

# Non-Invasive Vascular Tests: A Must-Know for Every CLT

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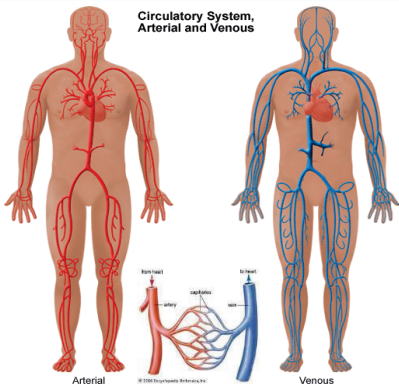
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How many of you receive generic “evaluate and treat lymphedema (edema) orders?”

How many of you question the etiology of the edema?

How many of you question the safety of performing CDT?

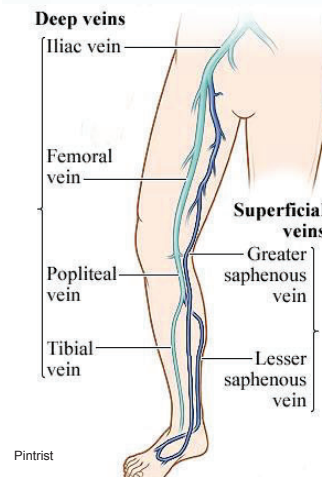
## Vascular A & P



- Arterial System delivers blood to skin, extremities
- Venous system returns blood to heart/lungs for oxygenation
- Vast network of capillaries connecting A & V systems for tissue support

gwhheartandvascular.org

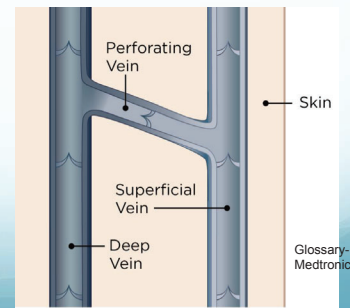
## Venous Anatomy



Deep veins are a high pressure system located within deep muscles

Superficial veins are a low pressure system located under the skin

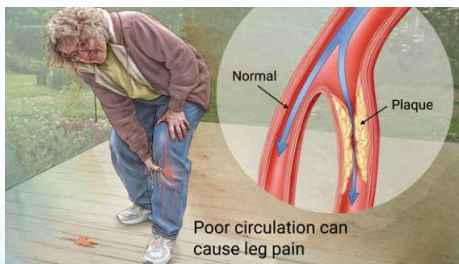
Perforators shunt from superficial to deep veins through the fascia



Pintrist

Glossary-Medtronic

## Vascular Pathology-Arterial (PAD)



Vascularcenterofmichigan.com

## Peripheral Arterial Disease (PAD)

- Incidence ~10% of U.S. adults
- Low BCP
- In isolation, typically results in little edema so is not seen as frequently in lymphedema clinics
- **Symptoms may include:**
- Pale, cool skin
- Trophic changes in nails and skin; (thin, shiny, hairless skin, thick nails)

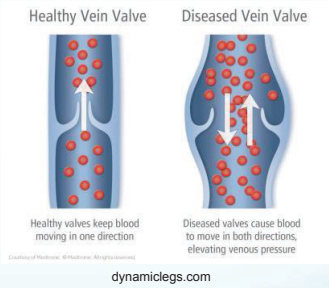
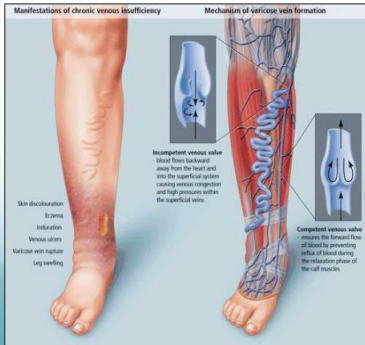


Youtube Arterial ulcer



- Intermittant claudication (pain in leg) with activity
- Pain with leg elevation
- Wounds, if present are located in feet/toes
- Poor sensation and wound healing in feet

