

Done by : Touleen Qatawneh

Introduction to Interventional Radiology

Dr. Osama Samara
Consultant Interventional Radiologist
Professor of Diagnostic and Interventional Radiology
Jordan University Hospital



INTERVENTIONAL RADIOLOGY

A subspecialty which provides minimally invasive techniques with the help of imaging modalities to diagnose or treat a condition.

- Minimally invasive
- Local anesthesia
- Early recovery



INTERVENTIONAL RADIOLOGY

Interventional radiology has exploded as a specialty in recent years and there is now a huge range of procedures that can be performed with imaging guidance by radiologists, for diagnosis and therapy of diseases.



Endovascular IR

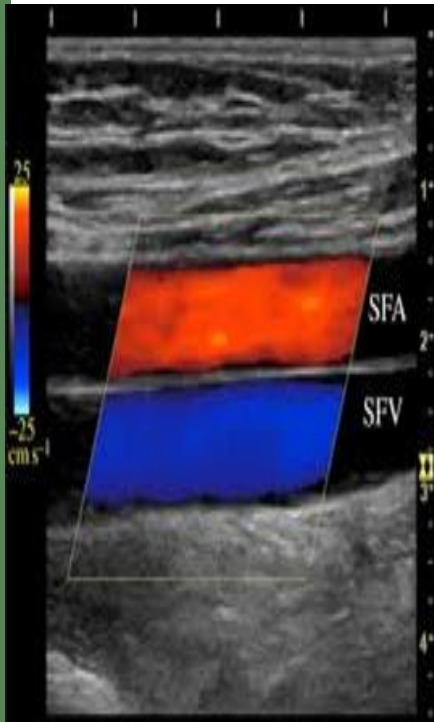
- Endovascular aneurysm repair
- Peripheral arterial angioplasty and stenting
- Thrombectomy and thrombolysis
- Venous thrombolysis
- IVC filter insertion
- Peripherally inserted central catheter
- Embolization
- Transjugular Intrahepatic Portosystemic Shunt

Percutaneous IR

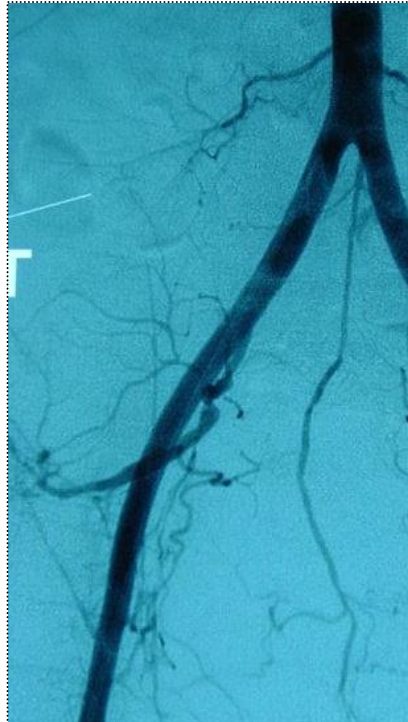
- Abscess drainage
- Percutaneous gastrostomy
- Percutaneous biliary drainage and biliary stent insertion
- Percutaneous nephrostomy
- Image-guided biopsy
- Pain control (nerve root block)

Modalities

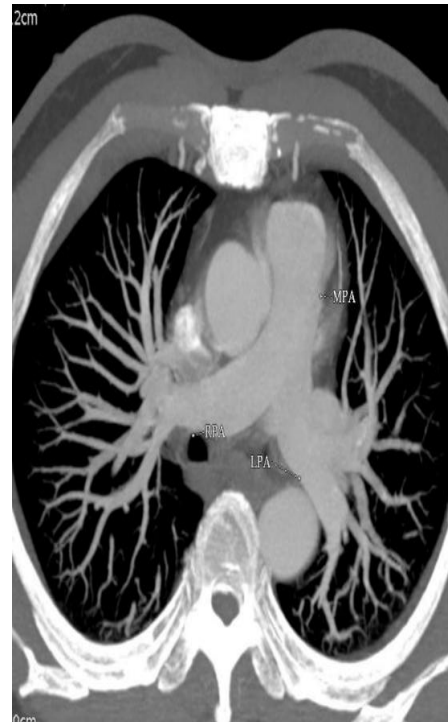
**Doppler
Ultrasound**



**Digital
subtraction**



**CT
angiography**



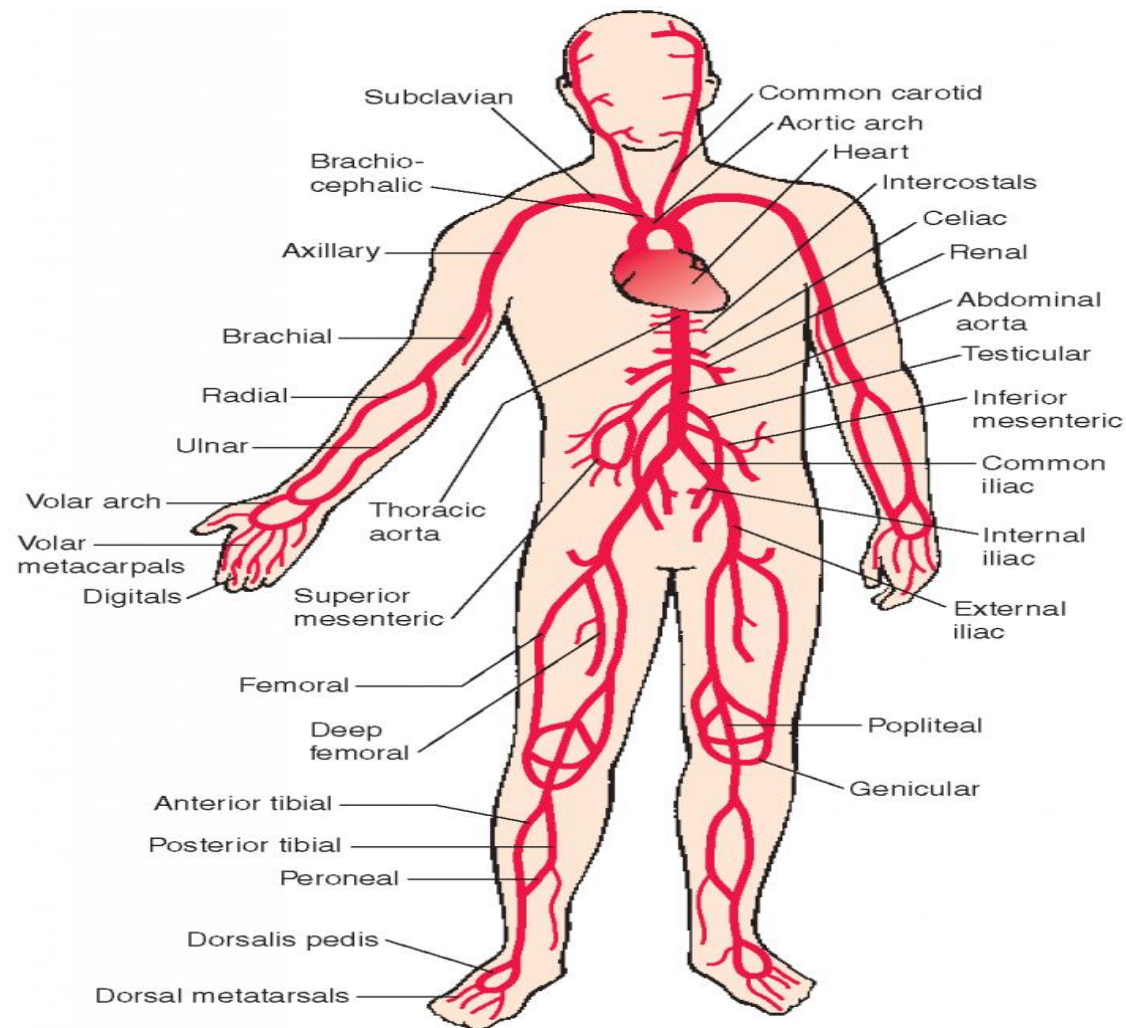
**MR
angiography**



Types Of Angiography

- Advanced US, CTA and MRA techniques made conventional angiography limited to therapeutic purposes.

Normal Anatomy



From Dossier:
Relevant clinical anatomy
Arterial anatomy:

1- Upper limb:

- The subclavian vein continues until the end of the lateral border of the first rib
- Beyond the lateral border of the first rib, the subclavian artery becomes the axillary artery
- The axillary artery then becomes the brachial artery; until the level of the cubital fossa.
- Beyond the cubital fossa, the brachial artery divides into the ulnar and radial arteries
- At the wrist, the radial and ulnar arteries form the superficial and deep palmar arches.

2- Abdomen and lower limb:

- When the aorta leaves the thoracic area, it becomes the abdominal aorta.
- At the level of L4, the abdominal aorta divides into the right and left common iliac arteries
- The common iliac arteries give rise to the internal and external iliac arteries
- The external iliac artery continues until the level of the inguinal ligament
- At the inguinal ligament, the iliac artery becomes the common femoral artery
- The common femoral artery divides into the superficial femoral artery and profunda femoris artery
- The superficial femoral artery continues until the popliteal fossa, where it becomes the popliteal artery
- Beyond the popliteal fossa, the popliteal artery becomes the peroneo-tibial trunk.
- The peroneo-tibial trunk gives rise to the anterior tibial artery, posterior tibial artery, and peroneal artery.

Venous anatomy:

1- Upper limb:

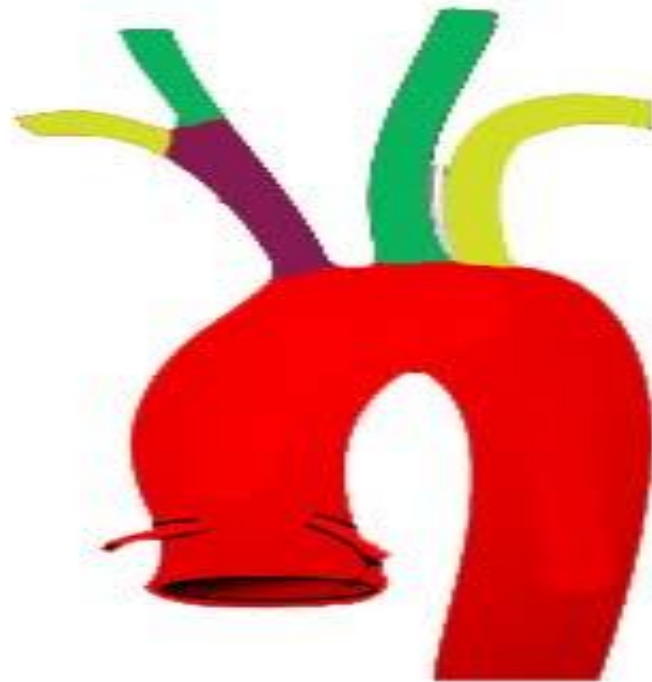
- The forearm contains basalic and median veins (superficially), and radial and ulnar veins (deep veins)
- In the arm, the brachial veins and basilic vein join to form the axillary vein
- The axillary vein become the subclavian vein

2- Abdomen and lower limb

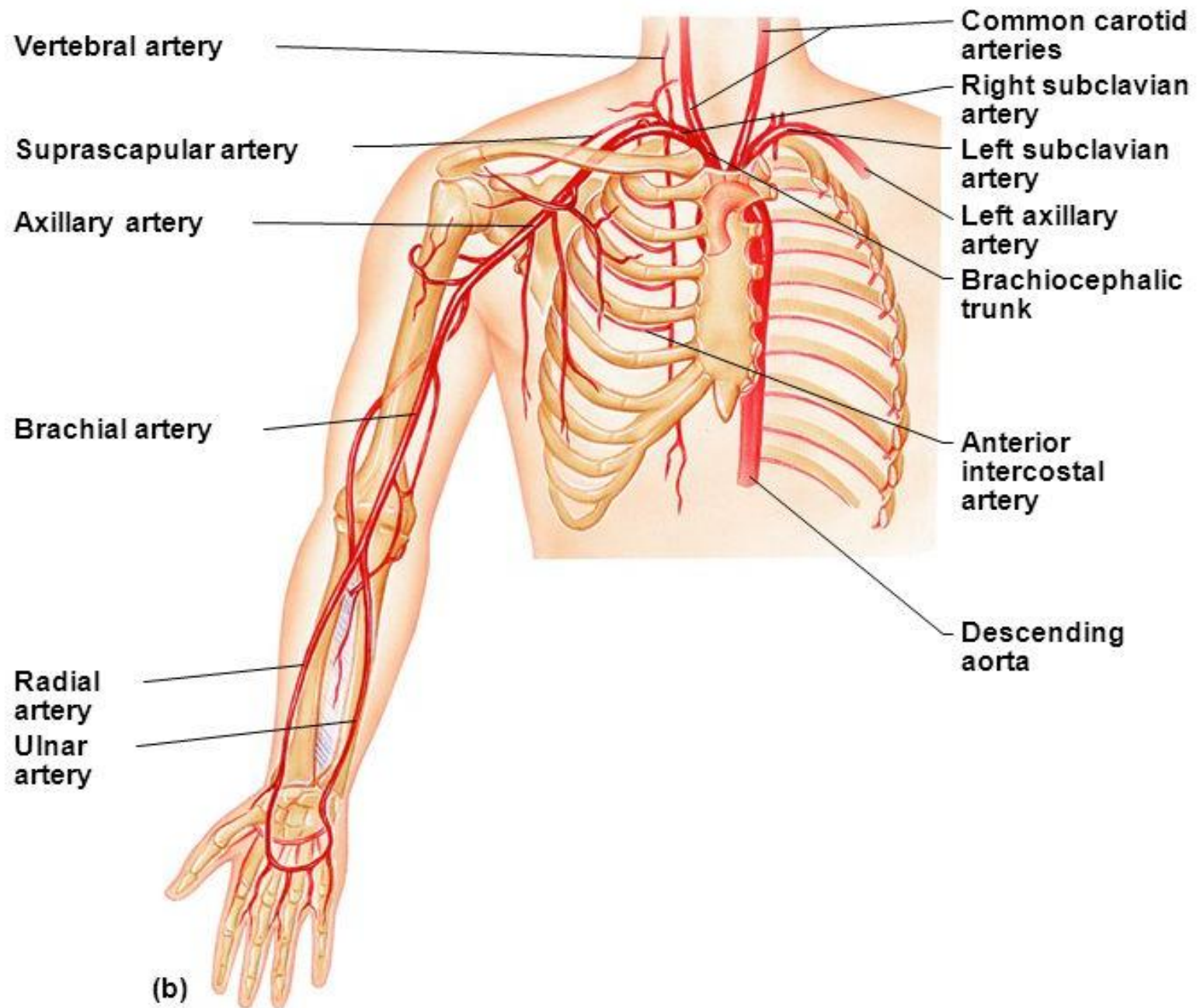
- The anterior tibial vein, posterior tibial vein, and peroneal vein join to form the tibeoperoneal trunk
- The tibeoperoneal trunk continues to form the popliteal vein
- The popliteal vein drains into the superficial femoral vein
- The superficial femoral vein joins the deep femoral vein to form the common femoral vein
- The common femoral vein drains into the external iliac vein
- The external and internal iliac veins join to form the common iliac veins
- The common iliac veins join to form the inferior vena cava

