

Instructor's Digital Curriculum Resource-

For Techniques in Noninvasive Vascular Diagnosis-4th edition.

by Robert J. Daigle, BA, RVT, RVS, FSVU, FSDMS

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Chapter 7. Venous Imaging for Insufficiency

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Definitions for this chapter

- **Valsalva maneuver**
 - moderately forceful attempted exhalation against a closed airway, usually done by closing one's mouth and "bearing down" with stomach muscles
- **Reflux**
 - abnormal, reversed flow direction
- **In situ**
 - Latin for "left in place" or in position

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Definitions for this chapter

- **Fascia**
 - A thin sheath of fibrous tissue enclosing a muscle or other organ.
- **Tumescence in venous ablation**
 - Injecting saline and lidocaine to cause local swelling around the vein to be "cooked". Acts as a heat absorber and prevents burns to the underside of skin.

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Venous Insufficiency Venous Incompetence

- **Primary**
 - Congenital absence or malfunction of valves
- **Secondary**
 - Post phlebitic- damage to valves secondary to thrombosis and/or venous outflow obstruction

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Symptoms of Venous Insufficiency

- **Recurrent calf, ankle, or foot swelling.**
- **Varicosities.**
- **Venous claudication.**
- **Stasis dermatitis.**
- **Ulceration.**
- **Chronic limb swelling.**

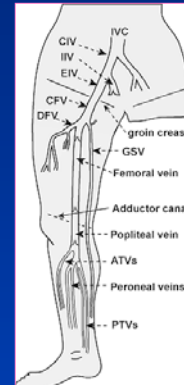
Note that these symptoms are distinctly different from those of acute venous thrombosis.

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Venous Insufficiency Symptoms



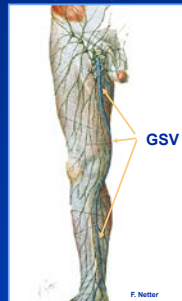
Anatomy Review



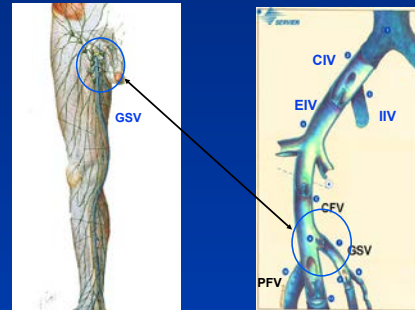
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Anatomy Review Great Saphenous Vein (GSV)

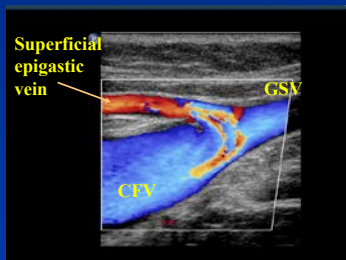
- Joins deep system at CFV
- Carries approx. 15% of venous blood volume in leg.
- Often anomalous, with double systems (8%), or non-continuous (25%)
- No adjacent artery



Saphenofemoral Junction (SFJ)

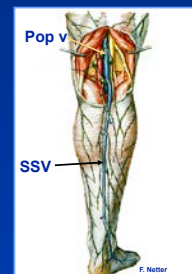


Superficial Epigastric Vein

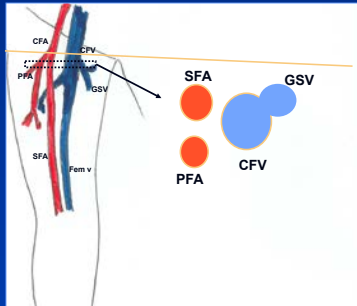


Small Saphenous Vein (SSV)

- Posterior aspect of calf
- Typical confluence is at popliteal vein
- In 20-30 % of population, SSV will enter above the popliteal vein or join the giacomini vein
- No adjacent artery



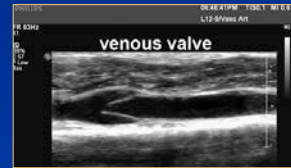
Crayon Venous Anatomy



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Venous Valve Distribution

- IVC - 0
- CIV - 0
- EIV - 0 in most
- FV - 4
- Pop - 2
- PTV - 10
- Per - 10
- ATV - 10



