

Instructor's Digital Curriculum Resource-

For Techniques in Noninvasive Vascular Diagnosis-4th edition.

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

Produced by Summer Publishing, LLC

This collection is designed to aid instructors and students that are using the textbook Techniques in Noninvasive Vascular Diagnosis. Summer Publishing authorizes and licenses the use of this COPYRIGHTED material contained in this collection to the school educational program. Use of the slides, graphics, case studies or movies for endeavors outside the activities of the school is prohibited without written permission from Summer Publishing.

From: Techniques in Noninvasive Vascular Diagnosis-4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

Chapter 5. Venous Anatomy and Hemodynamics

Techniques In Noninvasive Vascular Diagnosis-4th edition

From: Techniques in Noninvasive Vascular Diagnosis-4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

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.

From: Techniques in Noninvasive Vascular Diagnosis-4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

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)

From: Techniques in Noninvasive Vascular Diagnosis-4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

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).

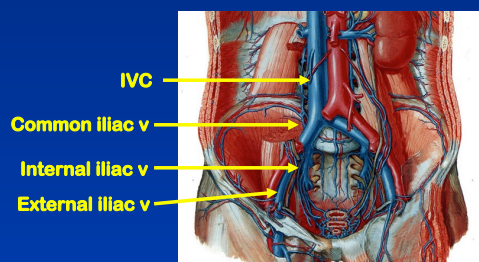
From: Techniques in Noninvasive Vascular Diagnosis-4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

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)

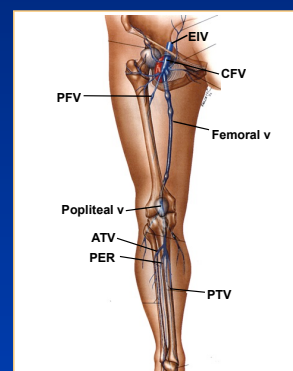
From: Techniques in Noninvasive Vascular Diagnosis-4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

