

Vascular Investigations

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Capitano McQs

2 types of investigations :
1- invasive 2- non invasive

اولا : Non Invasive Vascular Tests

Include :

1-doppler :

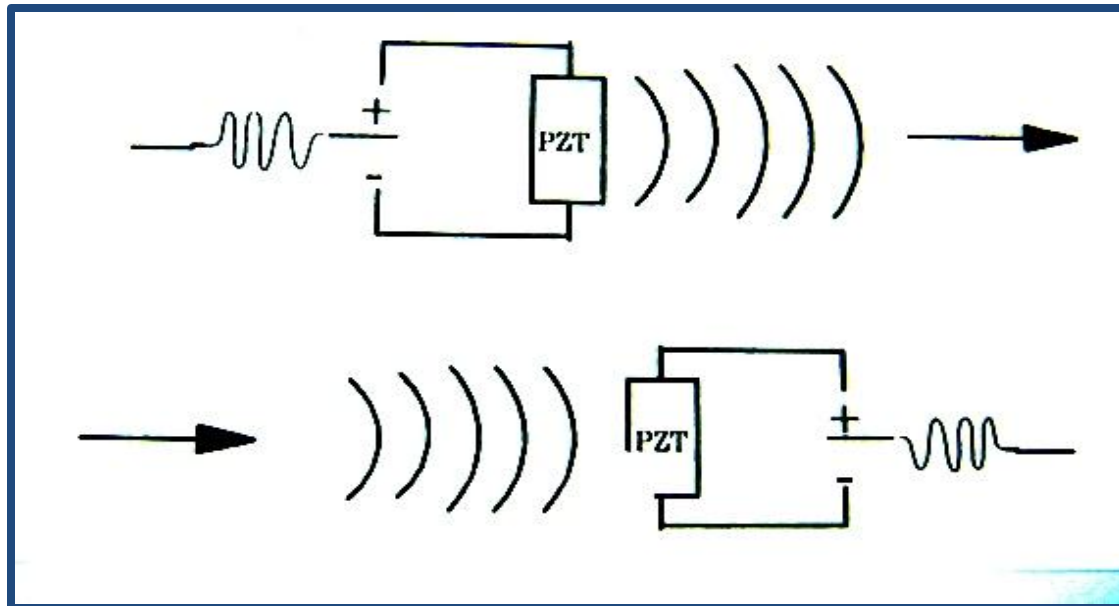
- Sound –longitudinal mechanical wave
of any frequency.
- Audible Sound range
20-20,000 cycles/sec.
20Hz-20kHz

- Ultrasound-'Ultra' means 'Above' human hearing - $>20,000$ cyc/sec(20kHz).
- Diagnostic Ultrasound –2MHz-12MHz
(2million-12million cyc/sec).

Transducer – device converts one form of energy to another

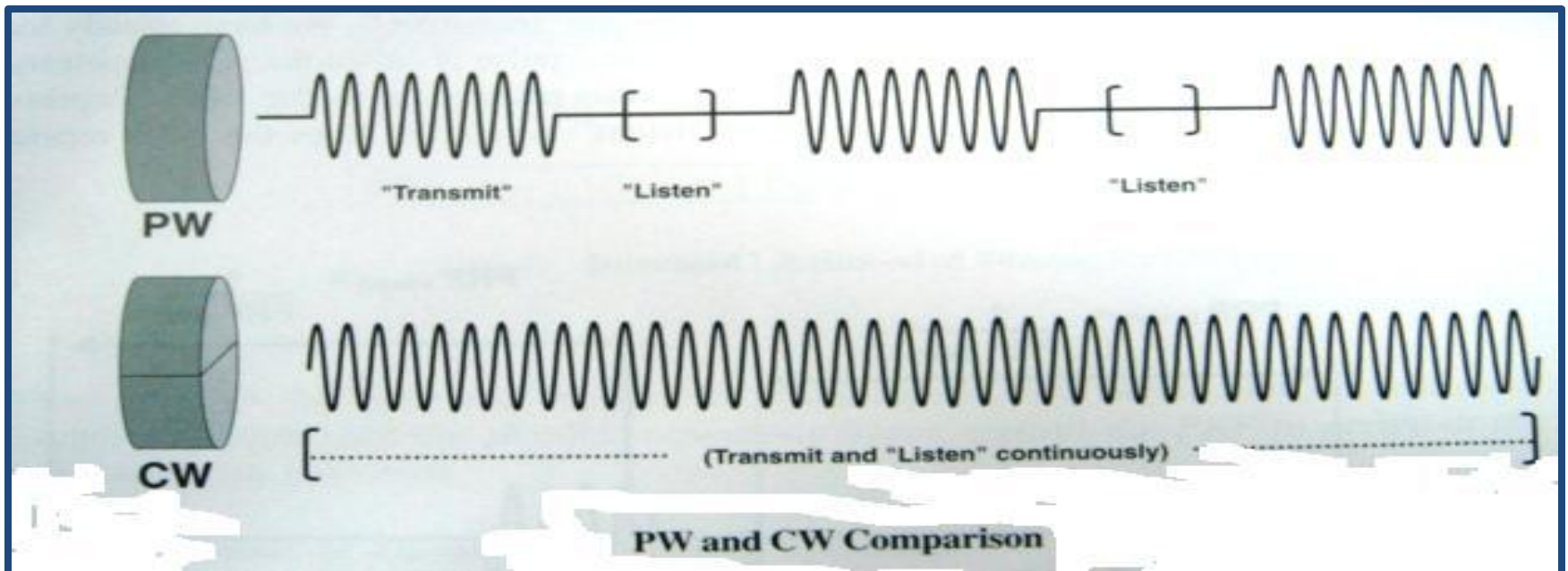
Ultrasound Transducer:

- Use piezoelectric crystals.
- Converts Electro potential energy (voltage) into Mechanical vibration (ultrasound) & Mechanical vibration into Voltage.

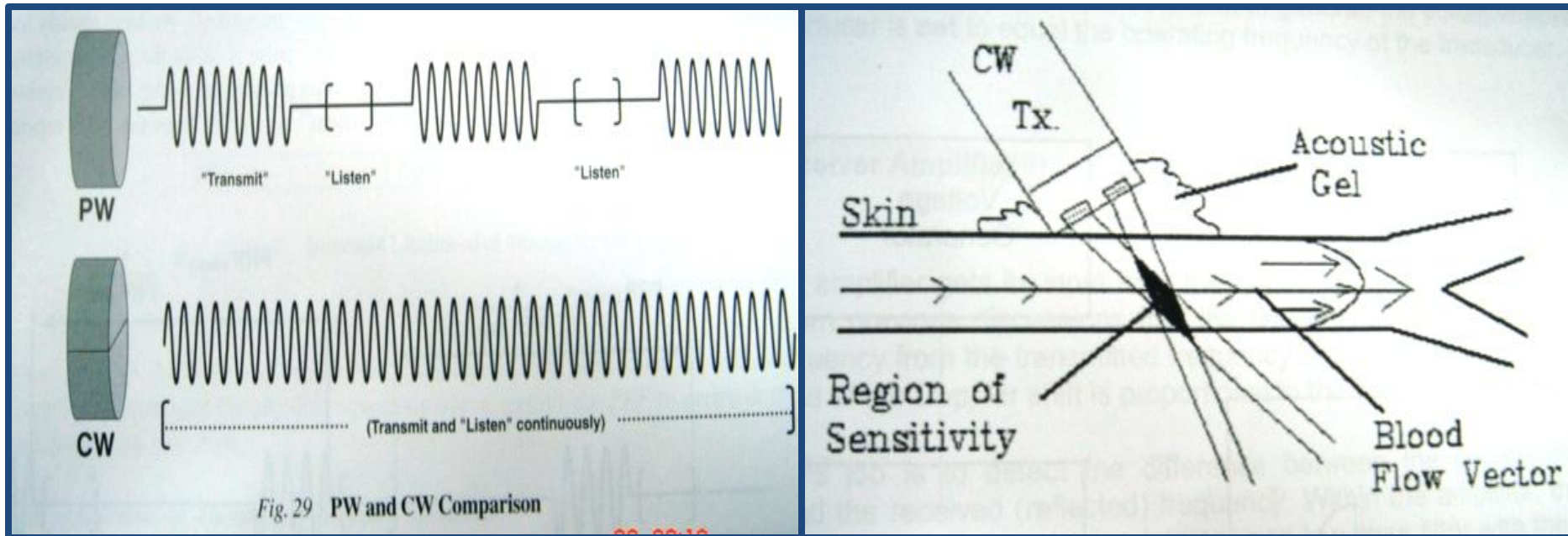


Types of Doppler instruments.

- Continuous Wave (CW)
- Pulsed Wave (PW)



