432 Surgery Team

15 Vascular Investigations

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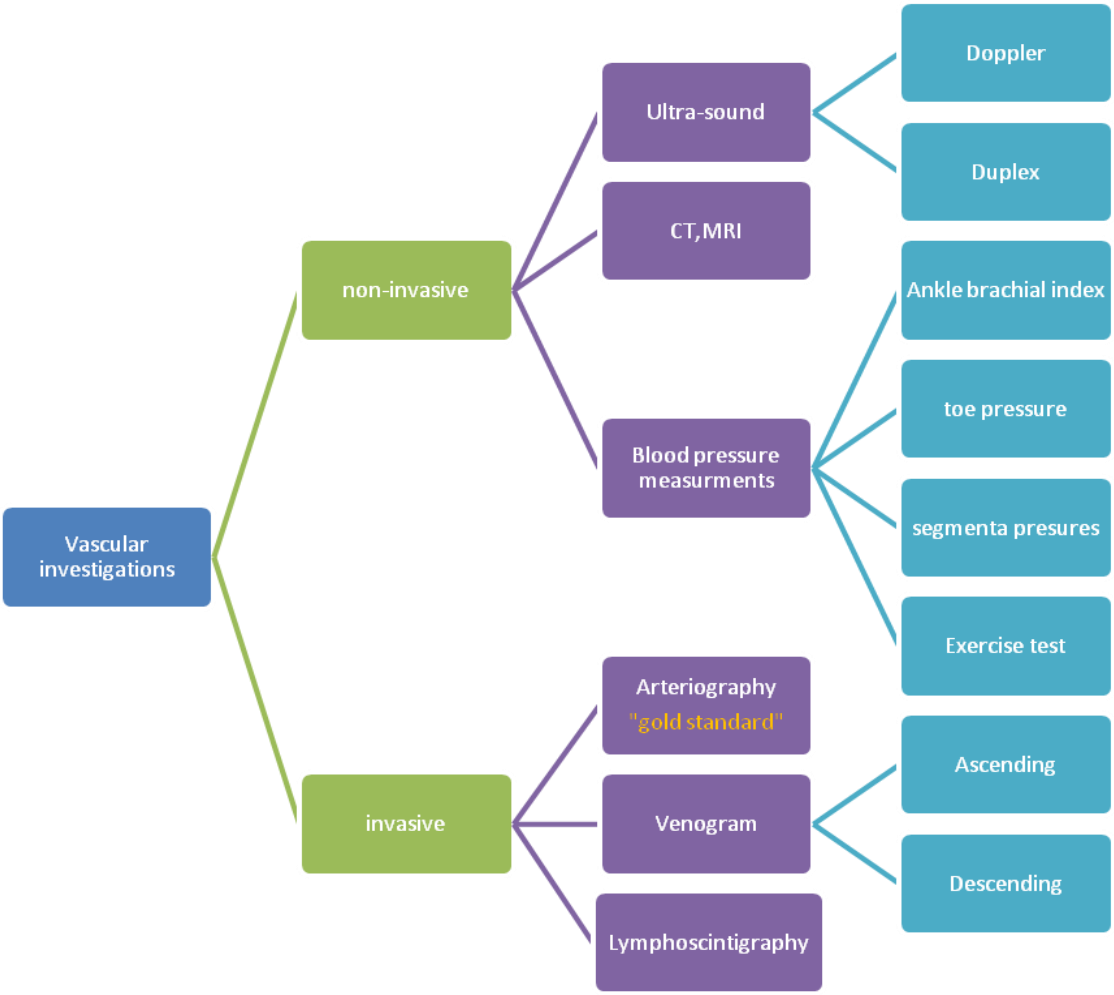
43 Teams

COLOR GUIDE: • Females' Notes • Males' Notes • Important • Additional

Objectives =(

Mind Map



Overview

Vascular diseases:

- ♣ Arterial diseases: such as aortic dissection which is caused by a tear in the inner layer of the aortic wall and then blood will flow between the layers and separate them or arterial occlusion. A lot of patients come with arterial occlusive diseases.
- ♣ Acute: ischemia
- ♣ Chronic: intermittent claudication or dilatation (arterial aneurysmal disease)...Etc.
- ♣ Venous diseases: deep vein thrombosis commonly referred to as "DVT", occurs when a blood clot, or thrombus, develops in the large veins of the legs or pelvic area, or chronic venous insufficiency which is an all-- inclusive term for vascular malformations, vascular tumors, and other congenital vascular defects. The more commonly used term, Chronic Venous Insufficiency (CVI), implies abnormally formed blood vessels that one is born with... etc.
- ♣ Lymphatic.