Deep Venous System

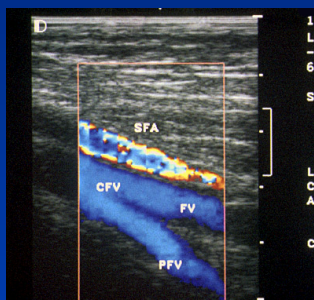


Deep Veins

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

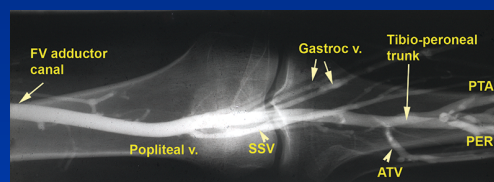


Longitudinal Anatomy



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagga

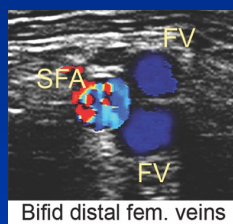
Venogram of Popliteal Anatomy



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagga

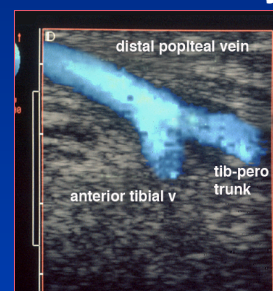
Bifid Femoral Vein is Not Uncommon

FV duplicity in thigh, 30% in some studies

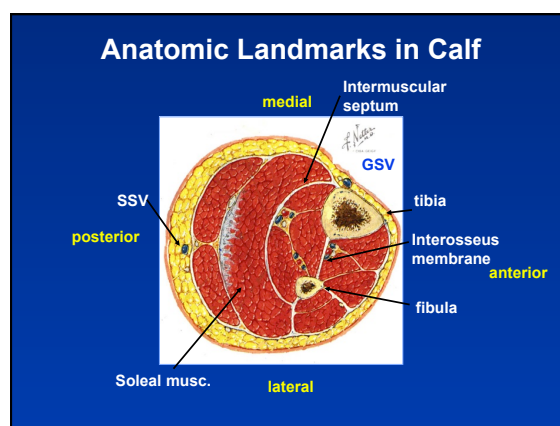
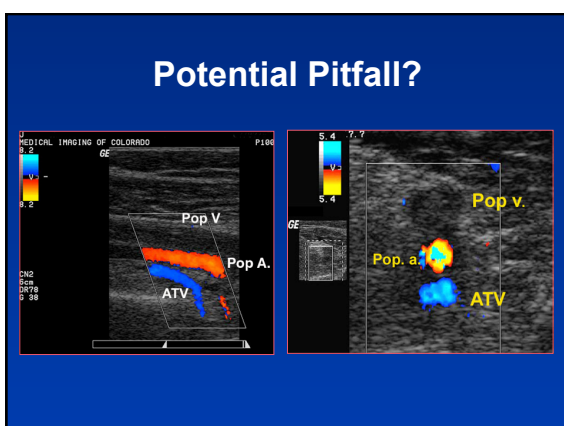
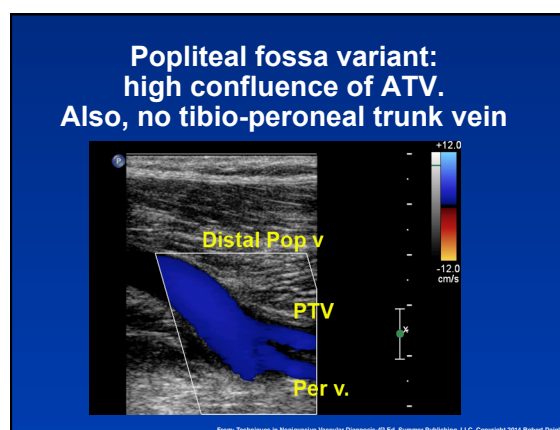
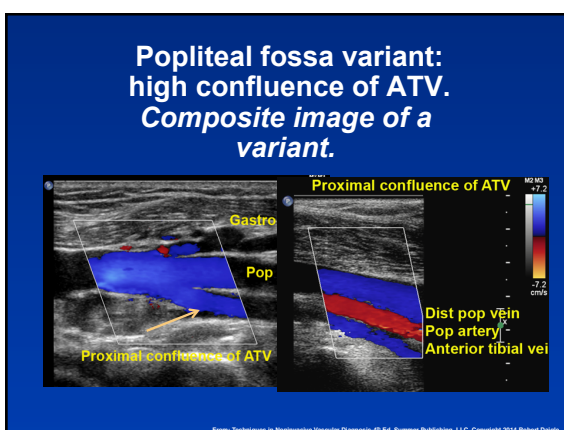
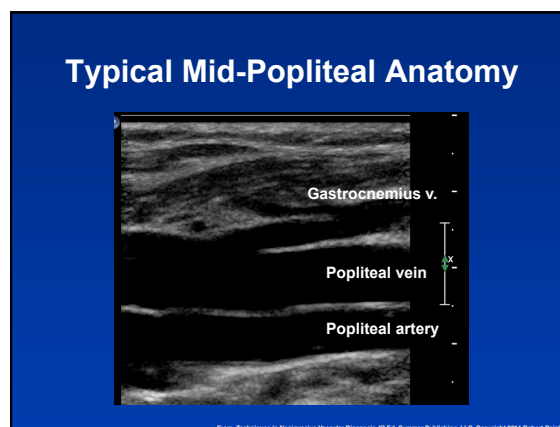
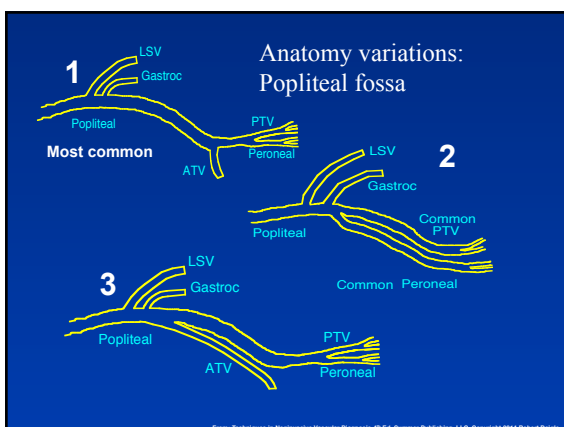


