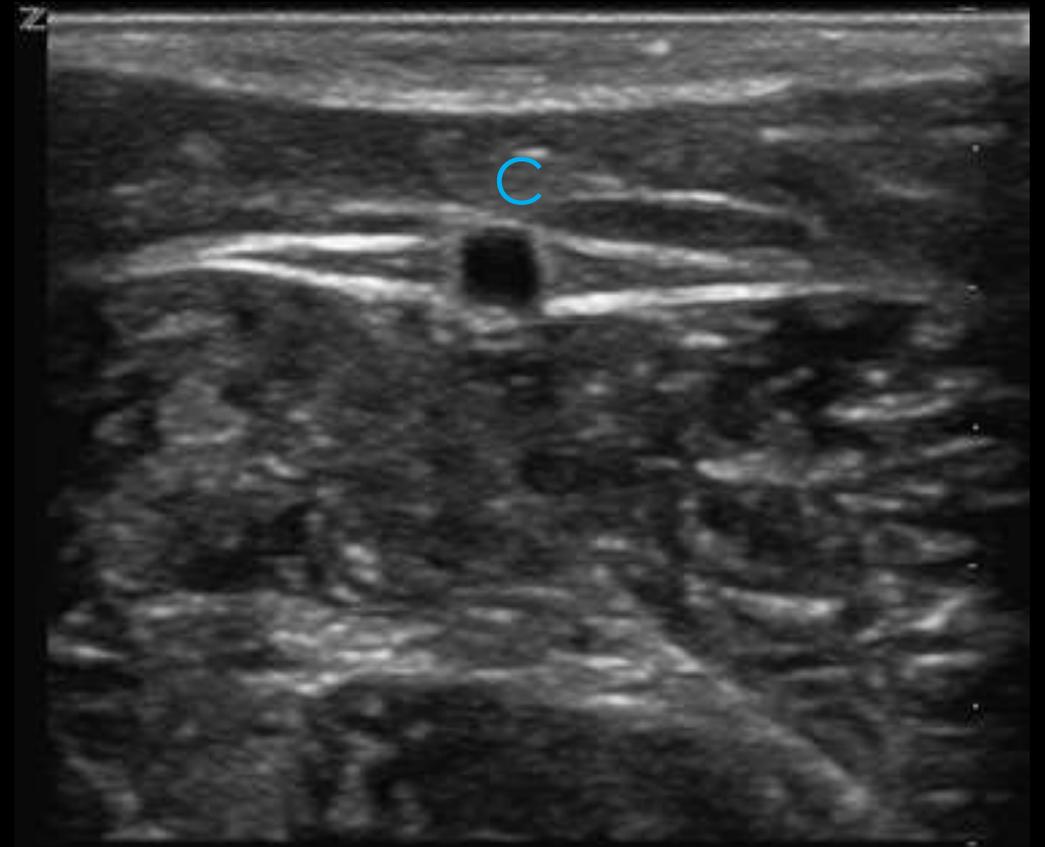
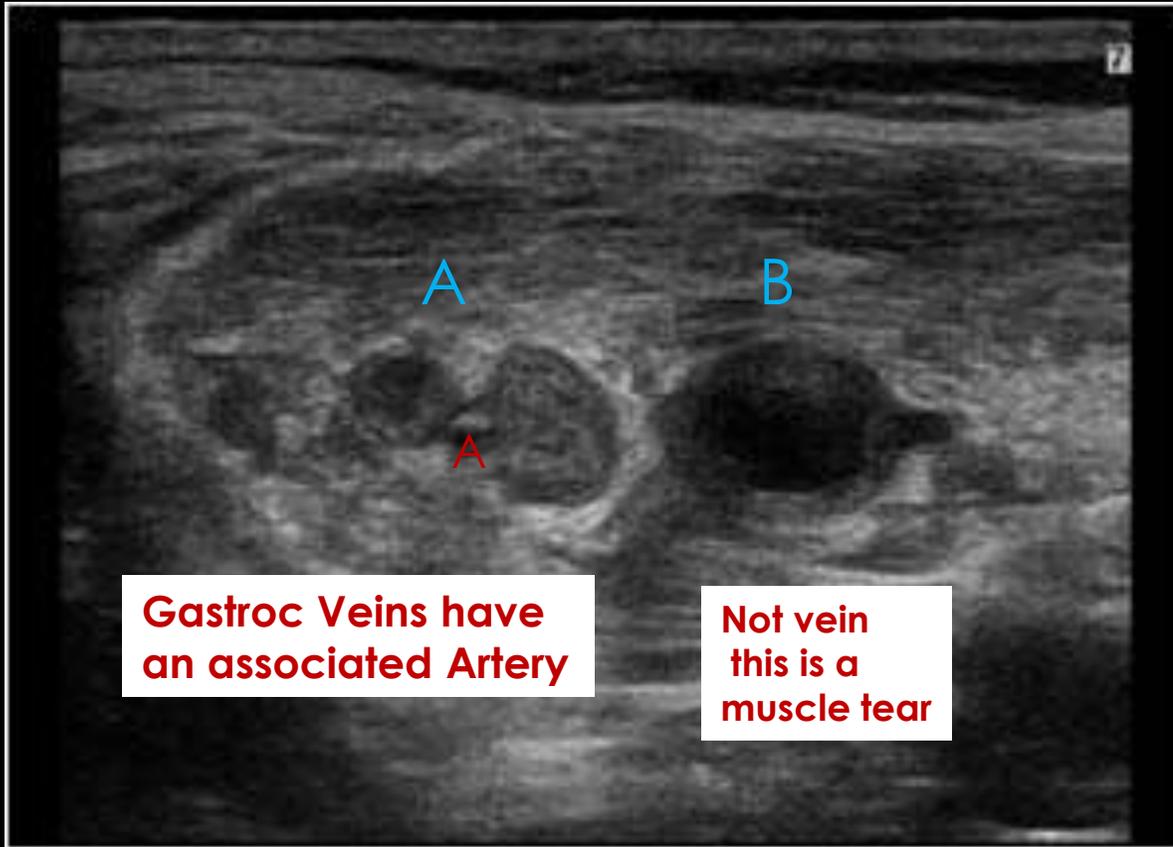
The small Facial compartment and the SSV looks like a cat-eye