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Imaging Technique

- Torso elevated 10-20 degrees in semi Fowler's position
- Leg rotated externally
- Start at groin crease in transverse plane



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Recommended Venous Protocols

Protocols based on "logic" and symptoms

1. Acute deep venous thrombosis protocol
2. Venous insufficiency protocol
 - Step #1: Rule out chronic DVT
 - Step #2: Reflux test of deep veins
 - Step #3: Identify reflux in GSV, SSV
 - Step #4: Identify incompetent perforators
3. Pre-ablation protocol (includes #2)
4. Vein mapping for arterial bypass

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Protocol #2 - Insufficiency

Protocol for Venous Insufficiency

- Chronic outflow obstruction can cause venous insufficiency.
- Ablating or removing GSV if it's functioning as a major collateral is a no no!

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Protocol #2- Venous Insufficiency

Step #1

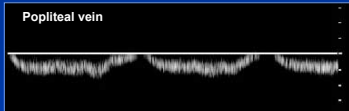
Rule out chronic DVT in proximal veins, **Quickly**

- Compress CFV, prox FV, & Pop. veins only
- Record spontaneous flow with respiratory variation at popliteal vein
- Don't scan calf veins for deep vein insufficiency.

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No chronic outflow obstruction if:

- CFV and Popliteal veins are compressible
- If respiratory phasic flow is present at popliteal v.



The above findings also rule out acute DVT.

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Protocol #2- Venous Insufficiency Step # 2

Protocol for Reflux Testing

- Deep veins- test 2 sites only
 - CFV
 - Proximal femoral vein
 - Popliteal vein
- Initial exam with patient in reverse Trendelenburg or semi-Fowler's position.

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Venous insufficiency

Evaluate Valve Competency

- Spectral Doppler – quantitative
- Color Doppler- qualitative
- Valsalva
- Proximal limb compression
- Following distal limb compression

Patient in reverse Trendelenberg position

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Normal proximal CFV valve with Modified Valsalva (hand placed on abdomen, pt. pushes up against hand)



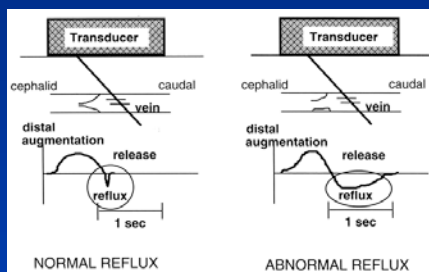
When in PowerPoint Show, click on link below for video demo on youtube.

<http://youtu.be/cUFno1hIBpE>

Movie- CFV valsalva.mov

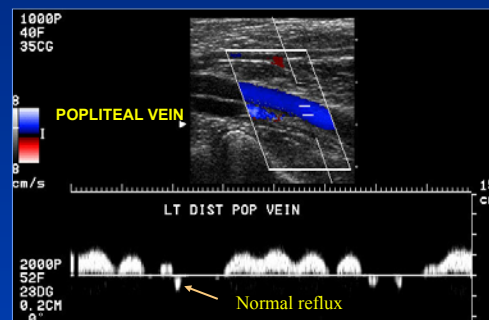
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Normal versus Abnormal Reflux



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Some venous reflux is common, it takes a moment for valves to close.



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**Protocol #2- Insufficiency -
Step # 2**

Deep System: Popliteal v.

- Patient in semi-Fowler's position, or reverse trendel.
- Transducer on Pop V. Squeeze calf to augment, then watch for reflux following augmentation.
- Record & measure duration



Reflux

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Reflux Duration Criteria

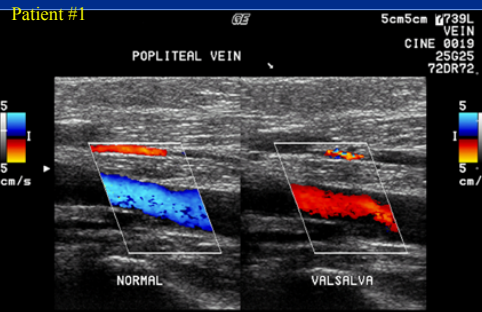


- abnormal ≥ 1.0 seconds for deep veins

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Venous insufficiency

Often, Valsalva will cause reflux in the entire deep system.