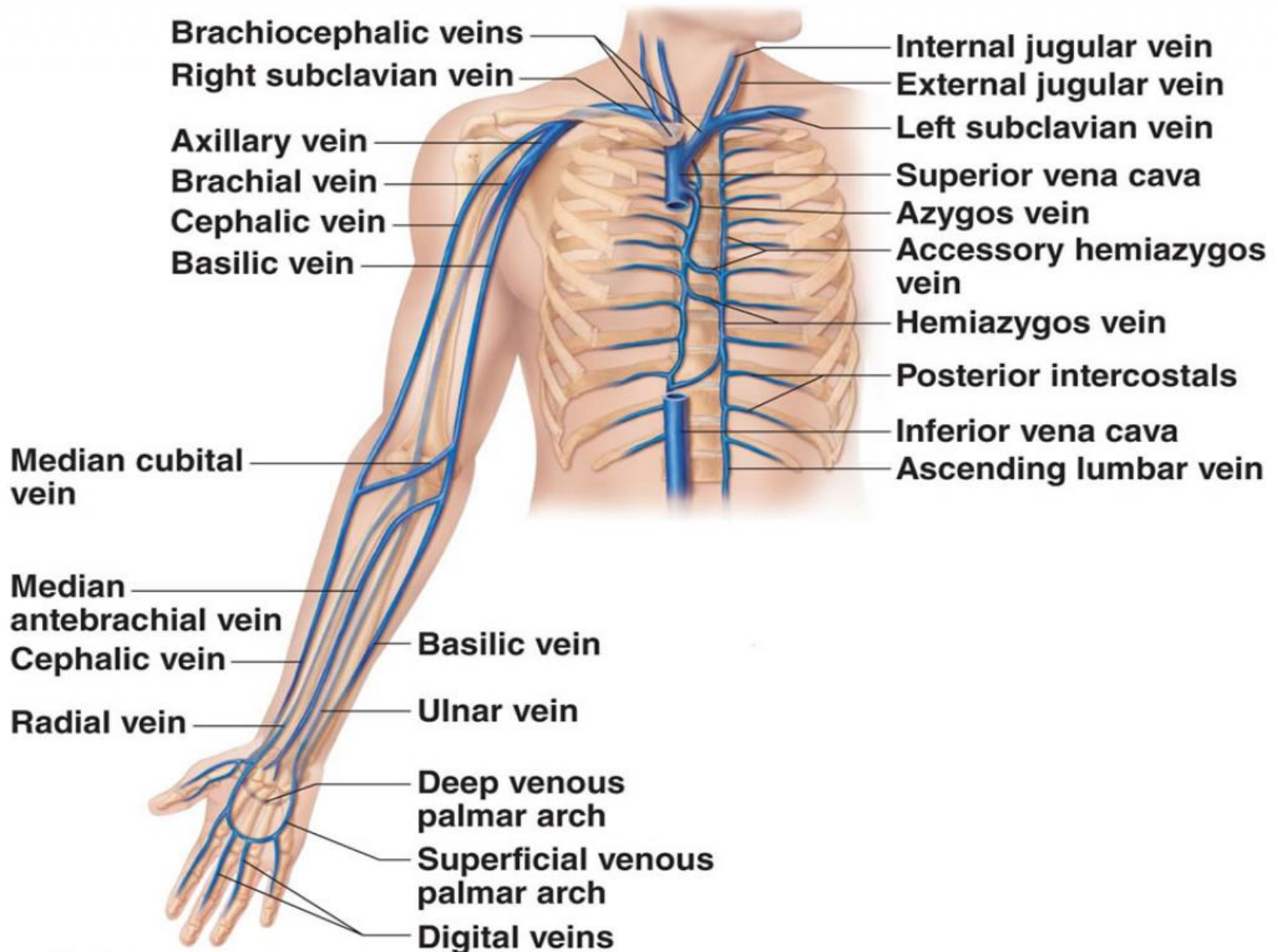
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L

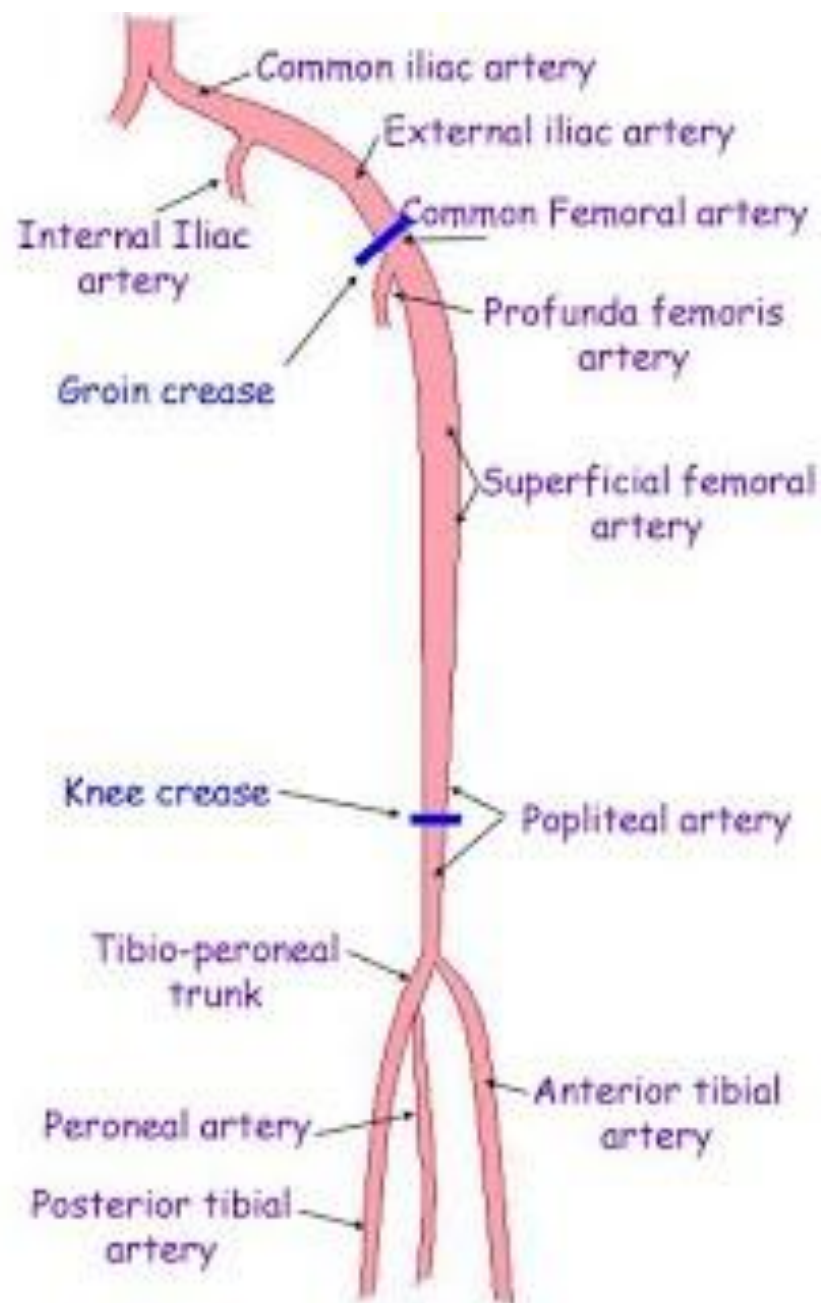


- Arch of aorta
- Subclavian arteries
- Common carotid arteries
- Brachiocephalic trunk

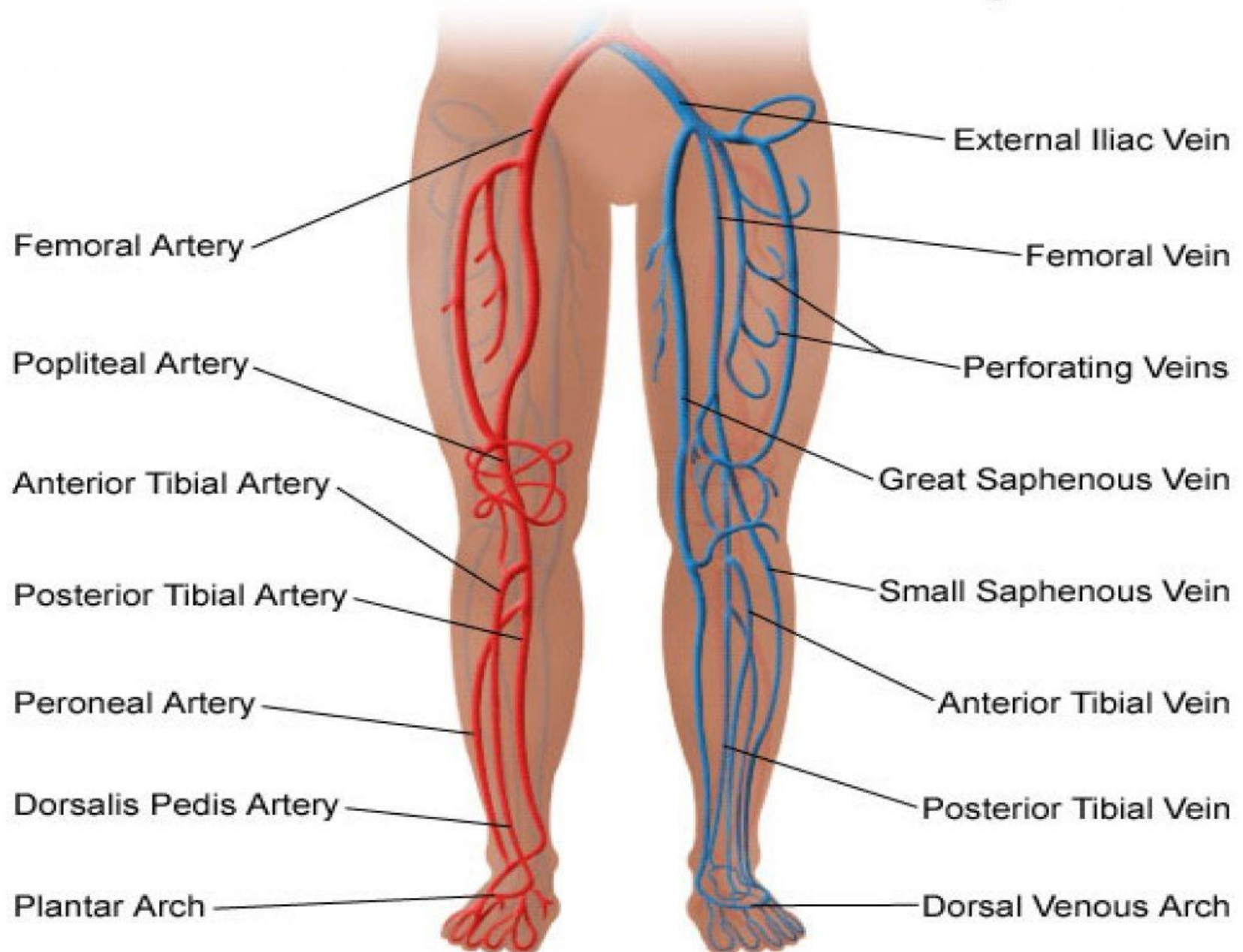




(b) Anterior view



Arterial and Venous Circulation of the Legs



Angiography

Definition

- An examination that utilizes contrast media to opacify blood vessels.

Angiograms:

1. Arteriograms
2. Venograms

LIMITED



EQUIPMENT

Angiographic Imaging Equipment



General angiographic room with biplane C-arm digital imaging

Patient Preparation

- Appointment time
- Nil orally 4-6 hrs.
- On trolley
- In hospital gown
- Groin shave
- Records
- PTI
- Should be well hydrated.
- Should void before procedure.
- Peripheral pulses marked.
- I.V line in place.
- Informed consent is a must

SELDINGER TECHNIQUE

- Site cleaned, area draped, local anesthetic given.
- The seldinger needle is introduced into the artery.

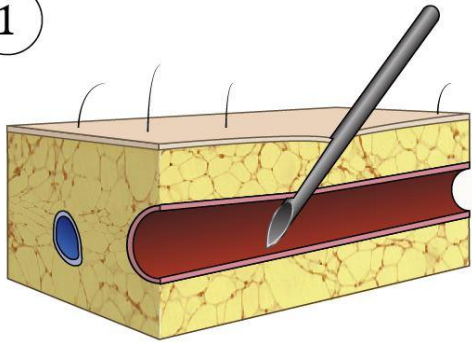
SELDINGER TECHNIQUE

- A **guide wire** is inserted through the needle.
- With guide wire in vessel, needle is removed.
- **Catheter** is threaded onto the guide wire.
- Under fluoro, the catheter is then advanced and the guide wire is removed.

