

Venous Disorders

Done By:

- AlAnoud AlHammad

-Mashael AlKhayyal

Green: Doctor's notes & explanation during the lecture.

Blue: Further explanation & team's notes.

Red: important.

General considerations:

- * The function of the Venous System is to transfer blood back towards the heart.
- *The challenge for the blood in the venous system to come back from anywhere in the body to the heart will be in the lower limbs (antiforce, anti gravity)
- *Arteries have two factors that help them transfer blood from the heart to anywhere in the body which are: gravity and muscle pump (mechanical function) both which are completely absent in the venous system.

Anatomy:

The difference between the venous system and the arterial system:

	Veins	Arteries
Valves	Veins have valves to maintain unidirectional movement of blood since there is no continuous pump pushes the blood through veins	There are no valves in the arteries.
Wall Thickness	Thin	Thick
Nature of Blood	All veins carry deoxygenated <u>except</u> for pulmonary vein and umbilical vein which carry oxygenated blood from the lungs (postnatal) and from the placenta (prenatal) respectively	All arteries, carry oxygenated blood, <u>except</u> the pulmonary and umbilical arteries, which carry deoxygenated blood to the lungs (postnatal) and to the placenta (prenatal) respectively
Direction of Blood	Veins carry blood towards the heart unidirectional > down to up (distal to proximal) , outside to inside (superficial to deep through perforators)	Arteries carry blood away from the heart
Flow of Blood	The flow of blood depends on the peripheral muscular activity	The flow of blood depends on the pumping action of the heart
Types	Deep & Superficial venous system. <u>-Deep veins:</u> are paired with arteries (femoral artery femoral vein popliteal artery popliteal vein) <u>-Superficial veins:</u> *Great saphenous: on the medial side starts from the groin and descends to medial malleolus. *Small saphenous: starts behind the knee from the popliteal vein to the lateral malleolus.	Deep

Skin & Fat

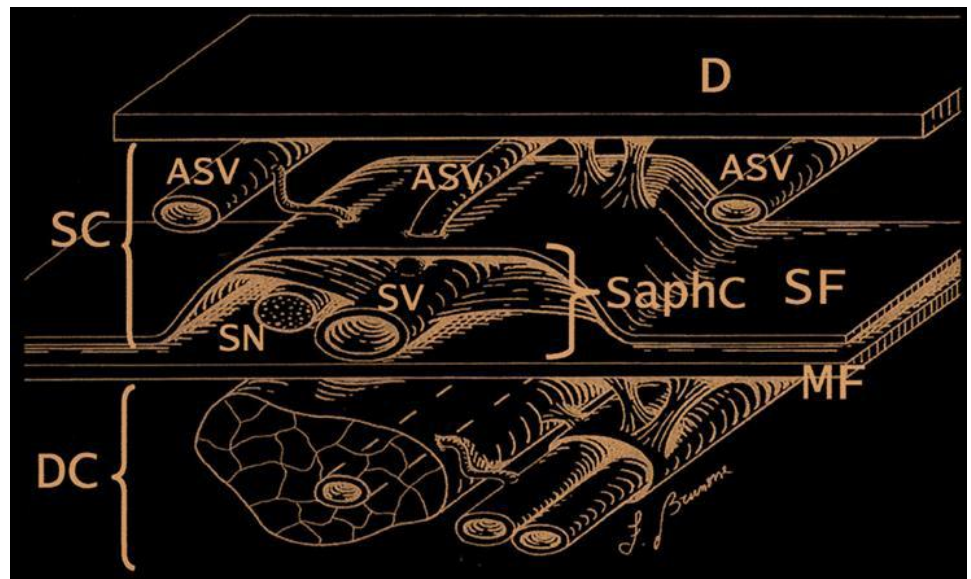


Fascia



**Muscles & Deep
venous system**

***Superficial system is
around the Muscles.**

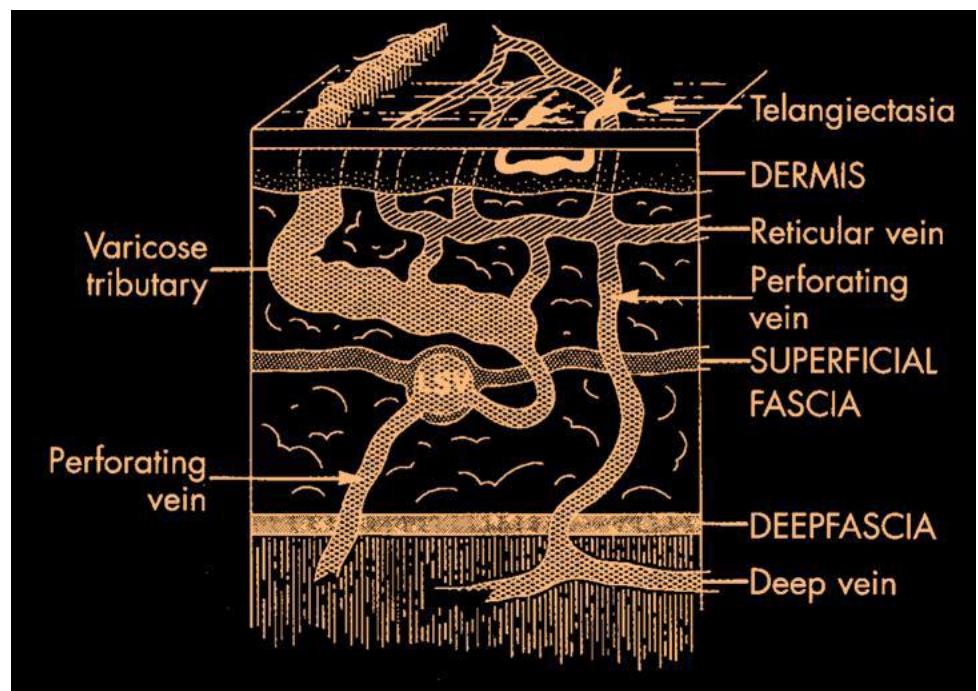


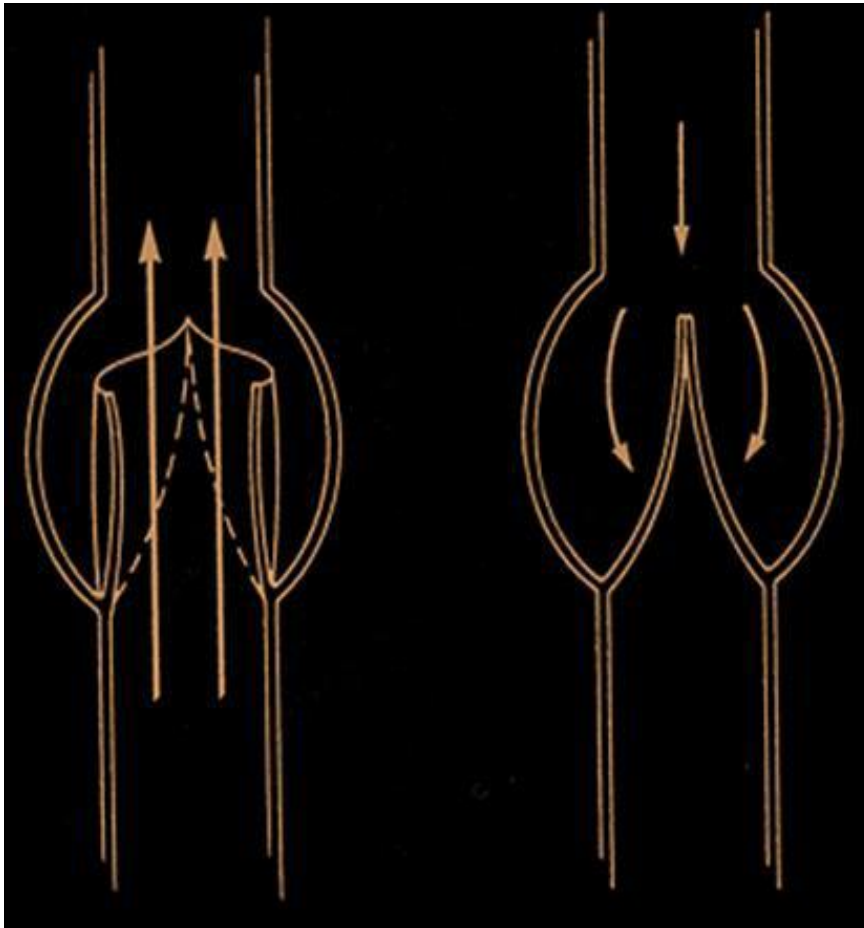
*Muscles in the limbs are covered by thick fibrous envelope (fascia) which give the limbs their outer appearance.

* Muscles are soft, if there was no fascia:
1- The limbs won't be shaped the way they are now.

2- Muscles wouldn't have function if there wasn't anything covering them they'll be loos.

So, there has to be something to contain them to when they contract they'll be in one direction and not bulging to the outside.



