

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 5. Venous Anatomy and Hemodynamics

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Definitions for this chapter

- **Bifid**- 2 of a kind
- **CCA** – common carotid artery
- **Fossa**- a depression or hollow
- **Fascia** – a layer of connective tissue that surrounds muscles, groups of muscles, blood vessels, and nerves.

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Definitions for this chapter

- **Hydrostatic pressure**- the gravitational weight of a column of fluids
- **Hypotensive**- low blood pressure
- **Retrograde flow**- reverse flow, flow in opposite direction
- **Post-phlebitic**- following thrombophlebitis (a blood clot in a vein)

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Definitions for this chapter

- **Claudication**- pain/fatigue in legs when walking
- **Transmural pressure**- the pressure inside a vessel that distends the walls.
- **Capillary bed**- capillaries are single-cell walled vessels where the exchange of nutrients and gases (O_2 and CO_2 takes place).

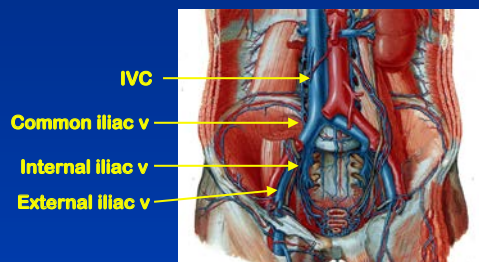
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Venous- Lower Extremities

- **Deep system** (carries 85% of limb blood volume)
- **Superficial system**
- **Perforators, communicators**
- **Calf muscle veins** (often considered deep veins)
 - gastroc veins
 - soleal veins (sinuses)

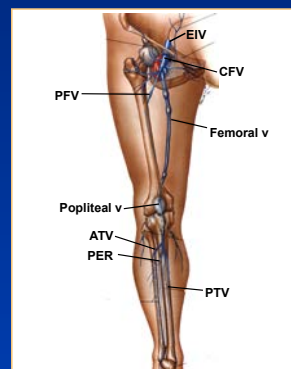
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Deep Venous System

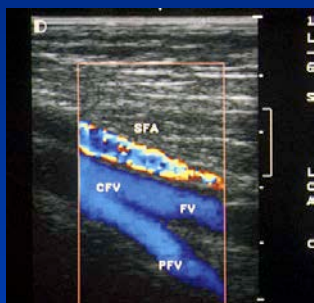


Deep Veins

1. Have an adjacent artery with the same name (except IVC)
2. Deep veins are paired in the calf



Longitudinal Anatomy



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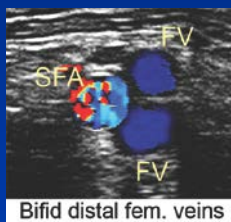
Venogram of Popliteal Anatomy



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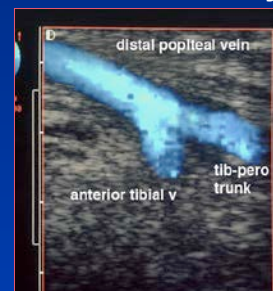
Bifid Femoral Vein is Not Uncommon

FV duplicity in thigh, 30% in some studies

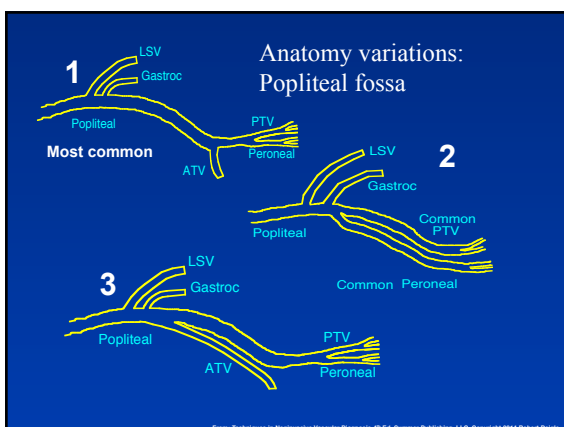


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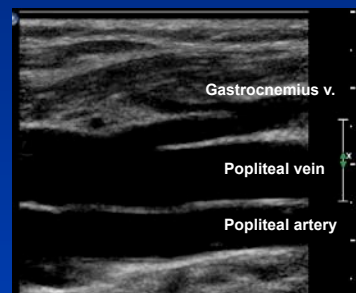
Most Common Popliteal Vein Anatomy



