Let's Take a Look...
Venous Insufficiency
Ultrasound Techniques

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Let's take a look...

- Differentiate between normal venous flow and venous insufficiency doppler waveforms
- Define the differences between a screening venous ultrasound and a comprehensive venous insufficiency exam
- Bonus: Describe why you are happy to be doing saph-fem incompetency studies rather than PPG...

History...

- Go find me a perforator
- Mayo visit
Pitfalls in imaging

Ref: Duplex Scanning in Vascular Disorders 2nd ed D. Eugene Strandness p. 42

- It is theoretically possible to locate and assess the status of the perforating veins, but this has proved more difficult than originally thought.....

In my experience, it is rare to have these communicating veins be incompetent in the presence of a competent deep venous system.

Let's take a look...

Venous Insufficiency Ultrasound Techniques

Live scan demo by Brent Wilkinson

DVT Exam Vs Venous Insufficiency Study

- Area of Concentration for deep venous thrombosis:
  - Deep Veins of the leg, those located within muscle and paired with arteries
    - Common Femoral
    - Femoral (Superficial Femoral)
    - Popliteal
    - Veins of the lower leg (Peroneal, Tibial, Gastrocnemius)
    - Proximal Deep Femoral and Saphenous Femoral Junction
Area of Concentration for Reflux Study

Superficial veins of the leg with limited interrogation of the deep system
- Long or Great Saphenous Vein
- Small Saphenous Vein
- Perforator Veins
- Limited views of the Common Femoral, Popliteal, and Mid Femoral

Ultrasound Technique

DVT
- Thorough compression in the transverse axis at a minimal interval of every 2 cm in the common femoral, femoral, and popliteal as well as other symptomatic areas to rule out presence of thrombus.
Spectral doppler in the long axis should be used to evaluate for respiratory phasicity or for the presence of abnormal patterns such as continuous venous flow within the deep veins.

Color doppler is also used to aid in identifying the extent or absence of thrombus in the veins.
In contrast, limited compression of the deep system is performed. Spectral doppler is used to evaluate for reversal of blood flow from incompetent valves within the venous system. Though the deep system is evaluated, a larger emphasis is placed on the superficial veins and the connections of the two systems.

What Are Some Of The Most Common Causes Of Venous Reflux?

- Damage to the valves resulting from postphlebitic syndrome.
- Congenital defect that results in a decreased number of valves in the venous system.
Weakened vein walls resulting in dilated veins that occur due to venous hypertension, congenital defects or hormonal changes from pregnancy.

**Patient Preparation For A Reflux Study**
- Patient should be well hydrated day of the study.
- Compression stockings should not be worn the day of or the day before the exam.
- Ideally the exam should not be performed first thing in the morning but later in the day when symptoms are most pronounced.

**Patient Positioning**
- The exam should be performed in a warm environment to avoid venous spasm.
- Patient must be in an upright position and should not be scanned supine.
- The legs must be in a dependant position with the majority of the weight on the leg not being scanned.
Patient Positioning

- Scanning the patient in the standing position
  - This can be limited due to patient mobility and is usually less ideal ergonomically for the sonographer
  - Scanning the patient on a tilt table in the reverse Trendelenburg at a minimum of 15-20°

As with any exam, you want to completely explain the process and expectations beforehand to the patient.

- The patient’s ability to perform the valsalva maneuver correctly is vital to getting accurate results.
- Inform the patient prior to any compression or augmentation of the extremity, tension or movement of the patient can affect the doppler image.
Protocol For Performing A Duplex Ultrasound For Venous Insufficiency

- Confirm the absence of acute deep venous thrombosis with compression of the CFV, Mid PV, and POP, while also differentiating between chronic and acute thrombosis.

- Once you’ve ruled out the presence of DVT, begin the assessment for reflux in the area of the groin.

- All interrogation of the superficial system should include compression, diameter measurement, and Doppler evaluation using Valsalva and/or distal augment.

- Begin with compression at the saphenous femoral junction as well as the proximal greater saphenous vein approximately 2 cm from the junction.
Take measurements at the SFJ and Prox GSV to identify enlargement of the vessels.

Normal GSV should be under 4mm.