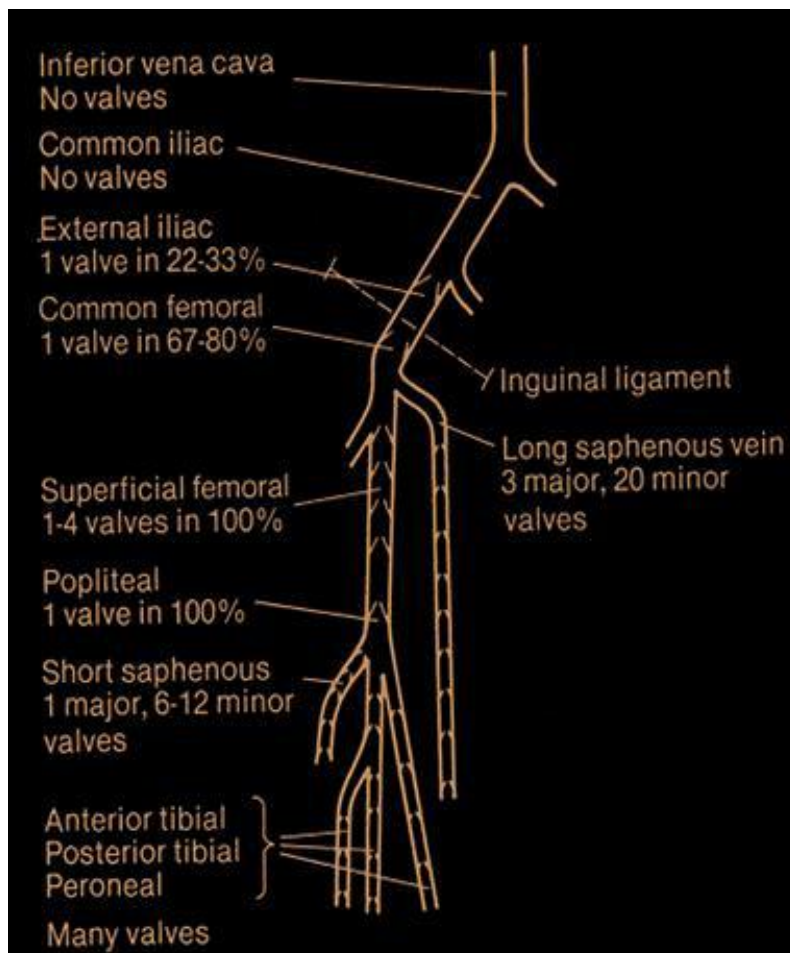


The venous system is not controlled by pumps so, it is not continuous (comes and goes) a temporary force comes and pushes the blood up to the heart.

*If we assume a force came and pushed some blood up then stopped what will happen?

Blood will come back.

Therefore, to prevent blood from refluxing and maintain the direction of blood there should be valves, so, whatever force pushes the blood upwards the valve will hold the blood until it goes up.



Valves maintain blood directions:

- From down to up

and

-From outside to inside
(superficial to deep)

Physiology:

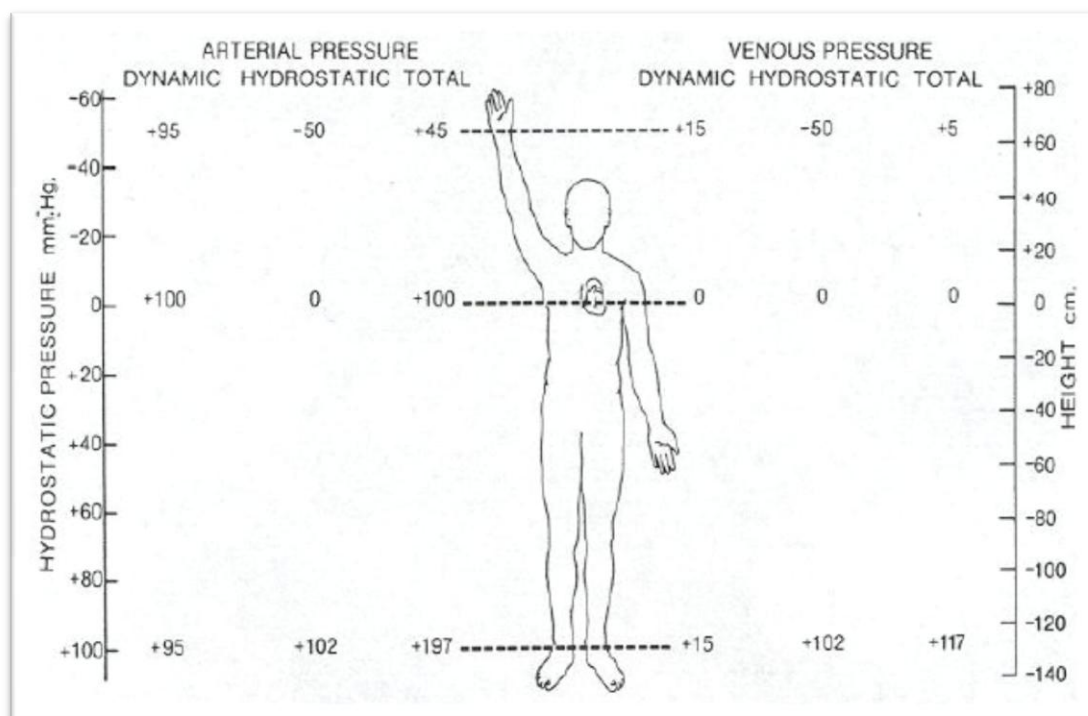
Any fluid column is subjected to: Hydrostatic\Atmospheric pressure and Dynamic\Mechanical pressure. If we consider the human body is a fluid column and the reference (starting) point is the heart =0 the:

1-Hydrostatic pressure:

The hydrostatic pressure in the upper limbs will be negative (-ve) whereas in the lower limbs will be positive (+ve)

Q: Why is the hydrostatic pressure in the upper limbs negative?

So blood can descend from the upper limbs to the heart. If it was positive, the blood won't be able to descend to the heart and will go the other way around.



2-Dynamic pressure:

The dynamic pressure is the heart pumping mechanism in the venous system which will create positive pressure in the lower limbs to push the blood upwards. It is generated by:

A-Muscle pump (Calf Muscle pump):

***Perforators:** channels between the deep and superficial venous system

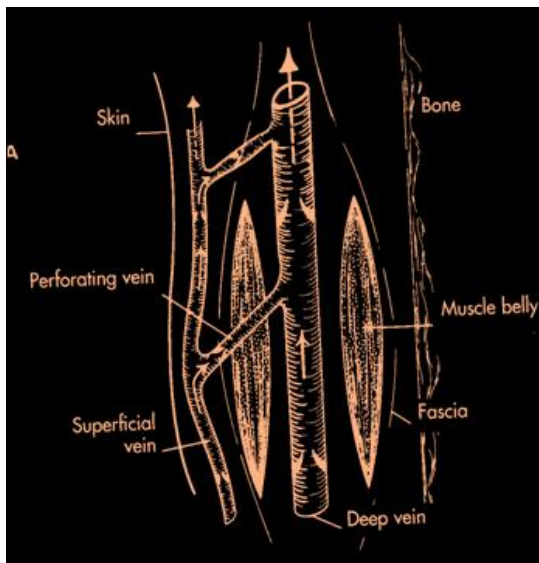
- When the muscles contract: they pump blood from the deep venous system upwards, and at the same time they close the valves of perforators to prevent blood from going back again.

If blood went back there will be high pressure in the superficial system and will cause serious problems.



Contraction

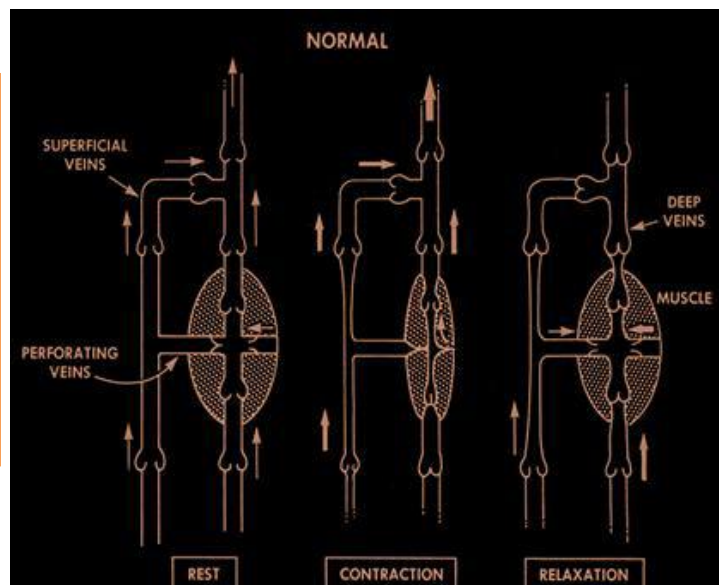
- When the muscles relax (rest): Perforator valves will open > Deep veins will expand and blood is drawn from the superficial veins > Deep veins will be filled with blood.



Rest

-During relaxation calf muscle pumps work as a sponge they suck (suction) blood from the superficial veins.