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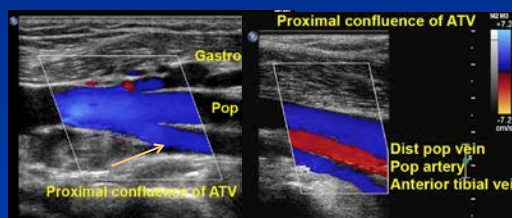


Typical Mid-Popliteal Anatomy



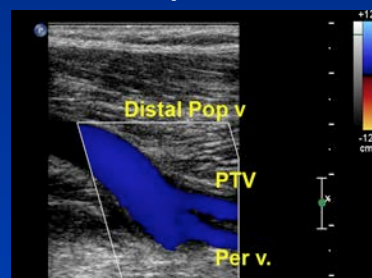
Popliteal fossa variant: high confluence of ATV.

Composite image of a variant.

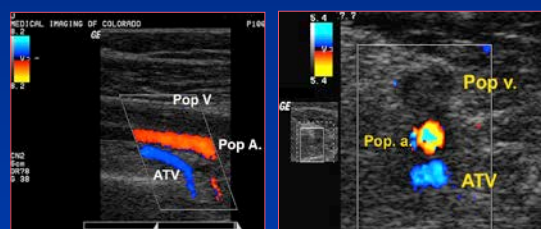


Popliteal fossa variant: high confluence of ATV.

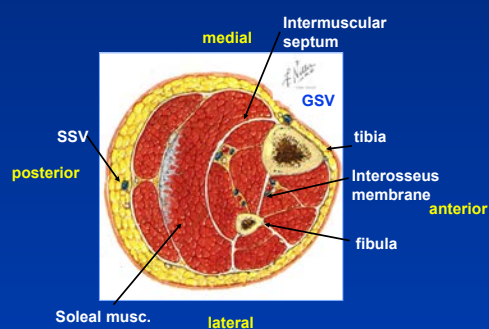
Also, no tibio-peroneal trunk vein

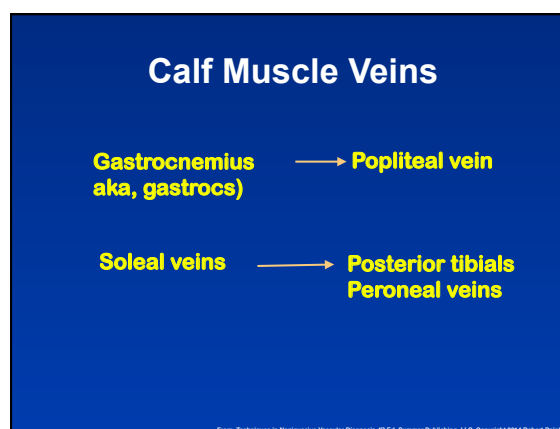
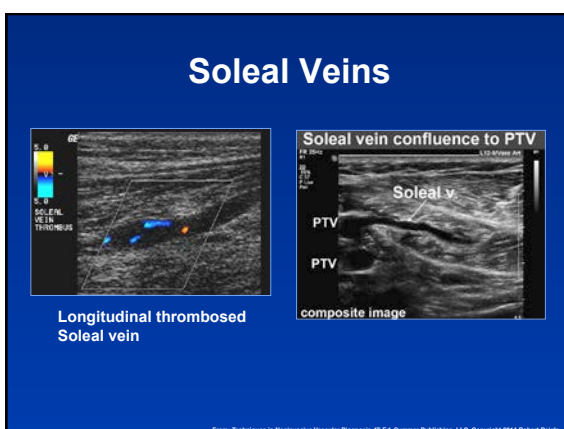
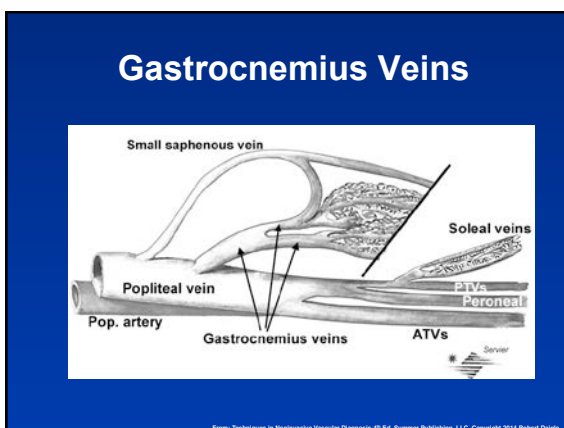
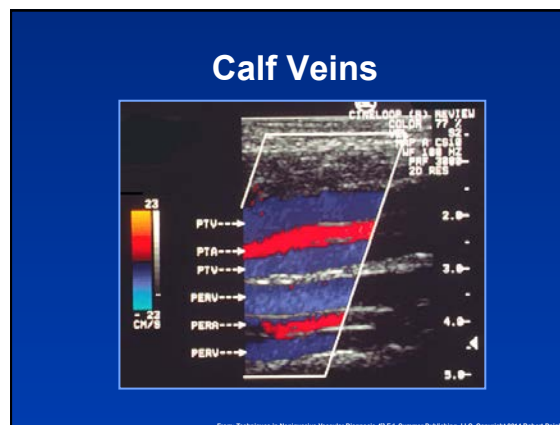
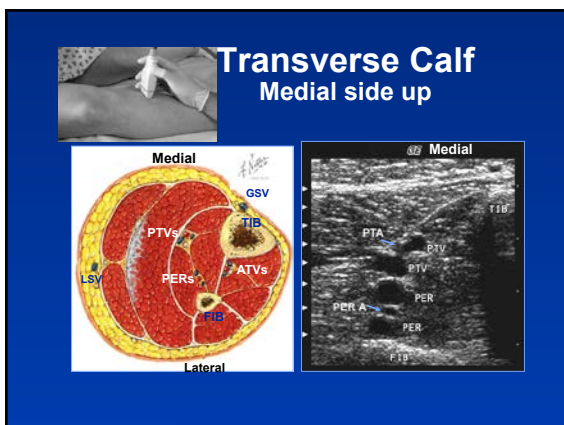


