L10

Revised by

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Vascular Investigations

Objectives:

Identify the types of vascular investigations including:

- Ankle brachial index
- Duplex ultrasound
- CT angiogram
- MR angiogram
- Conventional angiography

Discuss the classification of vascular investigation based on:

- Sensitivity
- Operator dependency
- Toxicity
- Therapeutic or diagnostic.

Color index:

Main Text
Males slides
Females slides
Past notes
442 notes
Textbook
Important
Golden notes
Extra

Editing file

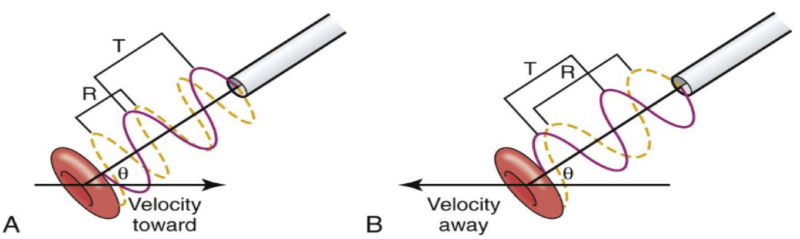
Handheld Doppler

General Info:

Doctor skipped it, but we advise you to review it for the exam

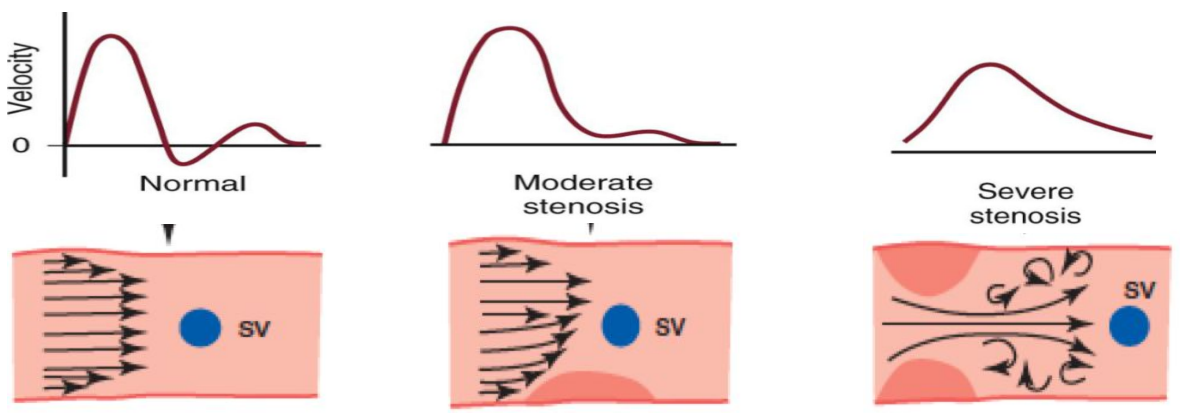
- Used to hear the arterial signals in the peripheral arteries if it is not palpable
- The Doppler device compares the frequency of backscattered sound from moving red blood cells with the transmitting frequency. to determine the frequency shift, which is proportional to the speed of the flowing blood, the transmitting frequency, and the cosine of the doppler angle, θ.

How It Works:



The drawing shows a Doppler probe transmitting ultrasound at a wavelength T to a red blood cell moving in a direction indicated by an arrow:

- The red cell is moving toward the probe in (A) and away from the probe in (B). The angle between the ultrasound beam and the direction of red cell velocity is given by θ.
- The frequency of the ultrasound that is transmitted is the same in both cases (red line). The ultrasound signal that is received (yellow line) has a shorter wavelength (R) in (A) and a longer wavelength in (B).
- Velocity: - If stenosis velocity will increase.
  - If occlusion velocity will be zero.