While during contraction they empty the deep veins and push the blood upwards. At the same time they close the perforators to make sure blood doesn't go outside because if blood went outside there will be high pressure in superficial system and causes problems.



B- Thoracic abdominal Pressure gradient:

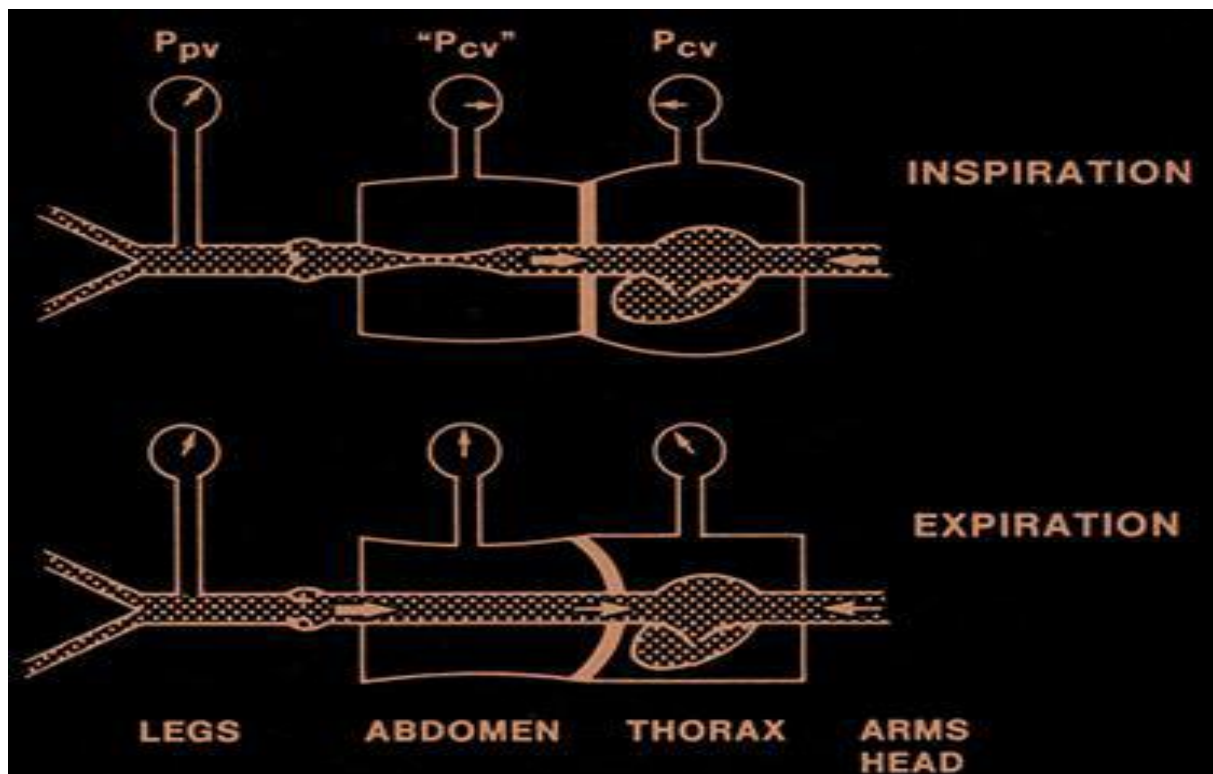
Both chest and abdomen have valve like functions.

Chest is always (– ve)

But abdomen:

- In expiration diaphragm will go up creating a (–) ve pressure > abdomen acts as a valve > opens which will lead to blood sucking to heart, and subsequent blood sucking from the legs.
- On inspiration diaphragm will go down, creating a (+)ve pressure > abdomen acts as a valve > closes which will lead to closure of veins.

That cycle will continue and form a valve like function.



Ambulatory Venous Pressure (AVP):

Ambulatory Venous Pressure is the venous pressure in the dorsum of the feet.

AVP when in supine position=heart=10 mmHg

AVP during standing=90 mmHg

AVP during walking=25 mmHg

-Supine and walking positions are not a problem (low pressure).
-Standing is a problem (high pressure builds up).

Muscle do not contract while standing,
NO draining forces (Muscle pump)

What is Chronic venous insufficiency?

Chronic venous insufficiency is the presence of (irreversible) skin damage in the lower leg as a result of sustained venous hypertension.

Or

Permanent changes in the venous system that affects lower limb tissues.

Or

Constantly high AVP unless in supine position = absence of the physiological lowering mechanism of AVP when someone walks/exercises

-Causes:

1-Primary (superficial system is diseased or perforators):

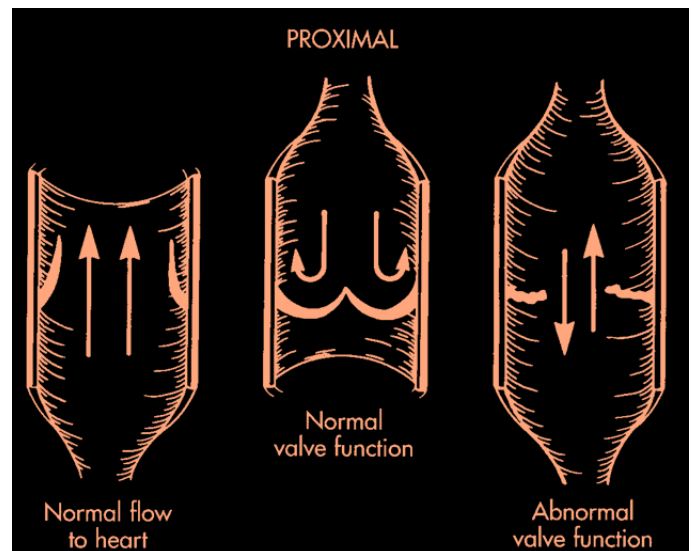
Idiopathic: Could be familial failure of the valves, Obesity, Pregnancy, Standing for long time.

2-Secondary (deep system is diseased):

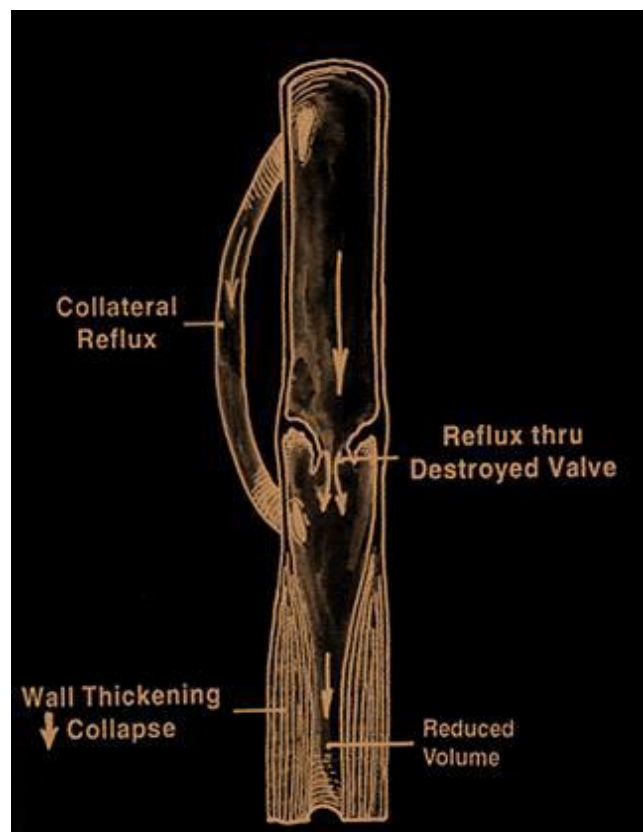
*Obstruction (mass, DVT)=10% there will be no drainage of blood which will create pressure and destroys the valve

*Reflux (valve incompetence)=90%

Whatever blood the veins are designed to handle will increase > with time pressure will increase and when this happens the valves will loose their function.