Potential Pitfall?



Anatomic Landmarks in Calf



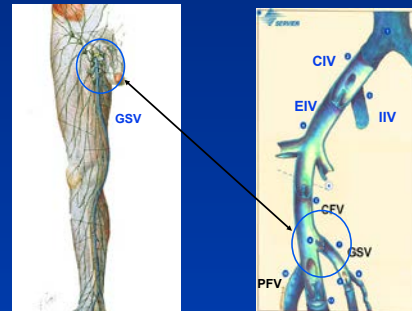


New Nomenclature

- Superficial Femoral Vein → Femoral vein
- Greater saphenous vein → Great saphenous vein
- Lesser saphenous vein → Small saphenous vein

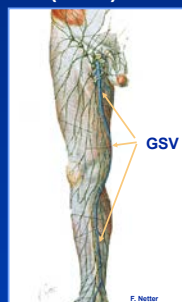
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Great Saphenous Vein



Superficial System Great Saphenous Vein (GSV)

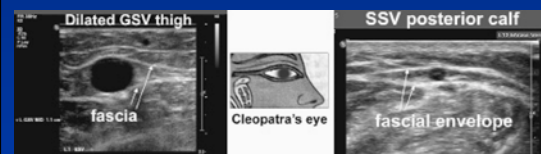
- Joins deep system at CFV
- Carries approx. 15% of venous blood volume in leg.
- Often anomalous, with double systems (8%), or non-continuous (25%)
- No adjacent artery



GSV

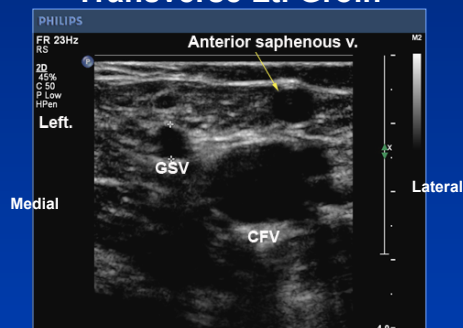
F. Netter

Saphenous veins are contained within fascial envelopes



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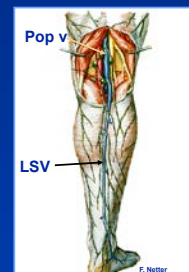
Transverse Lt. Groin