# Vascular Pathology- Venous (CVI)



# Chronic Venous Insufficiency (CVI)

- Incidence- ~40% of U.S. adults
- High BCP
- Typically results in extensive edema; seen **very** frequently in lymph clinics
- **Symptoms may include:**
  - Orthostatic edema
  - May develop secondary phlebolympheema due to damage of pre- and subfascial lymphatics
  - "Phlebarthrosis"
  - Progressive hemosiderin staining and lipodermatosclerosis in the distal leg (gaiter area)
  - c/o leg aching, heaviness, itching, generalized fatigue
  - Varicosities, spider, and reticular veins common
  - Wounds, if present typically along medial side of leg



## Differentiating between CVI and lymphedema

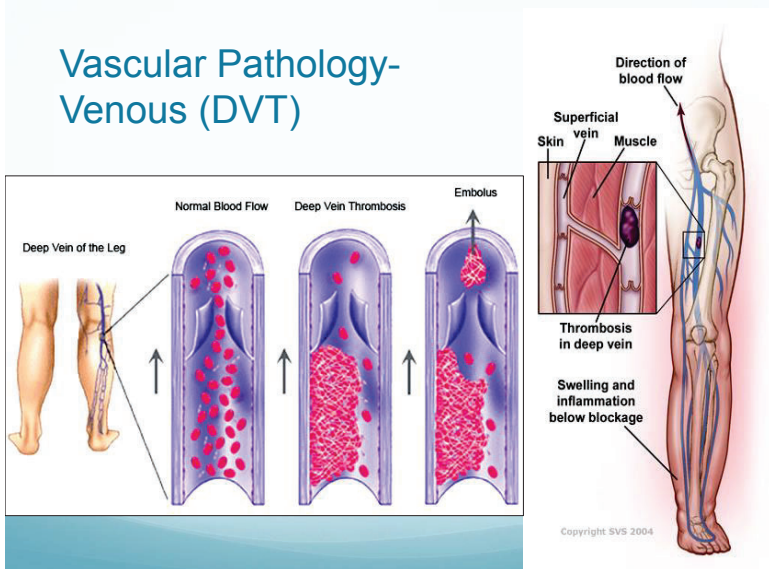
- Lymphedema and CVI both result in edema but from entirely different etiologies. **Look at the differences.** In contrast to CVI, the skin in cases of lymphedema maintains elasticity far longer than that with CVI.



## CVI and Lymphedema commonly coexist!

Phlebolympheema is among the **MOST** common forms of lymphedema in the western world!!!

# Vascular Pathology- Venous (DVT)



## DVT and Post-thrombotic syndrome

- Incidence: DVT/PE ~0.2% of U.S. adults\*
- 60,000 – 100,000 die of PE annually\*
- 50% will develop PTS post DVT\*
- 5-8% has genetic risk factor for DVT\*
- Elevated BCP leads to limb edema distal to DVT
- **Symptoms MAY include:**
  - Usually has a distinct and rapid onset
  - Often related to triggering event
  - Limb may be slightly dusky colored and edematous distal to the DVT
  - Pain may/may not be present
  - **Post-thrombotic sx are similar to CVI sx**

\*Stats from CDC.gov

## Take Home Message



- There exist potentially limb and life-threatening conditions that can develop within the vascular system!!
- **It is essential for proper medical management, that you are aware of any vascular insufficiency or impairment**

## Mechanism for Evaluation and Management

- Review medical hx and risk factors
- Signs & Symptoms
- Special tests
- Recommendation for or against PT/OT treatment
  - POC
  - Medical referral

## 3 cases in which the “edema” etiology was uncertain

## LE edema of unknown origin- the importance of vascular screening: Case Study #1



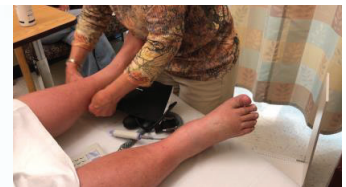
- What do you see?
- What information do you need to determine the cause of the edema?