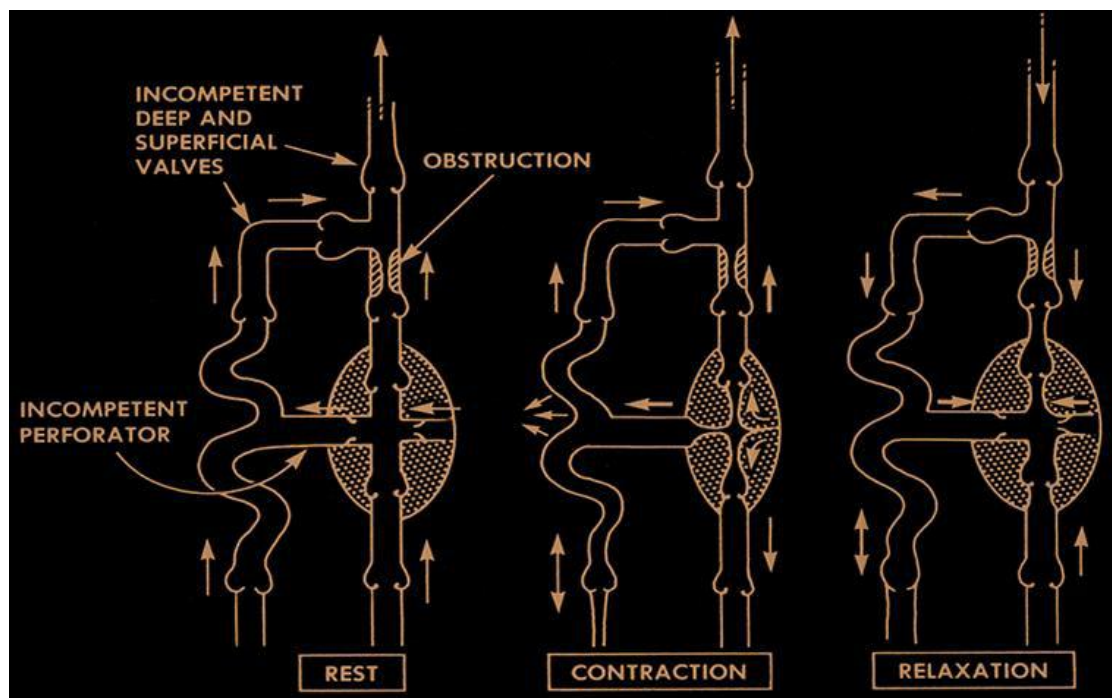
Primary Valvular Incompetence
"Floppy Valve"



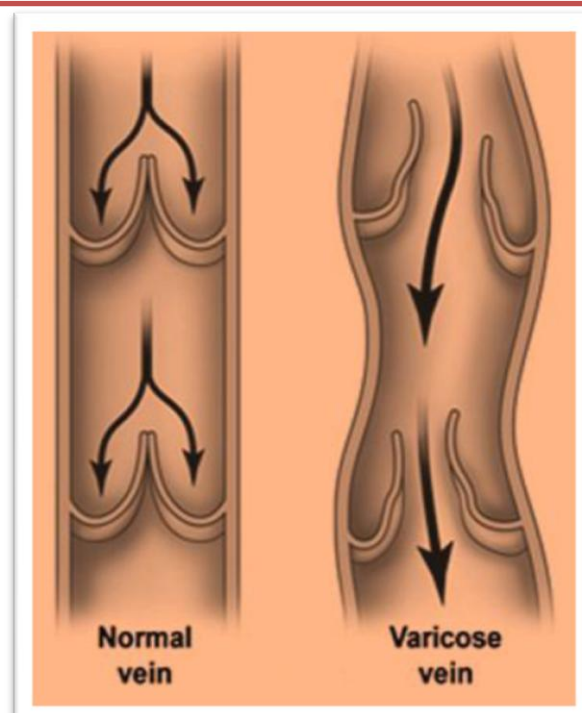
Secondary Valvular Incompetence

-Pathophysiology

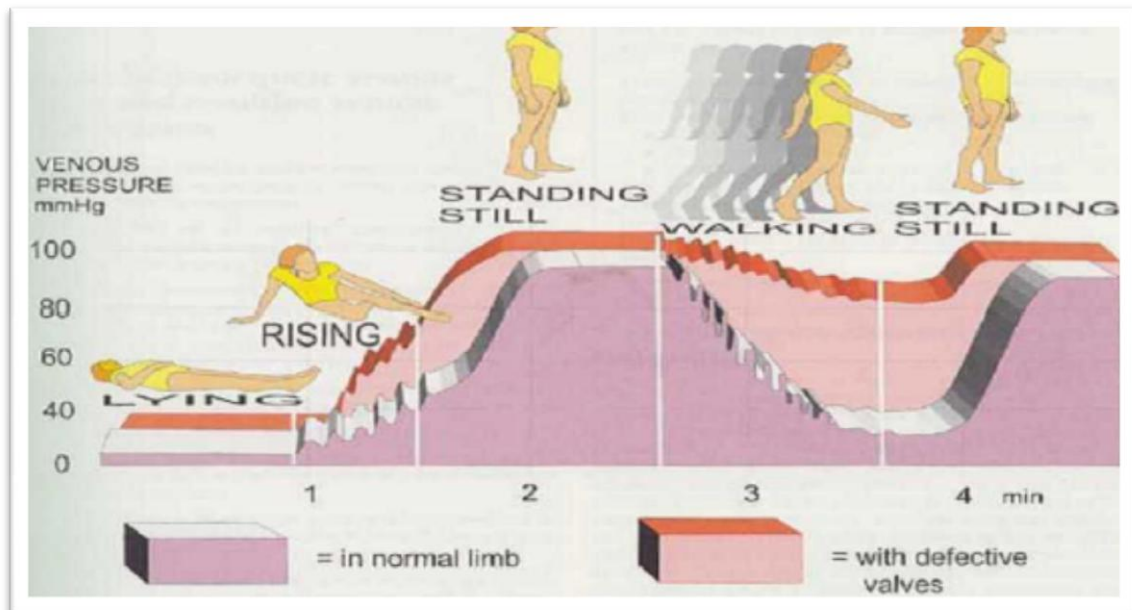
Valvular incompetence\occlusion of the deep system leads to failure of blood to go up in deep system and in from superficial system > high AVP > **varicose veins** > blood stays for a long time where it is not supposed to > fibrinogen deposition around cells=die & RBC destruction= Hemosiderin which is toxic to cells & WBC=oxygen radicals which is also toxic to cells > recurrent destruction of cells lead to the formation of fibrous tissue then the skin and subcutaneous tissue become hard like a wood this is called **Lipodermatosclerosis** ;irreversible condition, any minute injury to this ulcer > develop **Ulcer** (most common area is Gaiter area "the junction between the upper and lower half of the leg")



Note: the (down-to-up) and (out-to-in) mechanism is disturbed because of obstruction.



The pressure in the Venous System:



Normally:

- When lying supine, pressure in lower limbs is low (10 mmHg) (no draining forces)
- When rising, deep veins start pulling blood from superficial veins SLOWLY, so pressure starts to increase gradually.
- When standing, deep veins continue to pull blood and pressure increases reaching (90 mmHg)
- When walking, calf muscle pump will start working and pushes blood up through the valves, so pressure drops to (25 mmHg).

Valves then close, to prevent the pressure from increasing again by preventing the blood from refluxing.

If you stop and stand still, calf pump stops and the deep veins start to pull blood from the superficial veins again, so pressure builds up again.

IF VALVES DEFECTED:

- When rising and standing, blood will reflux from the valve, so the pressure will increase RAPIDLY.
- When walking/exercising, blood will reflux through the valve, and the pressure remains high.

When the muscle pump is active blood will go down because there are no valves to hold the blood. The entire circle will be damaged and destroyed so, in the end will be an increase pressure in the superficial system and will cause varicose veins

Failure of AVP to go down after walking/exercising → Chronic Venous Insufficiency.

Patients with Chronic Venous Insufficiency → AVP is constantly high unless they lay down.

Evaluation:

- History:

Take a good history, social history, type of job and any history of DVT.

- Physical Examination:

-Examine patient in a warm room during lying flat and standing

-Look for pitting edema, but when develop Lipodermatosclerosis > non-pitting edema

-Clinical Presentation:

1-Telegiectasias(spider veins or angioectasias):

Are small dilated blood vessels near the surface of the skin or mucous membranes, measuring between 0.5 and 1 millimeter in diameter)

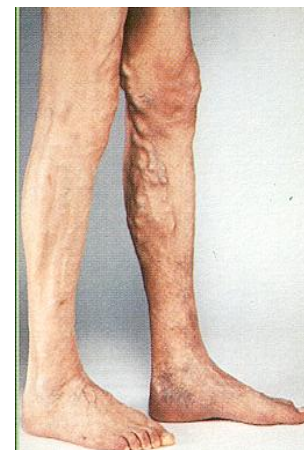


2-Reticular veins:

Are larger than telegiectasias but smaller than varicose veins, approximately 1-3 mm in diameter. They are usually flat and less tortuous than bulging varicose vein and appear as dilated blue and green veins beneath the skin surface)

3-Varicose veins:

Are swollen and twisted "rope-like", often unsightly veins. Any vein in the body may become varicose, but the veins most severely affected and most often visible are the ones in the legs and feet, due to the higher gravitational effect of the pooled blood at the lowest point of the body. Varicose veins do not occur suddenly. It usually takes years for signs and symptoms to develop.)