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Superficial system: Small Saphenous Vein (SSV)

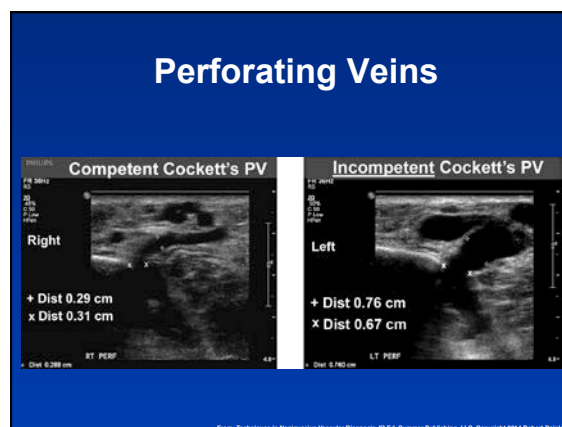
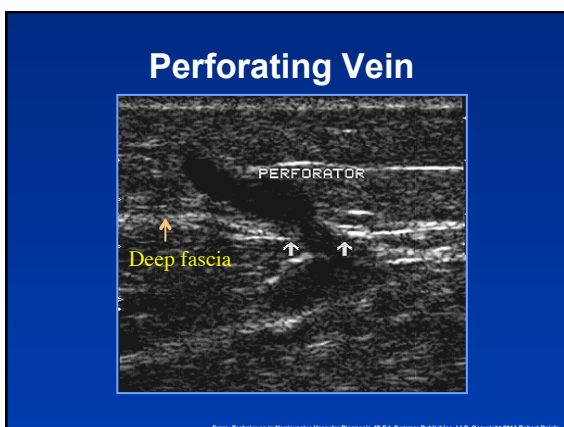
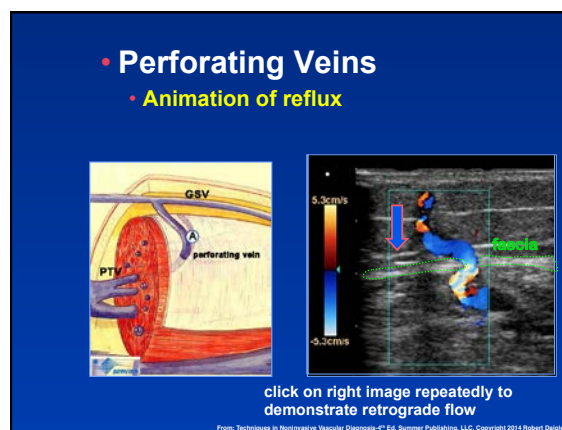
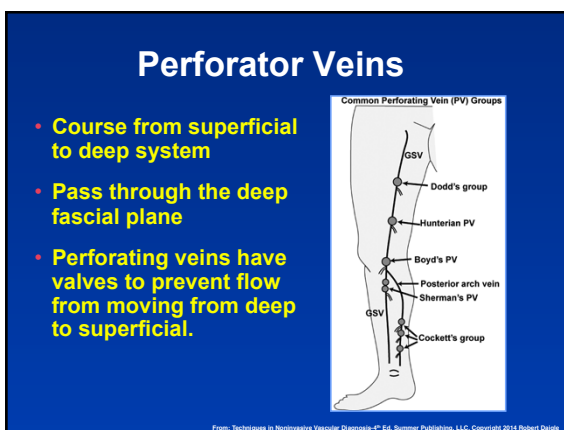
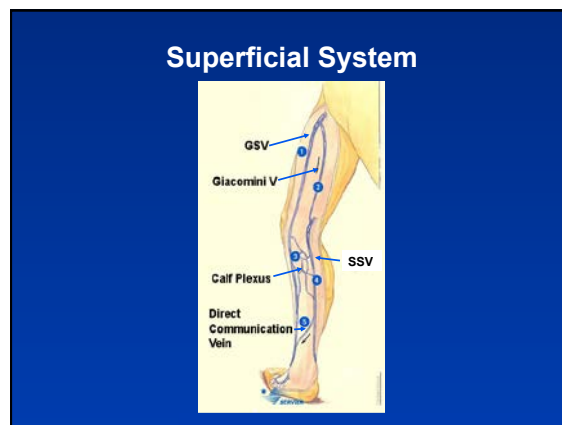
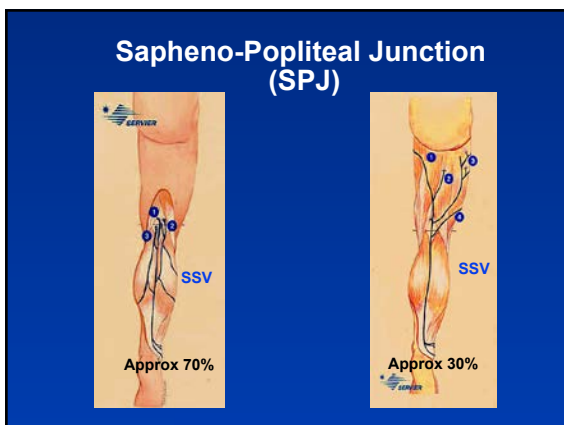
- Posterior aspect of calf
- Typical confluence is at popliteal vein
- In 20-30 % of population, SSV will enter above the popliteal vein or join the giacomini vein
- No adjacent artery