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If popliteal vein valves are competent, patient will not have deep vein insufficiency.

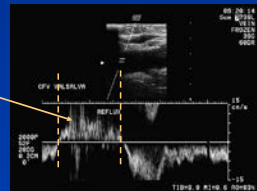
Competent popliteal vein valves are the critical components of the veno-motor pump.

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**Protocol #2- Insufficiency -
Step # 2**

Deep System: CFV

- Evaluate CFV, & proximal Fem V: Use modified Valsalva.
- Place your hand on patients abdomen, have patient hold breath and press upward with "stomach" against your hand.



Reflux

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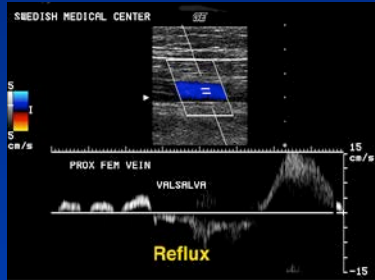
Abnormal Reflux Times

LOCATION	TIME
Deep Veins	≥ 1.0 seconds
GSV, SSV	≥ 0.5 seconds
Perforating Veins	≥ 0.35 seconds
Longer durations are observed in supine patients.	
Above values apply for a patient in a standing position.	

Lahropoulos N, Tsoungas J, Pryor L, et al. Definition of Venous Reflux in Lower Extremity Veins. J Vasc Surg. 2003; 38: 793-798.

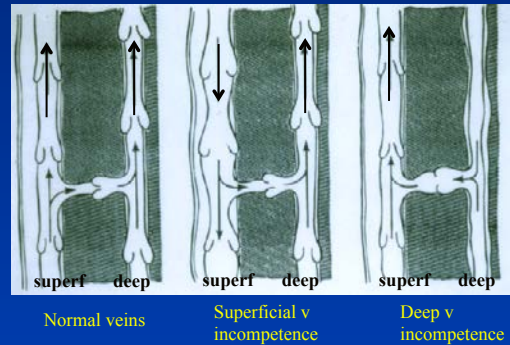
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Proximal Femoral Vein for Reflux



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Venous insufficiency



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Most patients with severe symptoms of insufficiency (venous ulcers), however, have multiple system incompetence.

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Distribution of valvular incompetence in venous stasis ulcers- 95 limbs

Hanrahan L.M, Araki CT, et al. J Vasc Surg 1991;13:805-12

D only	2.1 %	D= deep veins
P only	8.4 %	S= superficial
S only	16.8 %	P= perforating
P & D	4.2 %	
S & D	11.6 %	
S & P	19.0 %	
S & P & D	31.6 %	

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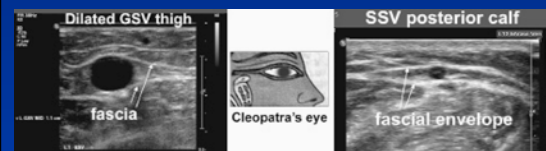
Protocol #2 - Step #3

Determine if the superficial system is incompetent

- Evaluate the entire Great Saphenous Vein (GSV) for reflux
- Evaluate Small Saphenous Vein (SSV) only if it's large and dilated.
- Evaluate perforating veins (if distended).

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Saphenous veins are contained within fascial envelopes

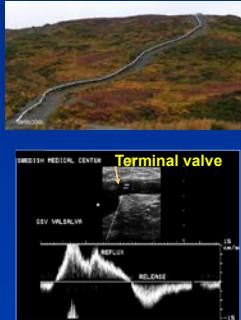


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**Protocol #2- Insufficiency -
Step # 3**

Great Saphenous Vein

- Evaluate GSV for reflux
- "Assisted" valsalva to evaluate GSV terminal valve
- Also "massage" the vein from distal to proximal, look for reflux, post augmentation



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GSV diameter consistent with reflux

- SFJ > 9.0 mm
- mid thigh > 7.0 mm
- mid calf > 5.0 mm

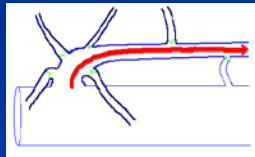


Engelhorn, Salles-Cunha S, et. al., Relationship between reflux and greater saphenous vein diameter. J Vasc Technol, 21 (3):167-172, 1997