(normal artery without stenosis)
The wave will be triphasic

(Mild stenosis)
The wave will be biphasic

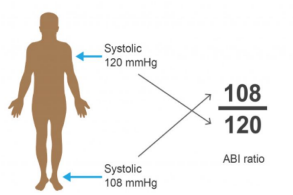
(Severe stenosis)
The wave will be monophasic

Ankle Brachial Index

Generally Used:

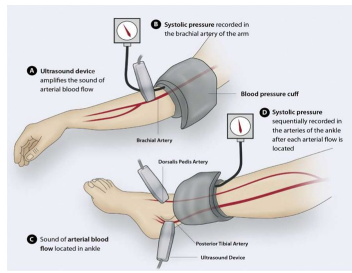
- If you suspect peripheral arterial disease (atherosclerosis of peripheral artery) which is chronic disease that could happen over years and end up either asymptomatic or with intermittent claudication and in advanced stages can cause limb ischemia, tissue loss or gangrene.
- **First step investigation in Peripheral arterial disease.**
- **Noninvasive vascular test.**

ABI= ANKLE SBP (PT OR DP) / HIGHEST ARM SBP:



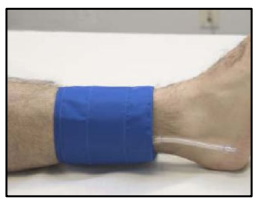
- Normally the pressure in upper limb and lower limb is the same so if you divide the systolic pressure of the ankle by the pressure of the brachial the result will be 1. (Acceptance range between 0.9-1.29).
- If the index is less than 0.9 that means there is decrease blood flow to the limb.
- Ex: stenosis of the arteries in the lower limb.

The ABI has limited use in evaluating calcified vessels that are not compressible as in Diabetics:



- >1.3 is considered false positive, in patient with DM their vessels are calcified so it can't be be compressed enough to read the pressure.
- In diabetics digital arteries are not usually calcified so we measure the pressure with small cuff for the toe, the normal range is (70-100)"they aren't available everywhere"





Important to remember this table !

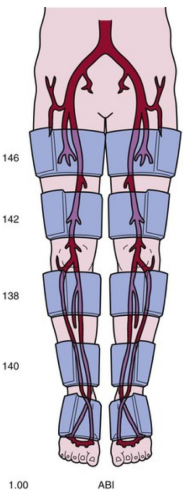
Interpretation of ABI	
>1.30	Incompressible
1.00-1.29	**Normal**
0.91-0.99	**Borderline** (equivocal) acceptable
0.41-0.90	Mild to moderate peripheral arterial disease Seen in intermittent claudication or asymptomatic
0.00-0.40	Severe peripheral arterial disease Critical Limb Ischemia, Gangrene or ulcers