4-Edema:

Swelling caused by leakage of fluid (essentially water) out of the varicose veins because these bulging veins are under high pressure)



5-Ulcer:

A break in the skin of the leg, which allows air and bacteria to get into the underlying tissue)

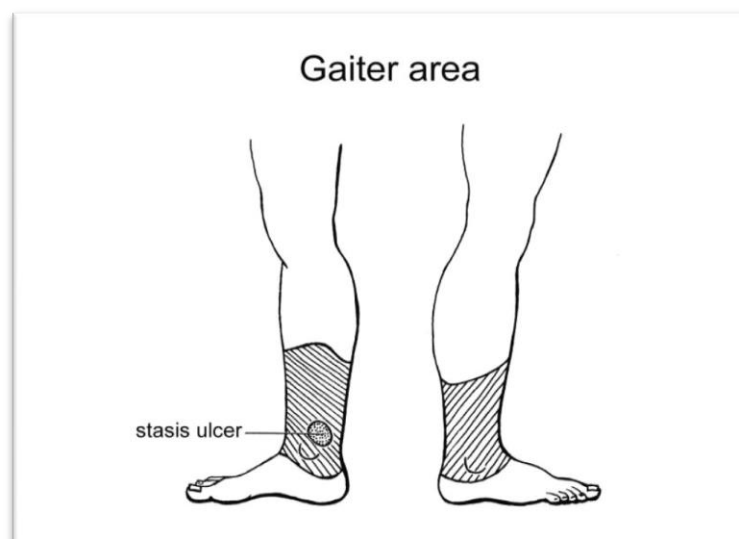


Active Ulcer



Healed Ulcer

The **gaiter area** (area around medial and lateral malleolus) is common site for venous ulceration because this area is skin on a bone (no tissue and fat between them) so the blood and inflammatory stuff will go directly from the veins to skin leading to certain manifestation like: lipodermatosclerosis, healed ulcer, and active ulcer.



- Investigations:

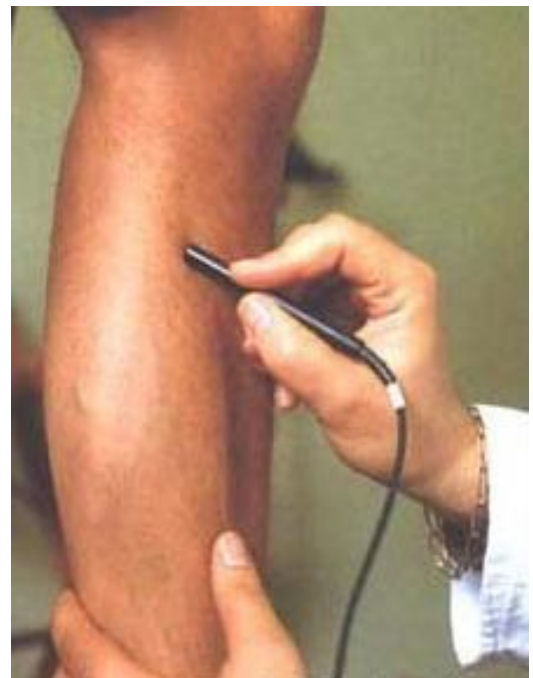
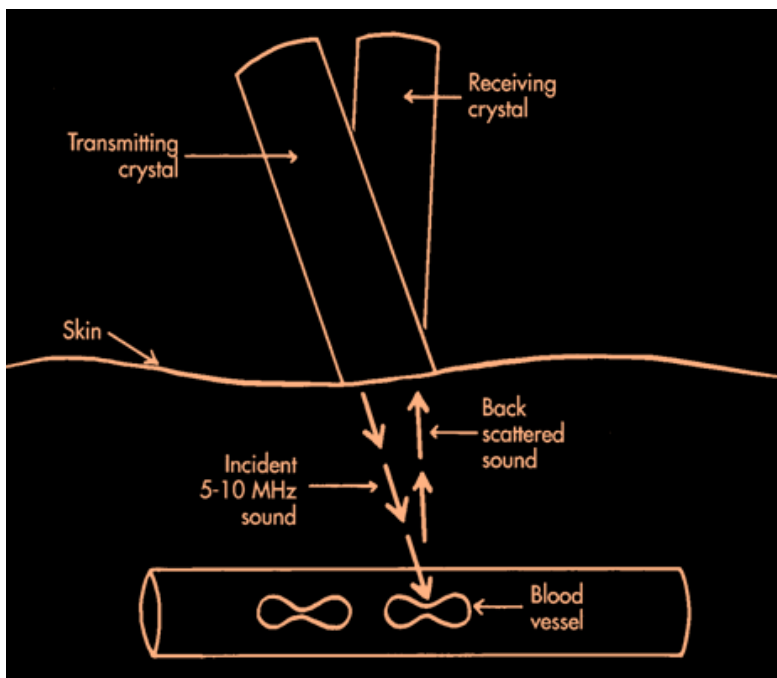
Non-invasive: (theoretically harmless) e.g. (Doppler/Duplex)

Invasive: (there is possible harm) e.g. (AVP/ Venography) phlebography (+contrast, precaution with renal impairment)

1-Doppler:

To hear blood flow in the veins. it can detect which valve isn't working, or an obstruction, by listening for abnormalities in the sound of the flow.

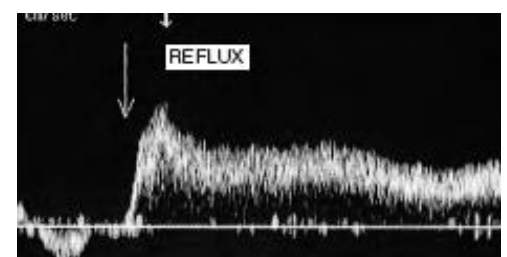
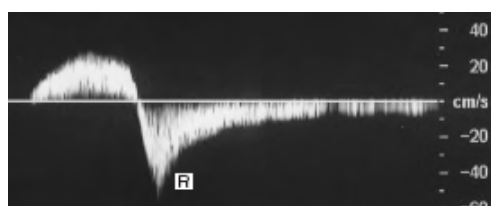
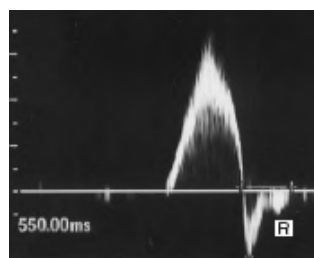
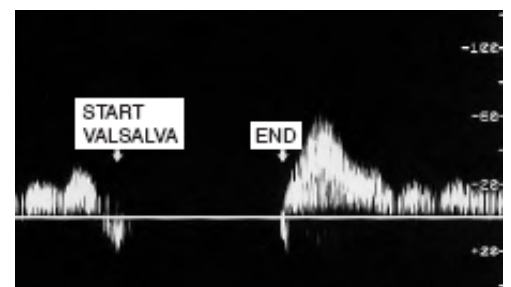
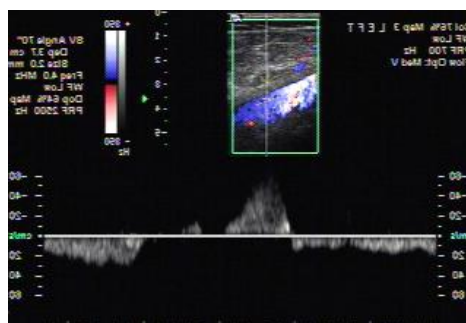
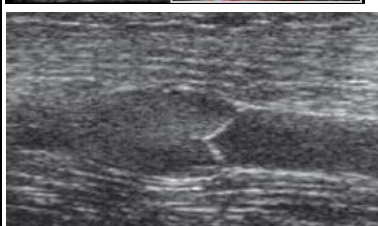
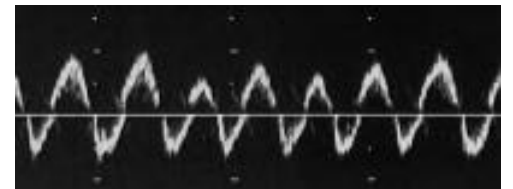
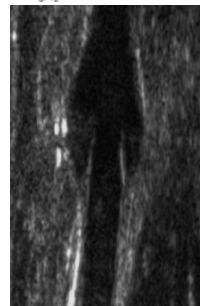
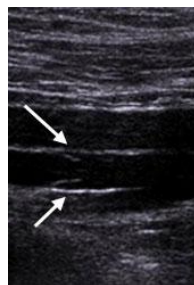
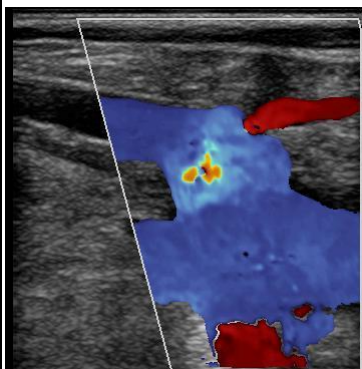
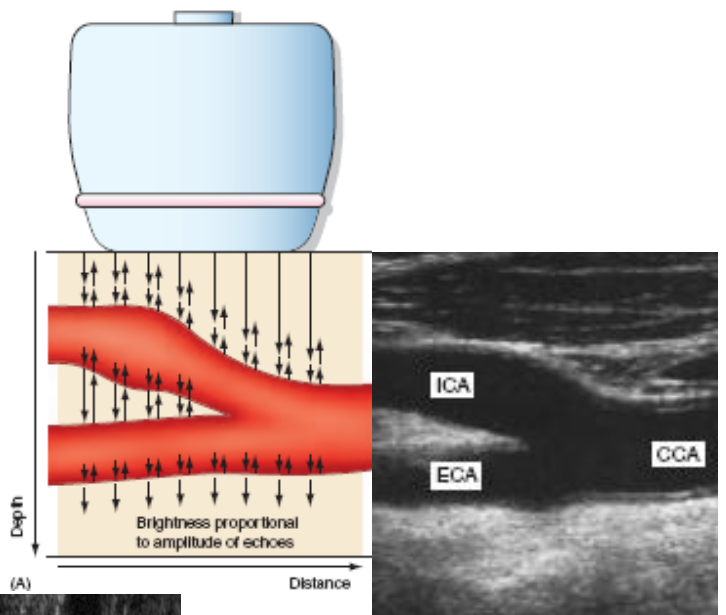
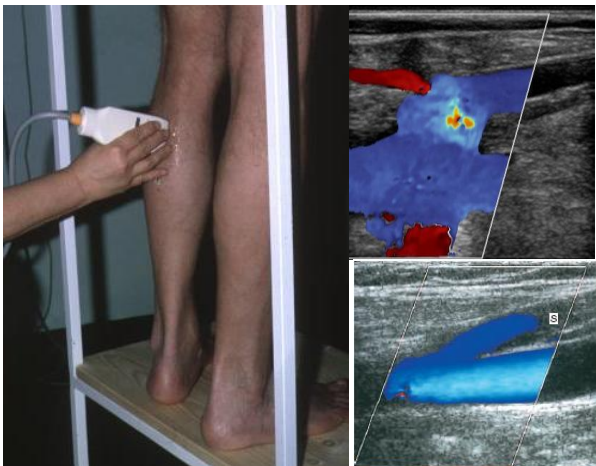
This non-invasive test is a more accurate means of assessing whether a vein is dilated but carrying blood in an antegrade direction or whether it is a true varicosity with retrograde flow. The Doppler probe is positioned directly along the axis of vein at 45° and the vein is tapped gently. A strong Doppler signal confirms that the probe is correctly positioned. Compression of the limb below the probe will produce a sound indicating flow in the direction of the valve. In incompetent veins, a signal is also produced when the pressure is released, indicating retrograde flow. This can be repeated at several levels until no retrograde flow is detected. All veins suspected by inspection or palpation of being varicose should be tested in this manner. If no veins are obviously dilated, simply record whether any retrograde flow can be detected along the length of the long and short saphenous veins.