## Medical Hx and Risk Factors

- 63 yr male referred to lymph clinic with recent onset of BLE edema (3 mo on RLE, 7 weeks on LLE).
- Dx: Stage IV colon cancer; BLE edema. Currently in remission but still on chemo
- Multiple co-morbidities: **NOT indicated in referral** COPD, DM, HTN, DDD lumbar spine, obesity, OA, L THA, depression, PAD, CVI, recently closed chronic L heel ulcer
- Pt had undergone arthroplasties on BLE arterial systems in past 2 months, but **no mention of that in the referral**

## Signs/Sx

- 227#; 5'11"; BMI 31.7; obese
- Moderate BLE edema feet to knees, RLE > LLE; moderately indurated and pitting
- Moderate soft, pitting feet edema
- Mild but non-pitting knee/thigh edema; no pelvic or genital edema
- Skin on lower legs, light red/warm
- A left heel ulcer is entirely closed
- Pt c/o the LE edema affecting his mobility and endurance
- Leg pain with activity prior to vascular surgeries



## Treatment considerations

- This patient has considerable BLE lymphedema needing treatment including compression
- Hx of severe PAD creating a heel ulcer, and leg pain with activity.
- He recently underwent revascularization, but does he have sufficient arterial supply to permit compression?

## Vascular Special Tests

Available on video

- **Capillary Refill test**
  - Measure of surface blood flow following brief pressure on end of toe
- **Rubor of Dependency**
  - Measure of ischemia (color change) in response to positional change
- **Venous Filling time**
  - Vascular test of arterial and venous sufficiency. Measure of speed of vein refill in response to positional change
- **Ankle Brachial Index (ABI)**- Doppler unit & B/P cuff
  - **Comparison of systolic B/P in arm with that of leg to determine adequacy of circulation to foot. Normal 1-1.2; mild-mod insufficiency .5- 1; severe <.5; >1.3 unreliable**

## Treatment considerations: What do you do?

- **Information obtained from the medical chart should be a red flag during your evaluation and you should NOT proceed with treatment until obtaining clarification on his vascular status**
- The following were performed:
  - Feet pulses not palpable due to edema
  - Skin on feet was pink, warm
  - Normal capillary refill (3 sec)
  - Rubor of dependency was unremarkable for signs of severe AI
  - ABI: RLE 1.08, LLE .92
  - **OR refer to vascular MD if no Doppler**
  - Sensory testing revealed good protective sensation in feet

## Differential Diagnosis and Treatment

- What is the most likely cause of the edema?
- What are potential contraindications/red flags?
- Is this patient appropriate to treat with conservative measures?

## Plan of Care

- Based upon the encouraging findings from testing: CDT was initiated including skin care and compression bandaging from feet to knees
- Instructed in remedial LE exercise
- Pt educated in pain and circulatory precautions
- Pt scheduled to return the next day
- Set up for CDT treatment 3-5x/wk for 4 weeks to include fitting with compression garments for BLE.

## Take Home Message



- **Secondary lymphedema, regardless of etiology may be mixed PAD. Without proper evaluation and vascular testing, treatment with compression could have been detrimental!!**

## LE edema of unknown origin- the importance of vascular screening: Case Study #2



- What do you see?
- What information do you need to determine the cause of the edema?

## Medical Hx and Risk Factors

- 50 yr male with long hx of BLE edema; referred to lymphedema clinic with diagnosis of "BLE lymphedema"
- Venous studies have ruled out DVT, but he has significant venous reflux
- No surgical history
- He reports the swelling would worsen during the day, and reduce at night for several years
- Currently the edema persists day and night
- He was fit with OTC compression stockings 2 yrs ago, but stopped wearing them when they creased in to the skin at the ankle and knee causing pain

## Signs/Sx



- BMI 42
- Edema present in B legs and feet
- Pitting edema noted in feet; distal legs are fibrotic with little pitting possible; mild soft edema present in proximal legs and knees
- Legs have hemosiderin staining in distal legs