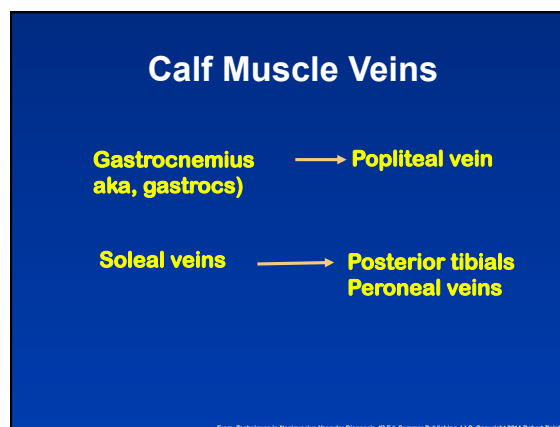
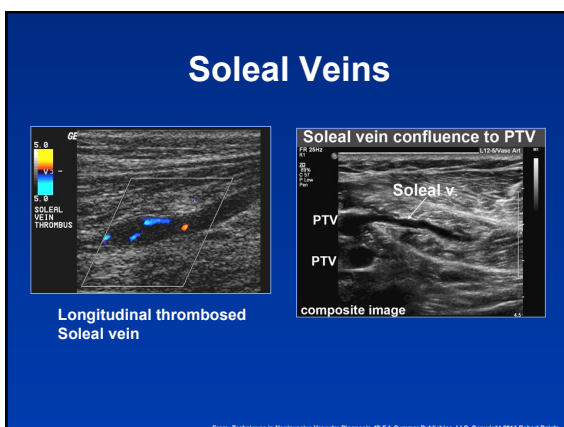
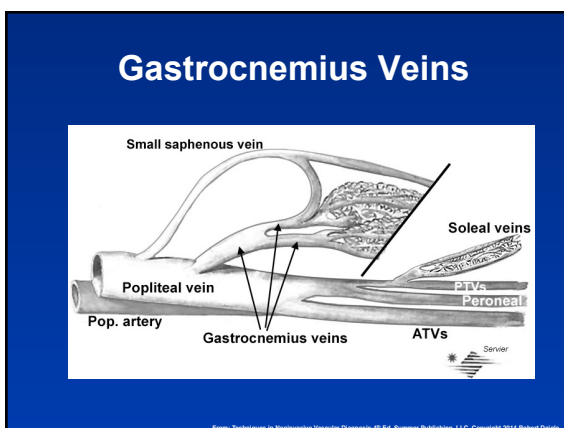
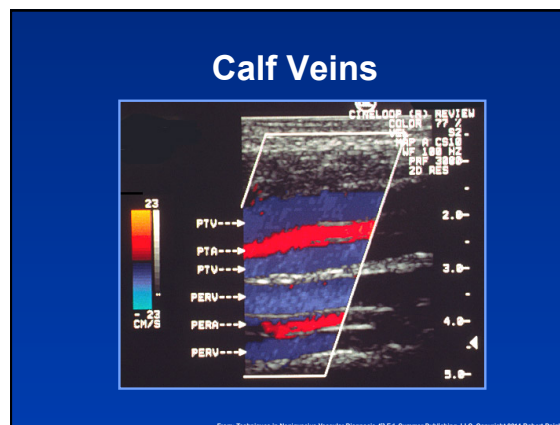
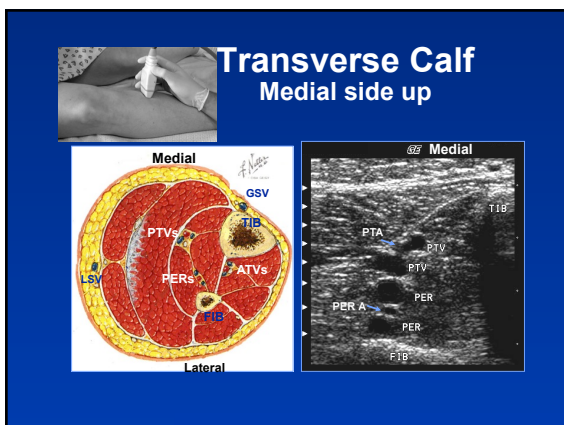
From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagga

Most Common Popliteal Vein Anatomy



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagga



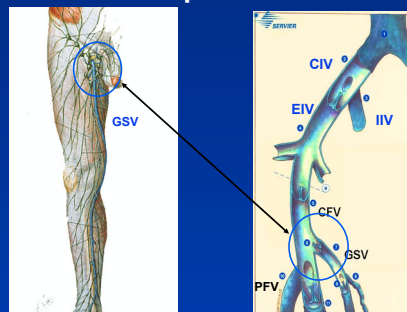


New Nomenclature

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

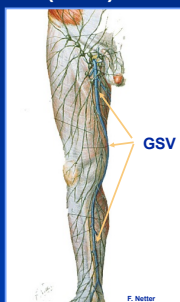
From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagga

Great Saphenous Vein

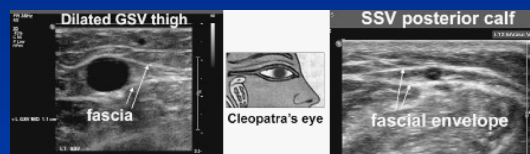


Superficial System Great Saphenous Vein (GSV)

- 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

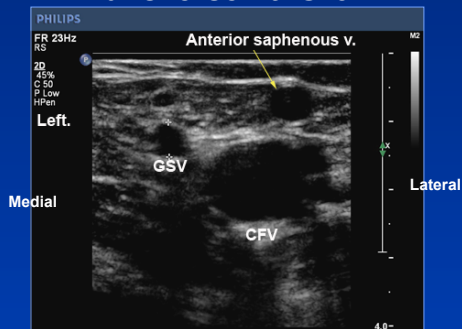


Saphenous veins are contained within fascial envelopes



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagga

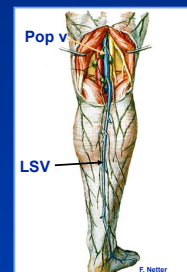
Transverse Lt. Groin



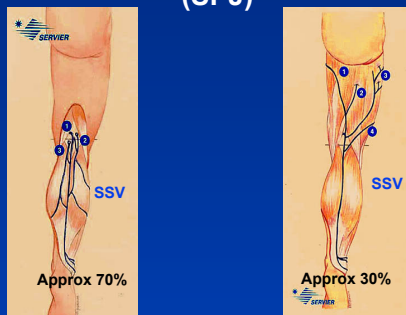
From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagga

Superficial system: Small Saphenous Vein (SSV)

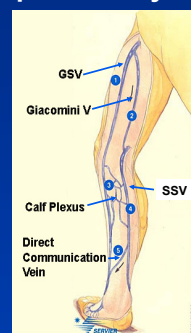
- Posterior aspect of calf
- Typical confluence is at popliteal vein
- In 20-30 % of population, SSV will enter above the popliteal vein or join the giacomini vein
- No adjacent artery



Sapheno-Popliteal Junction (SPJ)

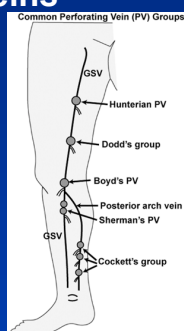


Superficial System



Perforator Veins

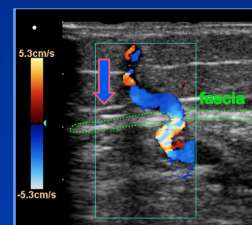
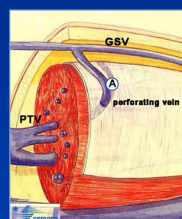
- Course from superficial to deep system
- Pass through the deep fascial plane
- Perforating veins have valves to prevent flow from moving from deep to superficial.



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

• Perforating Veins

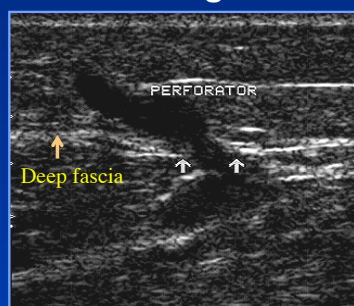
- Animation of reflux



click on right image repeatedly to demonstrate retrograde flow

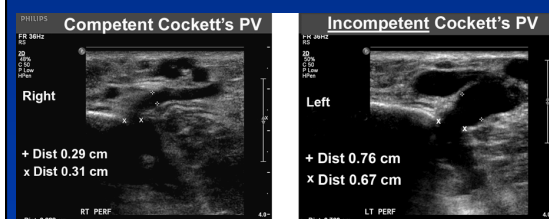
From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

Perforating Vein



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

Perforating Veins



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daigle

Venous Hemodynamics

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagla

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.