Vascular Investigations

Types:

- Invasive (in vascular surgery invasive procedures are the gold standard)
- Noninvasive.

1-non-invasive:

- ♣ Utilizes instrument; Utilizes the sound energy
- ♣ Doppler Ultrasound.
- ♣ Sound –longitudinal mechanical wave of any frequency.
- ♣ Audible Sound range 20-20,000 cycles/sec ι. 20Hz-20kHz
- ♣ Ultrasound-'Ultra' means 'Above' human hearing - >20,000 cycle/sec(20kHz).
- ♣ Diagnostic Ultrasound –2MHz-12MHz (2million-12million cycle/sec)

A-Doppler ultra-sound :(not important)

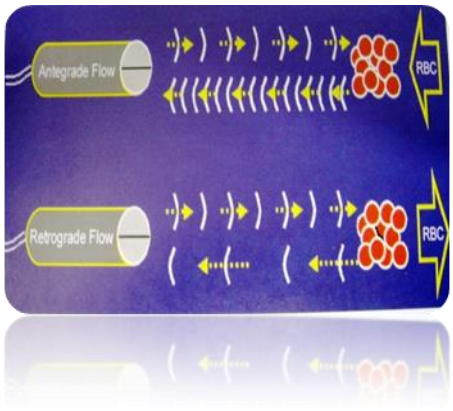
- ♣ Based on principle of Doppler effect/shift
- ♣ Normally blood vessels contain moving blood if there's a block it'll stop moving.
- ♣ Ultrasound interaction with stationary object:

a) No frequency change. B). No Doppler Effect or shift. C). Sound won't be heard.

- ♣ Ultrasound encounters moving object:

a) Doppler Effect or Shift occurs.
b) Change perceived frequency of ultrasound emitted by moving object.
c) Sound will be heard (3 voices)

- ♣ In clinical practice: moving targets RBC traveling with in the blood vessel.



♣ Source & Receiver of sound: ultrasound transducer

Ultra-sound Transducer

- 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)

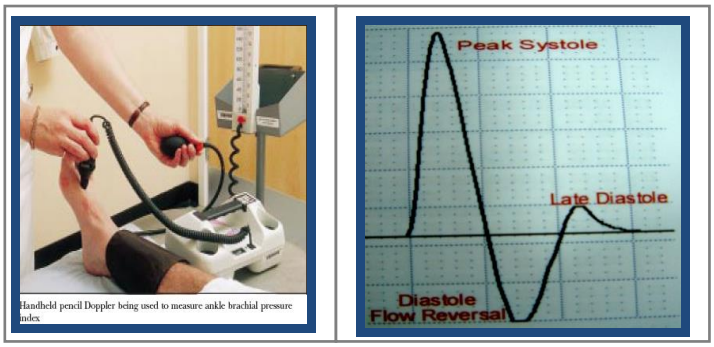
Continuous Wave (CW)	Pulsed Wave (PW)
Doppler transducer Transmits continuously ultrasound & Receive simultaneously. **Have two Piezoelectric crystals, one Transmit X & other Receive Y**	**Single piezoelectric crystal** – both transmission & reception. Alternate pulses On & Off. Transmit pulse – system waits – pulse travels to sample volume (specific area) – echo pulse returns
Advantages:	
Magnitude of detectable velocity-Limitless	Specific for depth and range. No mixture of signals like CW Doppler. (it is more advanced)
Disadvantages:	
Not specific for depth Detects any & all vessels in beam path	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'
- The smaller the Doppler angle, the higher the frequency shift.
- Optimal Doppler signalsı: transducer angle 45-60 towards direction of flow.