Doppler Evaluation

- Performed at the CFV, SFJ, Prox and Mid GSV, Mid PV, Pop, SPJ, SSV and affected Perforator at a minimum.
- Used to evaluate for retrograde venous flow (backwards flow above the baseline)
- Performed in conjunction with the Valsalva maneuver or a distal augment of the lower extremity.
- Valsalva is used for the veins located in the groin and proximal thigh only. The veins of the distal leg are accessed with an augment due to Valsalva becoming less effective as you move further down the leg.

Sample volume of the pulse wave should be open from wall to wall in the vessel of interest so not to miss eccentric reflux flow through the valve.

Doppler gain should be adjusted so there is a clean waveform free of artifact.
Using colorflow during valsalva/augment prior to doppler ensures proper pulse wave placement, especially within an enlarged vessel.

Once you have evaluated the veins located within the groin, the gsv should be followed from the proximal portion to the level of the knee.

While scanning the saphenous vein in the transverse plane any incompetent perforators, accessory anterior branches with reflux or varicosities should be documented.

If a segment of the gsv becomes tortuous, this also must be documented so that it may be taken into consideration in regards to treatment options.

Identifying The GSV/SSV
Short Saphenous Vein

- Interrogated using doppler and colorflow starting at the junction of the popliteal and saphenous vein if present.
- The saphenous vein only drains into the popliteal approx 50-60% of the time.
- The remaining instances the ssv continues traveling up the thigh terminating in either the gluteal vein, giacomini or perforators within the thigh.

SSV Compression

- Normal SSV measures < 3mm.

Perforator Veins

- The venous connection between the superficial and deep system that allows for the balancing of venous pressure.
- Common perforators and their location:
  - Cockett’s – located 2, 4, and 6 inches above medial malleolus.
  - Boyd’s – located in the area just below the knee.
  - Dodd – mid to distal thigh.
Incompetent Perforators

- Have dysfunctional valves that allow blood to backflow from the deep venous system to the superficial system, causing an increase of pressure within the superficial veins.

- This increase in pressure is a leading cause in discoloration, pain and tenderness around the ankle as well as ulcerated skin that is difficult or impossible to heal.
Reflux is defined as retrograde flow lasting longer than 350ms in perforators.

Dilated vessel leading to severe venous reflux.
Enlarged Varicosities Due to Increased Venous Pressure

Damaged Valve In Patient With Previous History Of Thrombosis
Patient Complaining Of Left Lower Leg Pain/Heaviness

Right SSV  Left SSV
Ultrasound Guidance During Radiofrequency Ablation

- Survey of the gsv starting at the groin continuing to below the knee noting any areas that may be problematic for the passing of the RFA catheter.
- Also evaluate for any accessory branches that may not be included in the treatment of the gsv.

Once the physician chooses the access point the vein is held in the transverse plane to allow visualizing of the access needle into the center of the lumen.
After placement of the catheter within the vein, the SFJ is visualized in the long access to aid in placement of the catheter approximately 2 cm from the CFV to avoid a heat induced thrombus.

Once the catheter is in place it is scanned in the transverse plan from access point to the tip during the injection of the saline, lidocaine and epinephrine mixture.

This insures complete coverage of the catheter with a bull’s-eye appearance to have proper insulation, as well as compressing the walls of the vein to provide proper contact with the catheter during treatment.
Post Ablation Ultrasound

- Insure closure of the treated vein and affected branches
- Insure absence of endothermal heat induced thrombosis (EHIT) extending into the deep system
- EHIT classifications
  - Class I: Thrombosis at the superficial junction (SFJ,SPJ)
  - Class II: Non-occlusive thrombosis extending into the deep system at an area of less than 50%
  - Class III: Non-occlusive thrombosis extending into the deep system at an area greater than 50%
  - Class IV: Occlusive thrombosis of the deep system
Thrombosis Extending Into The CFV

Technical Errors While Scanning Reflux Studies

- Doppler – gate placement, sample volume width, artifact filled baseline
- Positioning – scanning patient in supine position, ensuring patient in stable position to prevent motion artifact
- Ultrasound Technique – losing contact with vessel during augment giving inaccurate doppler results
Doppler Placement Is Vital

Severe Reflux Of Over 4 Seconds Potentially Missed
Distal Augment Creates An Immediate Increase Of Antegrade Velocity Then A Reversal Of Flow That Becomes Reflux In An Incompetent Valve

Primary varicose vein

- The patient with varicose veins, who has a strong family history and no evidence of stasis pigmentation, will have primary varicose veins.