Sensitive	Operator dependant	Toxic	Therapeutic
✓	✓✓✓	✗	✗

Gives idea about severity, but doesn't give exact site of the disease

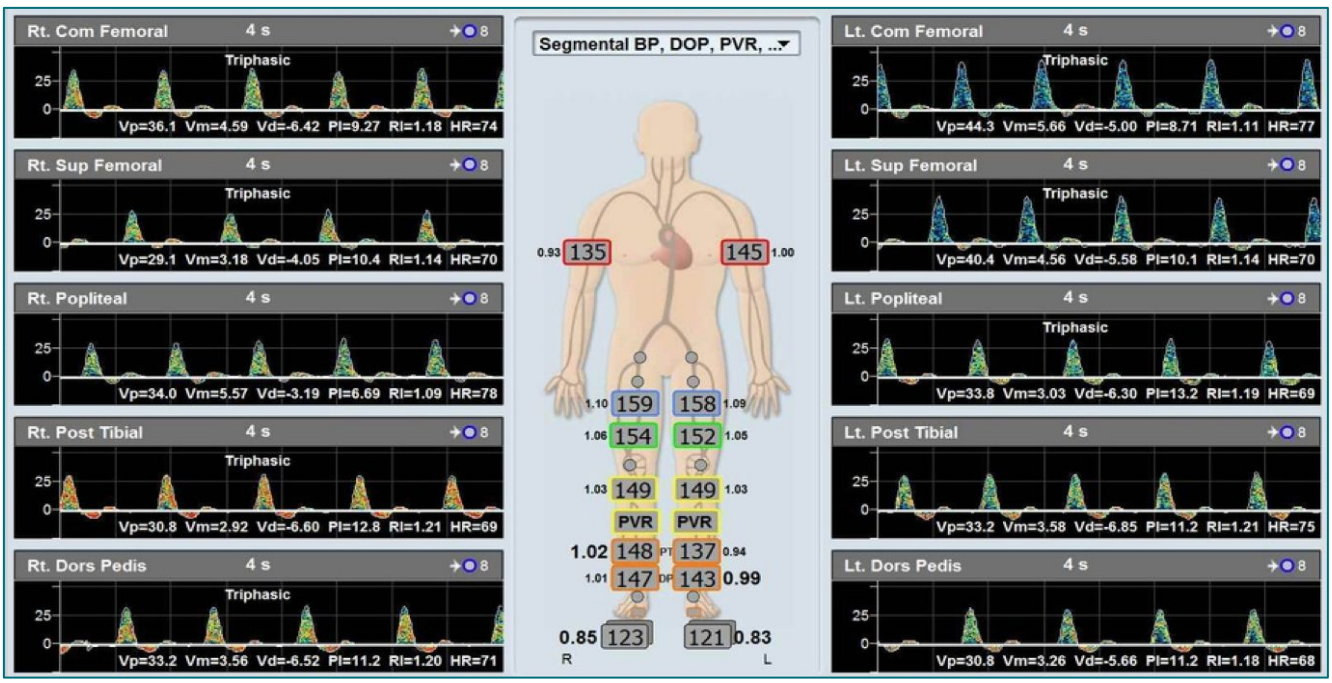
Segmental Pressure

- A non-invasive test used to measure the pressure in the lower limb.
- It doesn't tell us the exact disease.
- ABI is more important.
- Gives idea of severity of the disease



- Measures will be taken from multiple areas (upper thigh, lower thigh, upper leg, and lower leg).

- Normally pressure is the same all along the limb (normal person have same pressure in the whole body).
- If there is a change this indicated stenosis.
  - So if in one place its triphasic and distal to that area the reading was biphasic this means that there could be stenosis between the two segments.



Sensitive	Operator dependant	Toxic	Therapeutic
✓	✓✓✓	✗	✗
Could Gives idea about site of the disease But not as sensitive as CT or Duplex	Could give false readings if not done by an expert		

Duplex Ultrasound

B - Mode + Color Doppler.

Ultra sound

Used to see **anatomy** (liver, kidney, arteries or veins), to evaluate the integrity of the structure.

Duplex

Doppler + Ultrasound
Anatomy + function
Also called Colour flow Doppler

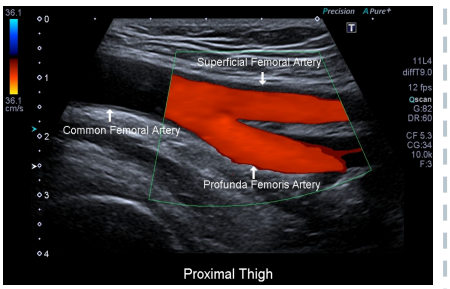
Doppler

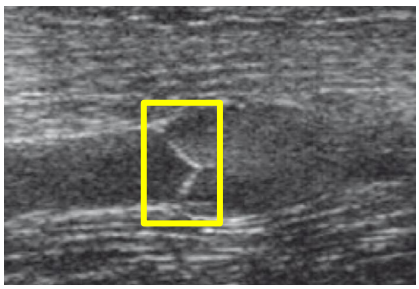
Used to hear sounds, that reflect pulsation, and evaluate the **physiology** of the artery or vein.