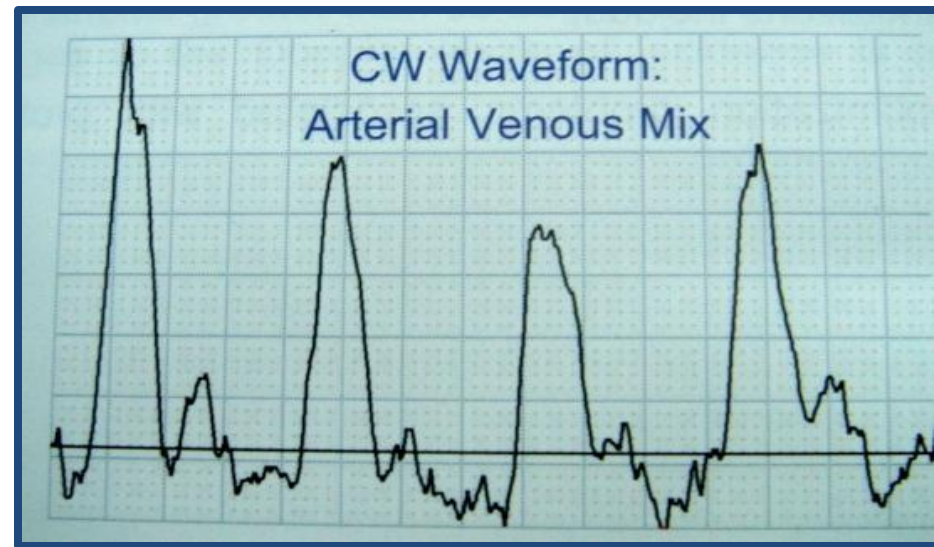
Continuous Wave Doppler



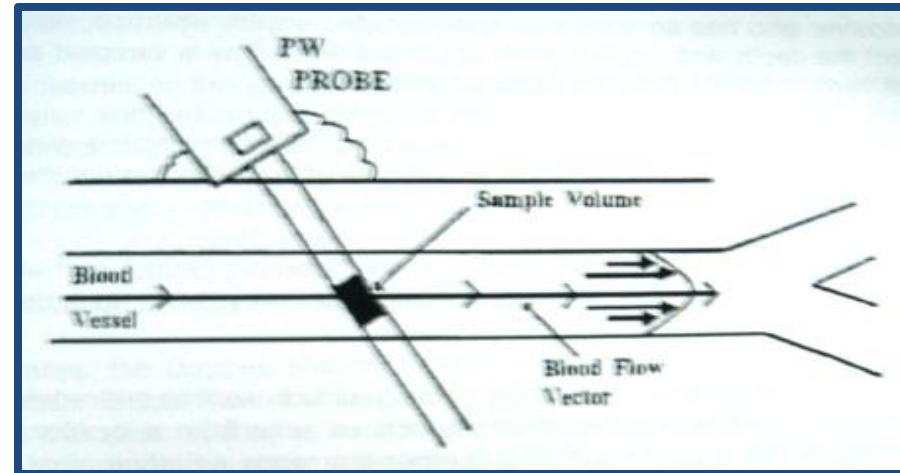
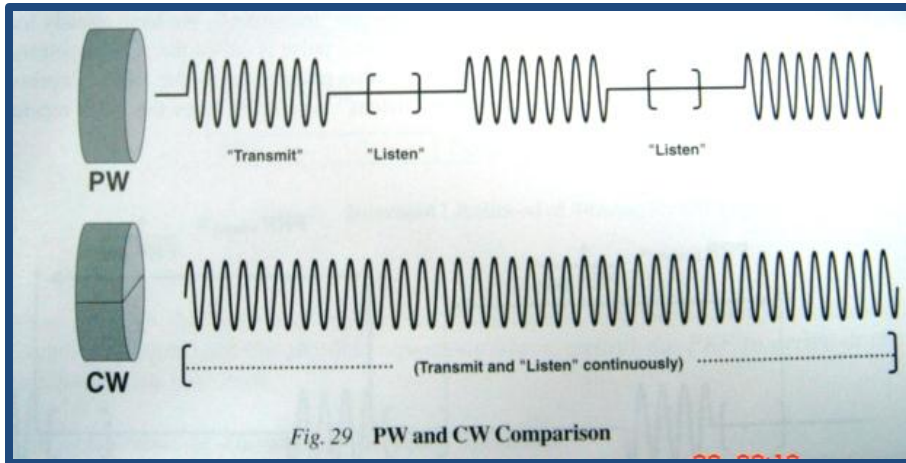
- Doppler transducer Transmit continuously ultrasound & Receive simultaneously.
- Have two Piezoelectric crystals, one Transmit & other Receive.

Continuous Wave Doppler

- Advantage
magnitude of detectable
velocity – limitless.
- Disadvantage **مهمه**
Not specific for depth
Detects any & all vessels
in beam path. من الممكن ان
الاشارات تتداخل بين وعائين
دمويين قريبين من بعض



Pulse Wave Doppler



- Single piezoelectric crystal – both transmission & reception.
- Alternate pulses On & Off.
- Transmit pulse – system waits – pulse travels to sample volume (specific area) – echo pulse returns

Pulse Wave Doppler

- Advantages

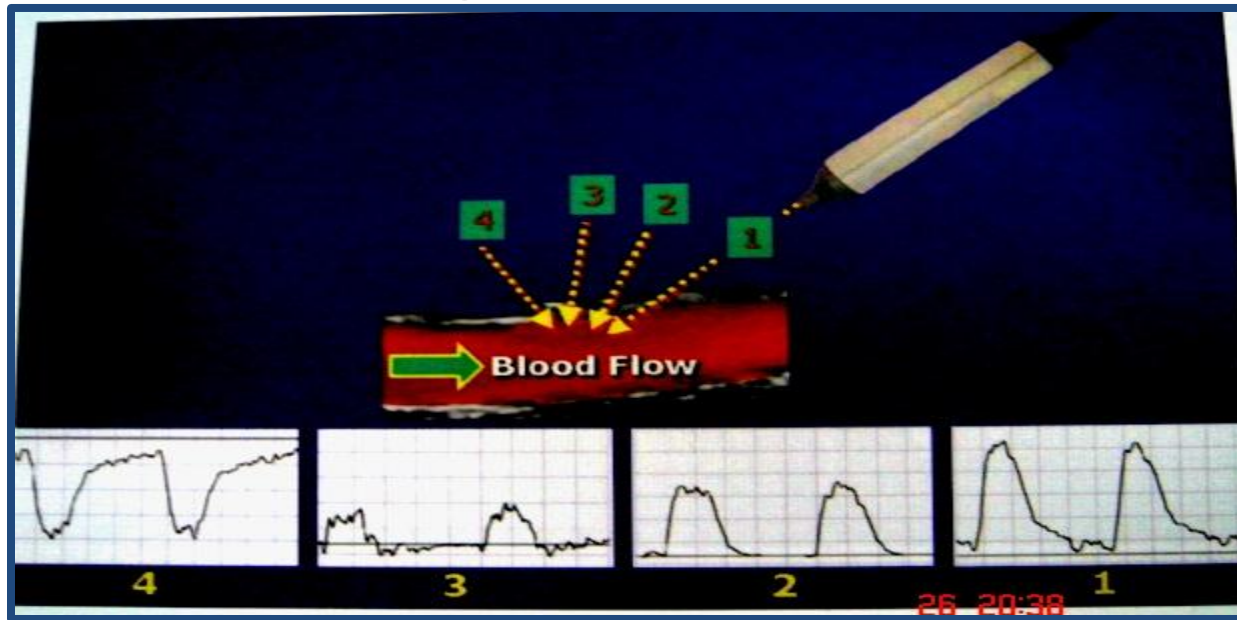
Specific for depth & range.

No mixture of signals like CW Doppler.

- Disadvantage

Limited maximum detectable velocity
unlimited for CW Doppler.

Angle of Incidence



- Doppler or frequency shift is what we hear & see on graphic display.
- Affected by 'angle of flow' or 'angle of incidence'
- Smaller Doppler angle higher the frequency shift.
- Optimal Doppler signals –transducer angle 45-60 towards direction of flow. مهمه جدا