-ARTERIAL ASSESSMENT – DOPPLER ULTRASOUND:

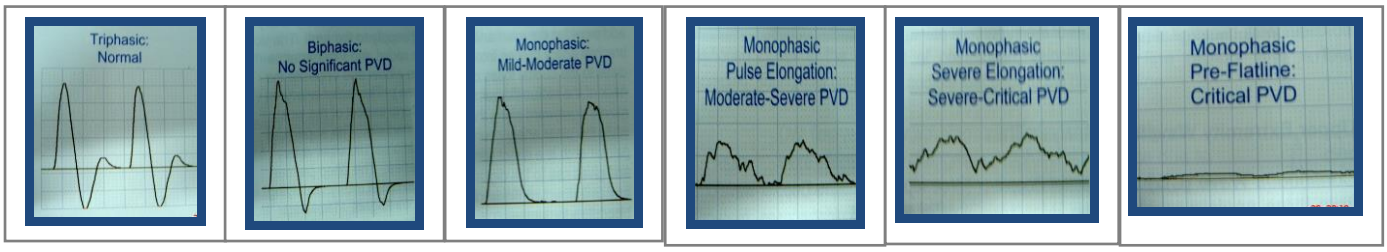
Audible interpretation; **1-**Waveform analysis. And **2-**Hand held Doppler.



Note(s):

-**Tri-phasic**: normal.
-**Bi-phasic :** is a normal sound usually heard after exercising due to peripheral vasodilatation.
- **Mono-phasic:** peripheral arterial disease.

- Normal Peripheral Arterial Doppler signal: **TRIPHASIC** .
- Triphasic arterial signal:
    a. 1st sound – phase: large, high velocity, forward flow, systolic component.
    b. 2nd sound – phase: smaller reverse flow early diastole.
    c. 3rd sound – phase: smaller forward flow late diastole.
- Audible interpretation & Wave form analysis



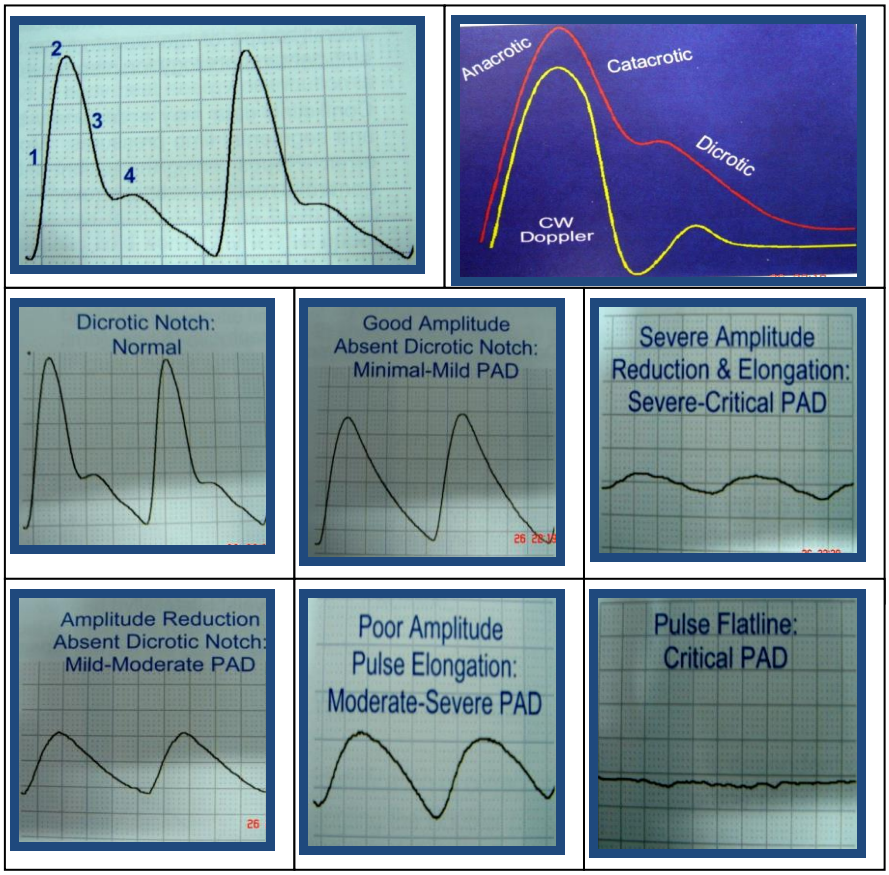
PVR (Pulse Volume Recording): Normal PVR:

