Deep Vein Imaging in the Calf

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Objectives

- Anatomy of the deep veins of the calf
  - Where do we look for DVT?
  - Location of vessels and their interaction
- Identification of DVT within vessels.
  - How do I know?
- Approaching the deep calf veins
  - How do I get better images?
  - When do I know that I just can’t see the calf veins?
Challenges of Calf Vein Imaging

- **Identification**
  - Which veins are which? Anatomy
  - What is the best way to approach the calf veins?
    - Patient positioning
    - Using the right equipment
  - What does calf vein DVT look like?
  - How important is calf vein DVT?
Approaching Calf Veins

- Most venous duplex exams start with the patient in a near supine position with the leg slightly externally rotated.
- A 30 degree reverse Trendelenberg positioning.
- Calf veins best imaged in a more extreme reverse Trendelenberg position.
  - Seated upright.
  - Lower leg over side of bed.
- Hydrostatic pressure = gravity = better visualization.
Duplex is the Best

- Duplex ultrasound examination has evolved to become the imaging method of choice for investigating calf vein thrombosis. Most vascular laboratories in France routinely assess the calf deep veins in patients suspected of having an acute deep vein thrombosis (DVT) of the lower limbs.\(^4\)

- Given the rapid advances in its resolution and widespread availability CFDU has supplanted contrast venography as the imaging method of choice for diagnosis of CVT. Including thrombosis involving the veins draining the gastrocnemius and soleal muscles.\(^1\)

- Duplex scanning frequently detects thrombi in ‘muscular veins’ and rarely distinguishes between soleal and gastrocnemius veins.\(^2\)
Patient Positioning

- Cannot be stressed enough!
- Use the exam bed or table to your advantage!
  - Reverse Trendelenburg
- Raise the head of the bed!
- Reposition the Patient!
- Prop the thigh to get the calf off the bed!
Proof Positive
(in a negative way)
Transducers

Superficial Imaging

Deep Imaging
Try another tool

- What is the old saying? “If it doesn’t fit, get a bigger hammer.”

Haines, Alaska
Leg dependent over side of bed

9MHz Linear

4MHz Curved
We have to be realistic though

- Sometimes it just isn’t going to happen, and very likely isn’t really that necessary.
Knowing the Anatomy

POPLITEAL
Deep Veins of the Calf

- Anterior Tibial Veins*
- Posterior Tibial Veins*
- Peroneal Veins*

* Receive blood from sole of the foot

- Gastrocnemius Veins (muscular)
- Soleal Veins (muscular)
Gastrocnemius Anatomy

- Veins run through the two heads of the gastrocnemius muscle.\(^3\)
- Medialis and Lateralis.\(^3\)
- Vein pairs connect forming one vein pouring into the popliteal vein.\(^3\)
- 87% of main gastrocnemius trunks drained into the popliteal vein.\(^2\)
- 2/3 of main gastrocnemius trunks contained valves at some point.\(^2\)
Anatomy: Gastrocnemius Veins

![Gastrocnemius Veins Image]

- **GASTROCS DUMP INTO POP V**
- **RIGHT POPV**
- **LSV DUP**
Soleal Vein Anatomy

- Comprised of over ten multi-branched veins. ³
- Centralis, medialis, lateralis. ³
- Veins combine (confluence) to form larger veins. ³
- Centralis of the soleal vein pours into the peroneal vein and posterior tibial vein or lower part of the popliteal trunk. ³
Anatomy: Soleal Veins
Soleal Vein Termination Points
Anatomy: Posterior Tibial and Peroneal Veins
So Where Is the “Trifurcation”? 

The diagram illustrates the branches of the popliteal trunk: 
- **POP**: popliteal trunk 
- **MG**: Upper part 
- **LG**: Middle part 
- **LPOP**: Lower part 

The image on the right shows anatomical structures: 
- **POPLITEAL VEIN** 
- **ANTERIOR TIBIAL VEIN** 
- **POSTERIOR TIBIAL VEIN** 
- **GASTROCNEMIUS VEIN**
What veins and pathology can we find?

- **Posterior Tibial**
  - Generally paired

- **Peroneal**
  - Generally paired

- **Gastrocnemius**
  - Medial Head most commonly imaged as lateral head will be deep to medial head from medial approach
  - If patient says the lateral calf hurts, look there!