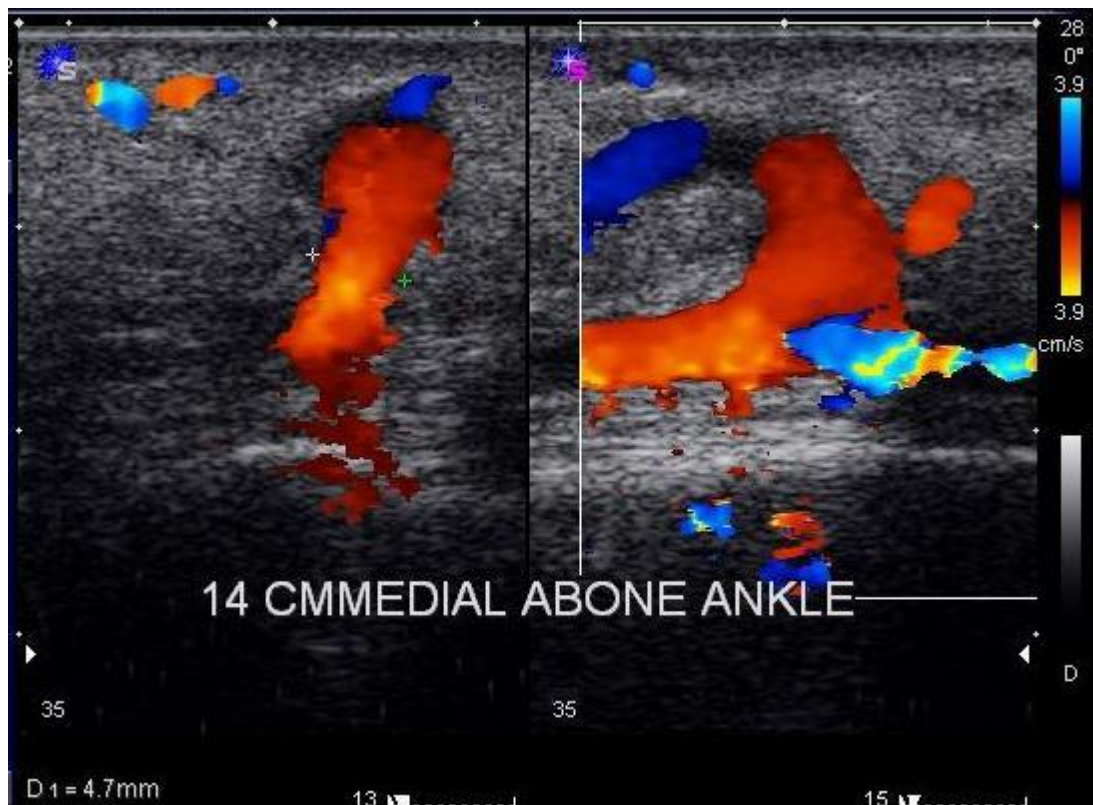
2-Duplex:

This uses a combination of Doppler and conventional ultrasound and gives a more accurate assessment than Doppler alone. It is used in patients with significant varices, although some authorities maintain that it should be used in all patients as a screening procedure.

It allows visualization of a portion of the venous system. It can determine the direction and speed of blood flow within the veins.



Incompetent Perforator Vein



3-Ambulatory Venous Pressure:

It is a test to measure the venous pressure in supine, standing, and walking positions to compare it with normal changes.

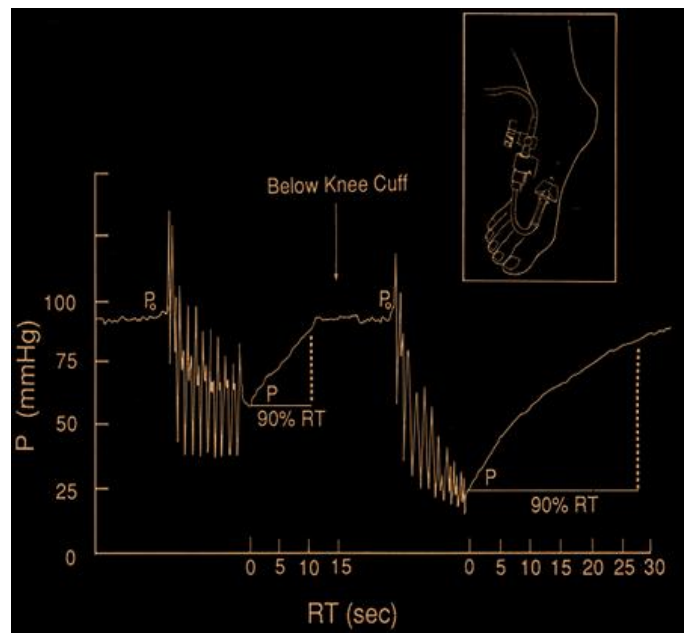
It is performed by placing a small needle into one of the veins on the back of the foot and connecting the needle to a blood pressure measurement machine. The test has three parts:

1. The subject is then asked to stand up and the standing venous pressure is measured. (N= 80-90 mmHg)
2. The subject is asked to perform ten heel raise exercises to work the musculo-venous pump and the ambulatory venous pressure (AVP) is recorded. (N= 20-30 mmHg = >50% drop)
3. The subject is asked to rest again in the standing position and the rate at which the ambulatory pressure returns to the standing pressure is measured, called the refilling time. (N=> 20 sec)

Reflux:

20-21gauge Butterfly Needle

- Superficial Dorsal Vein (Foot) or Ankle Vein
- Standing
- Heal Raised
- Measurements



Interpretation

Normal :

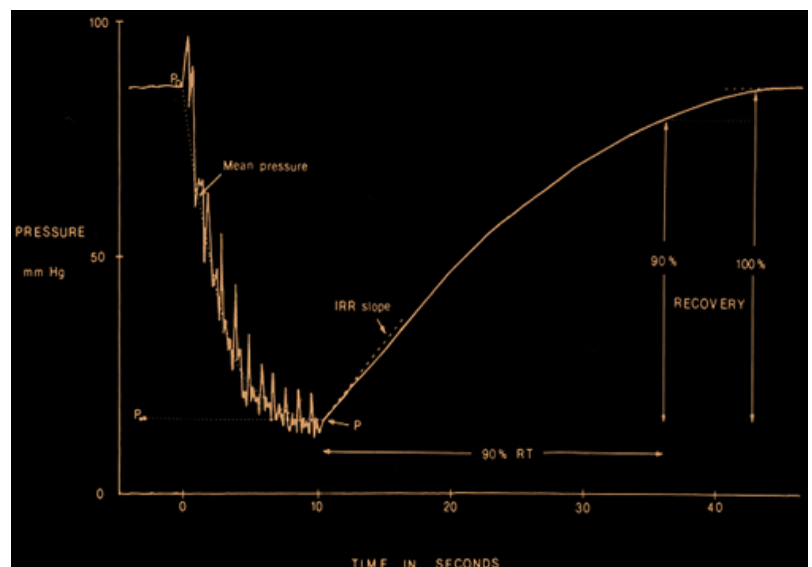
(When walking)