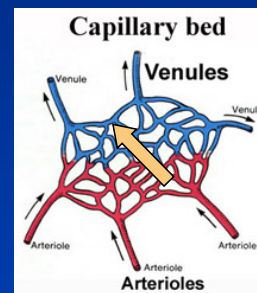
From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagla

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".

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagla

Capillary bed perfusion is dependent on a pressure gradient



Low pressure in venules

High pressure in arterioles

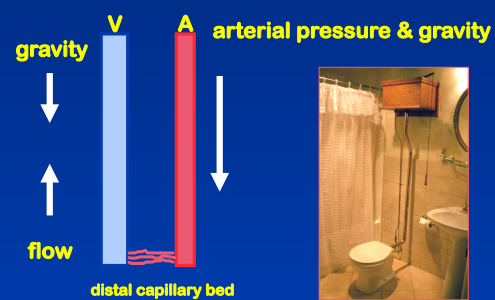
From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagla

Venous Hemodynamics

How does blood get back to the heart ??

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagla

Hydrostatic Pressure impedes venous return



Hydrostatic pressure model!

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dagla

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

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daggs

Distal Venous Pressures




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

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daggs

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**

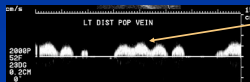
If you stand in one place for too long without moving, you'll faint.



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daggs

Flow Patterns and Venous Resistance

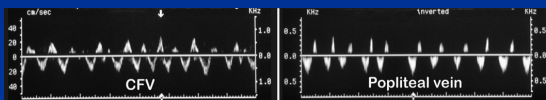
- **Cardiac influence**
 - Venous pressure and flow are affected by cardiac activity
 - This effect is most pronounced in the thoracic vessels.
 - Cardiac influence is usually not apparent or is reduced in the lower extremities



Cardiac pulsatility

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daggs

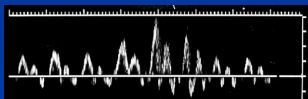
Pulsatile flow in the common femoral vein and ipsilateral popliteal vein in a patient with congestive heart failure (CHF)



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daggs

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.**

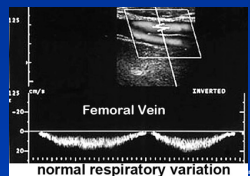


Subclavian vein

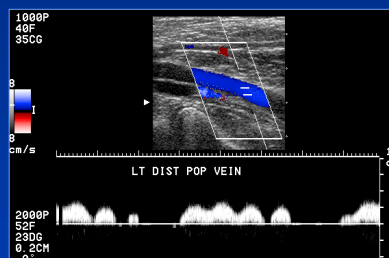
From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Daggs

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**

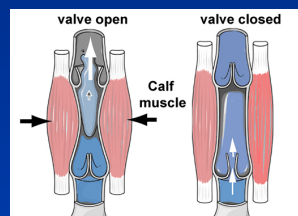


Venous Valve Distribution

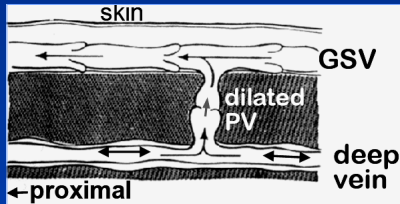
- **IVC - 0**
- **CIV - 0**
- **EIV - 0 in most**
- **FV - 4**
- **Pop - 2**
- **PTV - 10**
- **Per - 10**
- **ATV - 10**



Muscle contraction squeezes blood upward, valves prevent return



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



From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dargatzis

Venous Insufficiency Symptoms

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

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dargatzis

Venous Insufficiency Symptoms

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

From: Techniques in Noninvasive Vascular Diagnosis 4th Ed. Summer Publishing, LLC. Copyright 2014 Robert Dargatzis

Venous Insufficiency Symptoms