Pop v

LSV

F. Netter



Venous Hemodynamics

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Venous Hemodynamics

- Blood flow to tissue in the upper and lower extremities is governed by:
 - contractility of the heart.
 - intraluminal blood pressure.
 - peripheral resistance in the distal end of the arterial "tree", the capillary bed.
- Small arterioles leading into capillary beds in tissue are constricted in the basal state.

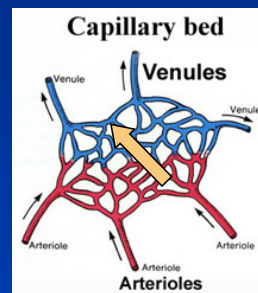
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Venous Hemodynamics

- During exercise, arterioles vasodilate, peripheral resistance decreases and flow increases
- Increased blood volume enters muscle tissue to support increases in metabolic activity related to the exercise. More red blood cells with hemoglobin and oxygen in, more metabolic waste, including lactic acid, out.
- More blood entering the limb means more blood volume for the venous system to transport back to the old "ticker".

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Capillary bed perfusion is dependent on a pressure gradient



Low pressure in venules

High pressure in arterioles

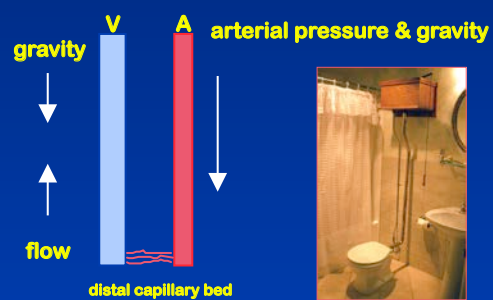
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Venous Hemodynamics

How does blood get back to the heart ??

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Hydrostatic Pressure impedes venous return



Hydrostatic pressure model!

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World's Tallest Man




Hydrostatic pressure:

22 mmHg for each
12" of vertical
distance below heart

Hydrostatic pressure
estimate: 120 mmHg

At 7 feet, 9 inches tall, Bao Xishun is the world's tallest man
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Distal Venous Pressures




Lying 10 mmHg. Standing 80 mmHg. Walking 25 mmHg.

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Hydrostatic pressure affect on lower veins when a person is stationary:

- ↑ transmural venous pressure distally
- ↑ venous distention
- ↑ venous pooling
- ↓ in capillary perfusion
- ↓ in venous return
- ↓ in cardiac output
- Hypotension**


If you stand in one place for too long without moving, you'll faint.