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**Protocol #2- Insufficiency -
Step # 3**

Incompetent Terminal Valve - GSV



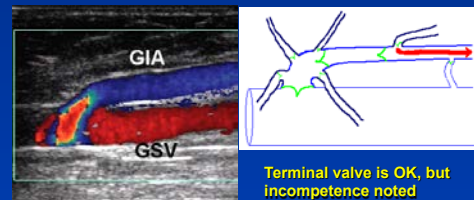
Oliver Pichot

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**Protocol #2- Insufficiency -
Step # 3**

If GSV Terminal Valve is Competent..

- Identify the highest level of reflux, i.e. proximal, mid or distal GSV



Terminal valve is OK, but incompetence noted distally.

Oliver Pichot

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**Protocol #2- Insufficiency -
Step # 3**

Patient Position: Standing or Not?

- No need if popliteal is positive in semi-Fowler's position.
- Maybe, if Pt. is truly symptomatic and no reflux found when reclined.
- Theoretically, standing is the best reflux test position, but practically, it's difficult.

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**Protocol #2- Insufficiency -
Step # 3**

Patient Standing.

- Test popliteal vein for reflux
- Test CFV (manual valsalva) for reflux

Optional, high-tech method- rapid cuff inflator/ deflator



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Protocol #2- Insufficiency -
Step # 3

Abnormal Reflux Time

- With patient standing
 - Deep vein veins ≥ 1.0 seconds
 - GSV, SSV ≥ 0.5 seconds
 - Perforator veins ≥ 0.35 seconds
 - Longer durations observed in supine patients

Labropoulos N, Tiongson J, Pryor L, et al. Definition of Venous Reflux in Lower Extremity Veins. J Vasc Surg. 2003; 38: 793-798.

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Protocol #2- Insufficiency -
Step # 3

- Assess small saphenous vein, identify in transverse plane.



Transverse view of normal small saphenous vein.

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Protocol #2- Insufficiency -
Step # 3

- Assess small saphenous vein:
 - if it's large
 - If there are associated varicosities
 - Look for reflux following calf augmentation.

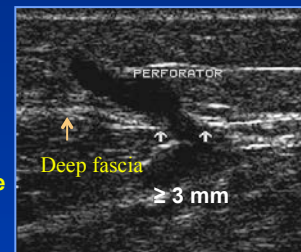


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Protocol #2- Insufficiency -
Step # 4

Identify Incompetent Perforating Veins

- Perforating veins course from superficial to deep veins
- If incompetent, local venous reflux can cause varicose veins and ulceration



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Protocol #2- Insufficiency - Step # 4

Perforating Vein Anatomy



It's difficult to see normal perforators, but easy to identify incompetent ones.

90% of incompetent PVs are ≥ 3.5 mm

Most visualized perforating veins are here.

Protocol #2- Insufficiency -
Step # 4

Perforator Evaluation

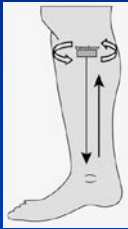
- Patient sitting, leg dependent
- or patient standing



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**Protocol #2- Insufficiency -
Step # 4**

Perforator Evaluation



Transverse scan, medial approach, scan straight down to ankle.

Scan for defects in deep fascia.

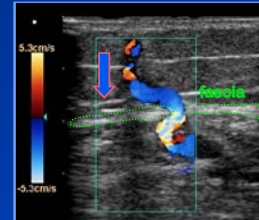
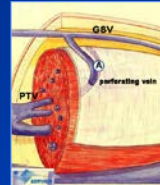
Move transducer one-probe width and repeat scan.

Proceed until entire calf circumference is scanned.

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Protocol #2- Insufficiency - Step 4

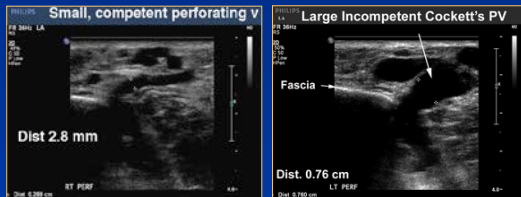
- Color Doppler can be used to good effect initially, on a suspect incompetent PV.
- If color is abnormal, then use Spectral Doppler and measure time.