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 **(so, if the notch is lost→abnormality).**



B-ARTERIAL PRESSURE MEASUREMENTS:

For Peripheral arterial occlusive disease

- **Sequence of pressure measurement tests:**

    a. Systolic Brachial & Ankle pressure at rest.

    b. Calculation of ABI.

    c. Toe pressure-non compressible tibial arts.

    d. Segmental pressure and waveforms: low ABI.

    e. Stress testing: severity of claudication & to R/O pseudo-claudication.

- **Contraindication to pressure measurements:** (because, you gonna place a cuff :/)

    a. Acute DVT; closure of veins makes it worse.(here might lead to→DVT)

    b. Bandages & casts

    c. Ulceration

    d. Trauma

    e. Surgical site

1) Ankle Brachial Index (ABI): (Important)

Before the test Consider :

a) Patient supine arms at sides.

b) Basal state (10mnts pretest rest).

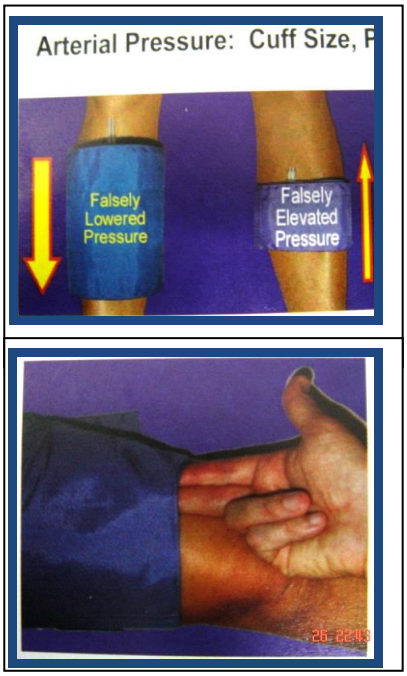
c) CW Doppler ultrasound.

d) Appropriate size pressure cuffs.

When testing :

a) Record <u>bilateral</u> systolic brachial pressure & systolic Ankle pressure (dorslis pedis & post.tib art).

b) Interpretation-Ratio highest ankle to brachial pressure.



ABI & Relation to PAOD (peripheral artery occlusive diseases) :

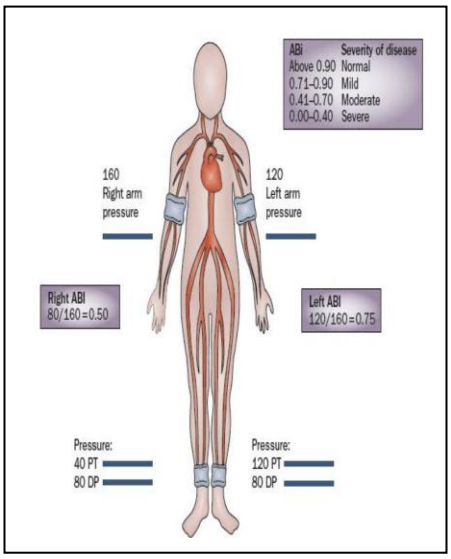
a) **0.97 -1.25 Normal.**

b) **0.75 – 0.96 Mild PAOD.**

c) **0,50 – 0.74 Moderate.**

d) **1.5 Vessels non compressible. (e.g. DM "False high" > toe pressure)**

* Usually the ABI is measured bilaterally (right & left) in which we divide the right brachial pressure on the highest right-lower pressure and we do the same for the left side.