~~mini~~
osce

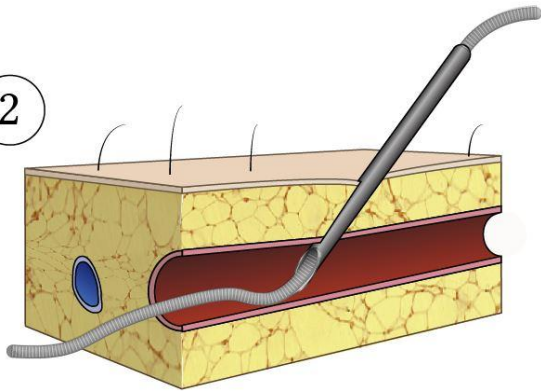


1



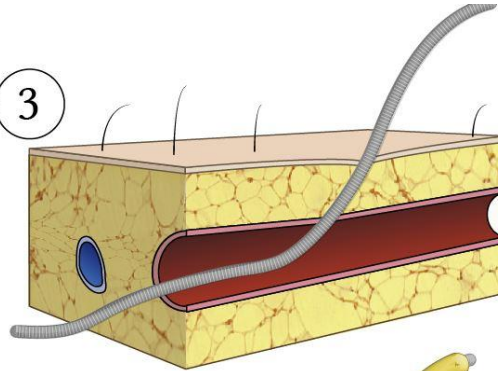
The artery is punctured with a hollow needle

2



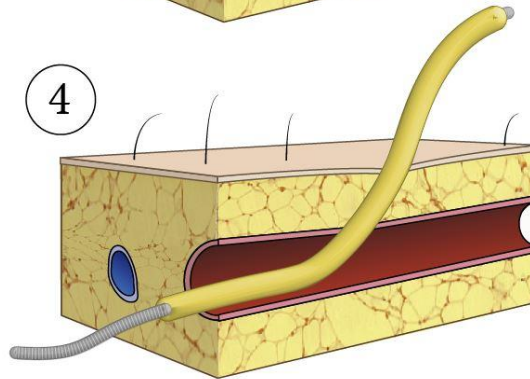
A flexible guidewire is introduced through the needle

3



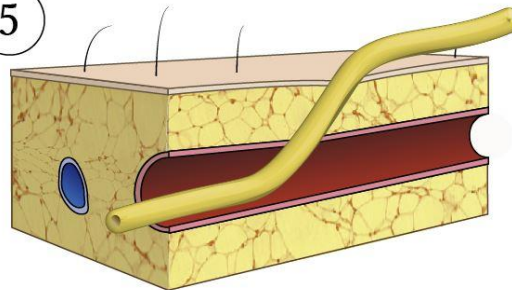
The needle is withdrawn, leaving the guidewire in the artery

4



The arterial catheter is introduced over the guidewire

5



The guidewire is removed and the catheter remains in the vessel

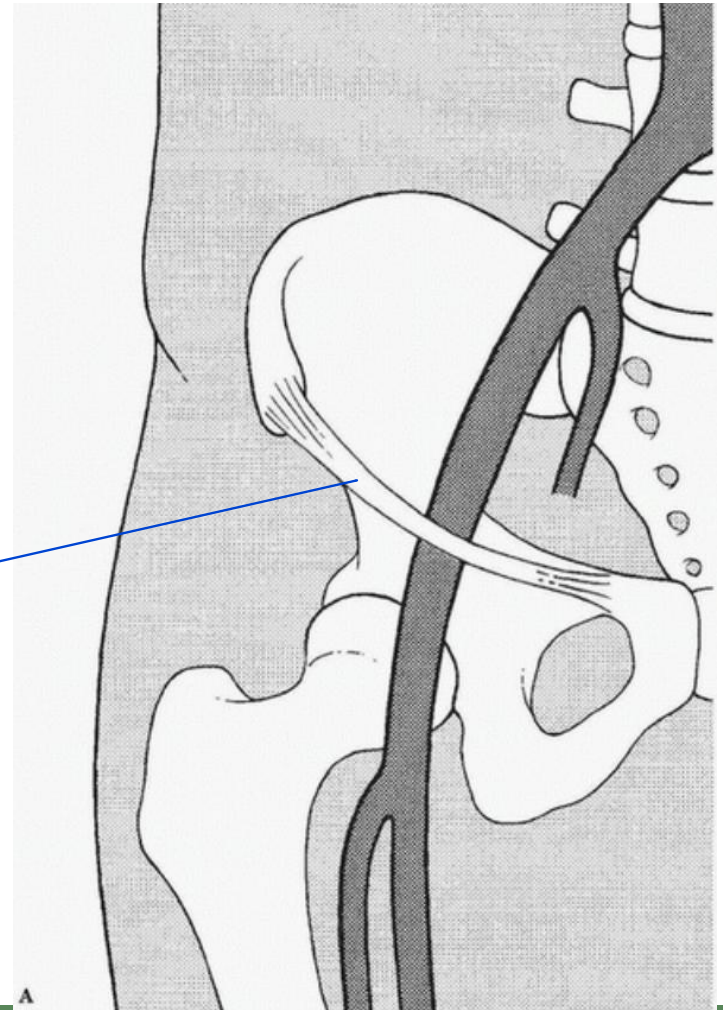
Femoral Artery Approach

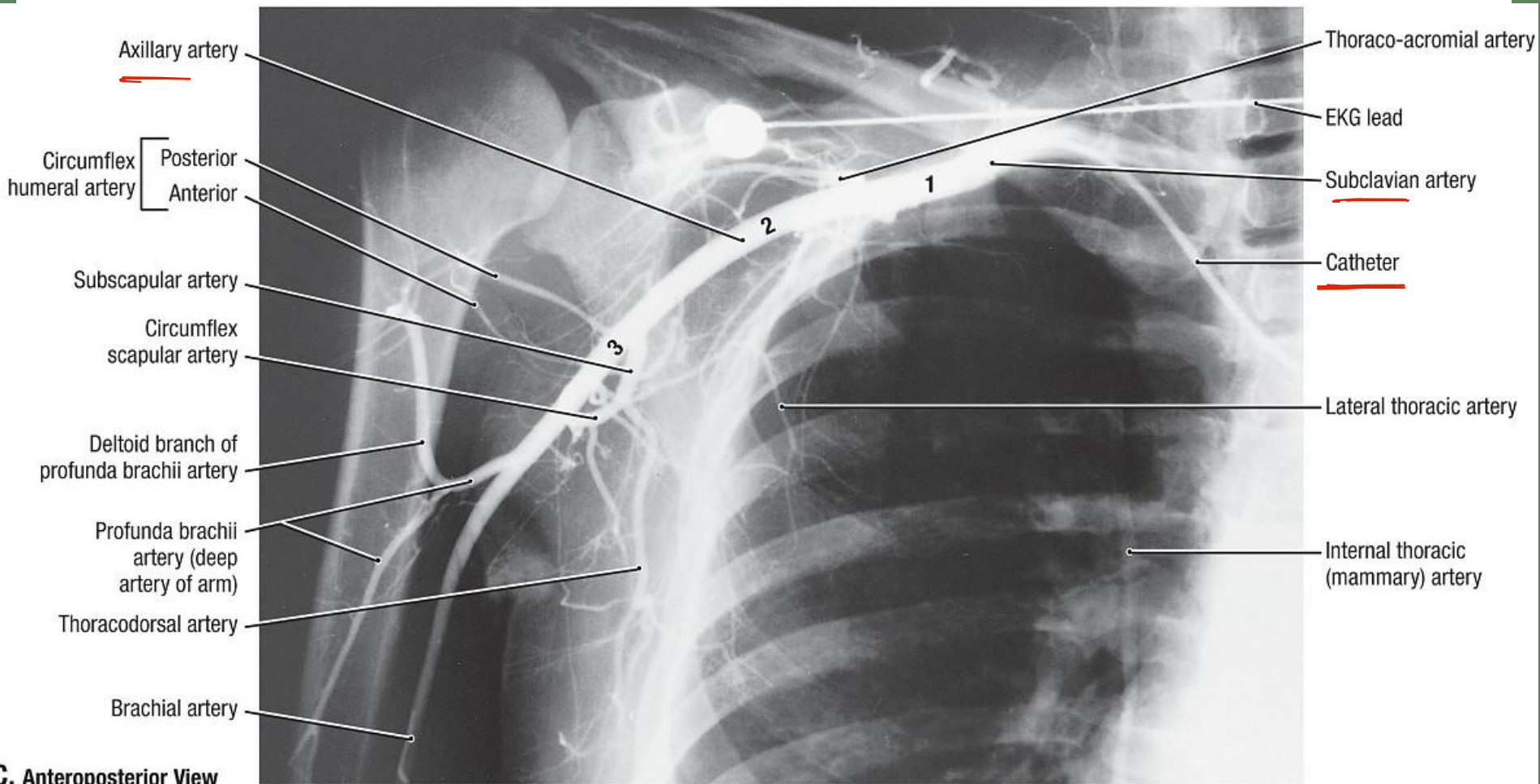
- Easily accessible.
- Large caliber vessel
- Well defined land marks exist.
- Low complication rate.

Left
Pulse

1. Infection
2. Pseudo aneurysm
3. Hematoma
4. Dissection

Inguinal
Ligament





C. Anteroposterior View

DSA

(digital subtraction angiography)



Principle:

Subtract the shadows that are present on the plain films from the films taken after the contrast has been injected for the angiogram, the result is an image containing details of the opacified structures only.

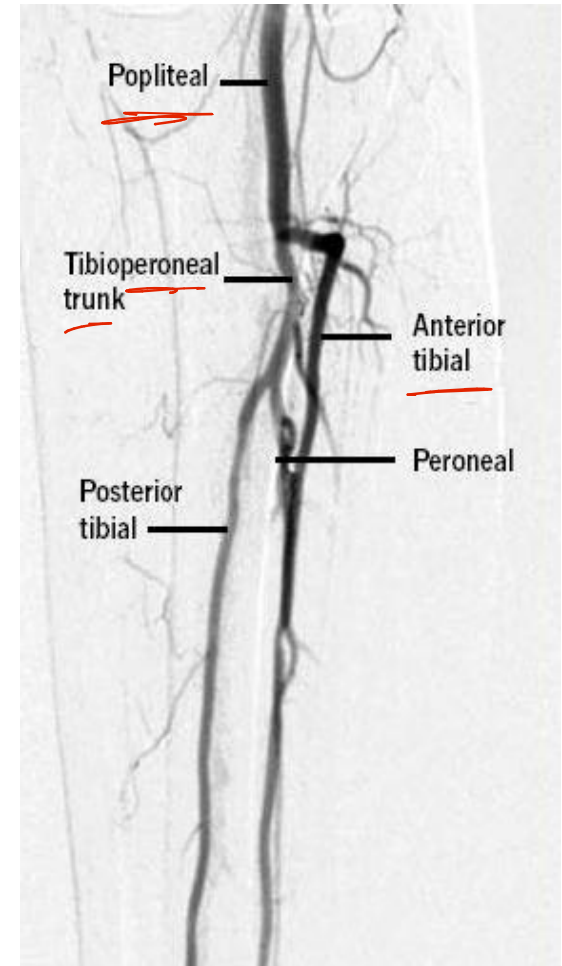
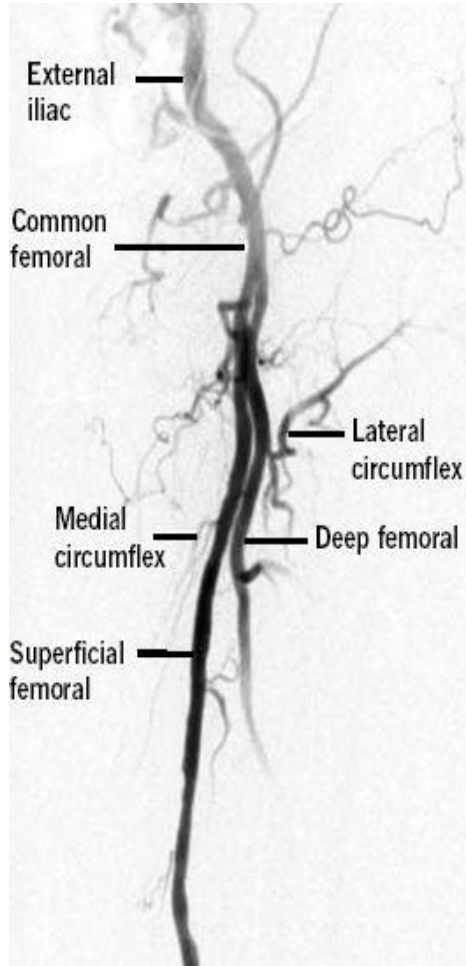
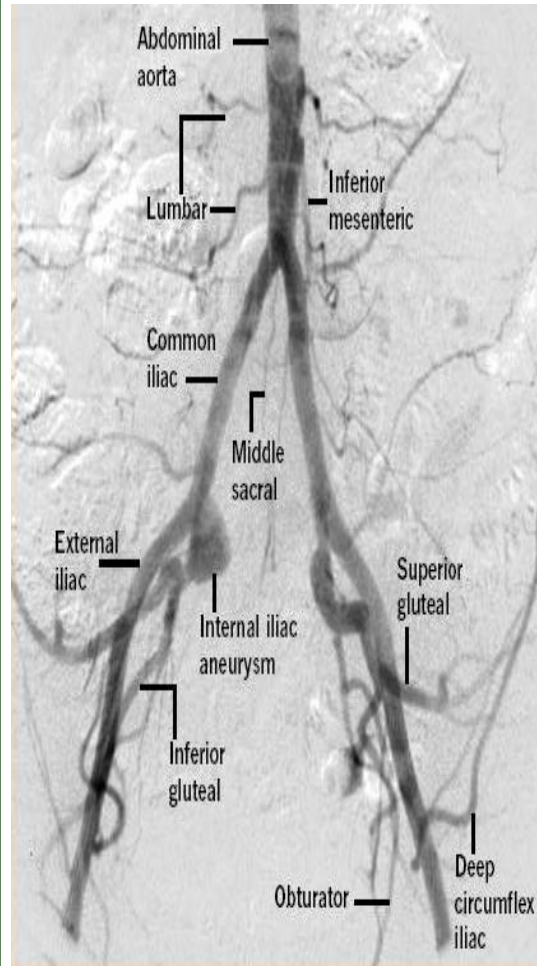


(2D DSA)



(3D DSA)

DSA



Post Procedural Care

- After the catheter is removed, compression is applied to the puncture site.
- The patient is asked for bed rest for a minimum of 4 hours
- During rest patient is monitored and vital signs like peripheral pulses distal to the puncture site are regularly checked
- The extremity is also checked for warmth, ²color, ³numbness to ensure circulation has not been disrupted.

Contra-indications

■ Contra-indications to contrast media

1. Allergy (allergy to CM is an absolute contraindication)

can be caused from first exposure

2. Impaired renal function
3. Medications

■ Blood- clotting disorders/ Anti coagulant medication

■ Unstable cardio pulmonary/ neurological status



COMPLICATIONS

■ 0.16% major complication rate:

1. Local complications: hematoma, vessel laceration, dissection, pseudoaneurysm, AV fistula.
2. Systemic complications: contrast reactions, fever, sepsis, dehydration, death.
3. Therapy related complications (ex: CnS bleeding during thrombolysis)

Pathology

- **Peripheral Vascular Disease/Occlusions**
- **Aneurysms**
- **Stenosis**

Arterial Occlusive Disease

- Acute vs chronic.

