OBJECTIVES OF THIS LECTURE:

UNDERSTAND VENOUS ANATOMY AND HEMODYNAMICS

BE ABLE TO IDENTIFY NORMAL AND ABNORMAL VENOUS ANATOMY AND HEMODYNAMICS BY DOPPLER 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
KNOW YOUR ANATOMY
THE START OF VENOUS ANATOMY

The Capillary Bed

Arterioles

Size is 20-30µm
Micrometer
On millionth of a meter

Venules
SUPERFICIAL VENOUS ANATOMY

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

- Greater
- Lesser / Small

Perforators:
- 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

This is important to remember when looking at venous flow patterns.

VENOUS FLOW IS EFFECTED BY ABDOMINAL AND THORACIC PRESSURE

Carried to the heart by the Inferior Vena Cava.
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 Geertema
www.ultrasoundcases.info
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!
VARIATIONS OF VEIN THROMBUS
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
PARAMETERS OF NORMAL VENOUS FLOW

SPONTANEOUS PHASIC FLOW

Venous flow responds to respiration

Right Pop V
PARAMETERS OF NORMAL VENOUS FLOW

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

**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
<table>
<thead>
<tr>
<th>Acute DVT</th>
<th>Chronic DVT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrombus float in vessel</td>
<td>Thrombus adherent to vessel wall</td>
</tr>
<tr>
<td>Composed of RBC and fibrin</td>
<td>Composed of fibrin and covered with endothelium</td>
</tr>
<tr>
<td>Low level echogenicity</td>
<td>Enhanced echogenicity</td>
</tr>
<tr>
<td>Acoustically homogenous</td>
<td>Acoustically heterogenous</td>
</tr>
<tr>
<td>Thrombus expands diameter of veins</td>
<td>Diameter of vein decreases with time</td>
</tr>
<tr>
<td>Collaterals absent</td>
<td>Collaterals present</td>
</tr>
<tr>
<td>Vein non-compressible</td>
<td>Partially compressible</td>
</tr>
<tr>
<td>No evidence of recanalization within vessel</td>
<td>Recanalization within vessel</td>
</tr>
</tbody>
</table>

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

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 DOPLEX 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

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.
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.
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 0.5 seconds.

Deep vein flow is considered abnormal when reflux time is greater than 1.0 seconds.
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
Veins that ‘PERFORATE’ the fascia. The valves in the perforator vein can fail and have reflux.
Abnormal Perforators are very easy to find; they are large and have abnormal flow.
Measure the size of the perforator at the level of the fascia. This one measures 7.6mm.
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

Giacomin vein

GIAC

SSV

SPJ
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!

Gastroc Veins have an associated Artery

Not vein this is a muscle tear
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.

THERE ARE 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.
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

BEFORE AND AFTER VEIN TREATMENT

Location of GSV Varicosities
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
Sometimes it is ‘Just Spider Veins’ or it can be an early manifestation of CVI.
SWELLING: CVI OR NO CVI?

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

Congestive Heart Failure or Kidney Failure

Deep or Superficial Venous Insufficiency

Lymphedema or Lipedema
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.