2) Toe pressure

This test is done if the ABI showed very high values like in diabetic patient.

• Normal toe pressure – 2/3rd systolic ankle pressure

• Plethysmographic device –it records changes in volume (It is used as a sensor)

• Inflate cuff above 2/3rd of ankle pressure.

Note(s):

Vessels are <u>Non-compressible</u> in: DM, elderly, renal failure or any condition where arteries are calcified. Here, we do Toe pressure test

• **BP cuff (2.5cm)around the base of the toe.**

• **Gradual deflate until arterial tracing demonstrate return of pulsatile flow – recorded as systolic toe pressure.**

3)Segmental Pressure

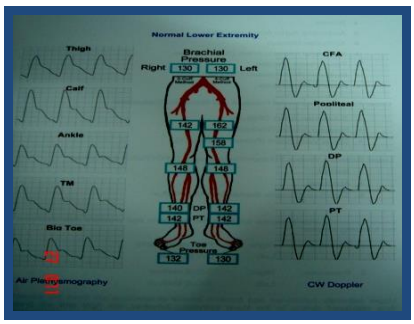
Drop in ABI at rest or post exercise indicates hemodynamically significant disease proximal to cuff.

• **Segmental pressure measurement – localizes the diseased arterial segment.**

• **Pressure difference between two adjacent segments <20 mmhg (fig-1)**

- **Gradiant >30mm of Hg - Hemodynamically significant disease between adjacent levels (fig-2).**Due to the significant drop between two segments e.g. from 120 to 90 (narrowing pressure which is caused by occlusion)

1



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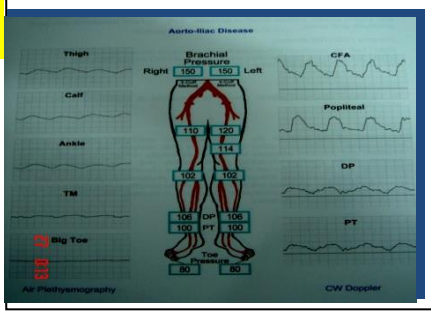
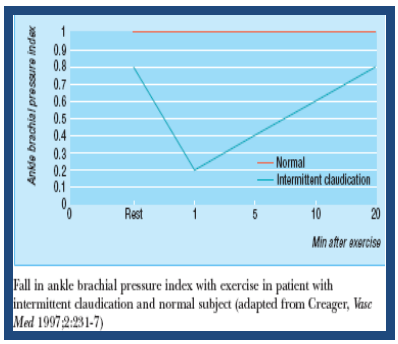


4) Exercise (stress) test

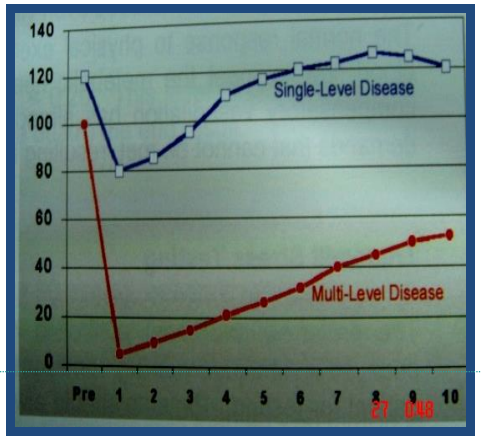
- **Treadmill stress test.**
- **Reactive hyperemia stress test.**
- **Assess functional limitation due to PAOD**
- **Differentiates PAOD – Pseudoclaudication Ex; neurogenic claudication.**
- **Resting ankle & brachial pressures.**
- **Pressure cuffs secured in place –ankle and arm.**
- **Walk at 2mph at 12% gradient-5mnts or point claudication symptoms.**
- **Return supine position & measure ankle pressure 30 seconds and 1 minute post exercise.**
- **Measure till baseline pressure is recovered.**

Note:

• **Duration of exercise.**



Fall in ankle brachial pressure index with exercise in patient with intermittent claudication and normal subject (adapted from Creager, *Vasc Med* 1997;2:231-7)