Acute Arterial Occlusion

- **Embolus** is the most common cause
- Other etiologies are thrombosis, dissections of the arterial wall, external compression , spasm or hemodynamic problems.
- **Immediate intervention** needed to prevent loss of extremity

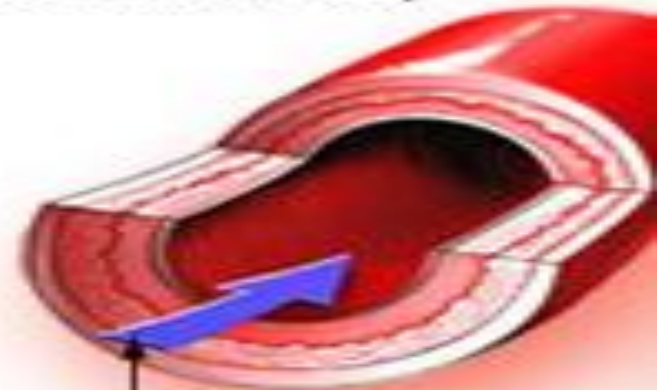
Acute Embolic Occlusion

- Cardiac origin : recent MI or a-fib
- Lower limb origin: DVT
- Emboli get trapped at **arterial bifurcations** and cause further thrombosis by apposition or stagnation of blood flow
- Most frequent location of arterial emboli is **the common femoral artery (46 %)**
- Another common site are the pulmonary arteries (PE)

Acute Thrombotic Occlusions

- Caused by atherosclerosis in over 90%.
- The clinical signs are **less severe than with acute embolic disease.**

Normal artery

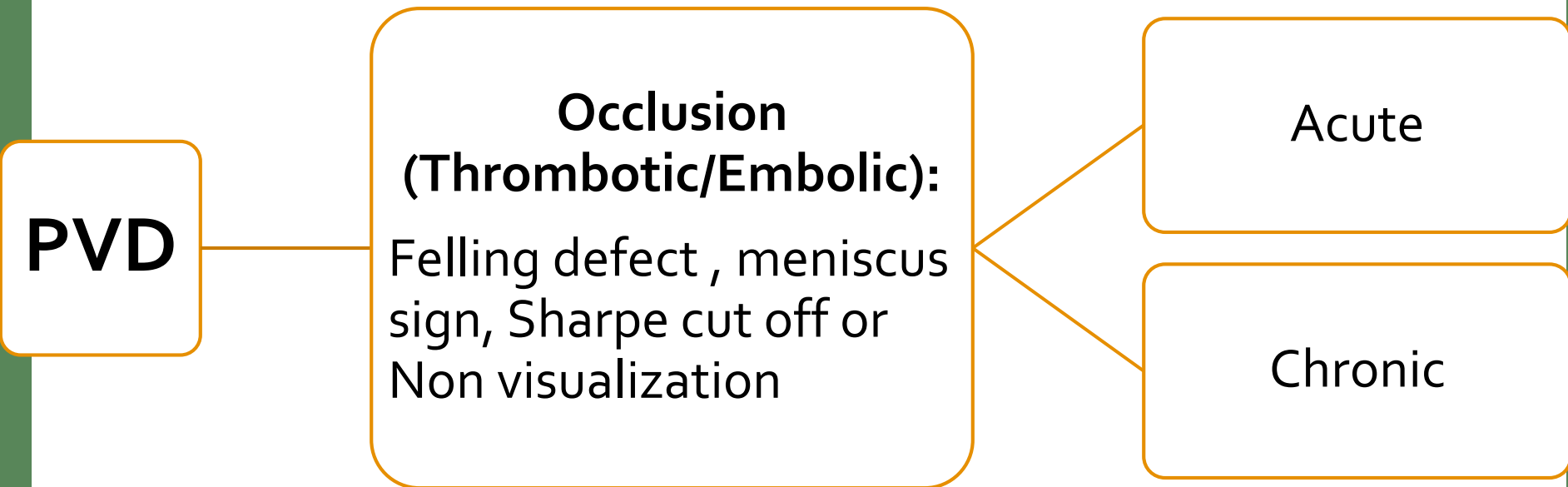


Blood flow

Artery narrowed by atherosclerosis



very important



Describe the picture:

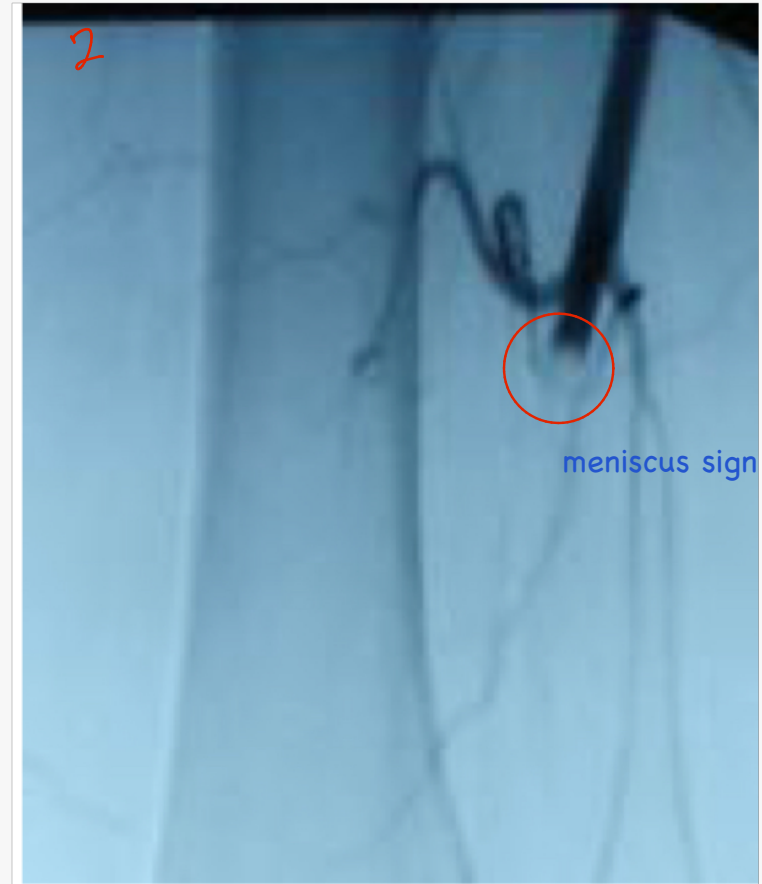
Acute occlusion



1- DSA showing incomplete occlusion in left common iliac artery
Filling defect with distal opacification

Why incomplete?

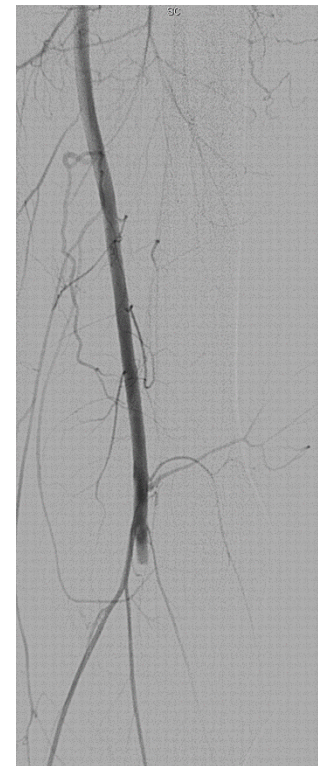
- A. Distal opacification
- B. Rim opacification (ring opacification)



2- Conventional angiography showing acute complete occlusion in superficial iliac artery
→ sharp cut off

Acute Occlusions

- On arteriography an acute embolic occlusion may show a relative **sharp cut-off** of the contrast column with the embolus being described as a **filling defect**



LT

ROT
-1

ANG
-1

RUN
2

20

MASK IMAGE
2 12

DSA showing complete occlusion in superficial femoral artery
→ sharp cut off

Chronic Occlusions



Chronic occlusions can be differentiated from acute occlusions due to the presence of **collaterals and faint distal opacification.**

not



chronic obstruction

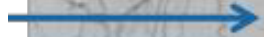
Aortoiliac Occlusive Disease, Also Known As Leriche's Syndrome



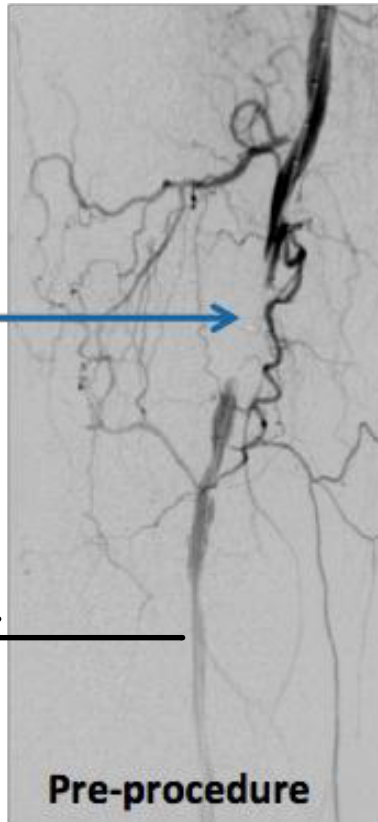
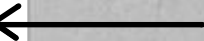
Classic Clinical Triad

1. Claudication
2. Erectile dysfunction
3. Absent pulses

Shaggy appearance

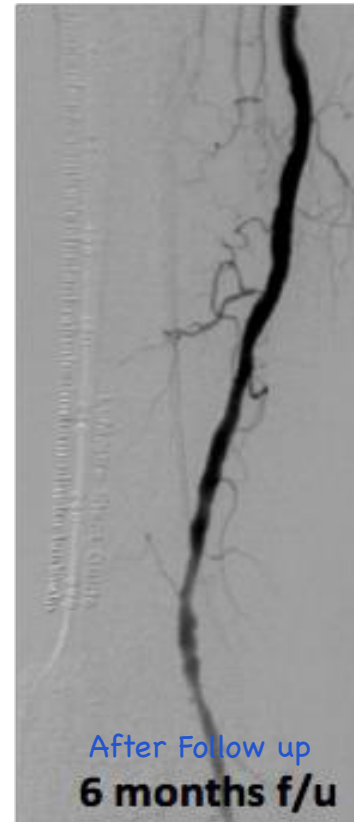


Distal opacification



DSA

Superficial femoral artery

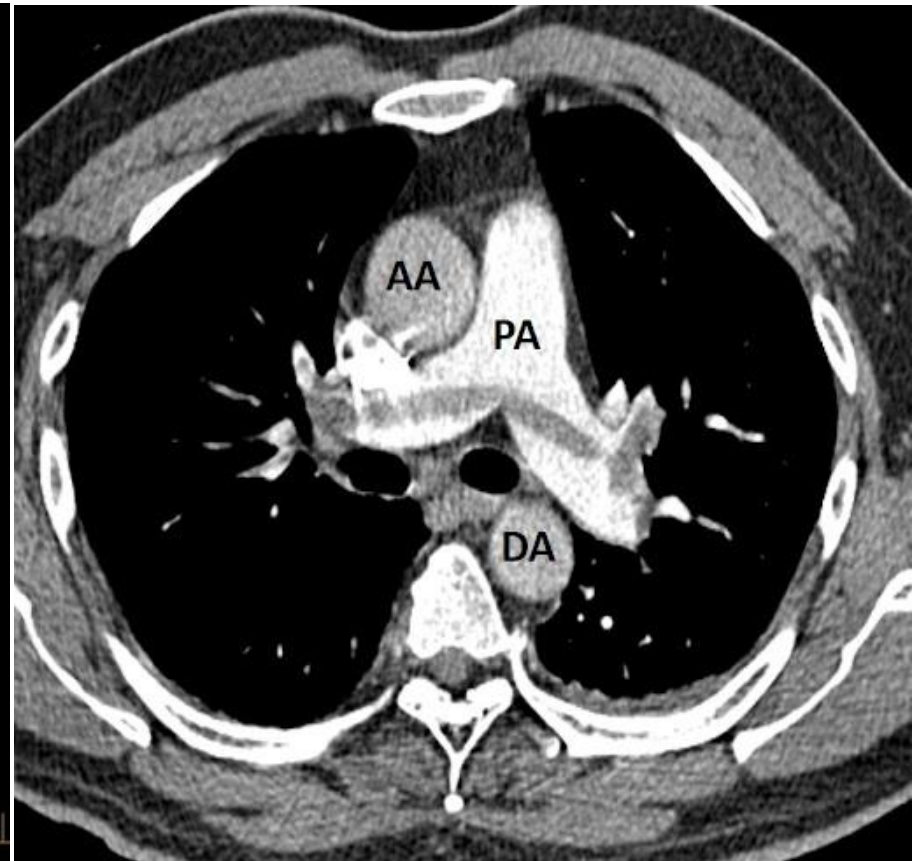
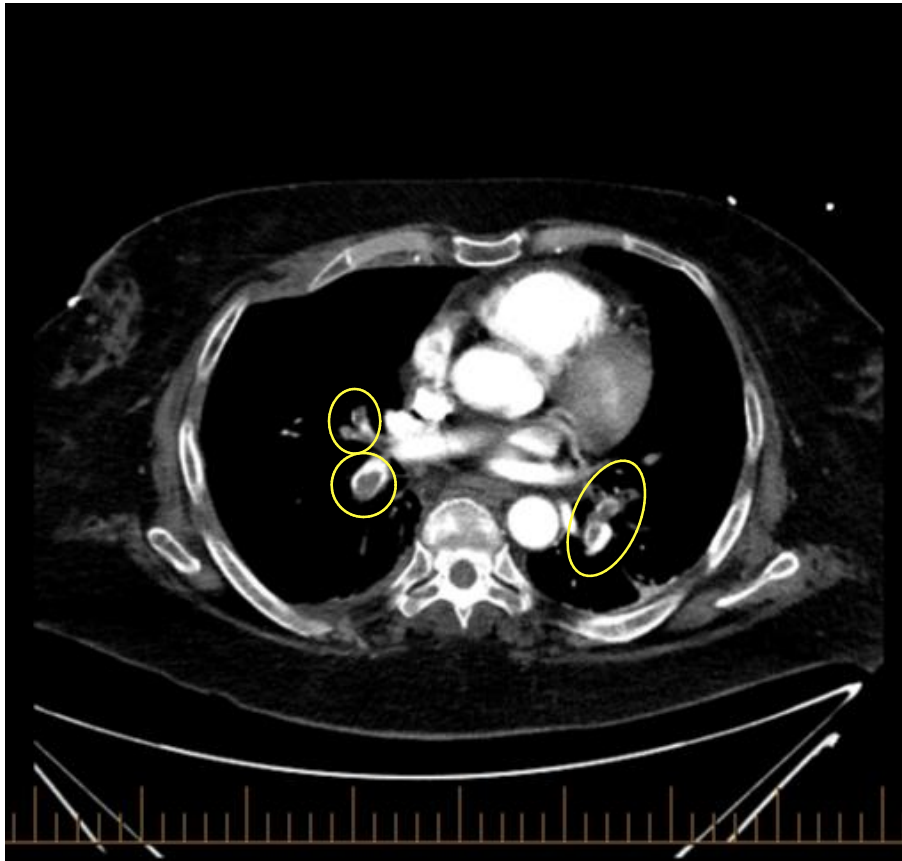


DSA showing chronic complete occlusion of superficial femoral artery with distal opacification