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**Protocol #2- Insufficiency -
Step # 4**

Cockett's Perforating Veins



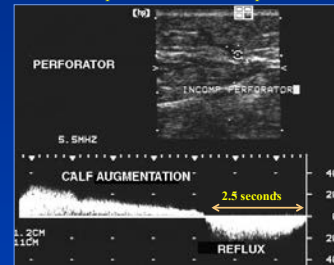
Also, measure the PV diameter on those suspected of being incompetent.

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**Protocol #2- Insufficiency -
Step # 4**

Incompetent Perforator

Determining flow direction is sometimes tricky, but it's not important in this example: WHY?



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Don't identify, label, record, play with, marvel at, swoon over, normal perforating veins



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Protocol #3-

**Protocol #3
Pre-op assessment for vein ablation procedures.**

- This protocol includes determination of incompetent venous segments, (Protocol #2,) but with added information and procedures.
- You should determine what the ordering physician requires prior to exam.

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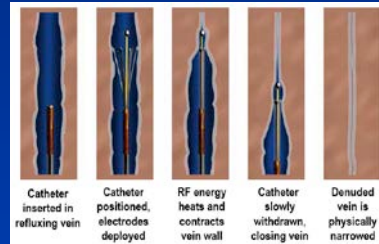
Vein Ablation (Closure) Procedures

- Obliterates the great saphenous vein, or small saphenous vein.
- Current, 3 methods:
 - Laser (EVLT)
 - Radiofrequency- (VNUS)
 - Sclerosing foam injection

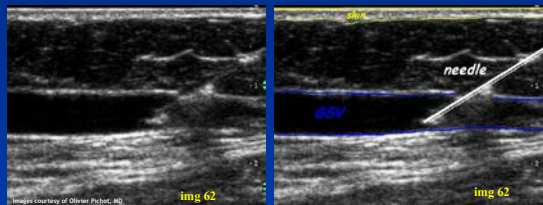
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Protocol #3- Pre-op for vein ablation

Radiofrequency Method

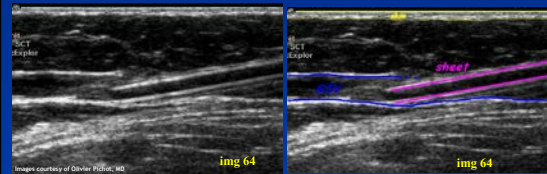


Needle is inserted into GSV usually in the distal thigh or proximal calf.



Images courtesy of Olivier Pichot, MD

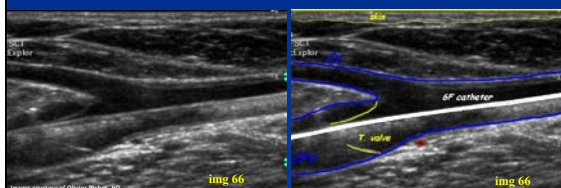
Ultrasound-Guided Catheterization Sheath



Images courtesy of Olivier Pichot, MD

Ultrasound images are courtesy of Olivier Pichot, MD
CHU de Grenoble, France.

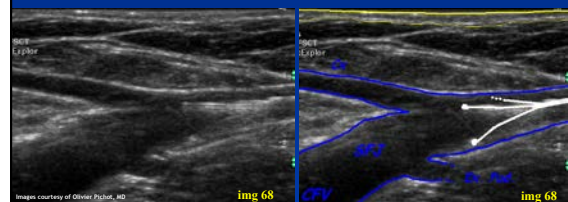
Ultrasound-Guided Catheter Positioning Catheter pre-positioning into the CFV



Images courtesy of Olivier Pichot, MD

Ultrasound images are courtesy of Olivier Pichot, MD
CHU de Grenoble, France.