## Special Tests

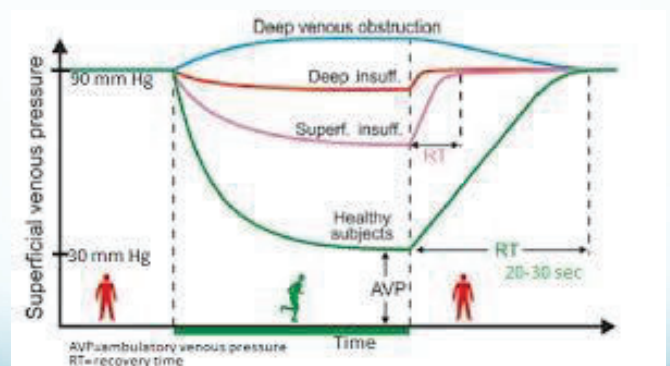
- Foot pulses were not palpable due to edema
- Skin on feet was warm, pink
- Normal capillary refill (<3 sec)
- Nothing in medical hx indicated risk of PAD, and sx were not consistent with PAD, so ABI and Rubor of Dependency tests were not performed

## Differential dx & treatment



- What is the most likely cause of the edema?
- Is this patient appropriate to treat?
- Contraindications/red flags
- Compression garment recommendations

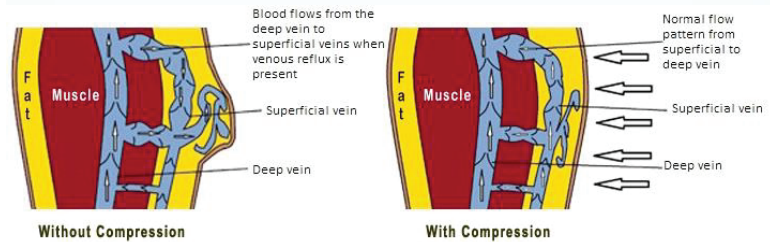
## Ambulatory Venous Pressure



## Benefits of compression garments during ambulation

- Decreases venous reflux and v. hypertension<sup>1,2</sup>
- Decreases ambulatory venous pressure
- Improved venous flow promotes release of beneficial vasoactive mediators<sup>1,2</sup>
- Reduces blood volume in legs due to reduction in vein diameter; enhances blood volume return to the heart<sup>1,2</sup>
- Improves efficiency of calf ms pump<sup>3</sup>
- Stimulates lymphatics for improved drainage<sup>1,2,3</sup>
- Opposes fluid filtration<sup>1,2,3</sup>

## Why do 30-40 mm Hg stockings help venous return from the legs when standing pressures are ~100 mm Hg?



Nuvelaveins.com

## Plan of Care

- Based upon the positive findings from testing: CDT was initiated including skin care and compression bandaging from feet to knees
- Education included: remedial LE exercise, walking program, weight control, LE elevation when at rest
- Set up for CDT treatment 3-5x/wk for 4 weeks to include fitting with ~30-40 mm Hg compression garments for BLE.

## Combined PAD and CVI

- ~10 % of US adults have AI
- ~40% of US adults have CVI
- ~30 % of those with CVI, also have some degree of AI. How might you know about these patients?

## Medical history and risk factors

### PAD

- Hx of CVD (MI, CVA, angina, stents)
- Smoker
- Hypertension
- Hyperlipidemia
- Obesity
- Diabetes

### CVI

- Hx: Deep venous thrombosis (DVT)
- Clotting disorders
- Lower extremity trauma
- Prolonged inactivity or standing
- Pregnancy
- Obesity
- Family history of venous disease (varicose veins)
- Age > 50 years