1- Arterial Assessment – Doppler ultrasound

- Audible interpretation

Waveform analysis

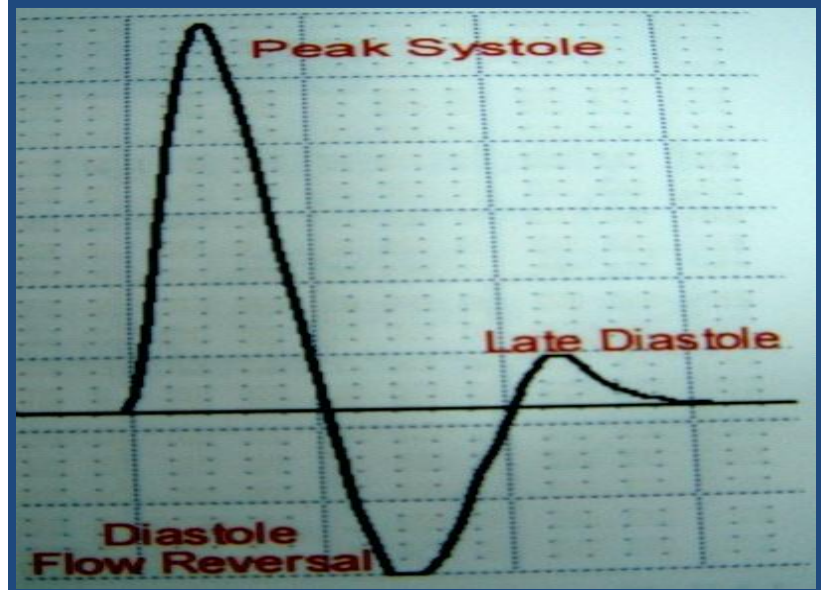
Hand held Doppler

- **Normal** Peripheral arterial Doppler signal

مهمه – ثلاث TRIPHASIC
اصوات – وتظهر على شكل
ثلاث موجات

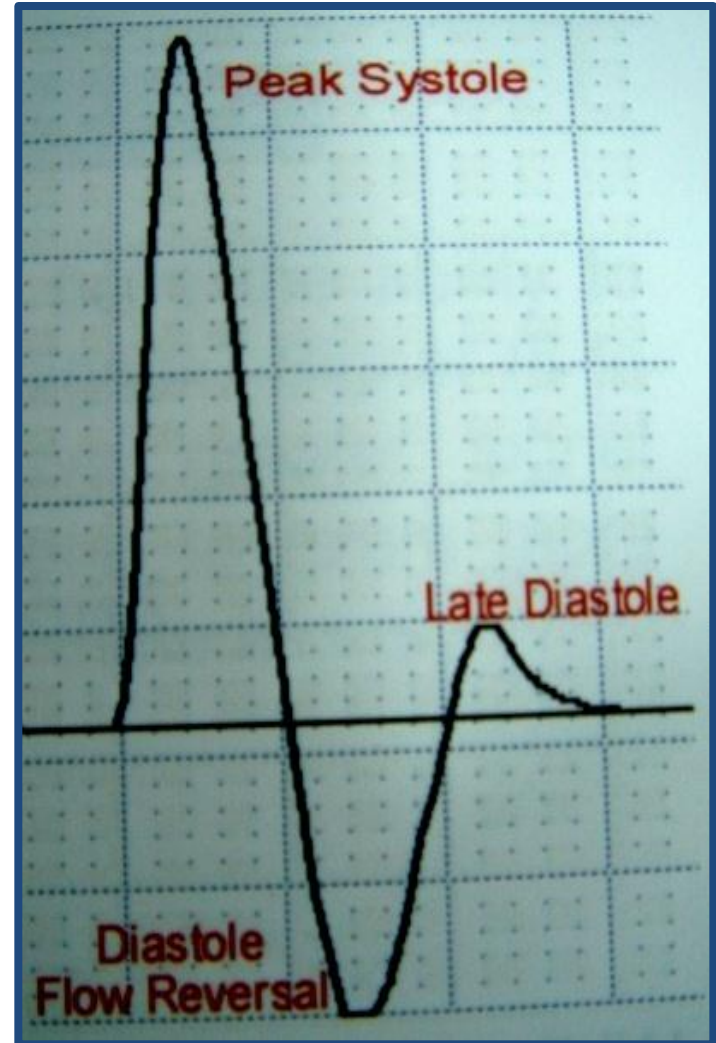


Handheld pencil Doppler being used to measure ankle brachial pressure index

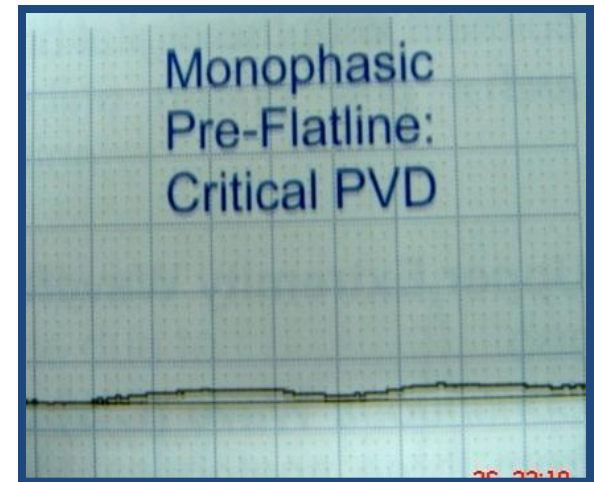
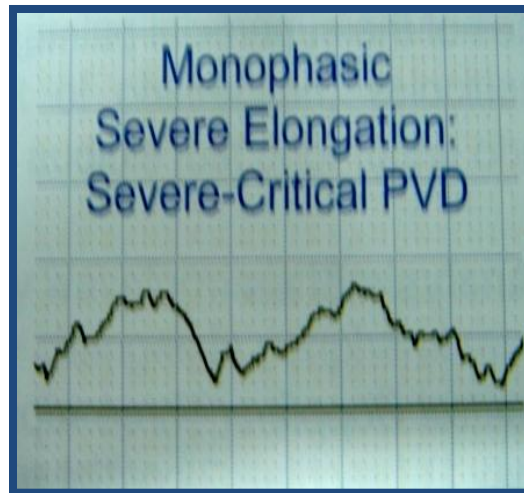
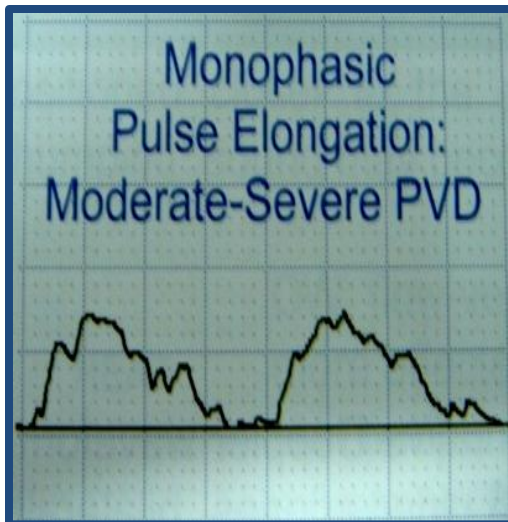
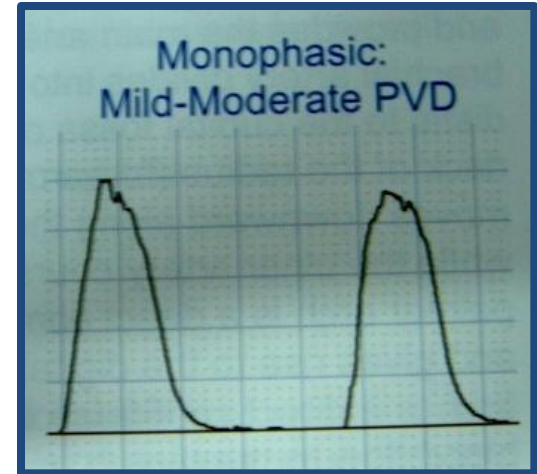
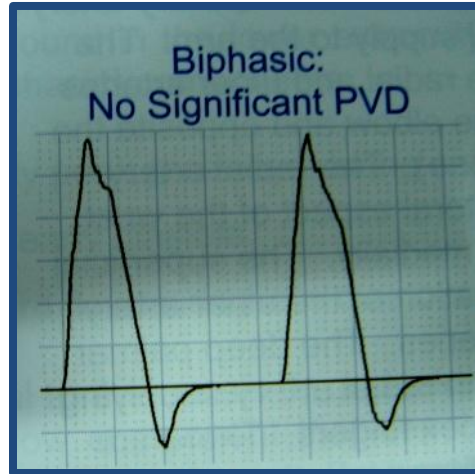
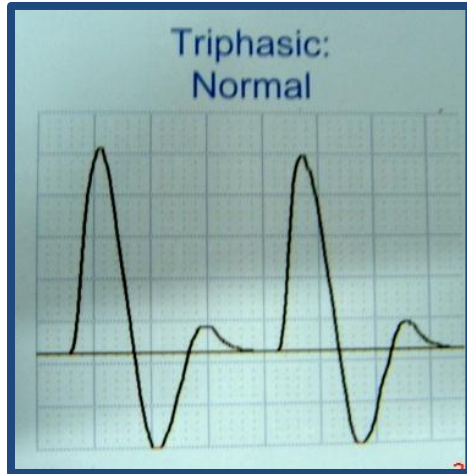


TRIPHASIC ARTERIAL SIGNAL

- 1st sound – phase
large, high velocity,
forward flow, systolic
component.
- 2nd sound – phase
smaller reverse flow
early diastole
- 3rd sound – phase
smaller forward flow late
diastole



Audible interpretation & Wave form analysis

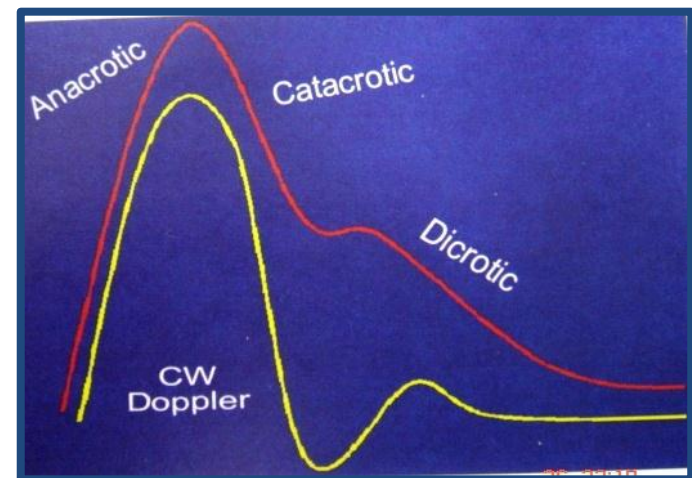
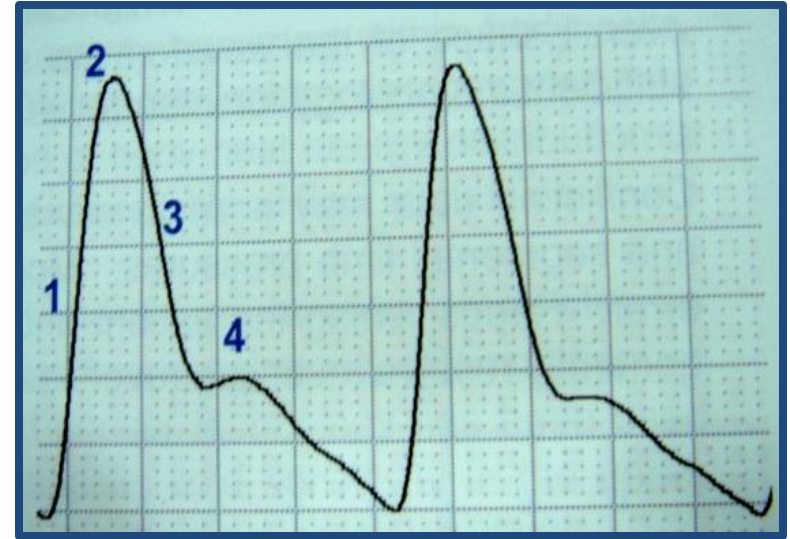


PVD : peripheral Artery disease

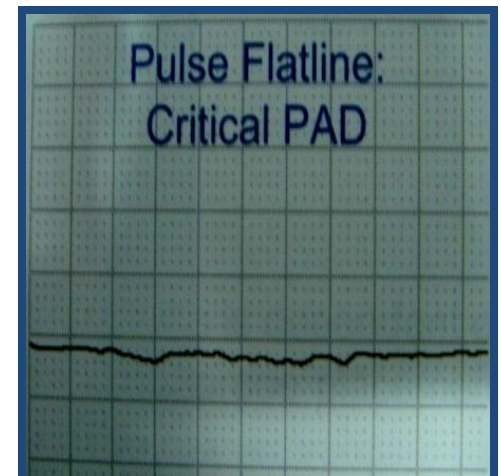
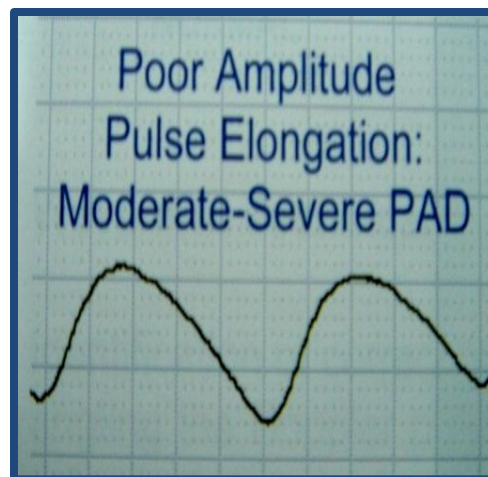
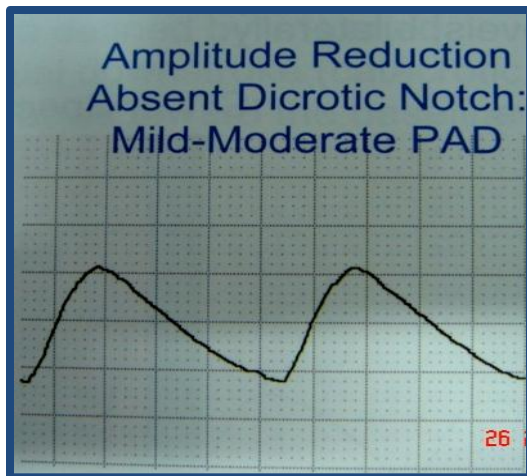
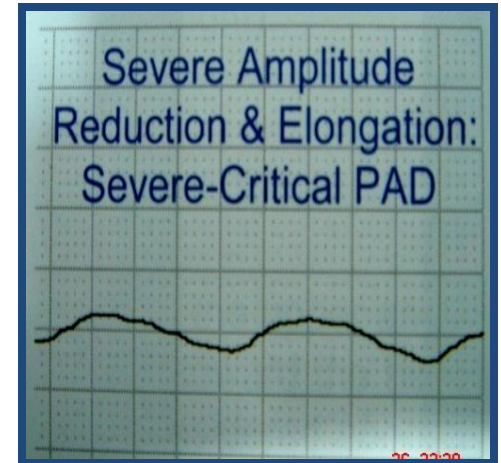
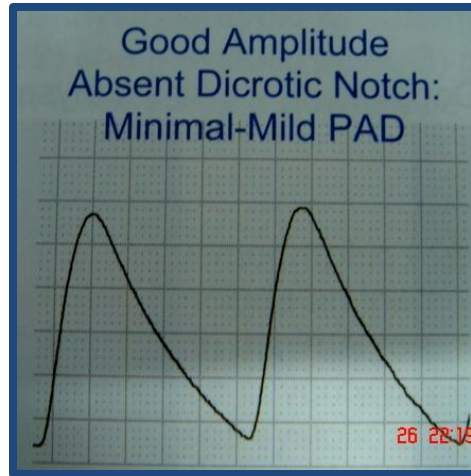
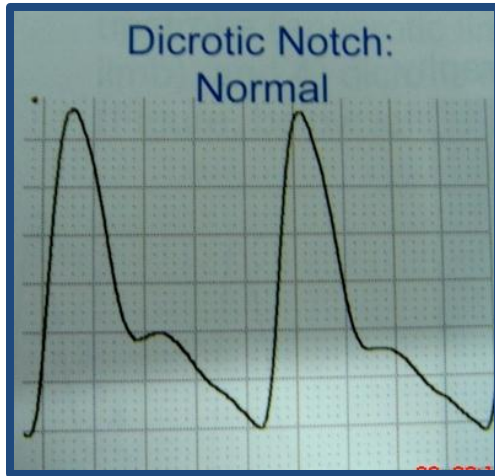
PVR (Pulse Volume Recording)

Normal PVR

- 1.Brisk systolic upstroke
Anacrotic limb.
- 2.Sharp systolic peak.
- 3.Gradual down stroke
Catacrotic limb
- 4.Dicrotic notch-reflective
wave-during diastole
normal peripheral
resistance



PVR (Pulse Volume Recording)



Arterial Pressure measurements

Peripheral arterial occlusive disease.