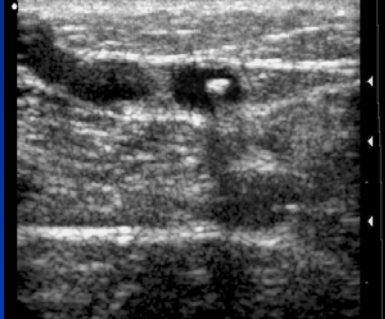
Catheter positioned below the SFJ tributaries



Images courtesy of Olivier Pichot, MD

Ultrasound images are courtesy of Olivier Pichot, MD
CHU de Grenoble, France.

Small Saphenous Vein with catheter- transverse view

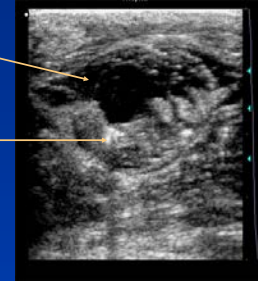


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SSV Tumescence

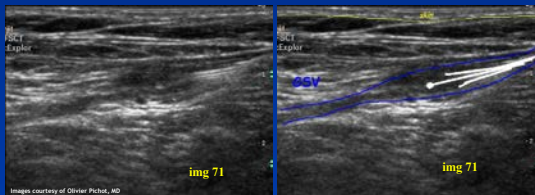
Lidocaine/saline fluid

Catheter in compressed vein



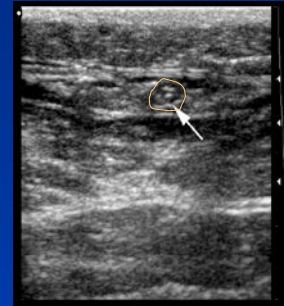
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The electrodes are activated and slowly withdrawn along the vein.



Images courtesy of Olivier Pichot, MD
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Thrombosed SSV post-RF



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Protocol #3- Pre-op for vein ablation

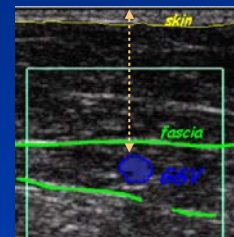
- Measure diameter of GSV at origin, mid lower and thigh
- Radio frequency venous closure limited to veins 2- 14 mm in diameter.



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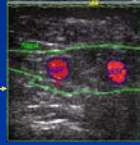
Protocol #3 - Pre-op for vein ablation

- Note if GSV is excessively deep, or superficial.
- A superficial (< 1 cm) vein may require additional tumescence.



Protocol #3- Pre-op for vein ablation

- Mark course of GSV on skin in thigh
 - a road map for tumescence
- Mark accessory GSVs
- If warranted, mark course of SSV (LSV)



Protocol #3- Pre-op for vein ablation

- Identify the source vessel of large varicosities



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Vein Mapping Prep.

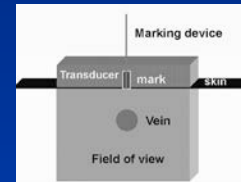
- Mark the mid-point of the transducer. Apply a strip of clear tape on the side of the transducer.
- Mark the middle of the transducer



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Vein Mapping

- Identify the proximal GSV
- Position the vein in the center of the ultrasound field of view
- Create an indentation on the skin over the vein at the mark on the transducer.



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Vein Mapping

- Move the probe a few cm, then repeat over the vein.
- Continue until the course of the vein is marked with indentations.
- Wipe off gel, connect dots with an indelible marker.



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So far...

- Protocol #1- for Acute DVT
- Protocol #2- Insufficiency
 - Step #1: Chronic outflow obstruction?
 - Step #2: Incompetent deep veins?
 - Step #3: Incomp. superficial veins?
 - Step #4: Incompetent perforators?
- Protocol #3 -Preop evaluation for vein ablation

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Protocol #4- Pre-op for arterial bypass

Protocol #4

- Pre-operative assessment to determine suitability of GSV for arterial bypass conduit.
- Rule out chronic DVT.
- Is the vein
 - Continuous?
 - Of adequate size?
 - Sclerosed or post-thrombotic



Protocol #4- Pre-op for arterial bypass

Protocol #4

- An "in situ" vein bypass, the GSV remains in place (in-situ).
- Valves are excised with a valvulotome.
- Perforating veins and tributaries are ligated and cut.
- The proximal GSV is cut and sewn into the CFA, the vein is sewn in distally to bypass the occluded arterial segment.