## Signs/Sx: Comparison of Arterial and Venous Disease

	ARTERIAL INSUFFICIENCY	VENOUS INSUFFICIENCY
<b>Pain</b>	Intermittent claudication; may progress to rest pain	Chronic, dull pain; progressive throughout the day
<b>Color</b>	Pale to dependent rubor; a dull-to-bright reddish color; more common with advanced disease	Normal to cyanotic; more common with advanced disease
<b>Skin Temperature</b>	Poikilothermic (taking on the environmental temperature); much cooler than normal body temp	Usually no effect on temperature
<b>Pulses</b>	Diminished to absent without Doppler stethoscope	Usually normal; may be difficult to palpate; secondary to significant edema
<b>Edema</b>	Usually not present unless combined disease or can be related to cardiac disease and congestive heart failure	Present: from mild to severe pitting edema; can have weeping edema fluid from open wounds
<b>Tissue Changes</b>	Thin and shiny; hair loss; trophic changes the nails; muscle wasting	Stasis dermatitis with flaky, dry, and scaling skin; hemosiderin deposits (brownish discoloration); fibrosis with narrowing of the lower legs ("bottle legs")
<b>Wounds</b>	Distal ulceration, especially on toes and inbetween in the web spaces; may develop gangrene and severe tissue loss	Shallow ulcers in the gaiter distribution of the foot and ankle; usually the medial surface

Sussman C. 2012. Wound Care, 4th ed. A Collaborative Practice Manual for Physical Therapists and Nurses.

## Recommended guidelines for compression in presence of AI

- In patients with mixed ulceration, an ankle-brachial pressure index  $>0.5$  and an absolute ankle pressure of  $>60$  mm Hg, inelastic compression of up to 40 mm Hg does not impede arterial perfusion but may lead to a normalization of the highly reduced venous pumping function. <sup>4</sup>
- This recommendation would also apply to patients with AI, without ulceration

## How does compression help improve arterial flow?\*

- Reduces arteriovenous pressure gradient, especially when combined with walking <sup>1</sup>
- Increases intravascular flow, shear, and compressive strain in the venular endothelium causing release of vasoactive mediators <sup>2,5</sup>
- Assists in removal of edema, relieving congestion around capillary beds, improving exchange of oxygen, nutrients <sup>1,2</sup>
- \*When ABPI is  $>0.4$

## Take home message



- Compression is the treatment standard of care for CVI
- Many patients with CVI will also have PAD
- It may be safe to fit your patients with combined CVI/PAD, compression stockings (with vascular testing and MD clearance)
- Patients must adhere to other health-related activities: exercise and walking, smoking cessation, weight control

## LE edema of unknown origin- the importance of vascular screening: Case Study #3



- What do you see?
- What information do you need to determine the cause of the edema and the proper treatment protocol?

## Medical Hx and Risk Factors

- 40 yr male undergoing rehab S/P ACL repair
- Now 3 weeks PO. Pain is minimal; mild pitting edema present in the knee and lower leg to the ankle
- He has attended 5 OP treatment sessions, progressing well
- He arrives for his 6<sup>th</sup> visit, and the leg appears different and the patient voices concern

## Signs/Sx



- He arrives for his 6<sup>th</sup> visit, and the leg appears shiny, slightly dusky colored and there is an increase in visible edema.
- The patient reports minimal discomfort other than tightness in the leg
- You measure the circumference of the limb, finding it measures 3 cm greater in affected leg

## Deep Venous Thrombosis (DVT): Risk factors

- **STRONG FACTORS**
  - Fracture (pelvis, femur, tibia)
  - Hip/knee replacement
  - Major general surgery
  - Major trauma (esp. with venous damage)
  - Spinal cord injury
- **WEAKER FACTORS**
  - Prolonged immobility
  - Obesity, aging, smoking
- **MODERATE FACTORS**
  - Cancer/chemotherapy/Tamoxifen
  - CHF or respiratory failure
  - Oral contraceptive or HRT
  - Prior DVT
  - CVA
  - Pregnancy/postpartum
- **ADDITIONAL FACTORS**
  - Air travel, varicose veins, IV injections, sclerosing agents,
  - Hypercoagulation, hereditary thrombotic disorders (Factor V Leiden), and Buerger's disease.