Sequence of pressure measurement tests.

- Systolic Brachial & Ankle pressure at rest
- Calculation of ABI (Ankel Brchial index) مهمه
- Toe pressure-non compressible tibial arts

Arterial Pressure measurements

Sequence of pressure measurement tests contd,

- Segmental pressure & waveforms – low ABI.
- Stress testing – severity of claudication
& to rule out
pseudoclaudication

كلها سوف تفصل

Contraindication to pressure measurements

Acute DVT

Bandages & casts

Ulceration

Trauma

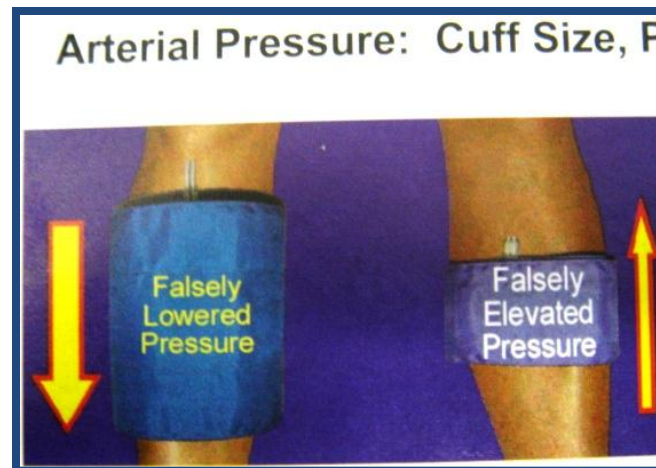
Surgical site

اولا: Ankle Brachial Index (ABI)

- Before the test Consider :
- Patient supine arms at sides
- Basal state(10mnts pretest rest)
- CW Doppler ultrasound
- Appropriate size pressure cuffs

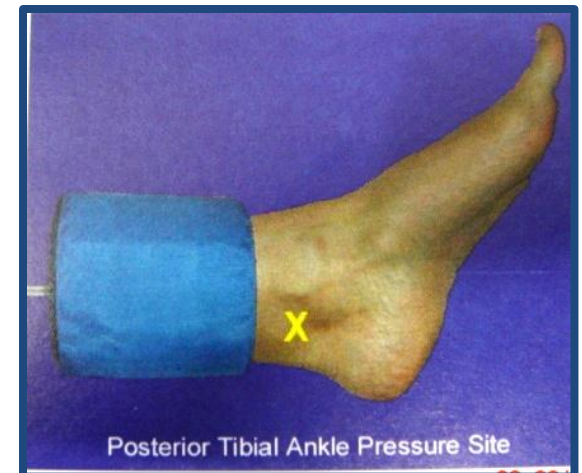
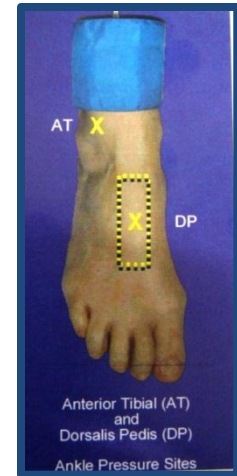


Handheld pencil Doppler being used to measure ankle brachial pressure index



Ankle Brachial Index (ABI)

- Record bilateral systolic brachial pressure & systolic Ankle pressure (dorsalis pedis & post.tib art)
- Interpretation-Ratio highest ankle to brachial pressure.



ABI & Relation to PAOD

- 0.97 -1.25 Normal مهمه
- 0.75 – 0.96 Mild PAOD
- 0,50 – 0.74 Moderate
- <0.5 Severe
- <0.3 Critical
- >1.5 Vessels non compressible مهمه

Remember : Normally the Ankle pressure is higher than the Brachial pressure because of the Gravity

: Toe Pressure ثانيا

- Do this test in case the previous one (ABI) show very high value → like in diabetic pt, مهمه
- Normal toe pressure – $2/3^{\text{rd}}$ systolic ankle pressure
- Plethysmographic device –records changes in volume (used as sensor).

Toe Pressure contd,

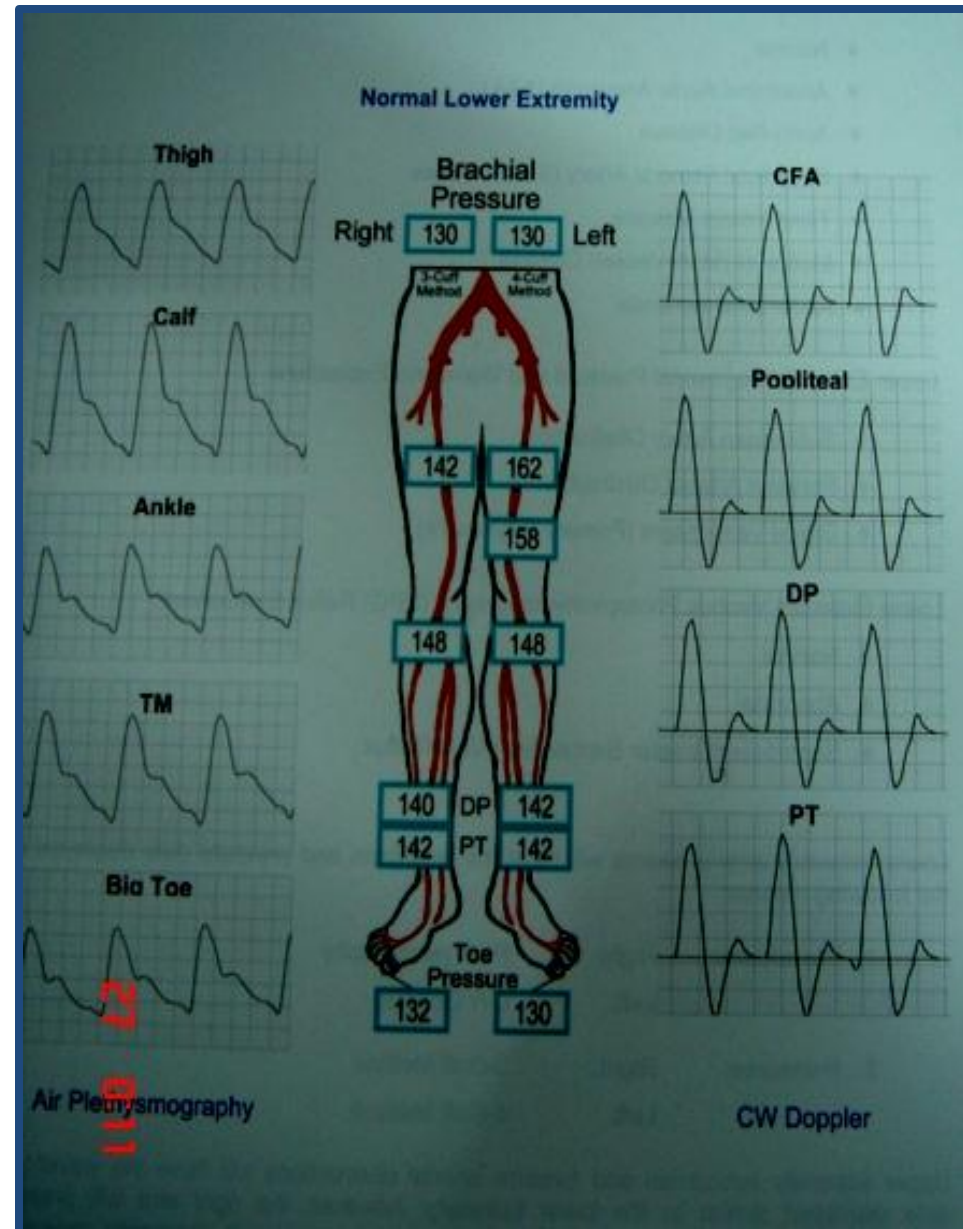
- Inflate cuff above $2/3^{\text{rd}}$ of ankle pressure.
- BP cuff (2.5cm) around base of toe.
- Gradual deflate until arterial tracing demonstrate return of pulsatile flow – recorded as systolic toe pressure.

ثالثا : Segmental Pressure

- Drop in ABI at rest or post exercise indicates hemodynamically significant disease proximal to cuff.
- Segmental pressure measurement – localizes the diseased arterial segment.

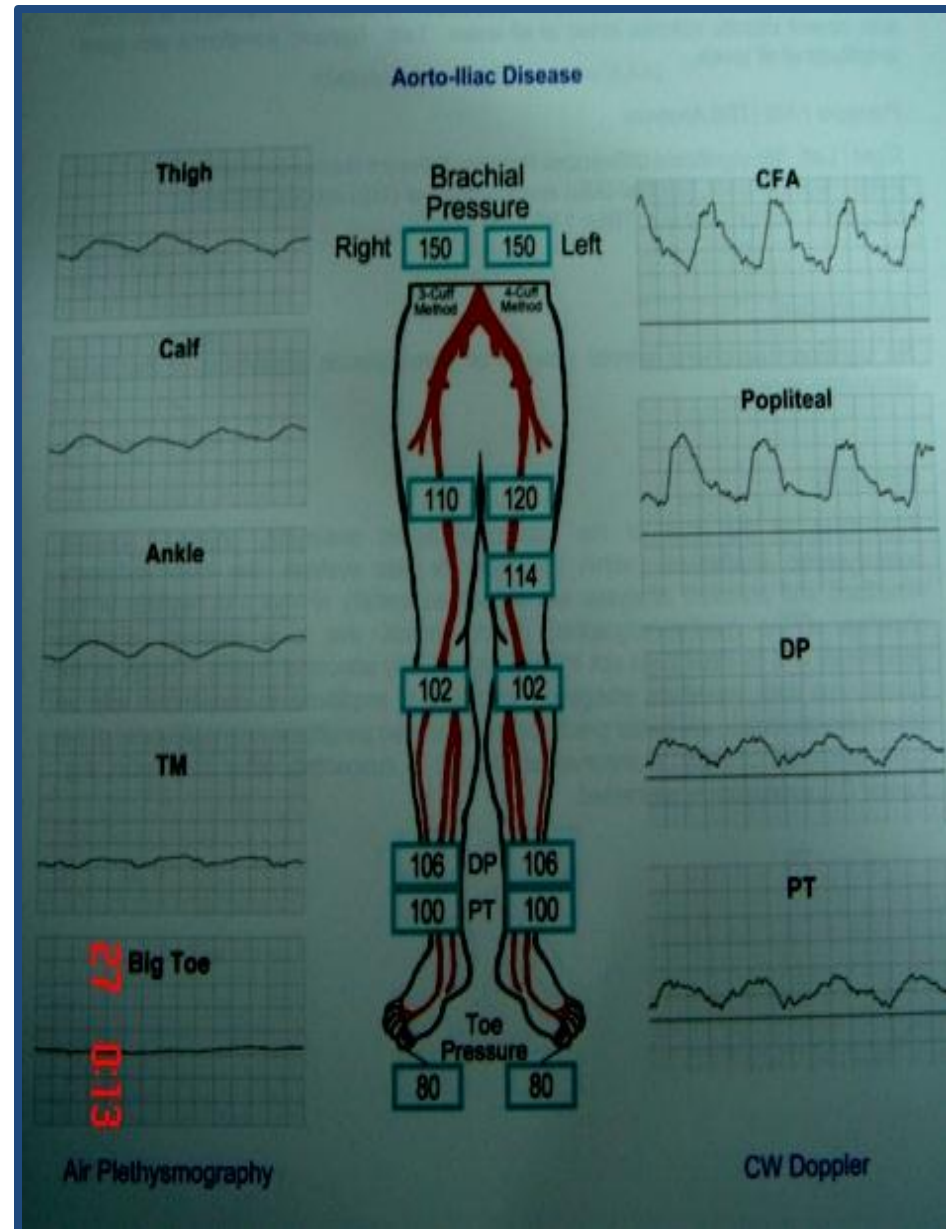
Segmental Pressure

- Pressure difference between two adjacent segments <20mm of Hg



Segmental Pressure

- Gradient $>30\text{mmHg}$ Hemodynamically significant disease between adjacent levels.