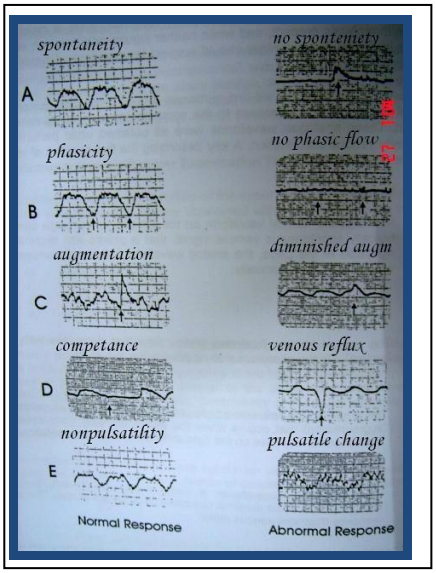


- **Distance walked.**
- **Symptoms prevented by exercise.**

Interpretation:

- **Normal: no drop in ankle pressure.**
- **Minimal disease pressure returns to baseline in 2 minutes.**
- **Single level disease: pressure returns to baseline in 3-5 minutes.**
- **Multi-level disease: pressure returns to baseline >10 minutes.**

DOPPLER ASSESSMENT OF VEINS



Five qualities of normal venous flow:

a. Spontaneity.

b. Phasicity; with respiration it changes because in inspiration there is no flow because there's no venous return.

Expiration increases in venous flow.

c. Augmentation.

d. Valvular competence.

e. Non pulsatility.

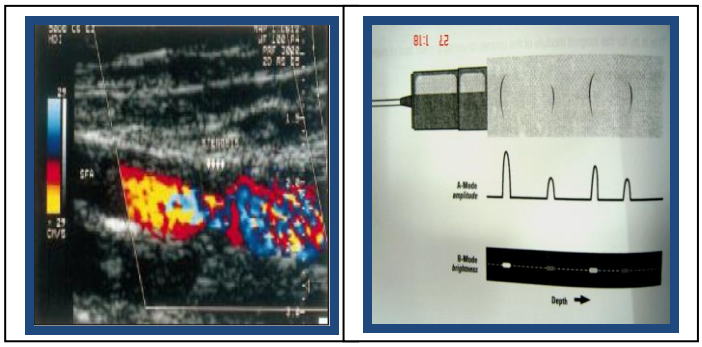
- In cases of DVT: Normal five qualities of venous flow are lost; because the vein is closed there will be no sound.

C- ULTRASOUND IMAGING DUPLEX

- ♣ **Imaging Principles:**

a. Amplitude mode (A-mode) method of presenting returning echoes of US on a display screen.

b. **A-mode:** displayed as vertical deflections or spikes, projecting from baseline. Stronger echoes-higher amplitude signals.



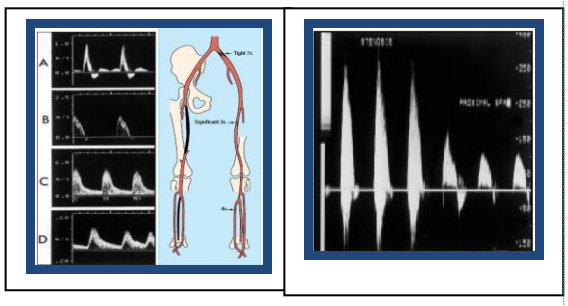
b. **B-mode**: **Brightness** mode Returning echoes displayed as series of dots.

d. Position of each doctor responds to distance from the sound source rightness corresponds to amplitude of returning echo – Gray scale intensity.

- ♣ **Duplex Scan:** (B-mode + Doppler US)

a. Combination of B-mode imaging with pulsed Doppler US – gives both anatomical & physiological information of vascular system →Duplex Scan.

b. Addition of color frequency mapping →Color Duplex imaging.