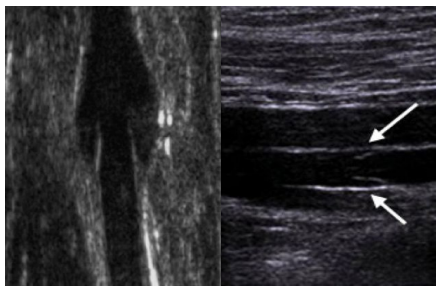
- Duplex can help you see
  1. the pulse (Triphasic...)
  2. Velocity (in stenosis there is high velocity, in occlusion there is low or no velocity)
- can check for DVT, reflux (Varicose veins, Venous insufficiency) by squeezing calf muscles.
- For venous system it can help:
  - Assess the diameter and flow rates
  - Determining the underlying etiology (reflux, obstruction, or reflux and obstruction)
  - Determining specific anatomical sites involved (deep or superficial veins, perforators, or greater veins)
  - Determining the severity of the disease

Duplex Ultrasound *Cont.*

- Shows the anatomy of the artery without physiology (normal function of that artery).

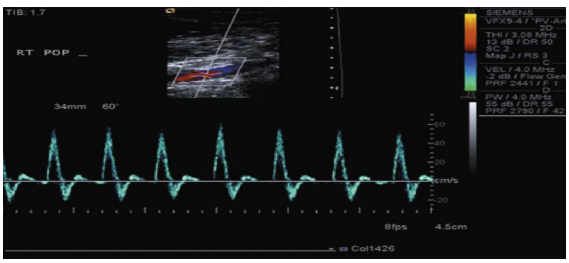




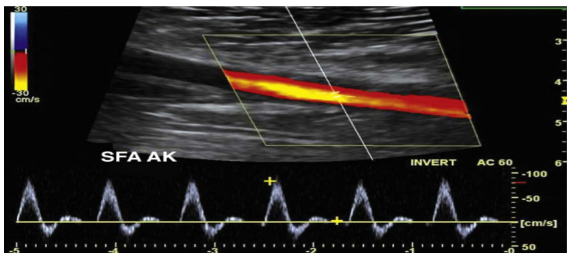


Common femoral artery

peripheral vein (you can tell its a vein from the valve)

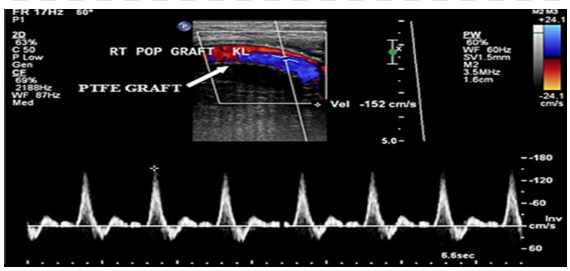


- Normal waves (triphasic).
- Normal velocity.



Duplex ultrasound of superficial femoral artery.

- Anatomically : no stenosis, no calcification.
- Functionally: normal velocity, triphasic wave.



Sensitive ✓✓✓

★ Operator dependant ✓✓✓

Toxic ✗

Therapeutic ✗

More sensitive than ABI because it gives you the exact spot of the stenosis.

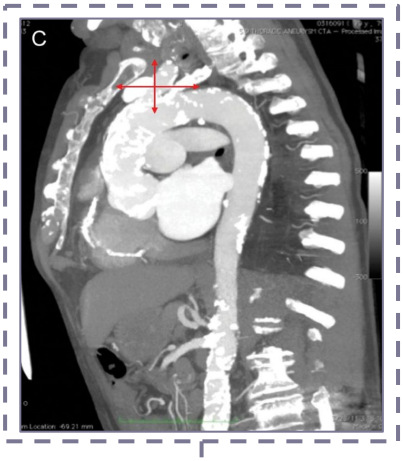
1. The colour flow by using Doppler ultrasound can show narrowing. By measuring the peak systolic velocity (PSV) and end-diastolic velocity (EDV) of the blood travelling through the stenosis it is possible to quantify the degree of narrowing