رابعاً : Exercise Test (StressTest)

- Exercise stress test
- Reactive hyperemia stress test

Exercise Test (StressTest)

- Assess functional limitation due to PAOD
- Differentiates PAOD – Pseudoclaudication
Ex; neurogenic claudication

Exercise Test (StressTest)

- Resting ankle & brachial pressures
- Pressure cuffs secured in place –ankle & arm.
- Walk at 2mph at 12% gradient-5mnts or point claudication symptoms.
- Return supine position & measure ankle pressure 30secs & 1mnt post exercise.
- Measure till baseline pressure recovered.

Exercise Test (StressTest)

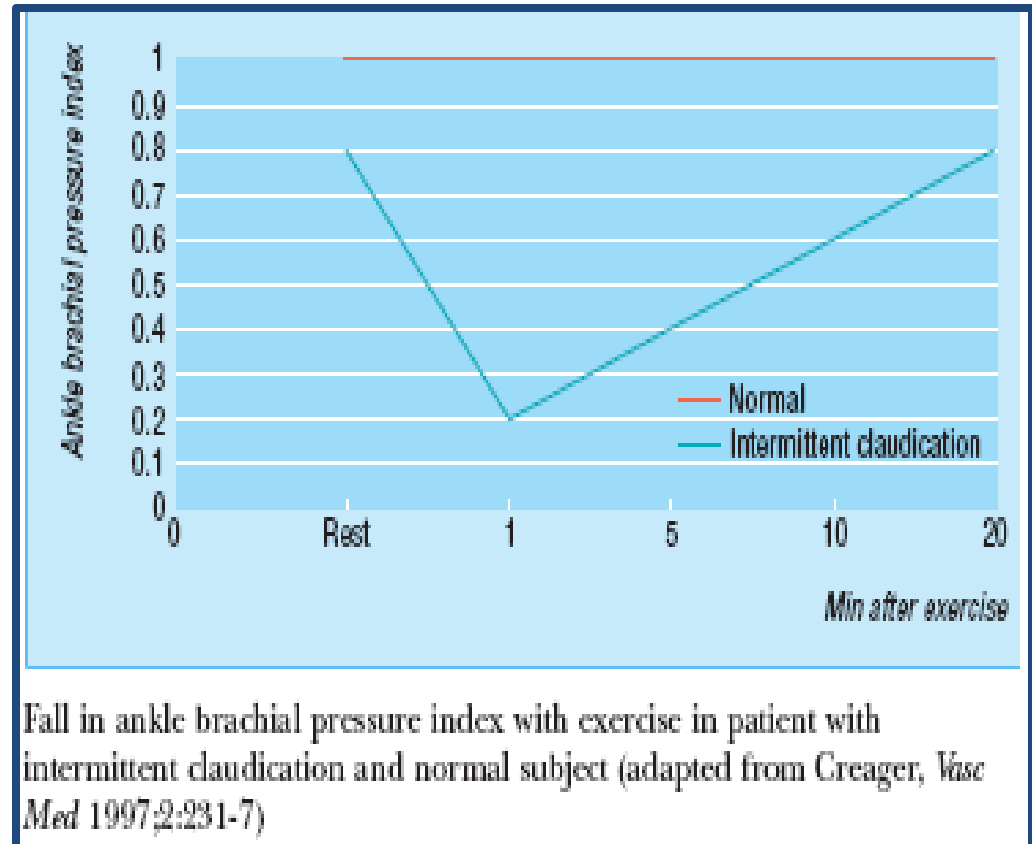
Note: مهمه جدا

- Duration of exercise.
- Distance walked.
- Symptoms prevented exercise.

Exercise Test (Stress Test)

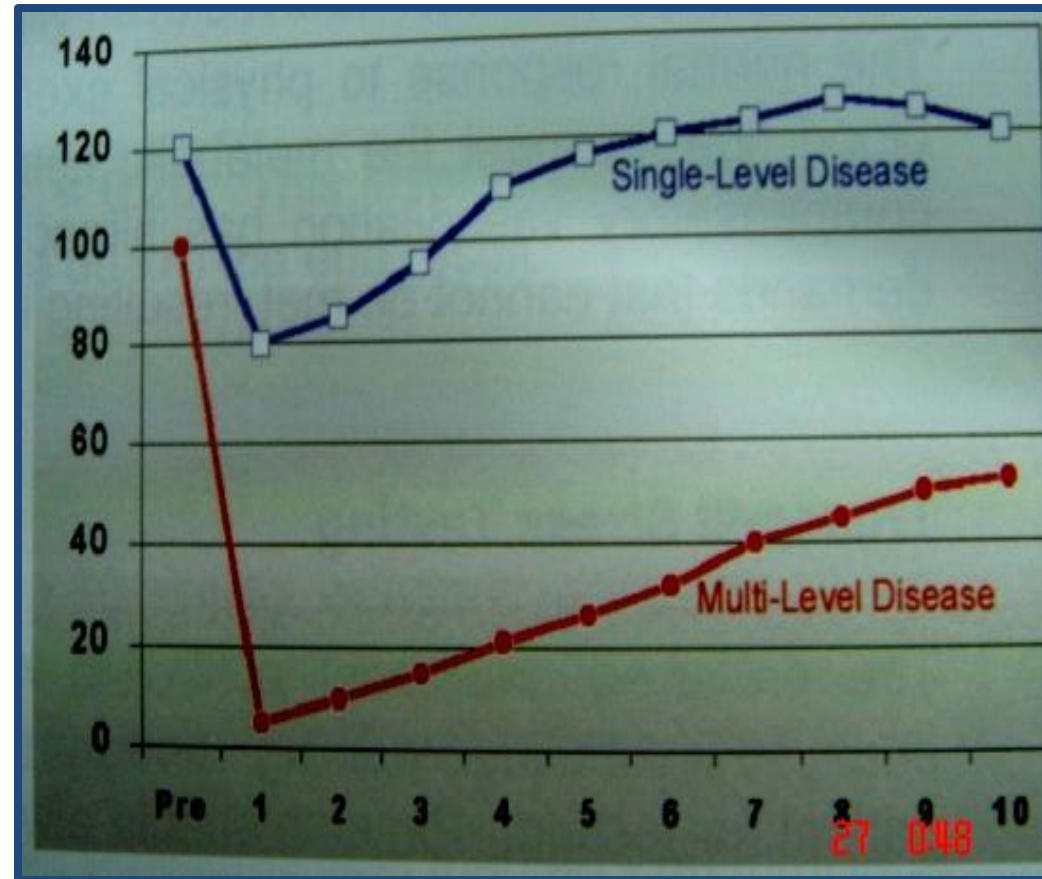
Interpretation:

- **Normal** :no drop in ankle pressure.
- **Minimal disease:**
pressure returns to baseline in 2mnts



Exercise Test (StressTest)

- **Single level disease**
pressure returns to baseline in 3-5mnts.
- **Multi level disease**
pressure returns to baseline >10mnts