- ♣ **Uses of color duplex imaging:**

a. Arterial:

i. Identify obstructive or aneurysmal atherosclerotic disease.

ii. Peripheral arteries.

iii. Carotid arteries.

iv. Renal & visceral arteries.

v. Surveillance of bypass grafts.

b. Venous Duplex

i. **Diagnosis of DVT.**

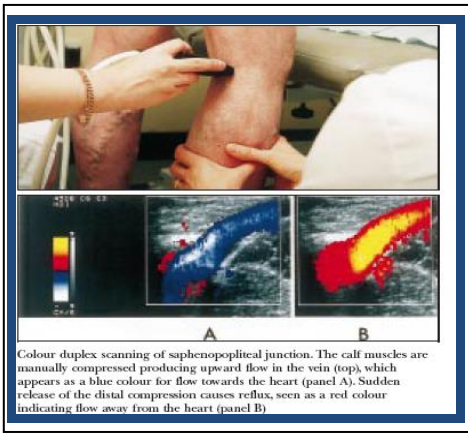
ii. Assessing competence of deep vein valves.

iii. Superficial venous reflux & identifying Sapheno Femoral & Popliteal Jnc refluxes.

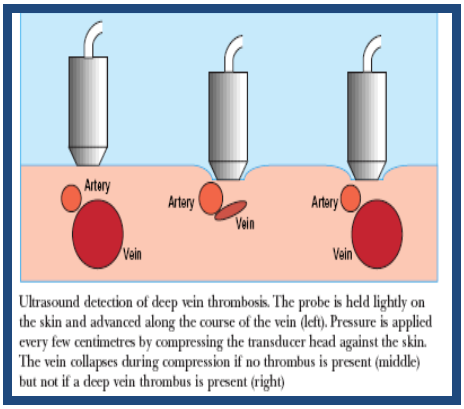
iv. Preoperative mapping of saphenous vein.

- ♣ **Criteria for Duplex examination of venous system (important)**

Normal	Abnormal (DVT)
• **Easily compressible**	• Non compressible
• **Should be echo free**	• Echogenic thrombus in vein
• **Normal valve motion**	• Incompetent valves
• **Normal Doppler signals**	• Absent Doppler signals



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)



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)

Note (important)

Q1/ If a patient came to you with a susceptible carotid artery stenosis or AAA, what is your initial investigation?

Arterial duplex Ultra-sound

Q2/ If a patient came to the ER with a susceptible DVT, what would be the initial investigation?

Venous duplex Ultra-sound

2- INVASIVE VASCULAR TESTS

A-ARTERIOGRAPHY

- ♣ Gold Standard
- ♣ Good resolution.
- ♣ Seldinger technique
- ♣ Access –commonly femoral artery & brachial artery; easiest accessible artery, least complications with larger arteries, never access small arteries.
- ♣ Inject iodinated contrast into the catheter you inserted in the large artery

-Types of contrasts:

Ionic or high osmolar ; **not used anymore**.	Nonionic or low osmolar ; **commonly used**
Water soluble • **Hypertonic, osmolality 5-10 times of blood.** • **Causes discomfort at injection site.** • **More nephrotoxic; more complications.**	Has same no of iodine ions ,no cations • Osmolality 1/3rd of high osmolar contrast • Still hypertonic twice that of plasma. • **Less nephrotoxic** • More expensive

-Complications

Local	General	Allergic reaction to contrast
• **Hemorrhage** • **Thrombosis** • **Pseudo aneurysm** • **AV fistula** • **Intimal dissection** • **Embolization**	• Renal – nephrotoxicity • Cardiac- hypertension, arrhythmias, CCF. • Neurological – Carotid angiogram – TIA stroke, convultions. • Pulmonary- bronchospasm, pulmonary edema.	• Minor – nausea, vomiting, head ache, chills, fever, itching. • Intermediate - hypotension. urticaria, bronchospasm. • Major-anaphylaxis, pulmonary edema, laryngeal edema

Note (important)

Pseudo aneurysm; is a pulsatile swelling around the artery due to leaking of blood, no dilatation of vessel.