CT Angiogram

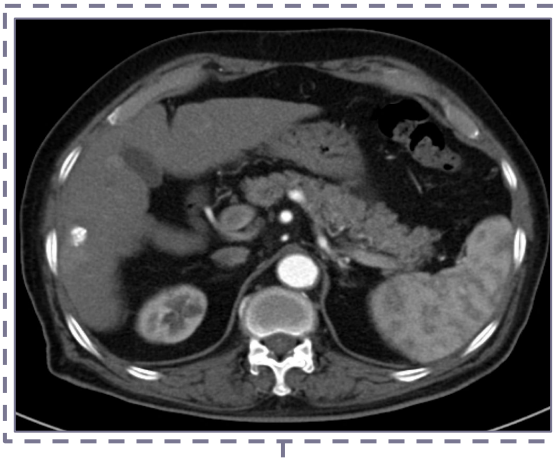
CT with injected contrast.
Based on time you get: (you give the order to the machine and it will measure the time needed)

- Angiogram = artery
- venogram = vein

Sagittal pic of ascending and descending aorta



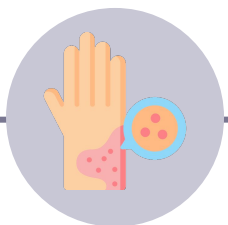
Abnormal calcification of the ascending aorta



(CT of the abdomen)
we use CT with contrast, if we use CT without contrast we won't be able to see the vessels

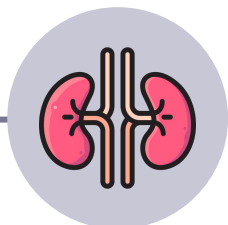
Side effect/contraindications Due to contrast:

Allergy



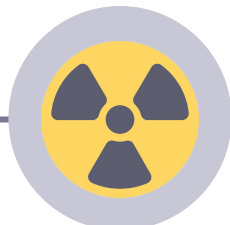
- Especially patients sensitive to iodine.
- Usually we give antihistamine and prednisone (steroids).

Renal impairment & Nephropathy



- patient with renal failure its fine, because the kidney is not functioning anyway and they are on dialysis. but if the patient is borderline creatinine then there is a high chance he will develop kidney failure, therefore we do dialysis.

Radiation



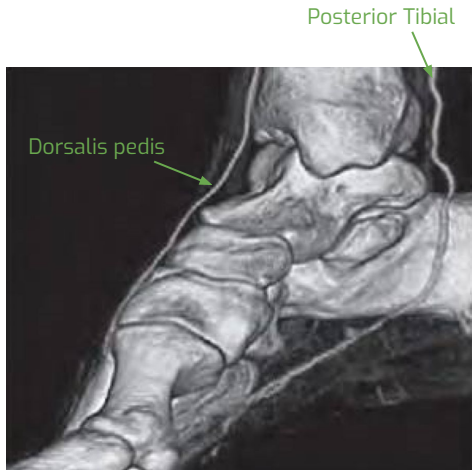
Sensitive[1]	Operator dependant	Toxic[2]	Therapeutic
✓✓✓✓✓	✗	✓✓✓	✗

1. more sensitive, shows exact location of abnormality & type of abnormality
2. Two types of toxicity
   Allergy; Ask the pt if they have allergy to contrast and prep them with antihistamine or steroids
   Nephrogenic toxicity due to iodine Contrast; if the pt isn't on dialysis but have high creatinine level then **prep them with hydration** and decrease the dose of contrast

CT Angiogram *Cont.*

3D Modality:

Pseudoaneurysm of the superficial femoral artery

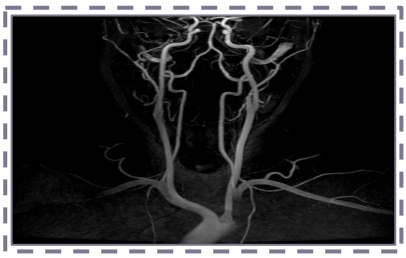


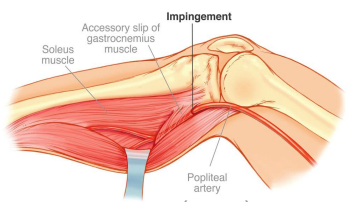
MR Angiogram

MRA is usually used in soft tissue diseases like popliteal entrapment syndrome.