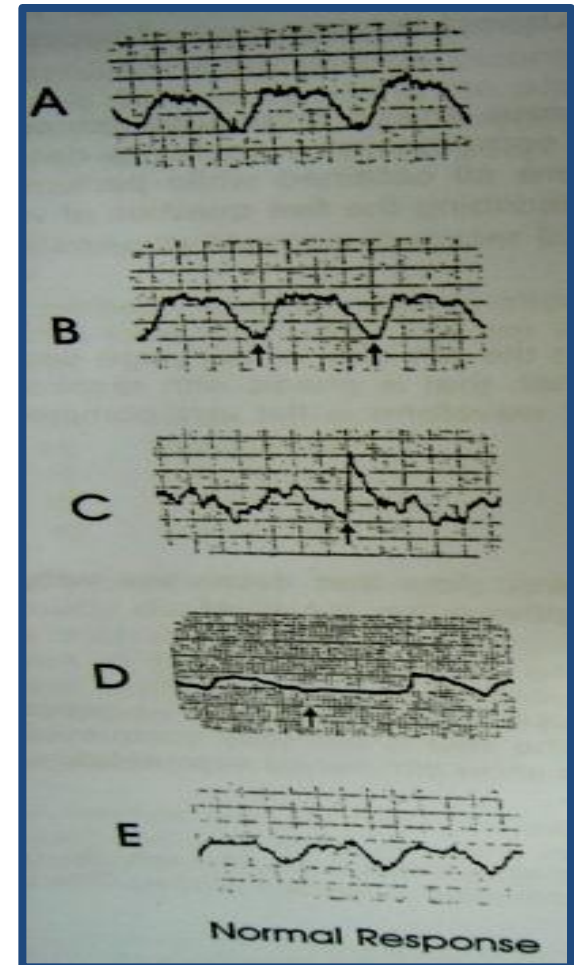


2- Doppler assessment of Veins

لا يستخدم بكثرة لهذا الغرض

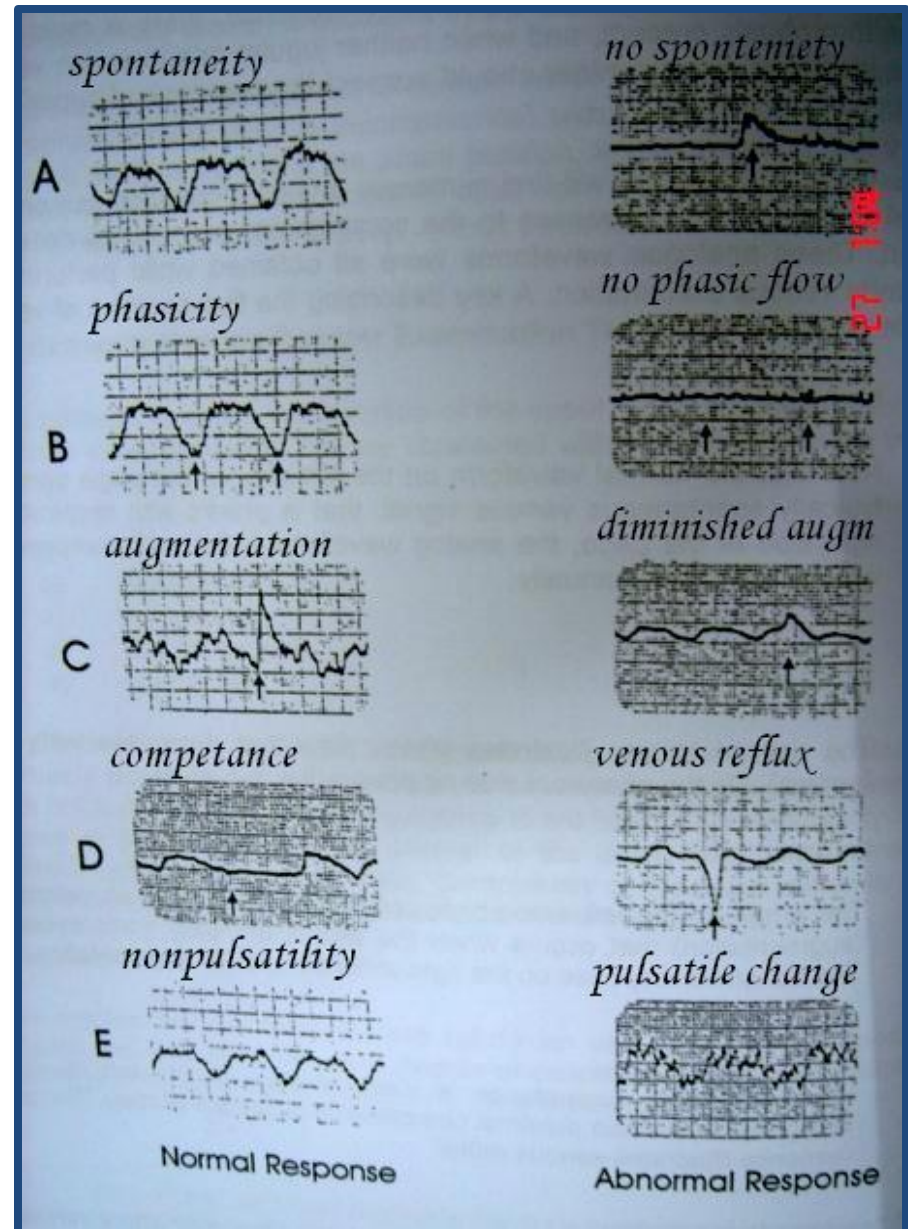
Five qualities of normal Venous flow:

- **A** - Spontaneity
- **B** - Phasicity
- **C** - Augmentation
- **D** - Valvular competence
- **E** - Non pulsatility



Doppler assessment of Veins

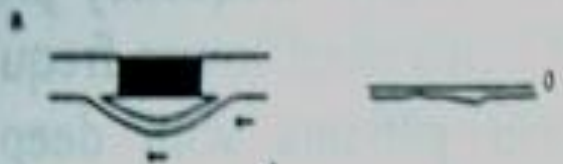
- In cases of **DVT**
Normal five qualities of
Venous flow are lost



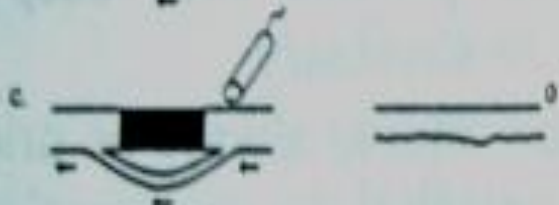
Doppler assessment of Veins - DVT



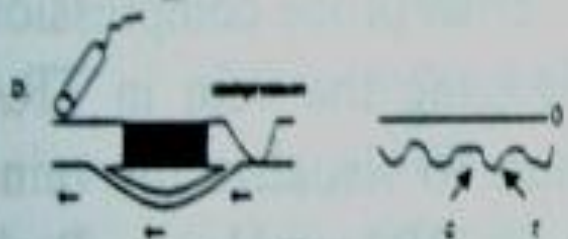
A. Absent or diminished flow at level of thrombosis



B. Continuous flow below the level of thrombosis



C. Increased flow through patent superficial veins



D. Diminished or no augmentation



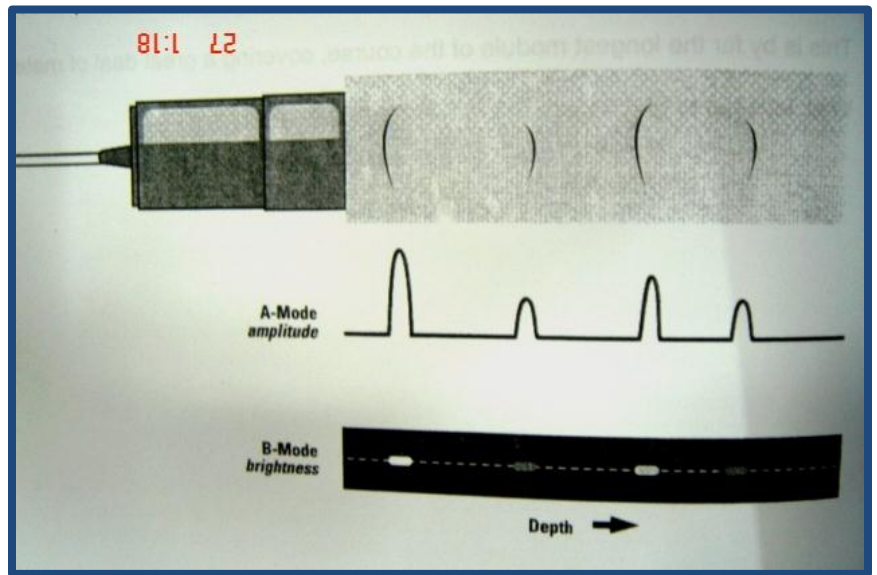
E. Abrupt response to distal compression

2- Ultrasound Imaging Duplex

Imaging Principles

Amplitude mode (A-mode)

method of presenting
returning echoes of
US on a display
screen

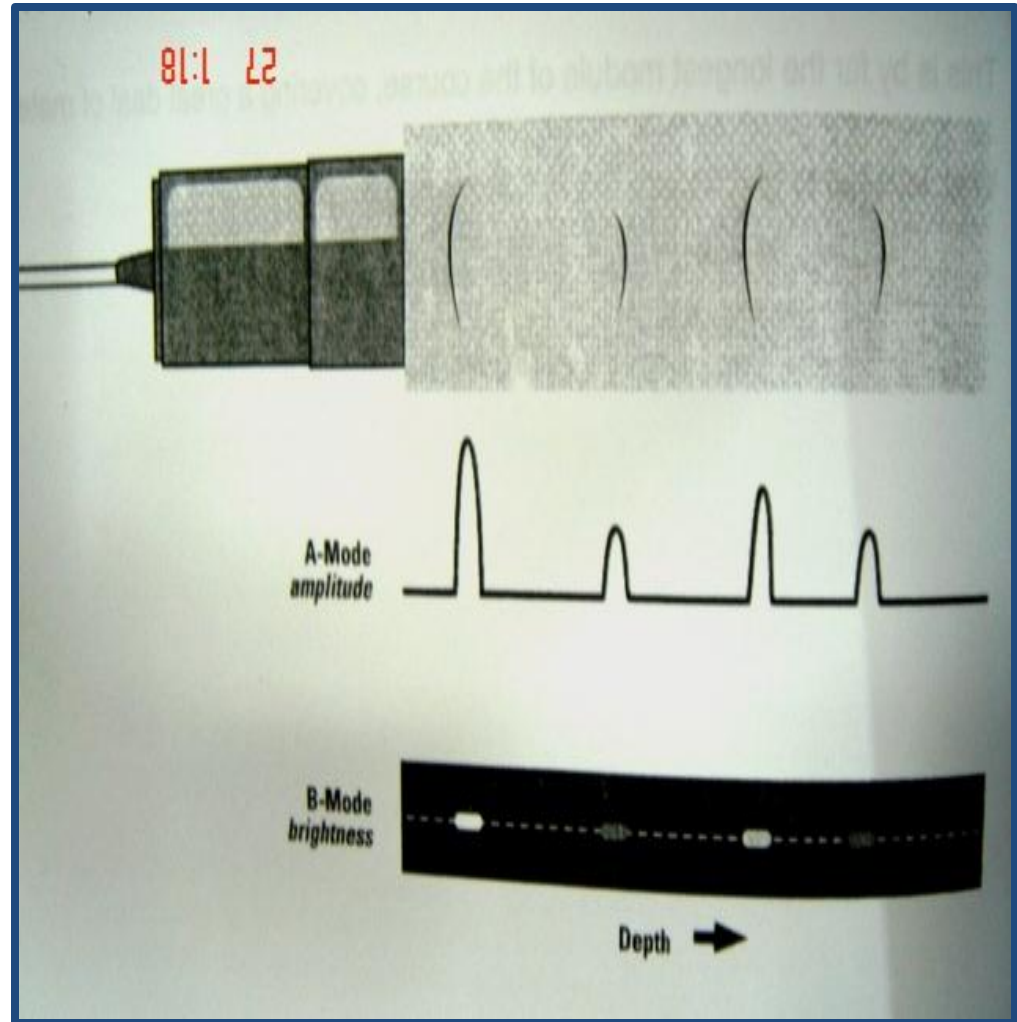


Ultrasound Imaging

A-mode:

displayed as vertical deflections or spikes, projecting from baseline.