## DVT: Signs/Symptoms

- The clinical indication of DVT can be difficult due to its various presentations. Some DVT cause distinct pain/tenderness, swelling, and discoloration in the limb; where others are relatively asymptomatic. **Absence of pain does NOT R/O DVT!!**
- **Anytime your patient presents with recent or sudden onset of otherwise unexplained change in the limb, testing for DVT is warranted!!**
- Homan's sign is no longer considered reliable; sensitivity of < 50%

## Well's Clinical Decision Rule (For LE DVT)

Clinical Feature	Points
Active cancer (treatment ongoing, within 6 months, or palliative)	1
Paralysis, paresis or recent plaster immobilisation of the lower extremities	1
Recently bedridden for 3 days or more or major surgery within 12 weeks requiring general or regional anaesthesia	1
Localised tenderness along the distribution of the deep venous system	1
Entire leg swollen	1
Calf swelling at least 3 cm larger than asymptomatic side	1
Pitting oedema confined to the symptomatic leg	1
Collateral superficial veins (non-varicose)	1
Previously documented DVT	1
Alternative diagnosis at least as likely as DVT*	-2
<b>Clinical probability simplified score</b>	
DVT 'likely'	2 points or more
DVT 'unlikely'	Less than 2 points

Wells Clinical Prediction Model for DVT 2003

## DVT case and Wells score

- 1 point- recent immobilization of LE
- 1 point – recent LE surgery
- 1 point – calf swelling of 3 cm
- 1 point – pitting edema of symptomatic leg
- NO alternative diagnosis to explain symptoms
- Total score = 4
- Decision is “DVT is likely” due to  $\geq 2$
- **Even when “unlikely” but still have concern, contact MD**

## Differential Diagnosis and Treatment

- What is the most likely cause of the edema?
- What are potential contraindications/red flags?
- Is this patient appropriate to treat?

## DVT: Treatment

- **DVT is emergency due to the risk of pulmonary embolism.**
  - anti-coagulant medication (blood thinner).
  - In severe or recurrent cases, a filter (e.g. Greenfield filter) may be inserted into the inferior vena cava in an effort to prevent emboli from reaching the lungs.
- **Compression therapy:** indicated in acute stage to reduce the risk of DVT becoming an embolism. Subacute stage, compression is indicated to prevent chronic swelling (post-thrombotic syndrome) and the formation of a new DVT.
- **MLD:** Lacking scientific research that establishes MLD protocols for patients with DVT, therapists generally observe the following clinical recommendations:
  - **No MLD should be performed for:**
    - 4-6 weeks if DVT present in lower leg; 4-8 weeks if DVT in thigh; 8-12 weeks if in pelvic veins; lifetime on abdomen after pelvic DVT

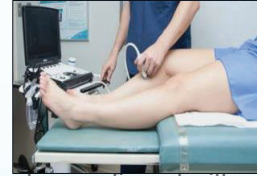


## Plan of Care

- Based upon the likelihood of DVT from the Wells Clinical Prediction Rule, the patient was NOT treated in rehab; MD was contacted ASAP
- Venous Doppler study confirmed LE DVT
- Pt was started on anti-coagulation and fit with OTC compression stocking, 30-40 mm Hg
- PT rehab was resumed soon after

## DVT Special Tests/Diagnosis

- DVT is typically diagnosed by venous Doppler exam performed in supine position. This differs from the venous Doppler performed with pt standing for diagnosis of CVI



- DVT may also be diagnosed or confirmed with a D-dimer blood test which tests for fibrin in the blood

## Take Home Message



- You WILL encounter patients in your practice who have undiagnosed DVTs. You may be the first one to identify them and bring to attention of MD. You just MAY save a life!!

## Thanks for your time and attention



### References

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- 6) Chronic Venous Insufficiency: A Frequently Underdiagnosed and Undertreated Pathology. Spiridon M, Corduneanu D. MAEDICA – a Journal of Clinical Medicine 2017; 12(1): 59-61.
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- 8) Expert Consensus Document on Direct Ambulatory Venous Pressure Measurement. Reeder SWI, Wolff O, Partsch H, et al. Int Angiology. 2013;32(5):453-458. 3)3