Pressure 80 - 90mm Hg
to 20-30 mm Hg
or > 50% drop

Venous RF Time: ≥ 20 SEC

**REMEMBER THE PHYSIOLOGY OF
VENOUS PRESSURE CHANGES
WHEN INTERPRETING RESULTS**



-Abnormal AVP:

I

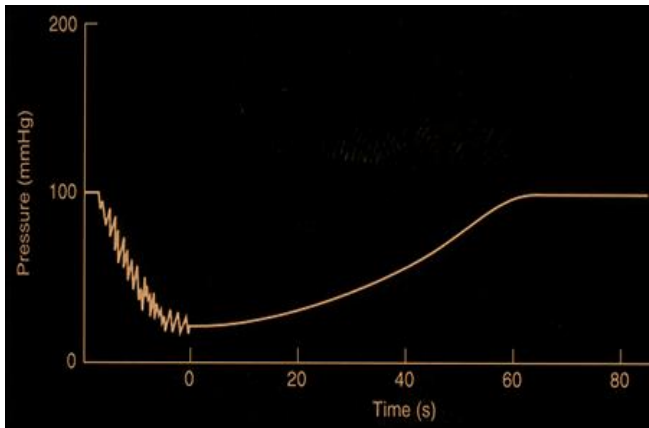
Lack of sufficient drop in pressure
with ambulation*



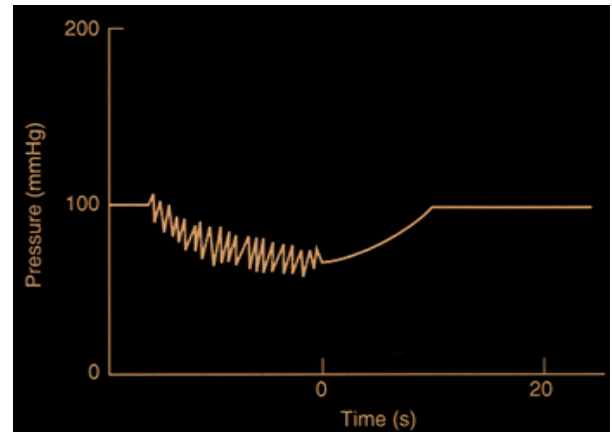
P < 50%

* Ambulation = walking





Normal

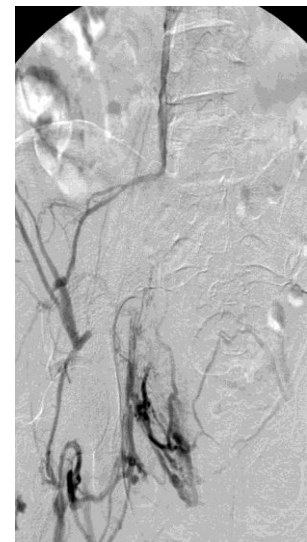
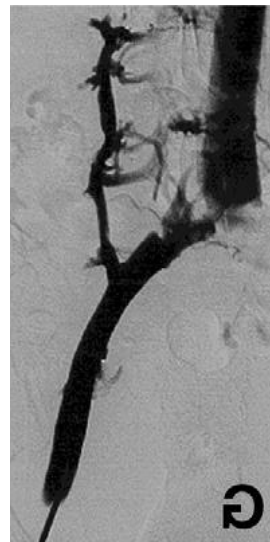
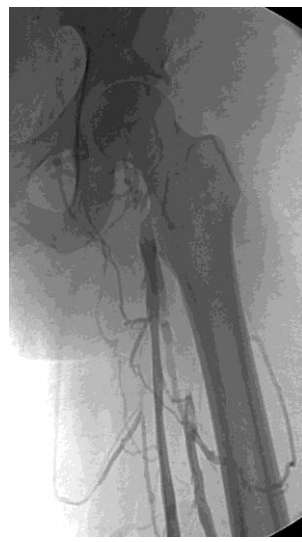


Deep venous incompetence

4- Phlebography (also called Venography):

It is a procedure in which an X-ray of the veins, a venogram, is taken after a special dye is injected into the bone marrow or veins.

Not used much nowadays, due to its complications (can harm the kidneys). But still has specific indications.



Treatment:

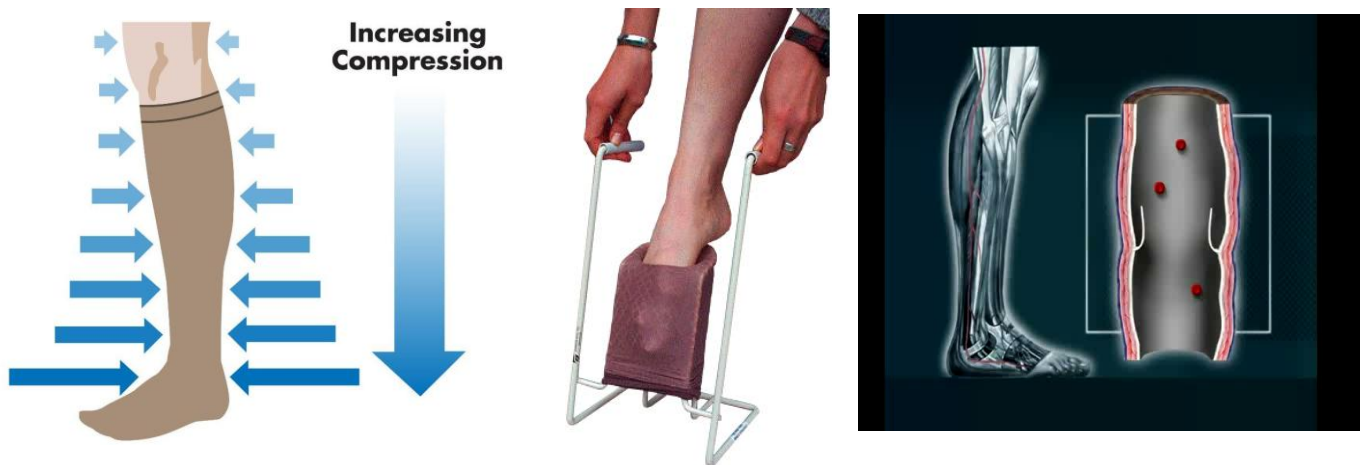
Principle of treatment: Restoration of blood pumping towards the heart, or else, remove the problematic vein (provided that there is another functioning vein draining the same area).

-Methods:

Depending on the problematic vein (Deep, Superficial, Small, Big).

- Stocking:

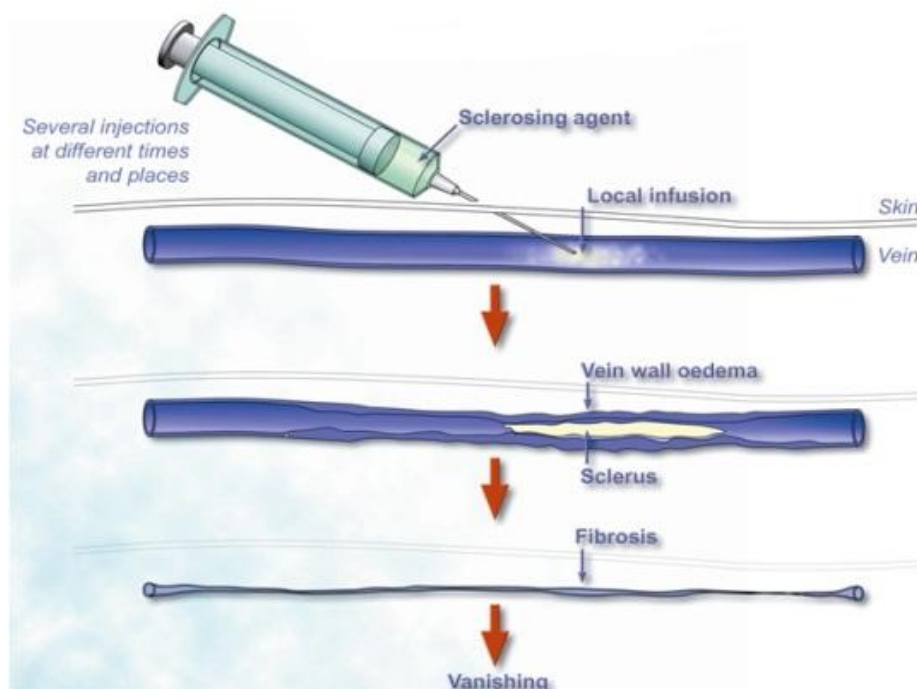
Compression stockings (physical), applies pressure, but its problem is low compliance, although it usually solves the problem.



- Ablate vein:

A-chemically: Sclerotherapy:

This is a non-surgical treatment used to eliminate small varicose veins and spider veins. It involves injecting a sclerosant solution into the vein which causes the vein to collapse and disappear.