- **Soleal**
  - Soleus muscle extends length of the calf
IGSVT

- Isolated Gastrocnemius and Soleal Vein Thrombosis

Study from Tokyo, Japan

- No systemic anticoagulation.
- 135 limbs with IGSVT studied for 3 months.
- 16.3% propagated to tibial or peroneal veins or higher.
- 3% propagated into popliteal vein.
- 90.9% IGSVT propagated within 2 weeks.
Etiology of Gastrocnemius DVT

- Achilles tendon trauma.
- Arthroscopic Knee Surgery.
- Unsure why, but these two presenting factors seem to increase the risk in my experience.
Pre-op Literally

- Patient presented from orthopedic office with calf pain and swelling.
- Achille’s rupture needing surgery.
- Surgery was put off for duplex to be done.
- Patient had been prepped, had been given a nerve block and lower leg was numb.
Gastrocnemius Trunks

LEFT GASTROCS AT POP

LEFT GASTROCS PRX CALF
Gastrocnemius Near Pop Pre-op
Gastrocnemius DVT

- 37 year old male with a history of superficial thrombophlebitis in the left greater saphenous vein one year prior, which responded well to conservative therapy (Aspirin and antibiotics).

- Presents with calf pain following a left Achille’s tendon injury while moving furniture for which he has been wearing a boot with limited walking and weight bearing.

- 2 Venous Duplex studies done 2 days apart.

- Starting taking 81mg Aspirin after first study.
Mid Left Calf
Gastrocnemius and Popliteal Confluence
48 Hours Later
Transverse Compressions

August 22nd

August 24th
Peroneal Vein DVT

- Reason for visit: Chest Pain.
- Left achilles tendon surgery 5 weeks ago.
- Ruptured achilles while boating in Canada (air travel).
- Non-weight bearing for 4 weeks post-op.
- Prescribed crutches, used scooter to get around.
Isolated Peroneal Vein DVT
Not-so Isolated Peroneal DVT

- Multiple segmental filling defects involving segmental branches of the right lower lobe pulmonary artery consistent with pulmonary embolism.
- Full anti-coagulation.
Arthroscopy

- S/P Right knee arthroscopic meniscus repair.
- “Cramping” in calf.
- Noticed right foot was swollen.
- Foot swelling went down after taking off the post surgical wrapping.
- Calf still sore.
Posterior Tibial Vein

Transverse Compressions in Proximal Calf
PTV Sagittal
Don’t squeeze too hard!
Gotta go on a Trip

- Puerto Rico.
- I want to drink.
- And take part in other local customs.
- Air travel.
Full Anti-Coag 41 days later
If at first you don’t succeed

- Duplex gives us the option of follow up studies.
Patient done at another facility 4 days prior to this exam and there was no reported DVT, just stated that calf veins were not well visualized and recommended MRV.

Radiologist called referring physician and recommended duplex exam as MRV would not properly diagnose lower leg DVT and could lead to thrombophlebitis.
Popliteal Vein Compressions

Proximal  

Mid
Distal Popliteal Vein Transverse
Distal Popliteal Vein Color
Posterior Tibial Vein
PTV to Trunk to Popliteal
Soleal Vein to PTV

Moving caudal from proximal calf

Moving cephalad from mid calf
Path of an unprovoked Popliteal Vein DVT

- Soleal Sinus ➔ Posterior Tibial Vein ➔ Tibial Trunk ➔ Popliteal Vein
Next stop Popliteal Vein

- 42 year old female with calf pain.
- Birth control.
- Sedentary job.
Peroneal Vein DVT
Isolated Calf Vein Thrombi

- 75 patients prospectively monitored with sequential scans 3 to 4 day interval.  
- 32% propagated; 46% of these into popliteal or larger veins of thigh.  
- Proximal soleal vein thrombi had the highest incidence in both propagating and non-propagating groups.  
- 5% had highly probable ventilation perfusion scans as their initial indication for duplex scanning.  
- DVT isolated to the calf is not a benign problem.
Pulmonary Embolism

- 85 year old female recently diagnosed with myasthenia gravis (neuromuscular disorder), which causes weakness.
- Per patients H&P at admit she has not been very active and basically sitting or lying around the house.
- Came in with shortness of breath, had chest CT which was positive for right truncus anterior and right lower lobe pulmonary emboli.
Bilateral Lower Extremity Doppler

- Lower extremities negative for DVT in CFV, FV, Popliteal, PTV and Peroneal veins.
PTV and Peroneal Veins
Soleal Vein
Appears Isolated
Why is the Soleal Vein Important?