Angioplasty and stenting of superficial femoral artery

Pulmonary Embolus

Axial abdominal CT scan with contrast showing filling defect in pulmonary arteries



Arterial Stenosis

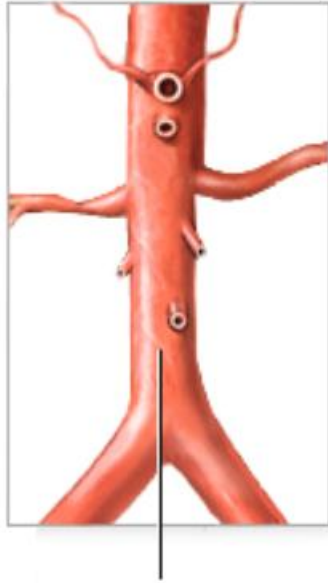
Artery stenosis may be caused by several pathological processes the most common being atherosclerosis (~75% of cases). ✱

- 2 types : Short and long segment

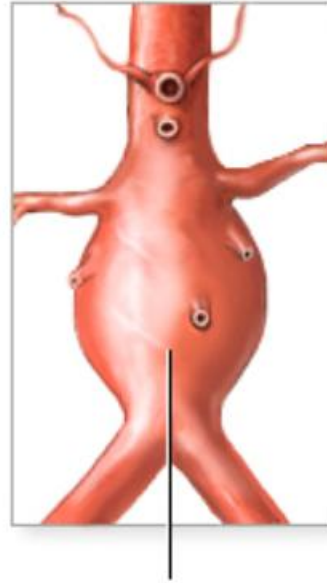
DSA showing short segment stenosis in femoral artery



Aneurysms



Normal aorta



Aorta with large
abdominal aneurysm

Aneurysms

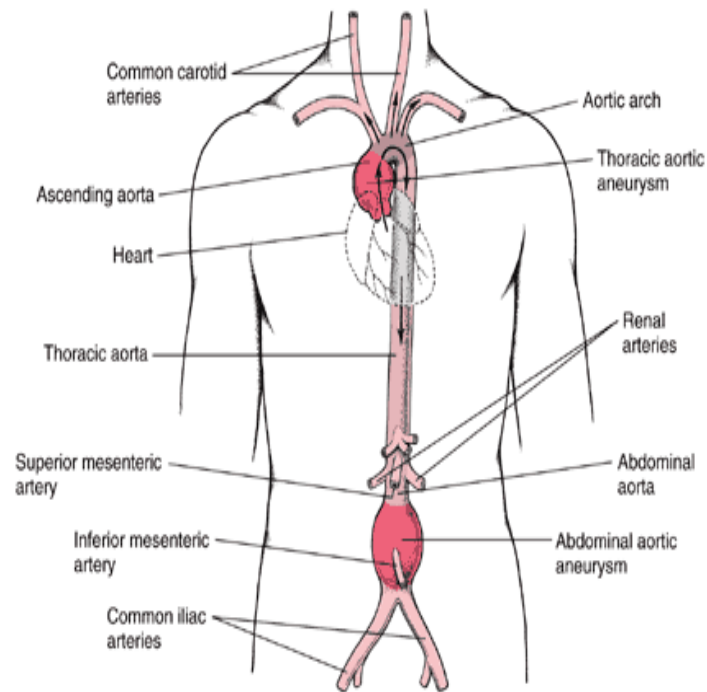
Dilation of an artery:

1. Fusiform or saccular
2. True or false

Aorta :

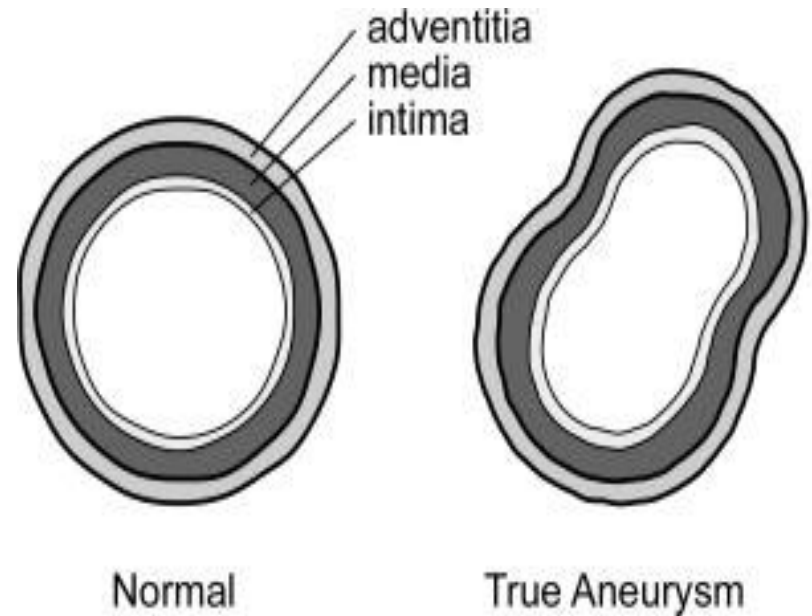
■ Thorax › 4cm.

■ Abdomen › 3cm.



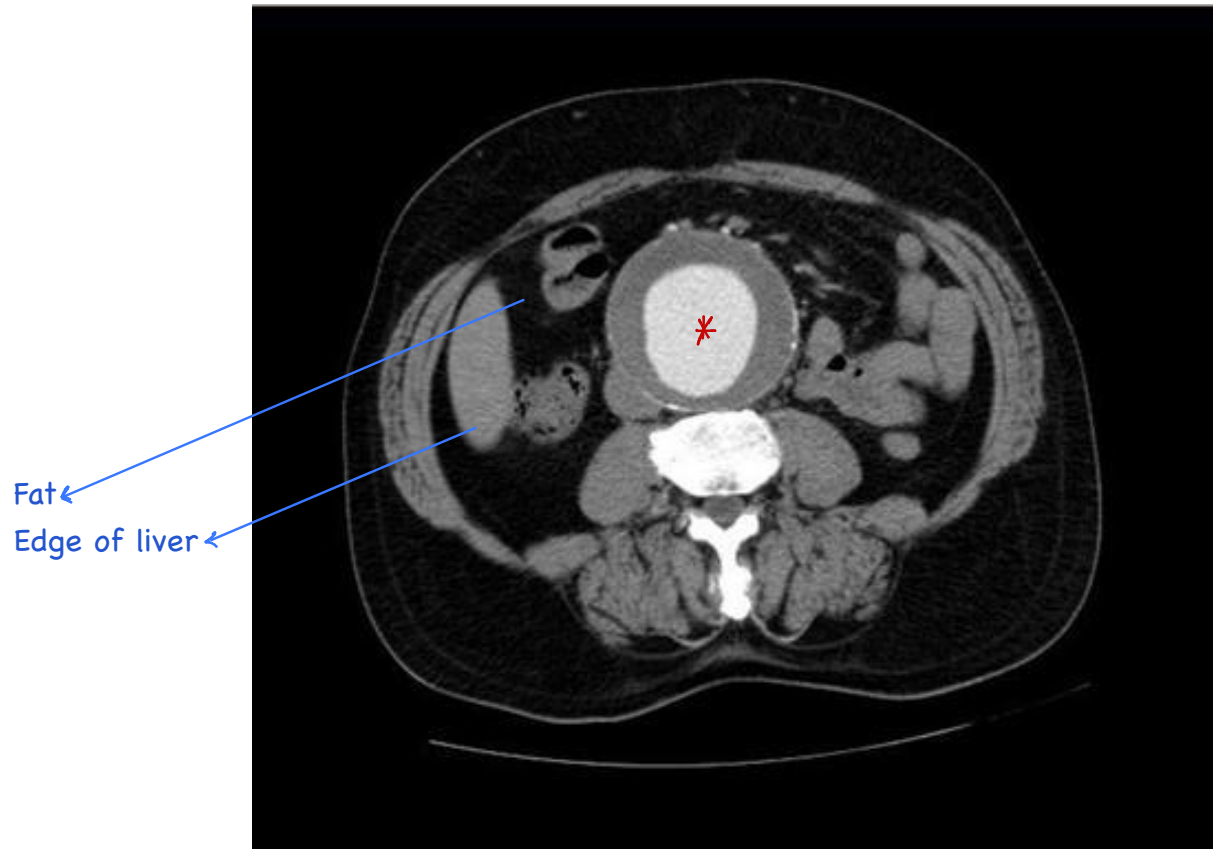
True aneurysms

- localized outpouchings, spindle shaped which involve **all three layers** of the arterial wall.
- The pathogenesis is mainly a degeneration of the media and in 70% to 80%
- The etiology is atherosclerosis.



Aneurysms

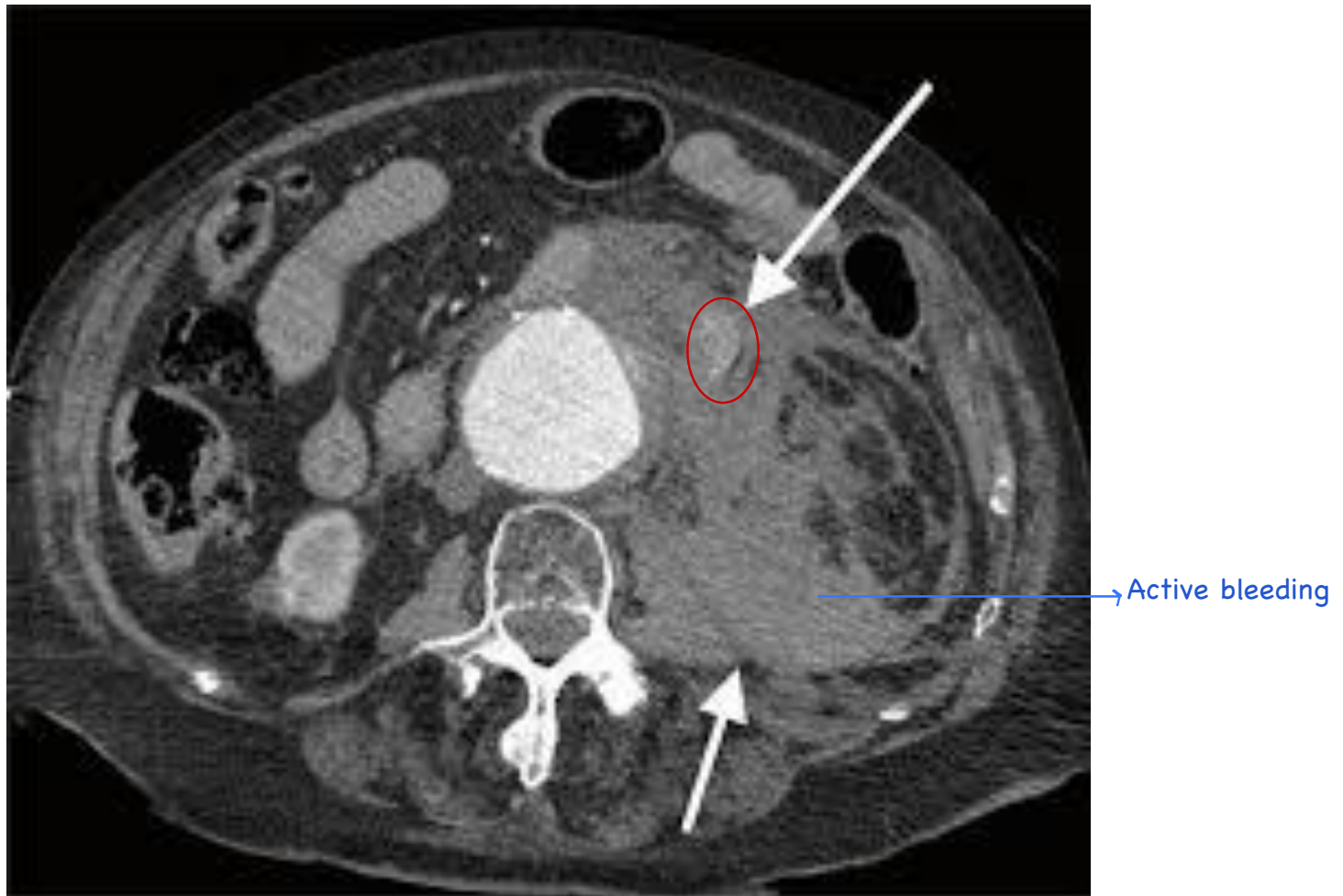
* Axial abdominal CT scan with IV contrast without oral contrast showing uncomplicated abdominal aorta aneurysm



Aneurysms can be diagnosed without contrast, however detecting complications typically requires contrast enhancing study

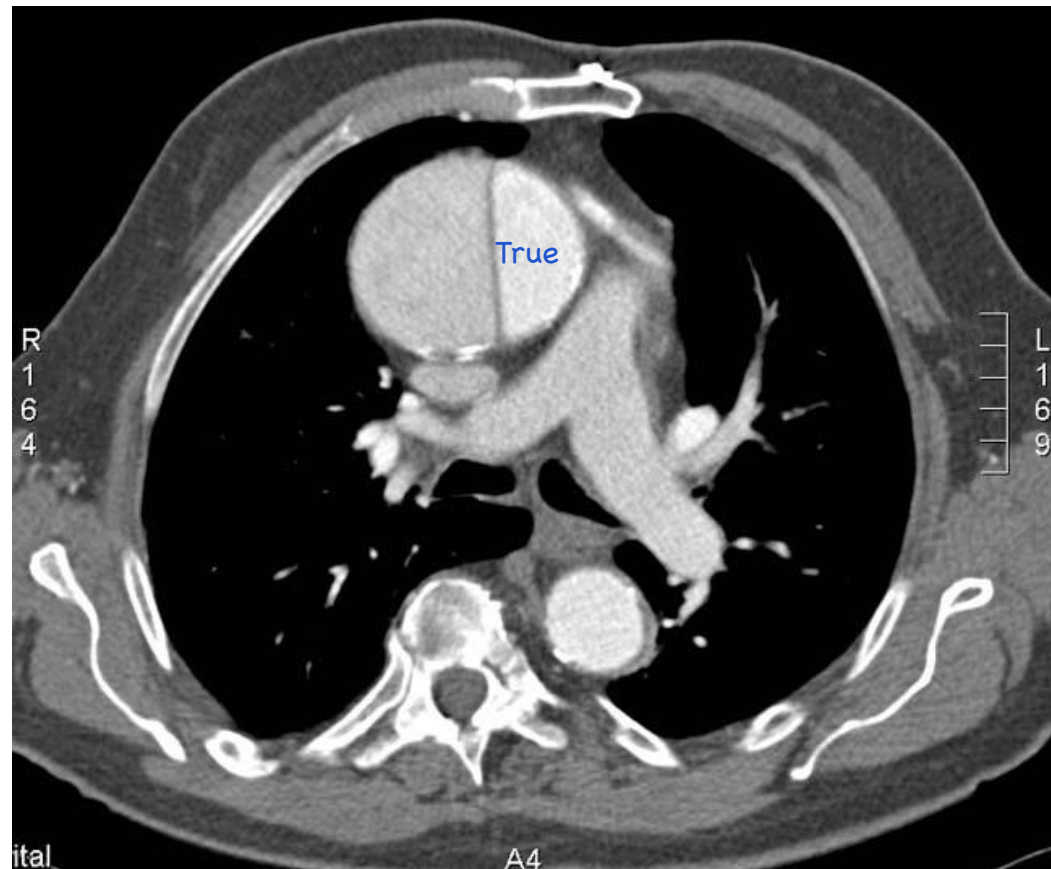
Ruptured Aneurysm

Axial abdominal CT with IV contrast showing complicated aneurysm with evidence of rupture and active leading (Extravasation sign)



Dissecting Aneurysms

Axial abdominal CT scan with IV contrast showing aneurysm complicated by dissection



No evidence of
rupture

In aortic dissection, the true lumen is usually receives contrast first so it appears brighter (more contrast-filled) while the false lumen is larger, fills more slowly, and appears less dense.