# WHICH IS SMALL SAPHENOUS VEIN?



IF YOU SAID C- YOU ARE CORRECT !



# MANEUVERS- TO DEMONSTRATE REFLUX



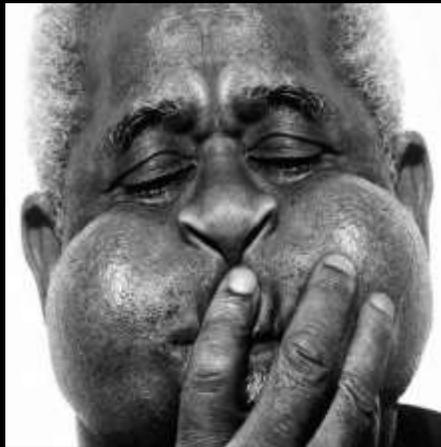
# PURPOSE OF A MANEUVER IS TO 'STRESS' THE VEIN VALVE



Valsalva maneuver is typically what most sonographers use to 'bring out' the reflux

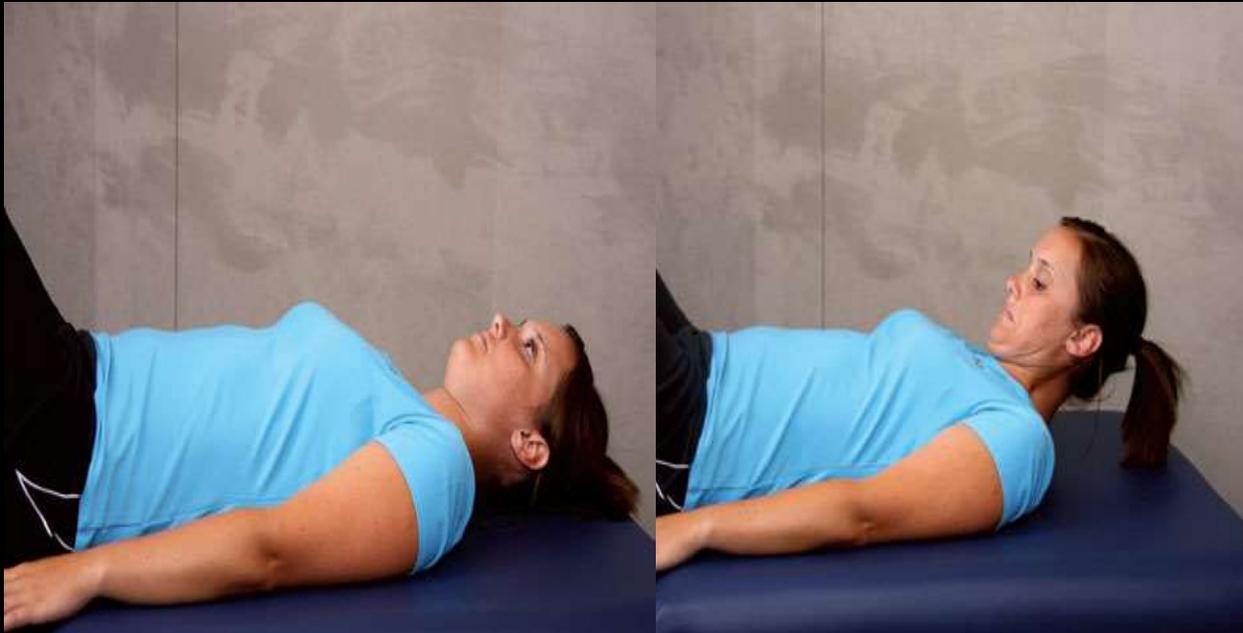
Problem: Many patients can not do it properly  
And if you have a patient standing, they will often get light headed or even faint.