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Flow Patterns and Venous Resistance

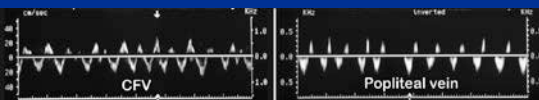
- Cardiac influence**
 - Venous pressure and flow are affected by cardiac activity
 - This effect is most pronounced in the thoracic vessels.
 - Cardiac influence is usually not apparent or is reduced in the lower extremities



Cardiac pulsatility

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Pulsatile flow in the common femoral vein and ipsilateral popliteal vein in a patient with congestive heart failure (CHF)

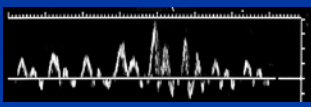


CFV Popliteal vein

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Flow patterns in upper extremities- central veins

- Cardiac pulsatility is usually apparent and pronounced.**
- Respiratory variation occurs, but flow during inspiration INCREASES, due to changes in thoracic pressure.**

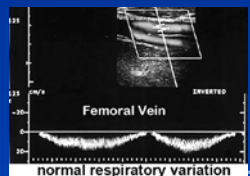


Subclavian vein

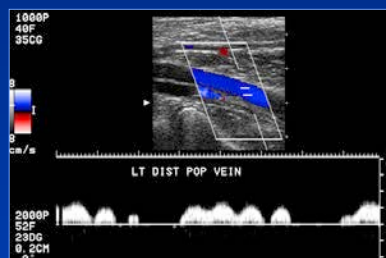
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Flow patterns and venous resistance in lower extremities

- **Respiratory variation**
 - During inspiration, diaphragm moves downward and increases intra-abdominal pressure.
 - IVC is compressed and venous outflow is temporarily reduced or stopped.
 - Flow resumes during exhalation.



Respiratory variation and cardiac pulsatility are sometimes seen in the same flow sample



We need a Pump!

- **3 pump systems in the lower extrem.**
 1. Foot pump- primes the calf pump
 2. Thigh pump- ejects thigh blood volume
 3. Calf veno-motor pump- major ejection

Calf Veno-Motor Pump

- **Abundant veins in calf:** PTV's, Peroneals, ATV's, Gastrocs, Soleal sinuses, Greater & Lesser Saphenous, Perforators
- **Abundant skeletal muscles**
- **Semilunar valves are abundant in calf**

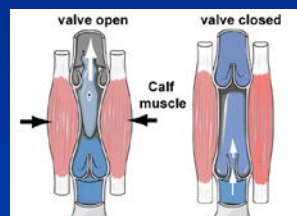


Venous Valve Distribution

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



Muscle contraction squeezes blood upward, valves prevent return



Calf Venomotor Pump

- Facilitates venous return to heart
- Reduces the effect of hydrostatic pressure
- Reduces venous pooling
- Is dependent on competent valves and muscle contraction

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The efficiency of the calf venomotor pump is dependent upon:

- 1) The ability of the calf skeletal muscles to contract.
- 2) The competency of the venous valves.
- 3) The patency of outflow veins.

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Incompetent valve- popliteal vein



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Venous Reflux



If the movie does not play, Click on Link (in Powerpoint Show) To play Youtube video

<http://youtu.be/X3eGBGzSNVo>

Movie= Pop vein reflux -dubbed.mov.

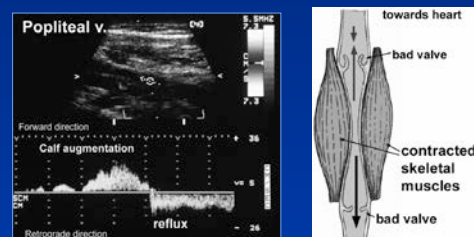
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Venous Insufficiency Venous Incompetence

- **Primary**
 - Congenital absence or defect of valves
- **Secondary**
 - Post- phlebitic: valves damaged by venous thrombosis, and/or chronic outflow obstruction

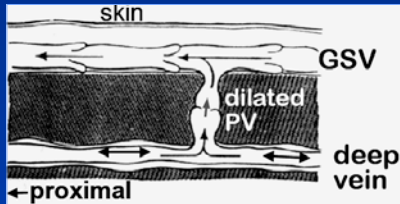
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Retrograde Venous Flow



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Increased deep vein intraluminal pressure may cause perforators to dilate and become incompetent.



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Venous Insufficiency Symptoms

- Recurrent swelling of calf & ankle
- Chronic limb swelling
- Spider veins (Telangiectasias)
- Reticular veins: subdermal veins of 1-4 mm

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Venous Insufficiency Symptoms

- Varicose veins-palpable, distended veins of > 4 mm in diameter
- Venous claudication
- Stasis dermatitis
- Ulceration

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Venous Insufficiency Symptoms