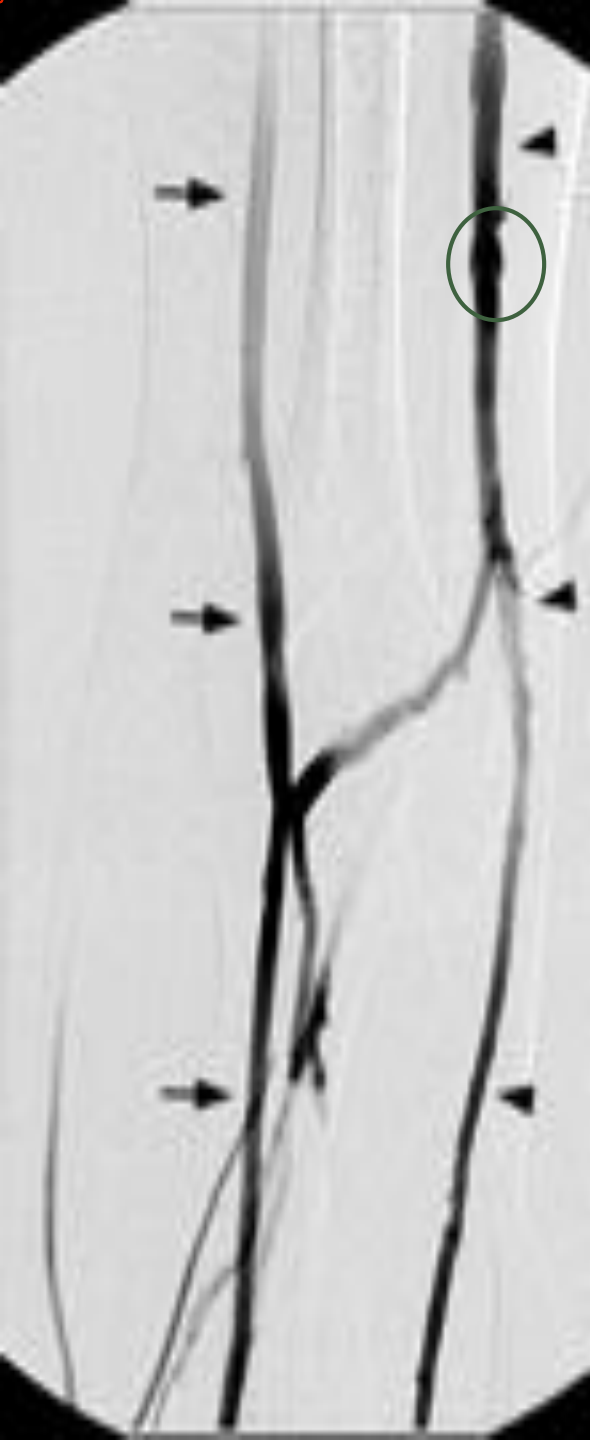
Venography

- Technique

contrast medium is injected into a small vein in the dorsum of the hand or foot.

LIMITED

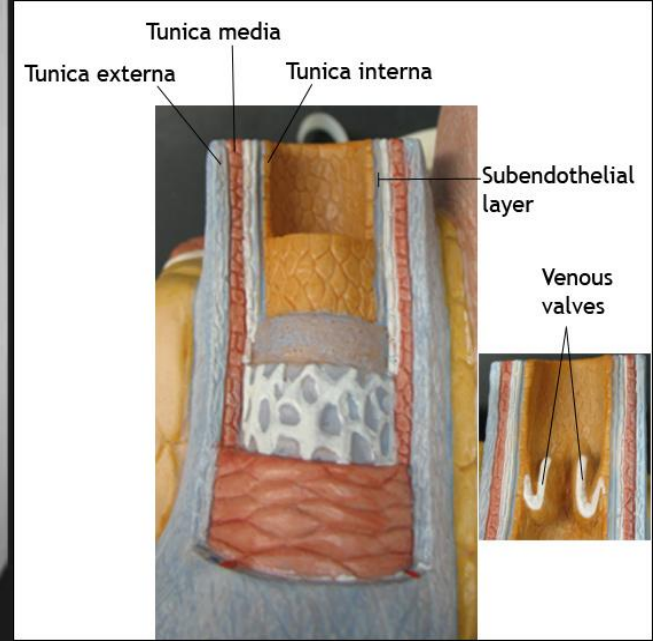




Venous valves

Inverted "V"
Prevent back flow

only seen
in venography



DVT

PO

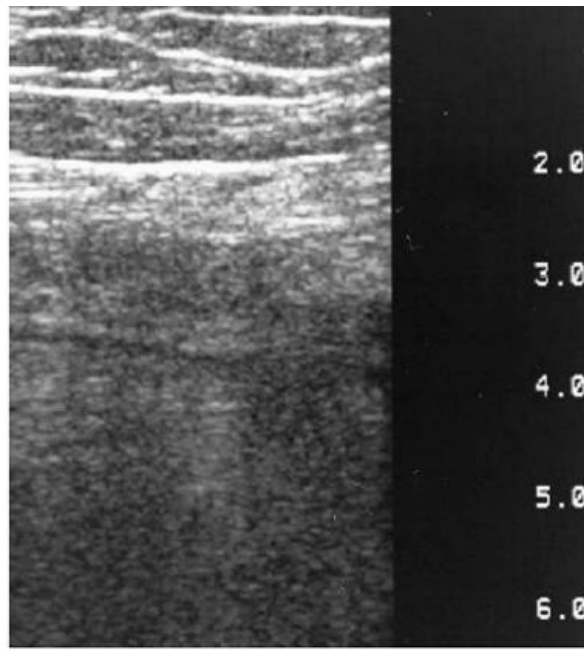
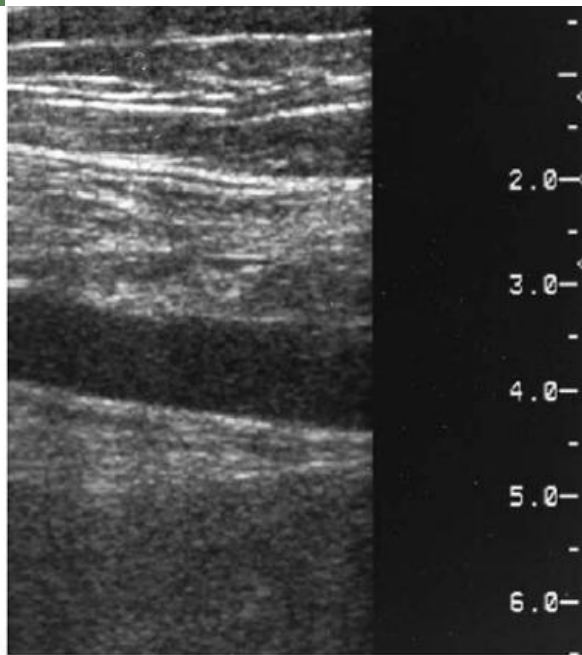
1. Filling defect

2. Non-visualization

Acute

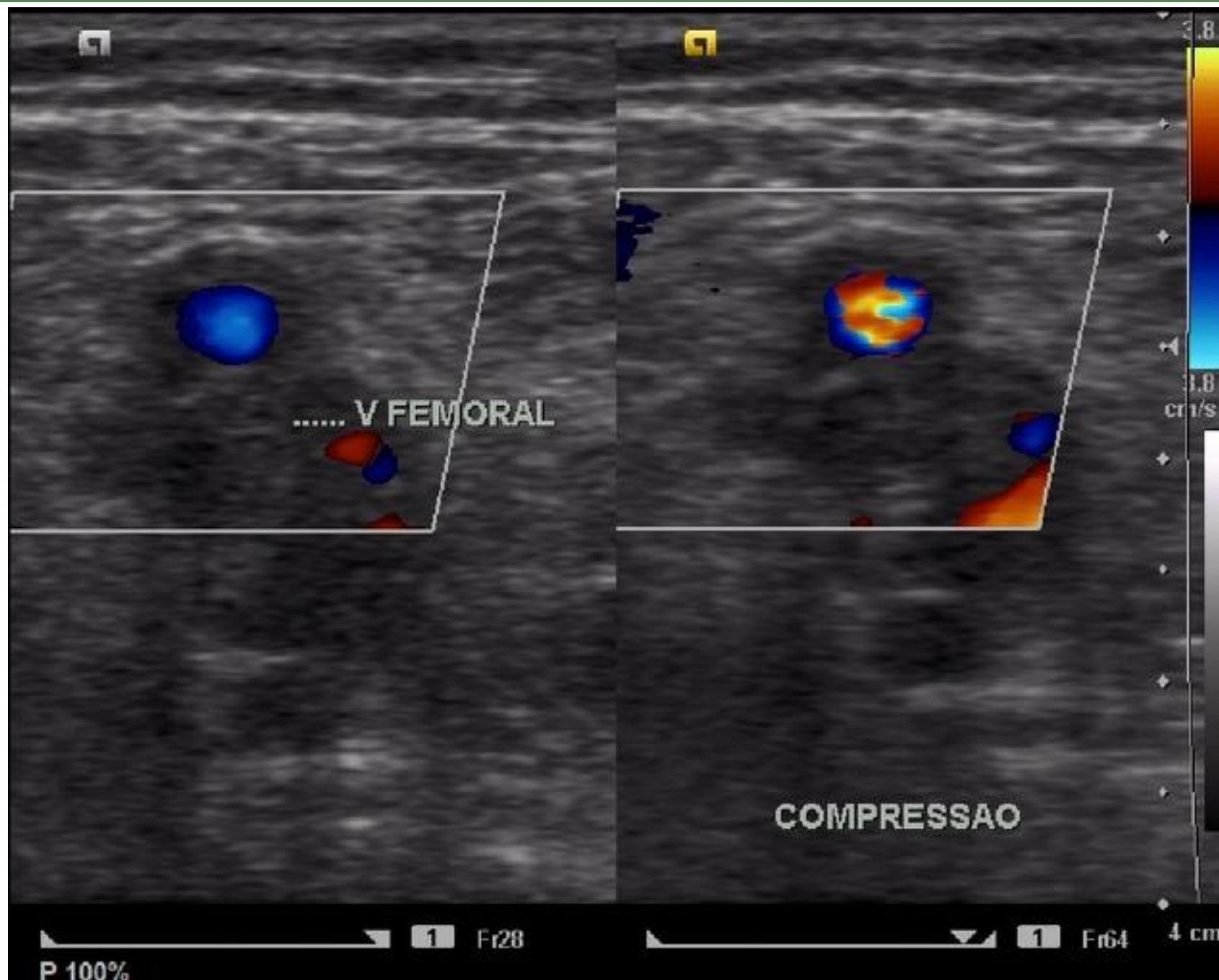
Chronic:

1. Collaterals
2. Faint opacification



How DVT appears on ultrasound:

- 1- dilated vein
- 2- non compressible
- 3- absent pulses
- 4- echogenic thrombus



Interventional Radiology

- Radiologists use per-cutaneous techniques under imaging control to guide small instruments through the blood vessels or other pathways to treat disease.
- These procedures are typically much less invasive.
- Imaging modalities:
 1. X-ray/fluoroscopy/DSA
 2. CT
 3. US
 4. MRI (limited)

Basic Interventional Techniques

Endovascular IR:



Complication and indication
are not required

- Aneurysm Repair

- Angioplasty

- Vascular Stents And Filters

- Therapeutic Embolization

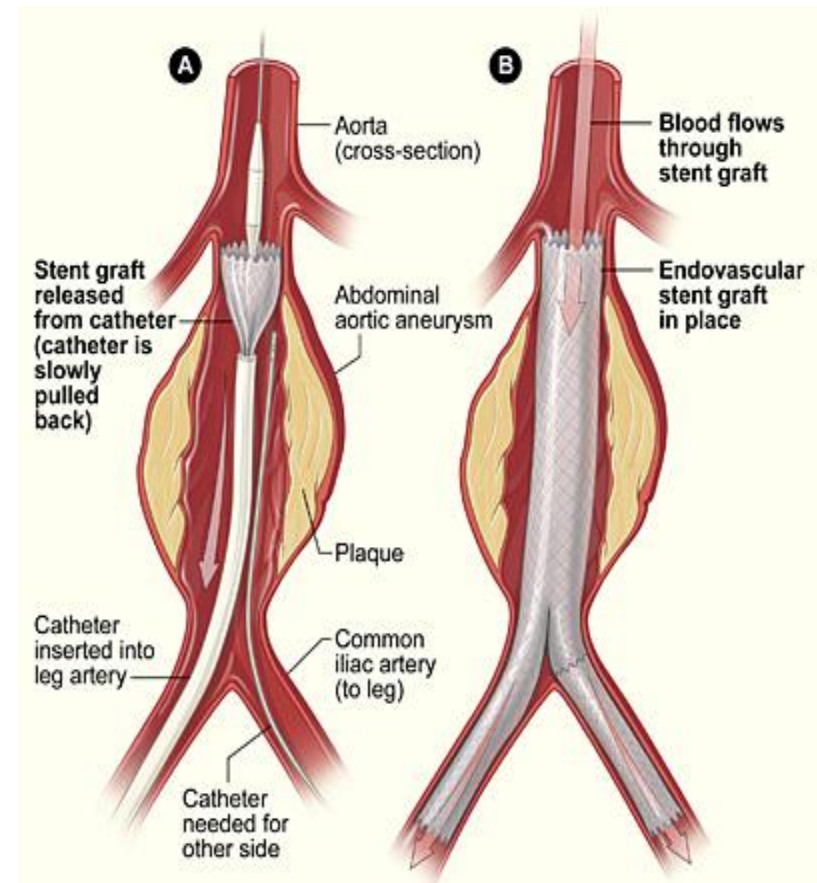
Percutaneous IR:

- Percutaneous Needle Biopsy

- Percutaneous Puncture/Drainage

Endovascular Aneurysm Repair

- For high-risk surgery patients
- Before aneurysm reaches the diameter for elective surgery
- Inserted through femoral artery
- Decreased length of stay in hospital
- Still need monitoring for complications



Angioplasty No stent

■ Technique

During the procedure a balloon catheter is placed **across the lesion** and **the balloon is inflated** and the lesion is compressed. The result is a wider vessel lumen and increased blood flow.