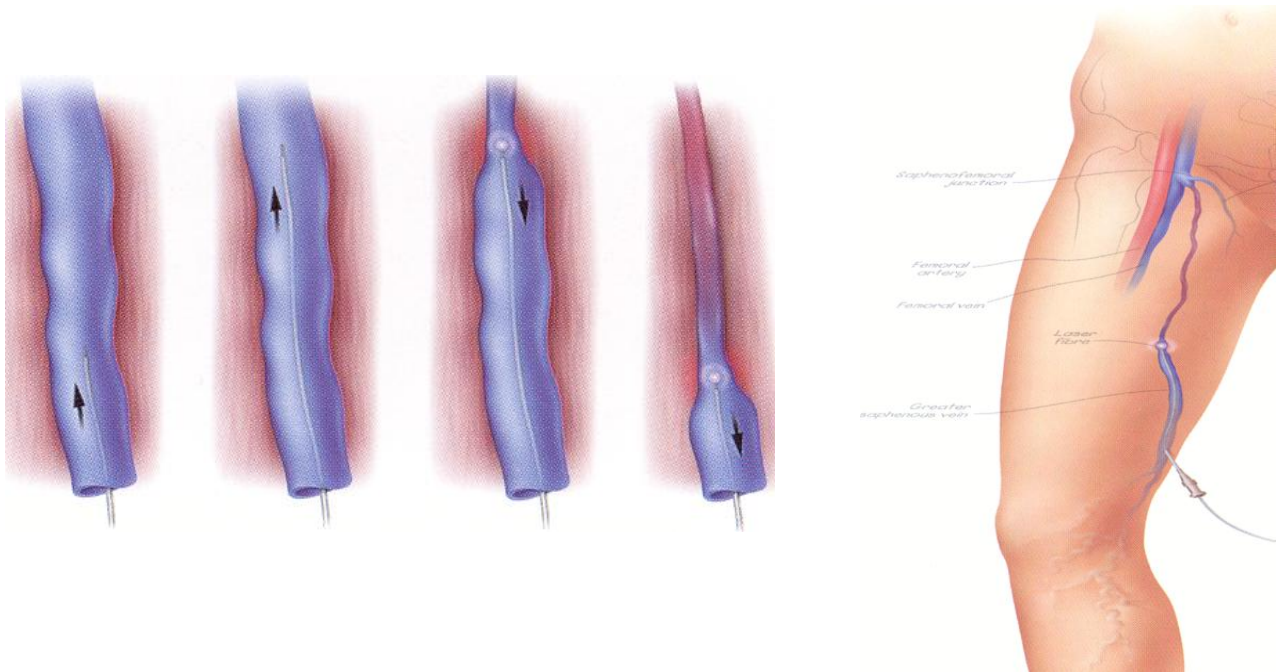


B- thermally: Endovenous Laser treatment:

During this procedure, a laser catheter is inserted into a large varicose vein in the thigh and laser energy is used to seal the vein closed. This is a variant on surgical phlebectomy (in which a large saphenous vein of the thigh is actually removed from the patient) The advantage of the laser treatment is that it can be performed in the office under local anesthesia and recovery is faster than if the vein is “stripped” using surgical techniques.

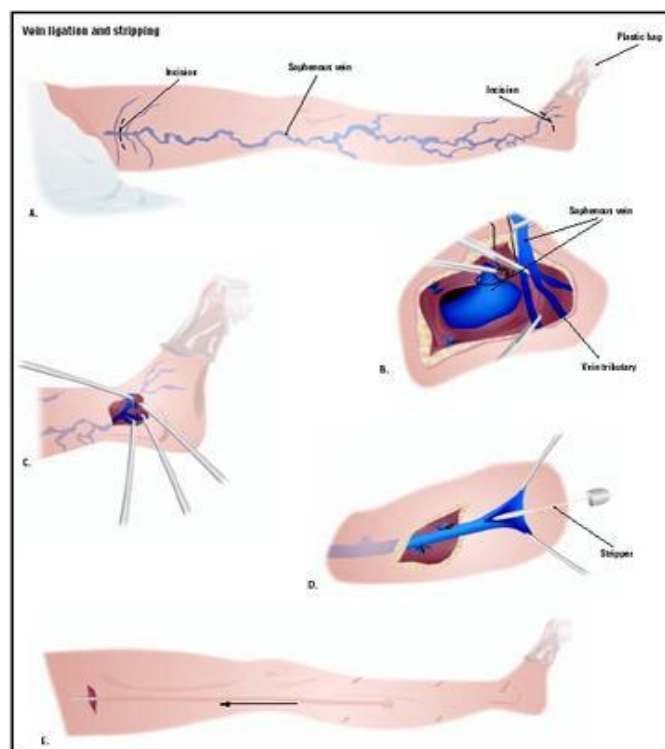
Endovenous Ablation techniques:

(Denaturation of vein wall collagen > Contraction > Fibrous obliteration)

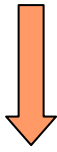


- **Conventional surgery:**

Problematic vein tied above and below, then taken out. Not used anymore



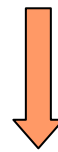
Telangiectasias



Stocking and/or Sclero-Rx



Varicose Veins



Stocking

USG-Sclero-Rx

EVLV/Surgery

Edema

Cutaneous Ulcer

Local Wound



Stocking

USG-Sclero-Rx

ELVT/Surgery



Usually the cause that leads to ulcer is not simple as venous incompetence; there is a serious secondary cause (e.g. mass, undiagnosed DVT)

Summery

The function of venous System is to transfer blood back towards the heart (most important/challenging is to transfer it back from the **lower limbs** "Anti-gravity")

The venous system:

-Anatomy:

1-Valves: unlike arteries it has valves, to maintain unidirectional movement of blood since there is no continuous pump pushes the blood through veins.

2-Wall thickness: thinner in compared to the arterial system.

-Nature of blood: deoxygenated (except for pulmonary vein and umbilical vein).

-Types: superficial and deep

-Direction of blood: down --> up (distal to proximal) , out --> in (superficial to deep through perforators).

-Physiology

*Ambulatory Venous Pressure (AVP): is the venous pressure in the dorsum of the feet.

Normally:

AVP while in supine position=heart=10 mmHg

AVP during standing=90 mmHg

AVP during walking=25 mmHg

(When someone is standing AVP=90 mmHg. After he exercise on tip of his feet for 10 times "maximum effect", pressure goes down to 5-10 mmHg. Due to, the peripheral heart "group of muscles in the calf area

Failure of AVP to go down after exercising\walking --> Chronic Venous Insufficiency

*Any fluid column is subjected to: Hydrostatic\Atmospheric pressure (reference point=0 is the sea level) and Dynamic\Mechanical pressure.

If we consider that a human body is a column of fluid:

1-**Hydrostatic pressure** (reference point=0 is the Heart):

Hydrostatic pressure in upper limbs is -ve whereas in lower limbs is +ve.(sometimes equals the arterial system)

2-**Dynamic pressure** in venous system is generated by:

A-Muscle pump;

- -when muscles contract: deep veins move blood down to up, valves of perforators close
- -when muscles relax: deep veins fill in blood, valves of perforators open

B- Thoracic abdominal Pressure gradient;

- In expiration diaphragm will go up creating a (-) ve pressure > abdomen acts as a valve > opens which will lead to blood sucking to heart, and subsequent blood sucking from the legs.
- On inspiration diaphragm will go down, creating a (+)ve pressure > abdomen acts as a valve > closes which will lead to closure of veins.

***Chronic Venous Insufficiency:** constantly high AVP unless when the patient lay down "supine position" = absence of the physiological lowering mechanism of AVP when someone walks\exercises.

❖ Causes:

1-Primary (superficial system is diseased or perforators):
Idiopathic ; Obesity, Pregnancy ,Standing for long time

2-Secondary (deep system is diseased): Obstruction (mass,DVT)=10% , Reflux (valve incompetence)=90%

❖ Evaluation

-History:

Take a good history ,social history, type of job and any history of DVT.

-Examination:

_examine patient in a warm room during lying flat and standing

_look for pitting edema, but when develop Lipodermatosclerosis > non-pitting edema

-Investigation

_invasive: there is possible harm (e.g. AVP, phlebography (+contrast, **precaution with renal impairment**)

_non-invasive: theoretically harmless (e.g. Doppler (microphone), Duplex (ultra sound))

-Treatment

In general, Vein ablation is done by: chemical (sclerotherapy) or mechanical (stocking) or thermal (EVLT) or surgical (stripping)

Depends on the clinical presentation:

1-Teleangiectasias & Reticular veins > Stocking (mechanical) , Sclerotherapy (chemical)

2-Varicose vein > Stocking ,Sclerotherapy ,Endovenous laser therapy (thermal)

3-Edema,ulcer,local wound > Surgery

*** In the case of an ulcer, usually there is a serious secondary cause of valvular incompetence that leads to the development of that ulcer (e.g. mass, undiagnosed DVT), not simple primary cause (e.g. floppy valve).**