Popliteal artery entrapment syndrome (PAES) is an uncommon condition in which an abnormally positioned or enlarged calf muscle presses on the main artery behind the knee (popliteal artery). The artery becomes trapped, making it harder for blood to flow to the lower leg and foot (common among athletes).

MRA is less toxic than CT.





EXTRA (PAES)

Sensitive	Operator dependant	Toxic	Therapeutic
✓✓✓✓	✗	✓✓✓	✗

Gadolinium Contrast cause nephrogenic toxicity.

Angiography

- **Invasive procedure** we rarely use it these days because there are better non invasive methods.
- We enter a catheter in a specific artery and inject a dye.
- It might cause bleeding or hematoma if it was done at the wrong site.
- There are also chances of thrombosis, or pseudoaneurysm.
- Used as **diagnostic** modality and **therapeutic** at the same time (Ballooning
- One of the most common problems in angiography is **the access point**

Areas of Entry:

01 **Common Femoral Artery 90%**

02 **Brachial Artery**

03 **Radial Artery**

- Not very good because it's small
- Best for cardiologist

- **Most of the time the arterial access is through the common femoral artery, why?**

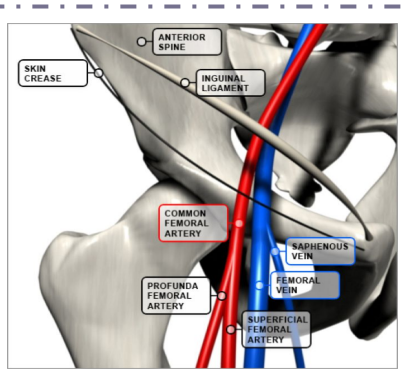
Accessible

Clear Anatomical Landmark (Femoral Head)

- It is important to enter with **ultrasound guidance** to search for the bifurcation of the common femoral artery
  - if you enter above the Common femoral (External Iliac) there is nothing to compress the artery against after the procedure.
  - If you enter below the Common femoral, this would lead to occlusion or thrombosis.
- We can use X-ray **(Fluoro Guide)** check where is the head of the femur and puncture over the head.

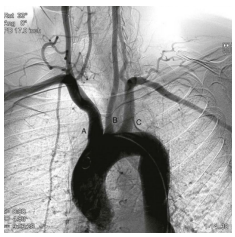
Easily compressed against the head of the femur

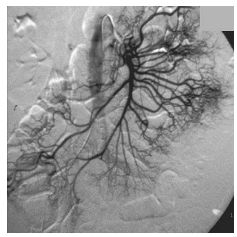
- To stop the bleeding after removing the catheter.
- Solid bed under common femoral artery.

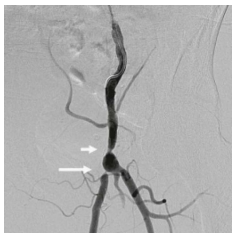
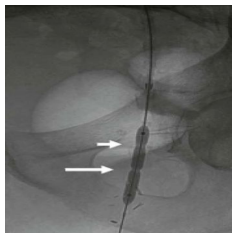
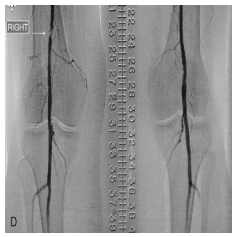


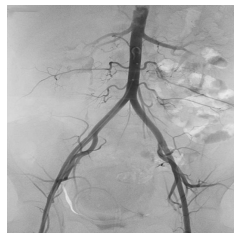
Femoral Artery

Angiography *Cont.*

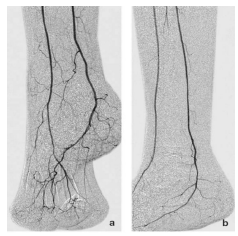





Popliteal Artery

Just for your knowledge, internal carotid artery never gives branches in the neck area, only in the head.