■ Indications

Short vascular stenosis or occlusion in the legs or arms, kidneys, brain or elsewhere in the body.

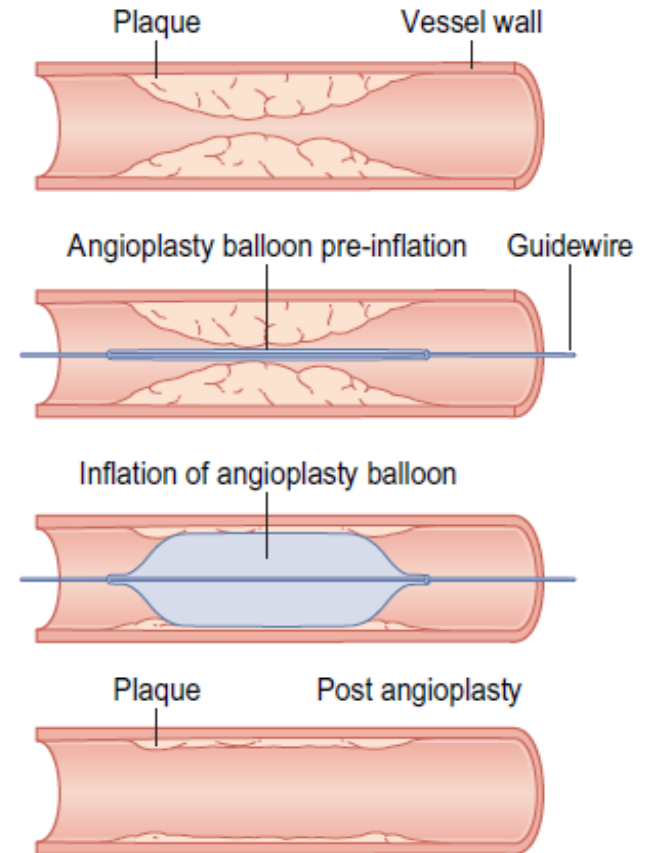
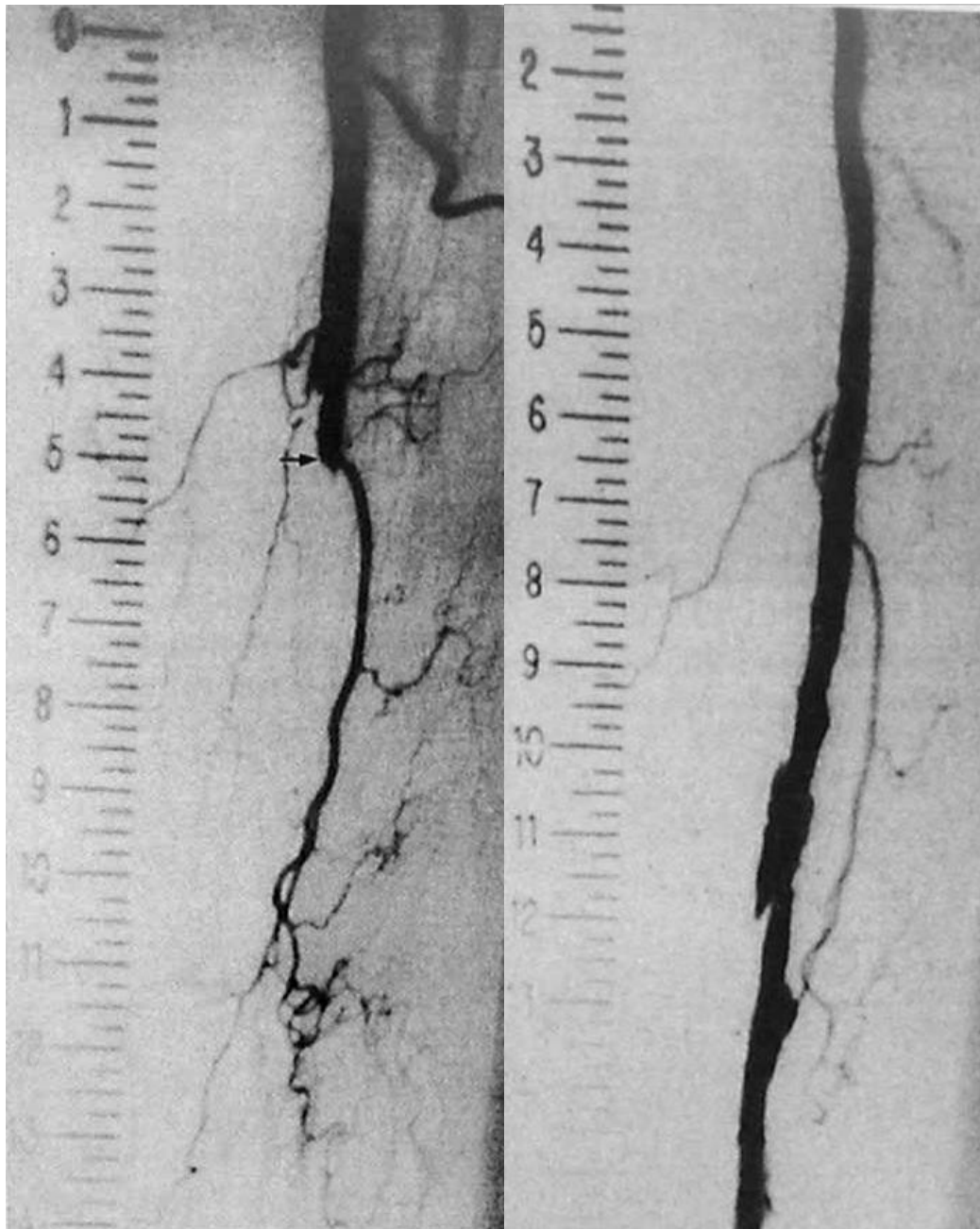


Diagram of angioplasty



DSA showing chronic occlusion
of superficial femoral artery

**Angioplasty of left
femoral artery**

Vascular Stents And Filters

■ Technique

Stents are **expandable metal cylinders** that can be embedded in plastic and collapsed to enable them to be inserted through an artery or vein. Stents help to **hold the artery open**, which improves blood flow and relieves symptoms caused by the blockage.

■ Indications

Vascular stenosis or occlusion

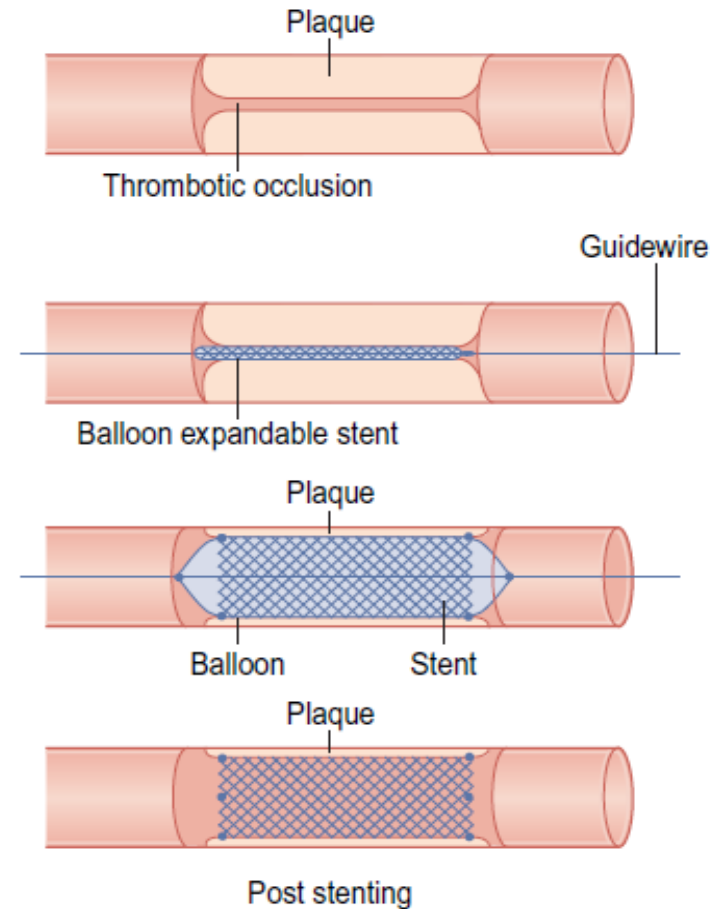


Diagram of stenting

Indications For Stents In Revascularization Procedures



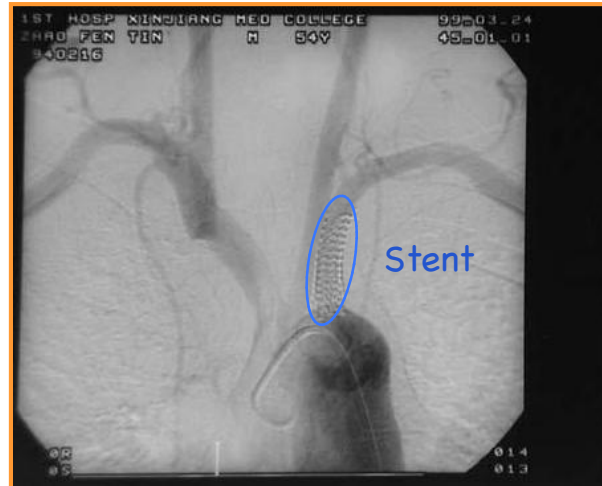
- Unsuccessful PTA (percutaneous transluminal angioplasty)
- Recurrent stenosis after angioplasty.
- Long segment stenosis.
- Total occlusion.
- Hard calcified or ulcerated plaque.

DSA

AP view



Oblique view

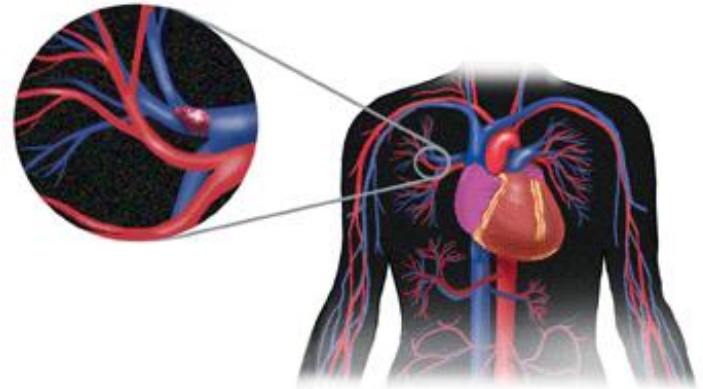


Angioplasty of left subclavian artery

Inferior Vena Cava Filters

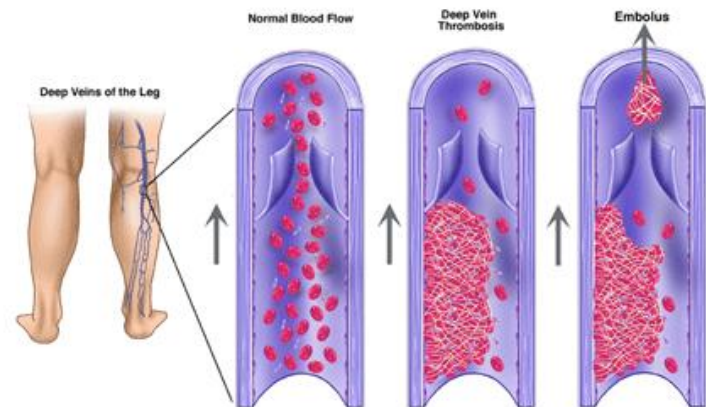
- Inferior vena cava filters can be introduced percutaneously through the femoral vein.
- The filters trap emboli originating from leg or pelvic vein thrombi.
- They are used in patients who are at risk of pulmonary embolism. Prevent DVT

Site of Pulmonary Embolus

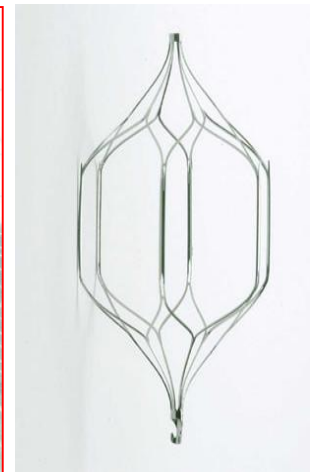
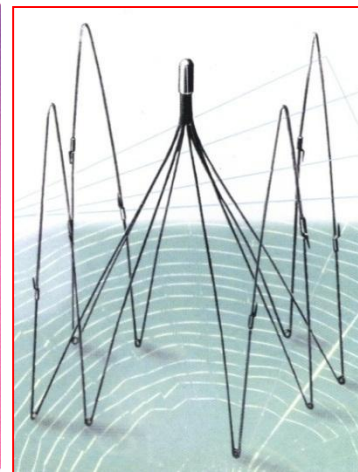
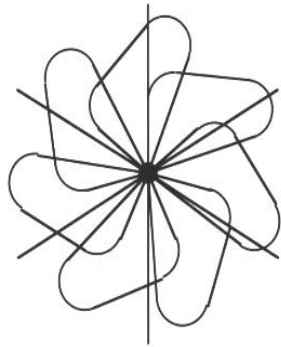
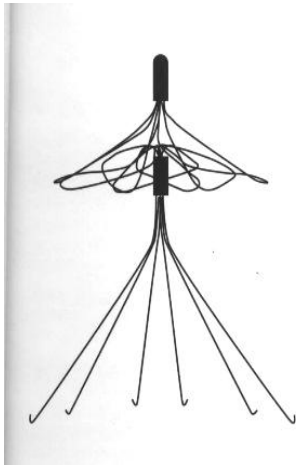
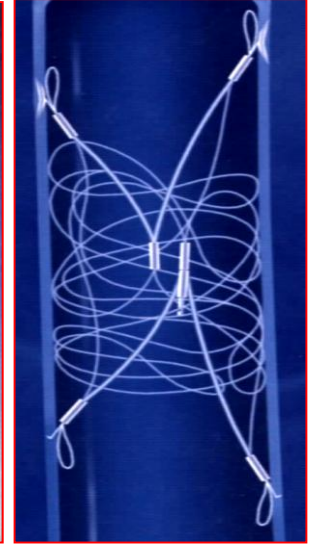
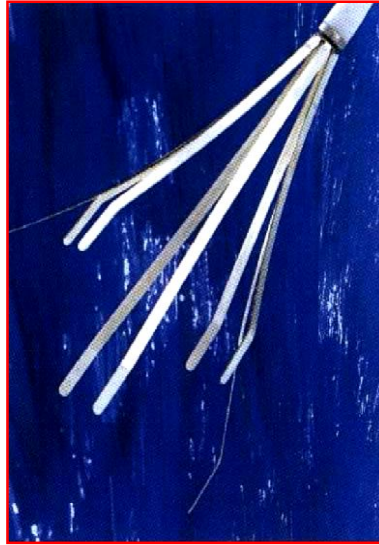
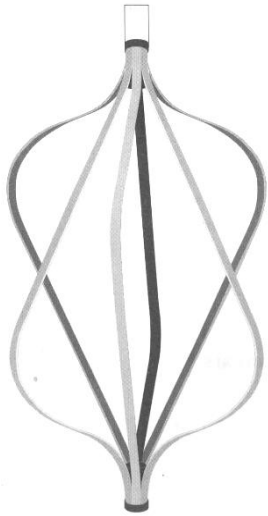


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Deep Vein Thrombosis (DVT)



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Indications For IVC Filters:

1. DVT and/or PE and one of the following:
2. Contraindication to anticoagulation.
3. Failure of anticoagulation.
4. Complication of anticoagulation.