Stronger echoes-higher amplitude signals



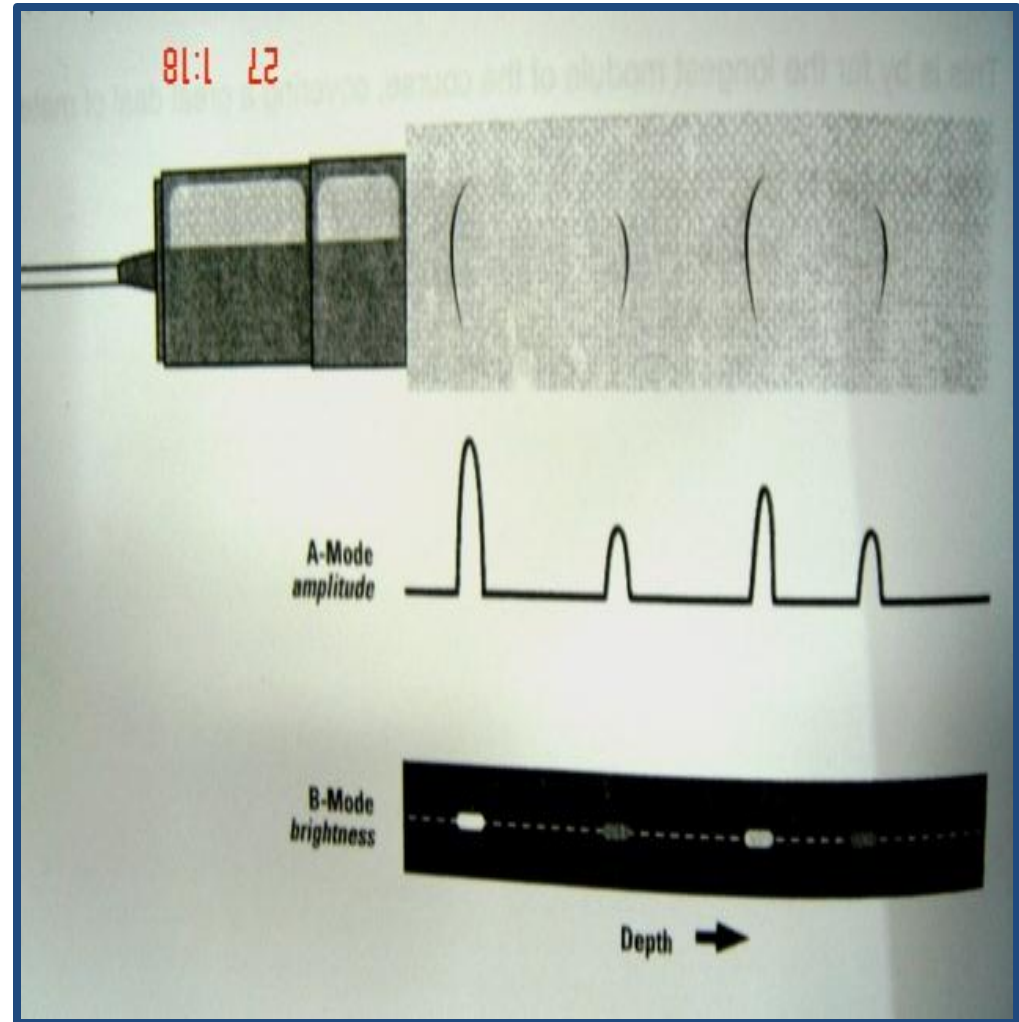
Ultrasound Imaging

B-mode

Brightness mode

Returning echoes
displayed as series of
dots.

Position of each dot
corresponds to distance
from the sound source
Brightness corresponds
to amplitude of returning
echo – Gray scale
intensity.



Duplex Scan

- Combination of **B-mode** imaging with **pulsed Doppler US** – gives both anatomical & physiological information of vascular system

Duplex Scan

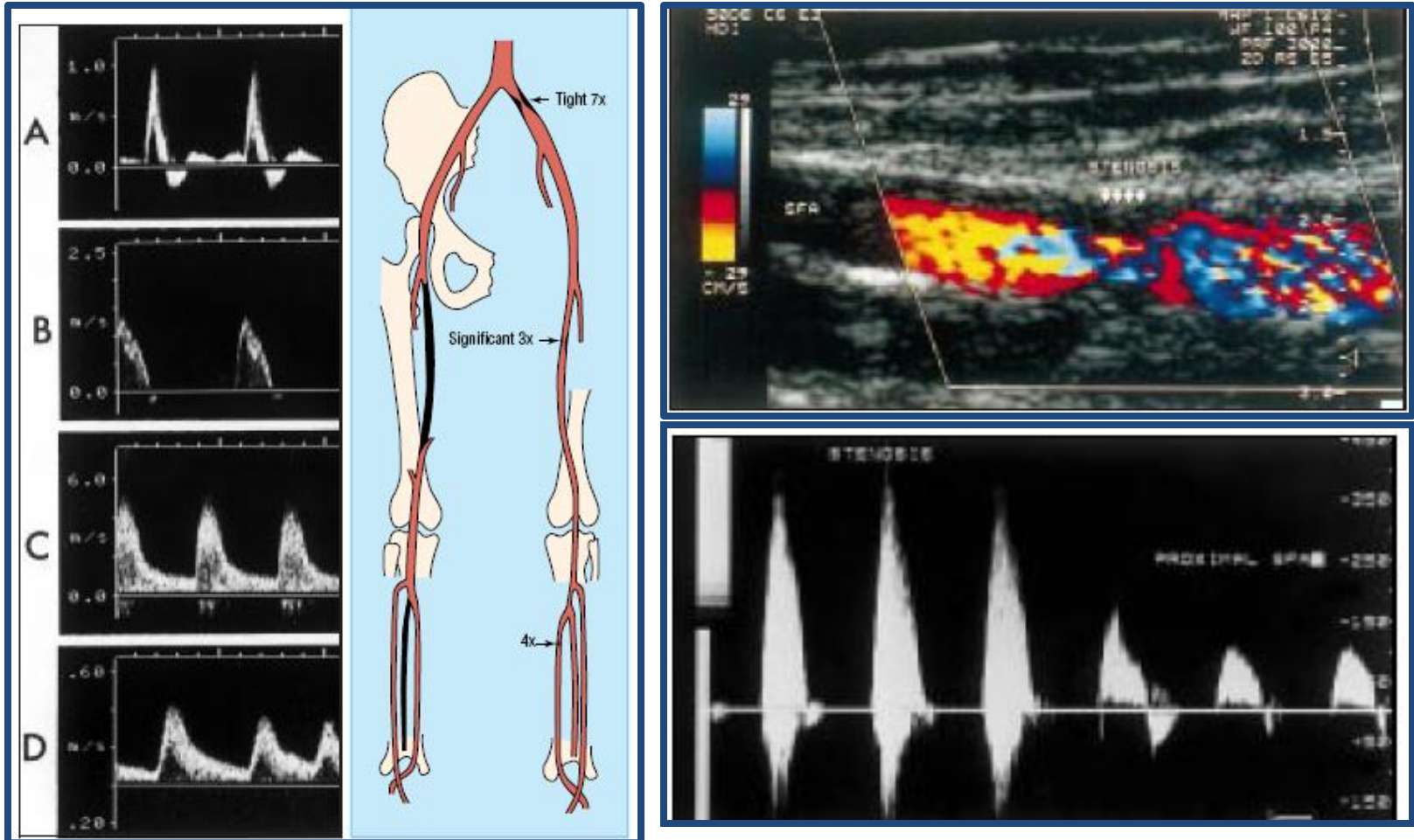
- Addition of **colour** frequency mapping –
Colour Duplex imaging

Uses of colour duplex imaging

1- Arterial:

- Identify obstructive or aneurysmal atherosclerotic disease
peripheral arteries
carotid arteries
renal & visceral arteries
- Surveillance of by pass grafts.

Arterial



**Remember : the comments peripheral A. to get Atherosclerosis is :
The Superficial Femoral A**

2- Venous Duplex

- Diagnosis of DVT
- Assessing competence of deep vein valves.
- Superficial venous reflux & identifying Sapheno Femoral & Popliteal Jnc refluxes.
- Preoperative mapping of saphenous vein

Criteria for Duplex examn. Of venous system

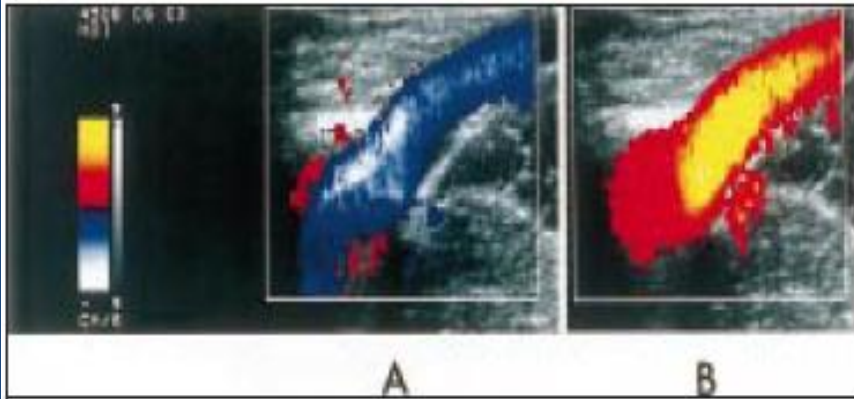
Normal

- Easily compressible
- Should be echo free
- Normal valve motion
- Normal Doppler signals

Abnormal (DVT)

- Non compressible
- Echogenic thrombus in vein
- Incompetant valves
- Absent Doppler signals

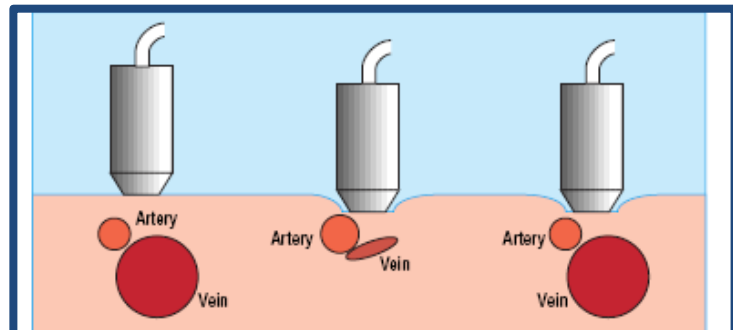
Venous Duplex



Colour duplex scanning of saphenopopliteal junction. The calf muscles are manually compressed producing upward flow in the vein (top), which appears as a blue colour for flow towards the heart (panel A). Sudden release of the distal compression causes reflux, seen as a red colour indicating flow away from the heart (panel B)



Colour duplex scan of deep vein thrombosis in common femoral vein adjacent to artery



Ultrasound detection of deep vein thrombosis. The probe is held lightly on the skin and advanced along the course of the vein (left). Pressure is applied every few centimetres by compressing the transducer head against the skin. The vein collapses during compression if no thrombus is present (middle) but not if a deep vein thrombus is present (right)

Arteriography

- Gold Standard.
- Good resolution.
- Seldinger technique
- Access –commonly femoral artery
& brachial artery

Arteriography

- Inject iodinated contrast

- Two types of contrast

Ionic or high osmolar لا تستخدم في الوقت الحالي

Non ionic or low osmolar

Ionic or High Osmolar Contrast

- Water soluble
- Hypertonic, osmolality 5-10 times of blood.
- Causes discomfort at injection site.
- More nephrotoxic.

Non Ionic or Low Osmolar Contrast

- Has same no of iodine ions ,no cations
- Osmolality $1/3^{\text{rd}}$ of high osmolar contrast
- Still hypertonic twice that of plasma.
- Less nephrotoxic
- More expensive عيبها الاساسي

Complications مهمه – سؤال

Local:

- Hemorrhage
- Thrombosis
- Pseudo aneurysm
- AV fistula
- Intimal dissection
- Embolization

Complications مهمه – سؤال

General:

- Renal – nephrotoxicity
- Cardiac- hypertension, arrhythmias, CCF.
- Neurological – Carotid angiogram – TIA stroke, convulsions.
- Pulmonary-bronchospasm, pulm edema.

Complications مهمه – سؤال

Allergic reaction to contrast

- Minor – nausea, vomiting, head ache, chills, fever, itching.
- Intermediate - hypotension. urticaria, bronchospasm.
- Major-anaphylaxis, pul edema, laryngeal edema

Venogram

- Ascending Venography
- Descending Venography

Ascending venography

- Relatively invasive study
- Requires painful venipuncture
- Injection of iodinated contrast
- Exposure to radiation

Ascending venography

- Indication

High clinical suspicion of DVT with negative
Or equivocal non invasive vascular tests.