B- Venogram (We do it when we are not sure of US results, if we have a doubt about the diagnosis, otherwise it is not routinely done)

Type1-Ascending venography:

- Relatively invasive study.
- Requires painful venipuncture.
- Injection of iodinated contrast.
- Exposure to radiation.
- **Gives information about anatomy and patency of deep veins.**
- Locates the incompetent perforator's veins.
- Inject about 40-60 ml of contrast into superficial foot arch veins and tourniquet tied above ankle to visualize deep veins.
- Indication: High clinical suspicion of DVT with negative or equivocal noninvasive vascular tests (Duplex).
- Complications: same as pervious + thrombophlebitis.

Type2-Descending Venography:

- Indication**: to assess the competency of the valves**
    a. To distinguish primary deep venous valvular incompetence from thrombotic disease.
    b. Identify level of deep venous reflux and morphology of venous valves.
- Venographic categories of Deep vein reflux (not imp) 1) Grade 0 – normal valve function no reflux 2) Grade 1 – minimal reflux confined to upper thigh 3) Grade 2 – extensive reflux reach lower thigh 4) Grade 3 – extensive reflux reach to calf level 5) Grade 4 – no valvular competence immediate reflux distally to calf.

Lymphoma:

- Lymphedema: accumulation of lymph in the limbs.
- Minimal invasive investigation to identify edema of lymphatic origin:
    a. **Lymphoscintigraphy**
    b. CT & MRI

-LYMPHOSCINTIGRAPHY

- Isotope Lymphography

a. Radiolabelled Colloid or Protein injected first web of foot.

b. Gama Camera monitoring of tracer uptake.

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

-CT & MRI

- Honeycomb pattern in the subcutaneous compartment, characteristic of lymphedema

-DIRECT CONTRAST X RAY LYMPHOGRAPHY

Lymphangiography.

- Lymph vessels identified by injecting vital dyes and 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. 5 OTHER MODALITIES OF VASCULAR INVESTIGATIONS Minimally invasive procedures;

-OTHER MODALITIES OF VASCULAR INVESTIGATIONS

- CT, CT Angiogram.
- MRI, MR Angiogram.

Note (important)

Q/ a 10-year old boy presented with a unilateral leg swelling,(after rolling out DVT) what would be the diagnostic tool?
Answer: **Lymphoscintigraphy**

Important notes

- Person with abdominal aortic aneurysm , what's the best for diagnostic and surveillance purposes? → noninvasive ultra sound or duplex.
- For follow up of aneurysm, which is 3 cm →US
- Start treating aneurysm when it's 5cm because larger has higher incidence of rupture, less than that don't treat just follow up with US.
- For following up after an open surgery (Endovascular Repair) EVR →CT
- Person with abdominal aortic aneurysm ,what's the best for therapeutic and plan management purposes? →CT
- Local diseases causing Limb swelling →DVT, chronic venous insufficiency, lymphedema.
- For DVT, chronic venous insufficiency →diagnosed by US or duplex US.
- To assess or diagnose lymphatic vessels or lymphedema →lymphoscintigraphy (not lymphangiography) sometimes MRI magnetic resonant angiogram (minimal invasive)
- MRV →venogram (not used because it needs a special software)

Questions

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

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

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 lymphedema
c. Patient needs arteriogram to confirm diagnosis
d. Is due to secondary lymphedema
e. Common treatment is lymphatic bypass surgery

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

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

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

5) 50 year old diabetic male smoker present with rest pain and gangrene of the 1st toe, the following statement are correct:

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

6) In vascular investigations:

a. Doppler is used only for arterial investigations
b. Duplex scan 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

7) 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

8) A 32 year old 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. Telangictasia
b. Lipodermatosclerosis
c. Healed ulcer
d. Active venous ulcer

9) Evaluation does not include which of the following tools?

a. Doppler
b. Duplex
c. Venogram
d. AVP

10) All of the following can treat the previous case except:

a. Stocking
b. Endovenous laser ablation
c. Endovenous laser therapy
d. Surgical ligation

Answers:

1st Question: B

2nd Question: B

3rd Question: C

4th Question: B

5th Question: C

6th Question: C

7th Question: C

8th Question: B

9th Question: D

10th Question: A