- The soleal muscle works only at the ankle joint. ³

- The soleal muscle would not be activated
  …prolonged sitting, e.g.,… a hospital stay or
  long plane flights… ³
Positive Chest CT

- Patient present to ED with shortness of breath and chest pain.
- Being treated for metastatic colorectal cancer to the liver and lungs.
- Venous Dopplers are ordered.
Distal Calf
Soleal to Peroneal?
Extensive Soleal DVT
## Prevalence of calf DVT

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of limbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peroneal vein</td>
<td>115 (41%)</td>
</tr>
<tr>
<td>Soleal vein</td>
<td>109 (39%)</td>
</tr>
<tr>
<td>Posterior tibial vein</td>
<td>105 (37%)</td>
</tr>
<tr>
<td>Gastrocnemial vein</td>
<td>79 (28%)</td>
</tr>
</tbody>
</table>

282 total limbs studied
Prevalence of calf DVT in a single or paired vein alone\textsuperscript{6}

<table>
<thead>
<tr>
<th>Location of thrombus</th>
<th>No. of limbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soleal alone</td>
<td>57 (20%)</td>
</tr>
<tr>
<td>Gastrocnemial alone</td>
<td>48 (17%)</td>
</tr>
<tr>
<td>Peroneal alone</td>
<td>42 (15%)</td>
</tr>
<tr>
<td>Posterior tibial alone</td>
<td>35 (12%)</td>
</tr>
<tr>
<td>Total</td>
<td>182 (64%)</td>
</tr>
</tbody>
</table>
Treating Calf Vein DVT (CVT)

- Anatomical characteristics and physiological mechanisms play a major role in the occurrence and propagation of venous thrombi. Thus, and understanding of these features is essential for effective prophylaxis of venous thromboembolism.³
Risk Factors

1. Cardiac disease (CAD, CHF, Atrial or Ventricular Arrhythmia)
2. Cancer (local or metastatic)
4. Recent surgery (general/orthopedic/vascular/gyn)
5. Trauma
6. Venous Disease (varicose veins, stripping, previous DVT or PE
7. Venous Stasis
Who gets treated?

- Etiology is important.
  - Fracture (includes joint replacements)
  - Cancer (chemotherapy, radiation)
- Unprovoked = Treat? At least follow up.
- Small burden in isolated segment.
- Surgery with temporary immobility or non-weight bearing status.
How are they treated?

- High dose NSAIDs.
- Aspirin.
- Antibiotics.
- Serial Duplex scans.
- IVC Filter.
- Anticoagulation.
  - Full cycle.
  - Abbreviated cycle.
Contraindications for Anticoagulation

- Bleeding.
  - Intracranial
  - Active
  - Ulcers
  - Falls risk
- Recent surgery.
  - Brain
  - Eye
  - Spinal Cord
- Malignant hypertension.
- Drug interactions.
- Severe thrombocytopenia.
Risks of Anticoagulation

- **Bleeding.**
  
  - With the advent of low-molecular-weight heparin (Lovenox), the risk-benefit ratio moves further in the direction of treating CVT with anticoagulation, because complications from heparin treatment are minimized.  

- **Inconvenience.**
  
  - With the development of outpatient home monitoring and the self-administration of subcutaneous low-molecular-weight heparin, anticoagulation therapy is far more cost effective than serial duplex scans.  

Issues from CVT

- **Pulmonary Embolism.**
  - Study from Tokyo investigating … fatal cases of acute massive PTE in forensic autopsy.$^3$
  - Results indicated highest frequency of [calf] DVT especially at soleal vein.$^3$

- **Proximal DVT (propagation).**

- **Venous Reflux.**
  - Pain.
  - Edema.
  - Hemosiderin staining.
  - Venous stasis ulcers.
  - Infection.
So what do they think in Seattle?

- The natural history of CVT is complicated by persistent symptoms and the development of valvular incompetence in approximately one-quarter of patients. This potential for persistent lower extremity symptoms should be considered in evaluating the clinical relevance of isolated calf vein DVT.
Serious Complications

- 105 patients with isolated CVT and symptoms.\(^7\)
- 26 patients had respiratory symptoms.\(^7\)
- 9 had PE.\(^7\)
- 2 died.\(^7\)
- 35% of patients who had both isolated CVT and respiratory symptoms had PE.\(^7\)
Conclusion

- Calf vein DVT is a clinically relevant finding and should be taken very seriously.
- DVT in the gastrocnemius and soleal veins is important to identify (and ultrasound is the way to find it!).
- Treating calf vein DVT requires a good understanding of the patient’s health history and unique circumstances.
- ICAVL requirements of calf vein interrogation are there for a reason.
Reference Articles


5. Early outcome after isolated calf vein thrombosis Markk H. Meissner, et al Seattle, Wash. Department of Surgery, University of Washington School of Medicine