## OTHER OPTIONS....



Patients can usually hold their nose or put their thumb in their mouth and blow without letting air escape – which creates a valsalva maneuver.

## OTHER OPTIONS....



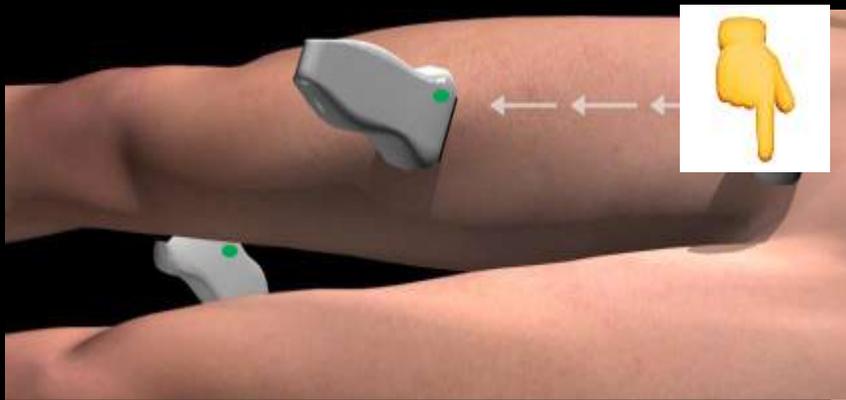
Another way to increase abdominal pressure is to have the patient lift their head .... **JUST** their head... sometimes, you can ask them to include their shoulders too, but only if they can do it **without moving their leg.**

## OTHER OPTIONS....



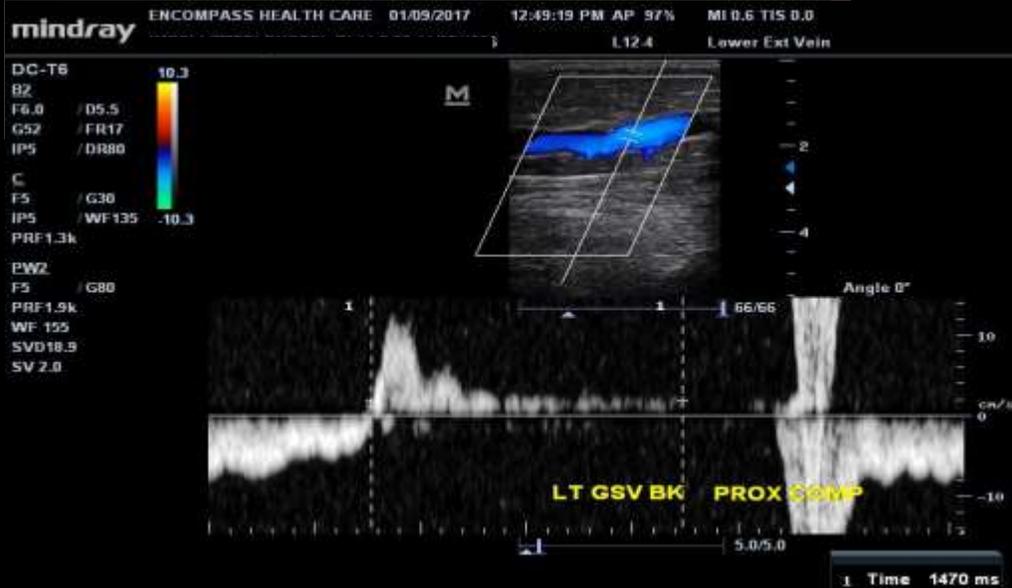
When all else fails, a simple abdominal compression will mimic the valsalva maneuver.