- Gives information about anatomy & patency of deep veins
- & locates the incompetent perforators veins.

Ascending venography

- Inject about 40-60 ml of contrast into superficial foot arch veins & tourniquet tied above ankle to visualize deep veins.
- Complications: thrombophlebitis

Decending venogram

Indication:

- To distinguish primary deep venous valvular incompetance from thrombotic disease.
- Identify level of deep venous reflux & morphology of venous valves.

الشريحة اطلاق

Venographic categories of Deep vein reflux

- Grade 0 – normal valve function noreflux
- Grade 1 – minimal reflux confined to upper thigh
- Grade 2 – extensive reflux reach lower thigh
- Grade 3 – extensive reflux reach to calf level
- Grade 4 – no valvular competence
immediate reflux distally to calf.

Lymphedema

- Lymphedema : accumulation of lymph in the limbs
- Minimal invasive investigation to identify edema of lymphatic origin

Lymphoscintigraphy

CT & MRI

Lymphoscintigraphy

- Isotope Lymphography

Radiolabelled Colloid or Protein injected 1st
web of foot

Gama Camera monitoring of tracer uptake.

Lymphoscintigraphy

- Measurement of tracer uptake within the lymph nodes after a defined interval – distinguishes lymph edema from edema of non lymphatic origin.
- Appearance of tracer outside the main lymph routes – dermal back flow indicates Lymph reflux & proximal obstruction

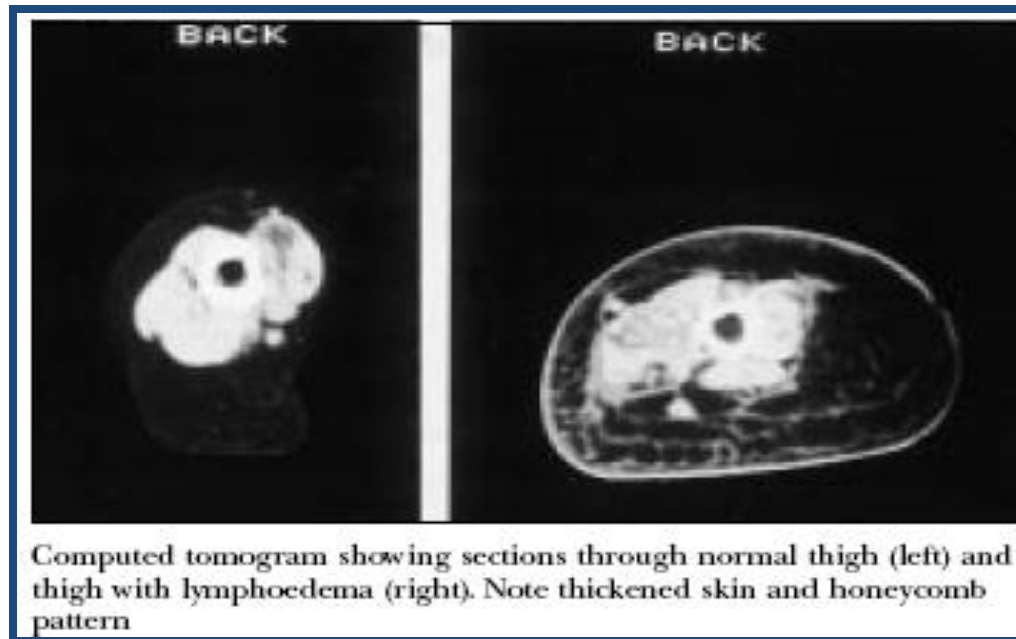
Lymphoscintigraphy

- Poor transit of isotope from injection site – suggest hypoplasia of lymphatics.

Lymphedema

- CT & MRI

Honeycomb pattern in the subcutaneous compartment, characteristic of lymphedema



Direct contrast X Ray lymphography

- Lymphangiography
- lymph vessels identified by injecting vital dyes & lymph vessel cannulated.
- Lipiodol contrast directly injected
- Normal limb shows opacification of 5-15 main lymph vessels as converge to inguinal lymph nodes.
- Lymphatic obstruction-contrast refluxes into dermal network – dermal backflow.

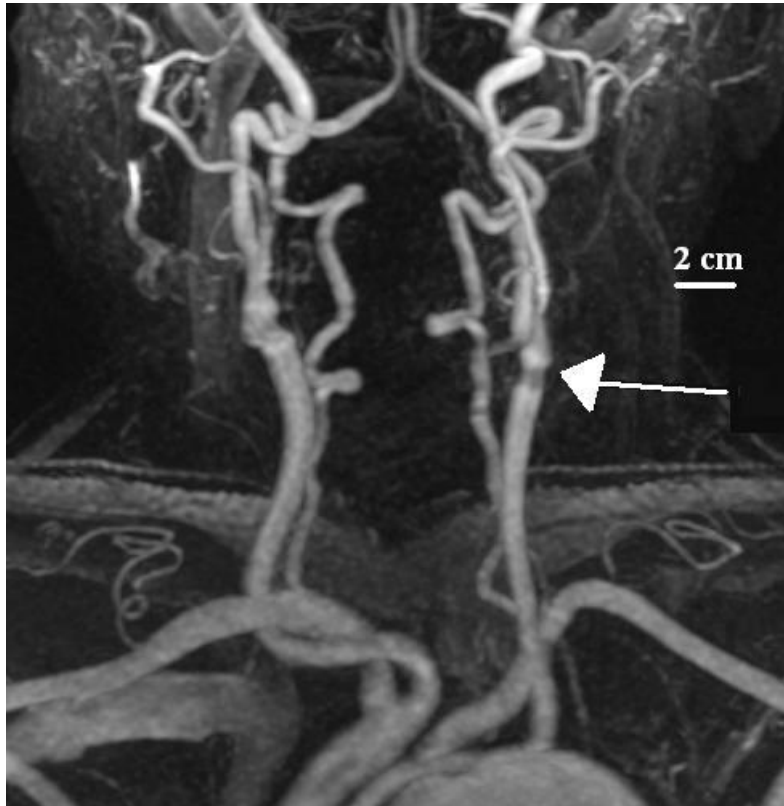
Other Modalities of Vascular Investigations

- CT, CTAngiogram



Other Modalities of Vascular Investigations

- MRI, MRAngiogram



Vascular Investigation

SUDG
 422-0
TRUE OR FALSE**1) Intermittent claudication:**

- a) Presentation of acute limb ischemia (F)
- b) Cramp like pain in a group of muscles present during rest. (F)
- c) Presentation of chronic bowel ischemia (F)
- d) Buttock and thigh claudication indicates aorto iliac occlusive disease (T)
- e) Deep vein thrombosis causes intermittent claudication (F)

2) Non invasive assessment of peripheral vascular disease includes:

- a) Ankle brachial index (T)
- b) Arteriography (F)
- c) Measurement of toe pressure (T)
- d) Duplex scan (T)
- e) Ascending venogram (F)

3) Causes of chronic lower limb ischemia in young, healthy and non-smoking individuals.

- a) Atherosclerosis (F)
- b) Popliteal artery entrapment syndrome (T)
- c) Diabetes mellitus (F)
- d) Cystic adventitial disease of popliteal artery (T)
- e) Thrombo angitis obliterans (F)

Vascular Investigation

4) The following statements are true regarding smoking:

- a) Risk factors for abdominal aortic aneurysm (T)
- b) Increases risk of amputation of limb in patients with peripheral vascular disease (T)
- c) Decreases the incidence of coronary artery disease (F)
- d) Has strong association with Buerger's disease (T)
- e) Smoking cause diabetes mellitus (F)

5) Acute lower limb ischemia:

- a) Presents as ulceration of toes and rest pain (F)
- b) Embolism is one of etiology and mostly from heart (T)
- c) Five cardinal signs of acute ischemia are denoted by "Five Ps" (T)
- d) Paralysis and fixed skin discolouration are the earliest signs. (F)
- e) Causes include emboli and trauma. (T)

Vascular Investigation

SUPER
 426

Select the ONE lettered answer that is BEST in each case:

1) In non invasive assessment of peripheral arterial disease, following is an appropriate candidate for exercise test:

- a) Patient with rest pain in foot
- b) Patient with intermittent claudication and normal resting ABI
- c) Patient with venous ulcer
- d) Patient with resting ABI <0.4
- e) Patient presenting with acute ischemia

(Answer - B)

2) 15-year-old girl presented with progressive, painless unilateral leg swelling:

- a) Most likely cause is chronic venous insufficiency
- b) Most likely cause is primary lymphoedema
- c) Patient need arteriogram to confirm diagnosis
- d) It is due to secondary lymphoedema
- e) Common treatment is lymphatic bypass surgery

(Answer - B)

3) 50-year-old male patient with swelling, brown pigmentation and ulceration around ankle region:

- a) Most likely cause is chronic lower limb ischemia
- b) Needs arteriogram for diagnosis and management
- c) Need non-invasive assessment by doppler and duplex for obstruction and valvular incompetence of venous system
- d) Brown skin pigmentation is due to excess of melanocyte activity in skin.
- e) Usually managed by amputation of limb

(Answer - C)

Vascular Investigation

SUDG 63
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4) 30-year-old female, 26 weeks pregnant has painful swollen and pale left leg and her pedal pulses are well felt:

felt:

- a) Arteriogram is indicated because of pale left leg
- b) Optimal initial diagnostic test is venous duplex examination
- c) Appropriate treatment would be warfarin.
- d) Venography should be the initial diagnostic test
- e) Heparin is contraindicated in this patient

(Answer - B)

5) 50-year-old diabetic, smoker presents with rest pain and gangrene of 1st toe. The following statements are correct:

- a) ABI in above patient is the ratio of ankle diastolic pressure to brachial diastolic pressure.
- b) ABI in normal persons is <0.9
- c) The above patient has critical ischemia and usually have ABI <0.4
- d) Calcification of arteries in this patient can give very low ABI results.
- e) Always ABI is measured in standing position

(Answer - C)

In vascular investigation:

- A. Doppler is used only for arterial investigation
- B. Duplex can be used to evaluate the lymphatic system
- C. Bleeding is a common cause of death with venogram
- D. None of the above is true

Venous system of the lower limb:

- A. Consists of superficial, middle, and deep systems
- B. No connection between its parts
- C. Superficial femoral and profunda veins join to form the common femoral vein
- D. Great saphenous vein starts posterior to the medial malleolus

Vascular Investigation

A 32 y/o woman presented to the clinic with thickening skin of her medial aspect of the leg, which was associated with dermatitis and hyperpigmentation. Which type of presentation is this?

- A. Telangiectasia
- B. Lipodermatosclerosis
- C. Healed ulcer
- D. Active venous ulceration

Evaluation does not include which of the following tools?

- A. Doppler
- B. Duplex
- C. Venogram
- D. AVF

All the followings can treat the previous case EXCEPT:

- A. Stocking
- B. Endovenous laser ablation
- C. Endovenous laser therapy
- D. Surgical ligation

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