Sensitive	Operator dependant	Toxic	Therapeutic
✓✓✓✓✓	✗	✓✓✓	✓✓✓

- Contrast allergy and radiation
- less contrast than CT because selective (to one area),not systemic.

- **The only therapeutic investigation**, we can treat the stenosis and open it with a balloon.

Example

Patient with rest pain the ABI is low (0.4), so we know that there is a peripheral arterial disease.
After that we did a duplex US that showed a superficial femoral artery lesion and stenosis.
Then we take the pt to the angiogram to confirm the diagnosis and do angioplasty to open the artery by balloon.

Summary

Recall

Q1: What is the ABI?
Ankle brachial index: simply the ratio of systolic blood pressure at the ankle to the systolic blood pressure at the arm (brachial artery) A:B ; ankle pressure.
Taken with doppler; the ABI is non-invasive.
Q2: What ABI are associated with normal, claudicators, and rest pain?

- Normal ABI: >= 1.
- Claudication ABI: < 0.6.
- Rest pain ABI: <0.4.

Q3: What gets false ABI reading?
Patients with calcified arteries, especially those with diabetes.
Q4: What are PVRs?
Pulse volume recordings; pulse waveforms are recorded from lower extremities representing volume blood per heartbeat at sequential sites down leg.
Large wave form means good collateral blood flow.
Non-invasive using pressure cuffs.
Q5: prior to surgery for chronic PVD, What diagnostic test wii every patient receive?
A-gram (arteriogram: dye in vessel and X-ray) maps disease allows for best treatment option (i.e., angioplasty vs surgical bypass vs endarterectomy)

Test	Sensitive	Operator dependent	Toxic	Therapeutic
Handheld doppler	✓	✓✓✓	✗	✗
Duplex ultrasound	✓✓✓	✓✓✓	✗	✗
CT angiogram	✓✓✓✓	✗	✓✓✓	✗
MR angiogram	✓✓✓✓	✗	✓✓✓	✗
Angiography	✓✓✓✓✓	✗	✓✓✓	✓✓✓

Non-Invasive **Minimally-Invasive** **Invasive**

Quiz!

Q1: Which vascular investigation is commonly used as the first step in evaluating peripheral arterial disease?

1. Duplex ultrasound
2. CT angiogram
3. Ankle brachial index
4. Segmental pressure

Q2: A 45-year-old patient with suspected arterial insufficiency undergoes an ankle brachial index (ABI) test. The results show an ABI value of 0.8. What does this value indicate?

1. Normal blood flow to the limb
2. Mild to moderate peripheral arterial disease
3. Severe peripheral arterial disease
4. Incompressible vessels

Q3: A 70-year-old patient with suspected deep vein thrombosis (DVT) undergoes a vascular test. The test involves squeezing the calf muscles to check for DVT and reflux. Which vascular investigation is being performed?

1. Segmental pressure
2. Angiography
3. Duplex ultrasound
4. CT angiogram

Q4: A 60-year-old patient with suspected arterial stenosis undergoes a vascular investigation. The procedure not only provides diagnostic information but also offers potential therapeutic benefits. Which vascular investigation is being performed?

1. Ankle brachial index
2. Segmental pressure
3. CT Angiogram
4. Angiography

3 (Q1) | **2** (Q2) | **3** (Q3) | **4** (Q4)

القادة

رزان المهنا

في الدوسري

محمد الغامدي

نوف الضلعان

وعد أبو نخاع

الأعضاء

مشعل الصويغ

عبدالله السالم

محمد الراشد

شكر خاص لتيم الجراحة دفعة ٤٣٩

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