- This simply means that all of the problems reside in the superficial venous system where the valves are incompetent.

Ref: Duplex Scanning in Vascular Disorders 2nd ed. D. Eugene Strandness p.269

Primary varicose vein

- A clue of primary varicose vein is the lack of significant discomfort, edema or pigmentation.

- It is generally accepted that primary varicose veins do not lead to the development of pigmentation and ulceration.

Ref: Duplex Scanning in Vascular Disorders 2nd ed. D. Eugene Strandness p.41
Possthrombotic syndrome

- Patient with a history of DVT (deep venous thrombosis) who presents with edema, pigmentation, and in some cases ulceration, can in most cases be labeled as having the postthrombotic syndrome. Ref: Duplex Scanning in Vascular Disorders 2nd ed D. Eugene Strandness p.269

- Primary varicose vein Ref: Duplex Scanning in Vascular Disorders 2nd ed D. Eugene Strandness p.269

Primary pathology will be found in the deep veins, where valvular incompetence will be found as the primary pathological change responsible for the clinical outcome.

- There will be patients who present with full blown symptoms and signs of post thrombotic syndrome who will not give a history of a previous episode of DVT. It is assumed there has been a silent episode unrecognized by patient or physician. Ref: Duplex Scanning in Vascular Disorders 2nd ed D. Eugene Strandness p.269

Venous Stasis
A photoplethysmogram (PPG) is an optically obtained plethysmogram, a volumetric measurement of an organ. A PPG is often obtained by using a pulse oximeter which illuminates the skin and measures changes in light absorption.

A conventional pulse oximeter monitors the perfusion of blood to the dermis and subcutaneous tissue of the skin.
PPG Technique

Physiologic Testing: Techniques and Interpretation 2nd ed 2012 Robert Scisson, RVT  pp76-77

- PPG is used to perform evaluation of reflux at the venous plexus below the surface of the skin (subdermal)
- Secure PPG sensor 10 to 15 cm above medial malleolus
- Avoid areas of inflammation or cellulitis because elevated skin temperature can produce false positive results. Also avoid placing sensor over large subcutaneous vein, skin ulceration, areas of joint motion, or a major artery (posterior tibial or anterior tibial artery)
Photoplethysmography (PPG)

Physiologic Testing Techniques and Interpretation 2nd ed. Robert Scisson, RVT pp 76-77

- Patient seated comfortably, edge of stretcher, legs dependent and non-weight bearing.
- Record baseline at rest. Allow 2-3 minutes to stabilize.
- Patient will then forcefully contract calves through plantar and dorsiflexion of feet a total of 5 times. Repeat. Repeat again.
  - This empties the venous sinuses and pumps venous blood through the deep and superficial systems.
- Venous refilling time is measured from the end of the 5th foot dorsiflexion to the return to a stable baseline.
A normal response to calf muscle activity is a reduction of venous volume and pressure.

When vein valves are competent, capillary refill is directed by arterial inflow, and venous refilling time is very slow. Normal venous refilling time is 20 seconds or longer.

With valvular reflux, as soon as the venous blood is pumped out and the calf muscles relax, the venous system is rapidly refilled because the valves are incompetent. This results in a PPG waveform that quickly returns to baseline levels in less than 20 seconds. In patients with severe valvular incompetence, calf muscle pump function is so poor and incapable of emptying venous blood, there is no drop in PPG baseline despite foot dorsiflexion.
Photoplethysmography (PPG)

Results could be from deep or superficial venous systems
To differentiate, apply tourniquet to occlude superficial system and allow isolated assessment of the deep and perforator veins.
At upper thigh for GSV, at knee for LS (small saphenous)

If venous PPG reflux is identified, tourniquet application and results:
Above ankle: Abnormal = deep vein reflux, if normal go below knee
Below knee: Abnormal = perforator vein reflux, if normal go above knee
Above knee: Abnormal = small saphenous reflux
Normal = Great saphenous vein reflux
Add on... patient is here today, can you squeeze them in?

Questions?

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References