# STRESSING VALVES NOT AT JUNCTION



Use a proximal compression.

By exerting pressure on the vein superior to the probe (must be some distance so as not to move the probe) the volume of blood will build in the vein and cause an incompetent valve to fail.

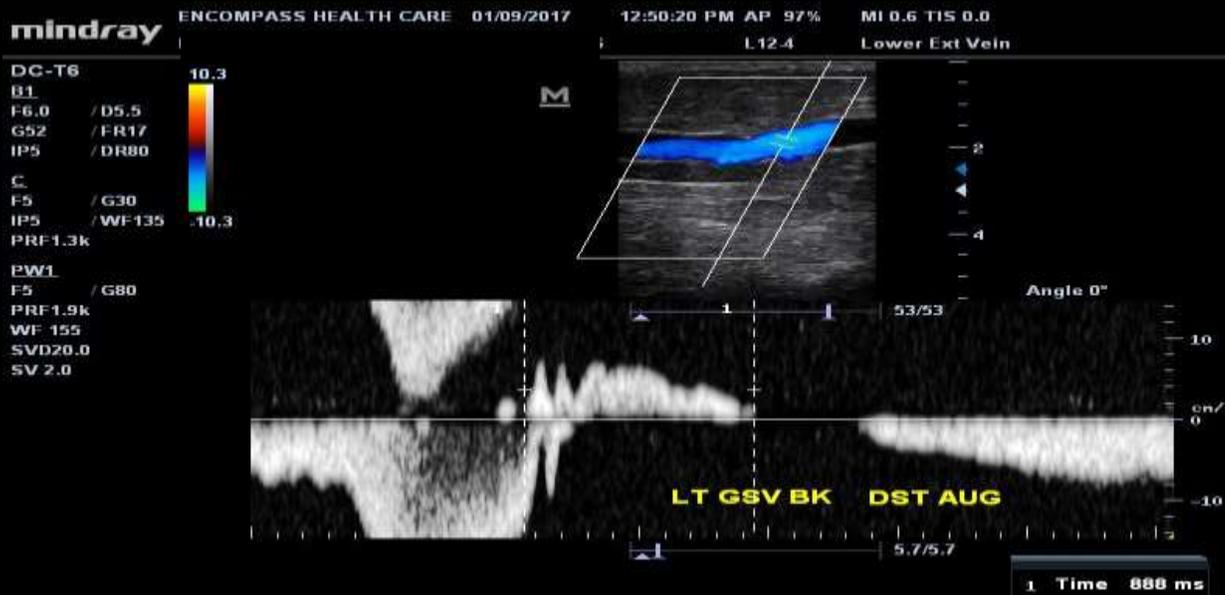


# STRESSING VALVES NOT AT JUNCTION



Use Distal Augmentation.

By exerting pressure Distal to the vein at probe level, the volume of blood in the vein will 'reflux' after the augmentation.



# LEG APPEARANCE WILL HELP GUIDE EXAM



# VARICOSE VEIN PATTERNS



**Location of  
GSV  
Varicosities**



BEFORE AND AFTER VEIN TREATMENT

BEFORE AND AFTER VEIN TREATMENT

# VARICOSE VEIN PATTERNS



Location of Anterior  
GSV/Accessory Vein Varicosities

# VARICOSE VEIN PATTERNS



**Location of SSV  
Varicosities**

# VARICOSE VEIN PATTERNS



**Location of Thigh Extensor / Vein of Giacomini Varicosities**

# OTHER PATTERNS OF VENOUS HYPERTENSION



Discoloration and swelling below the knee without a lot of varicose veins.....

Look for perforators in addition to saphenous reflux

# SPIDER VEINS: CVI OR NO CVI?



Sometimes it is  
'Just Spider Veins'  
or  
it can be an early  
manifestation of  
CVI

# SWELLING: CVI OR NO CVI?



Congestive Heart Failure  
or Kidney Failure



Deep or Superficial  
Venous Insufficiency



Lymphedema  
or Lipedema

Not all Leg Swelling is related to Venous Insufficiency – However CVI can co-exist with other conditions that cause swelling

# ULTRASOUND DETERMINES CVI BEST

The visual appearance of the leg is like looking at the tip of the iceberg....  
Ultrasound, and a diligent sonographer is the gold standard for determining  
Chronic Venous  
Insufficiency