Because IVC thrombosis is a complication of filter placement, **filters are usually placed below the renal veins.**

Complications:



- Filter migration.
- Filter failure (recurrent PE).
- IVC thrombosis
- Groin complications.
- PE after IVC filter may be due to filter thrombosis, collaterals, upper extremity DVT.

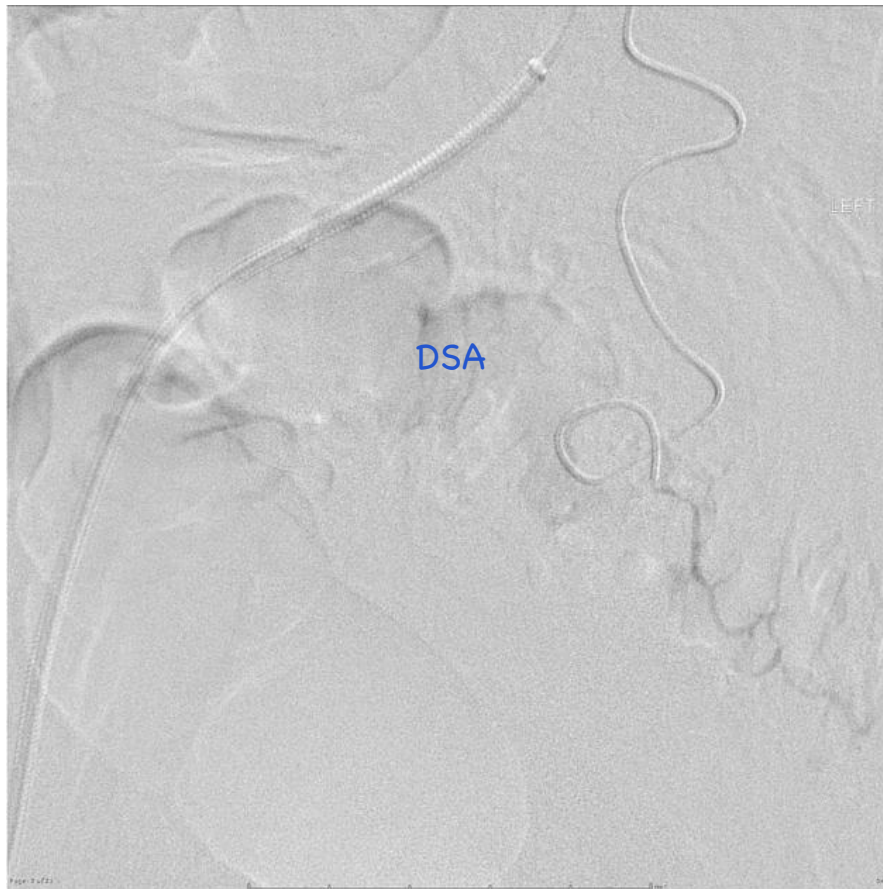
Therapeutic Embolization

Technique:

Introducing a variety of materials through a catheter selectively placed in the vessel.

Indications

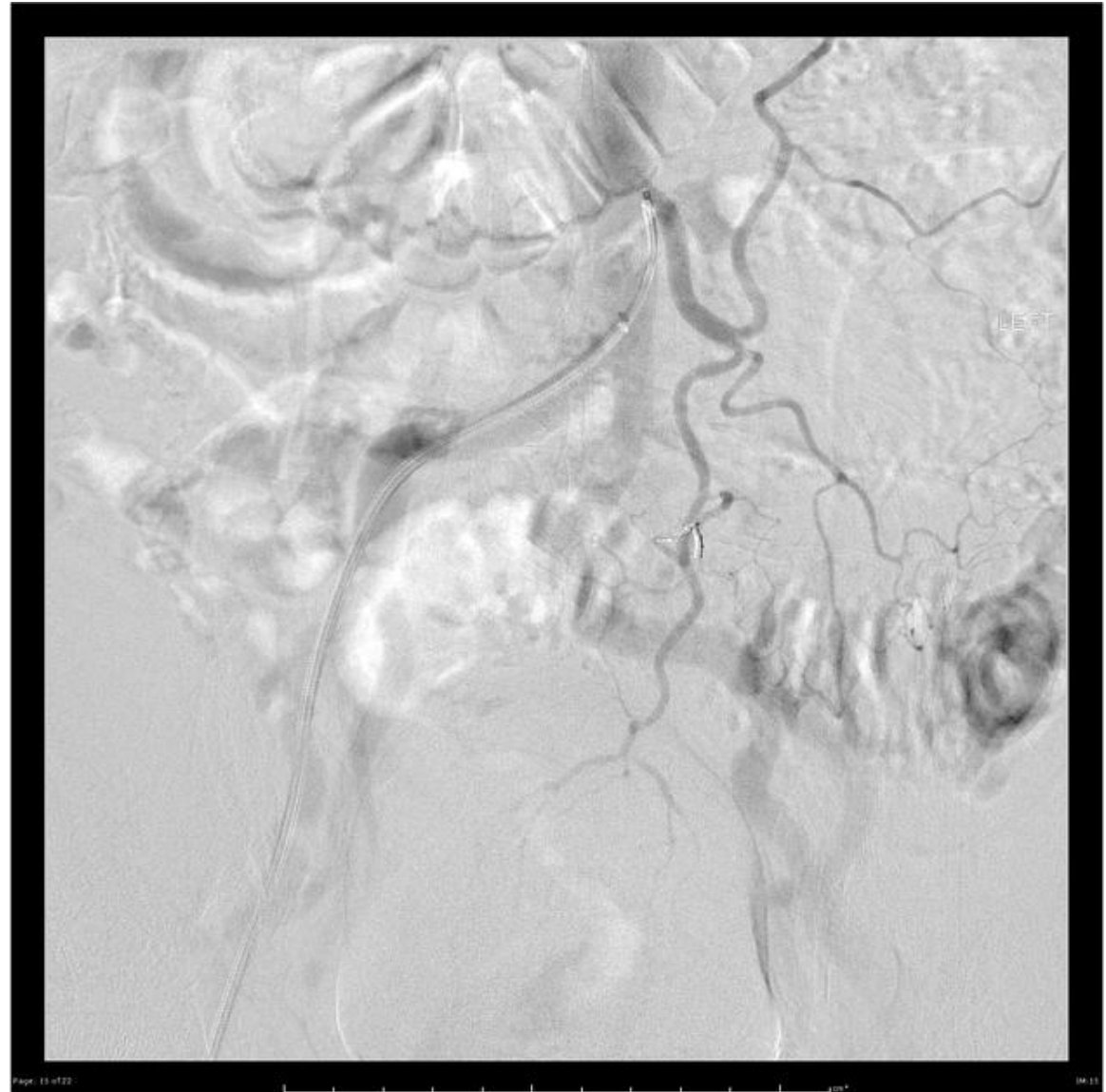
1. Bleeding
2. Tumors
3. Aneurysms
4. Arteriovenous malformations

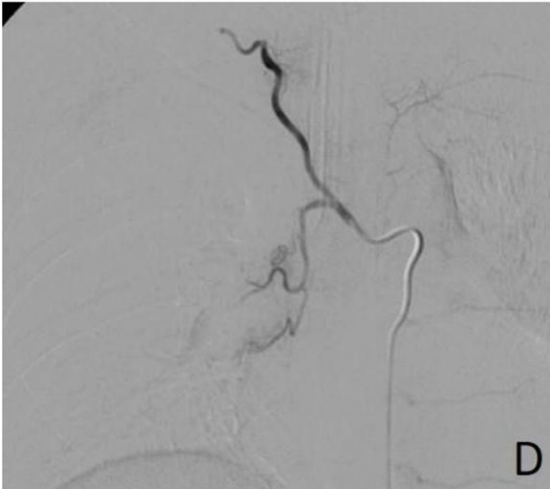
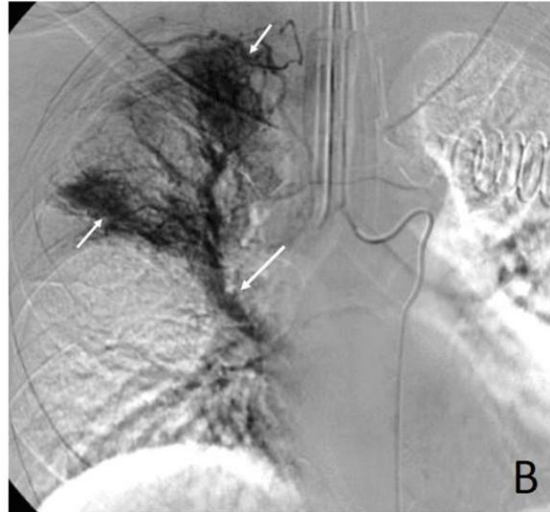


Gastrointestinal (GI) tract bleeding

Angiography demonstrated the bleeding site at a middle sigmoid branch of the IMA.

Post embolization





Hemoptysis

1. The extravasation of contrast medium, local hypervascularity and shunting of contrast from bronchial arteries to pulmonary artery are demonstrated in angiography of bronchial arteries
2. Following embolization with gelatin foam, the bleeding bronchial artery is occluded



Preoperative tumor embolization

- Many tumors such as meningiomas, and renal cell carcinoma are hypervascular thus making surgical resection more difficult and time consuming.
- Embolization of the tumor preoperatively with gelatin foam, particles, coils, and alcohol can make resection easier and faster.

Transarterial Chemoembolization

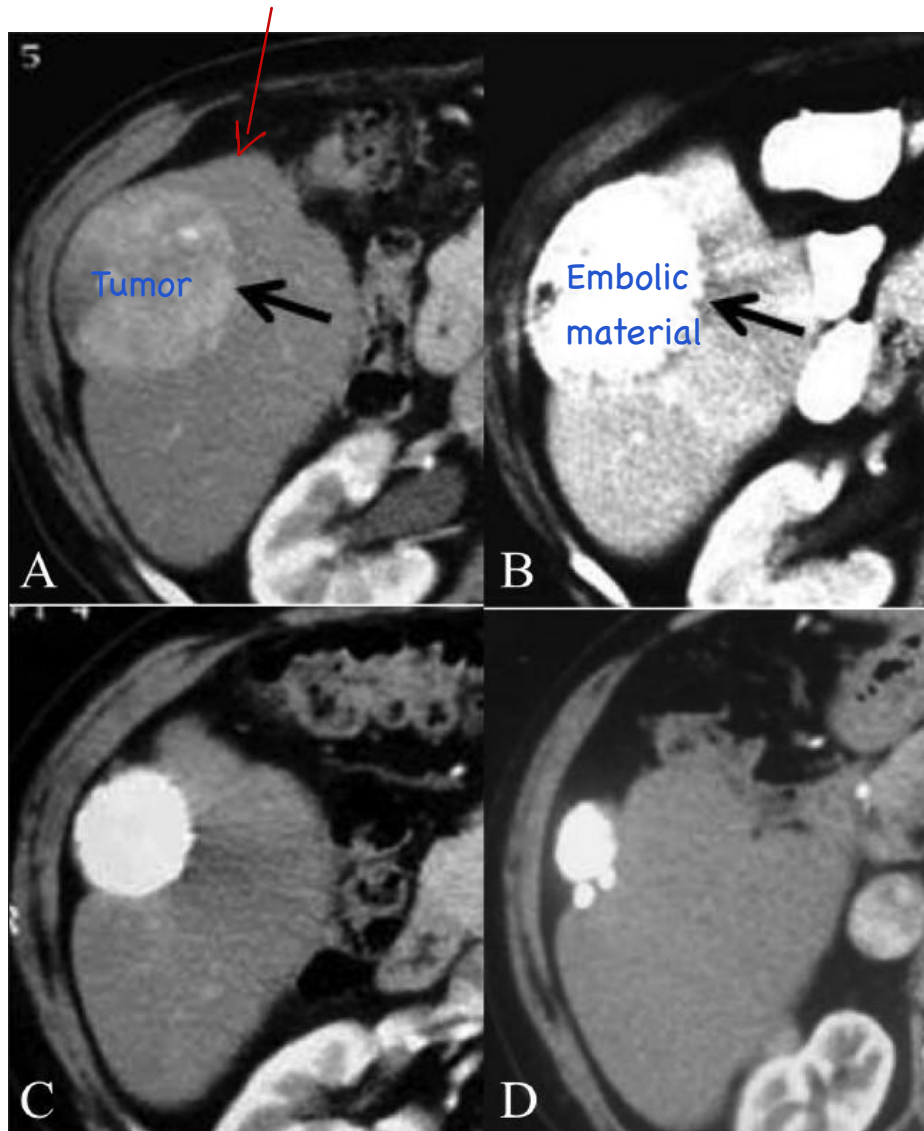
Technique

- Chemotherapeutic agents are usually combined with embolic particles to achieve chemoembolization of hepatic tumors.
- The aim is to cause ischemia and prolonged contact of the chemotherapeutic agent with the tumor.
- Such mixtures can dramatically increase the local concentration of the chemotherapeutic agent.
- The systemic drug levels is lower, thus reducing toxicity.

Survival

- The probability of cancer recurrence and/or metastatic dissemination was lower after TACE than after surgery.

Axial CT scan with contrast



C, D → Post embolization

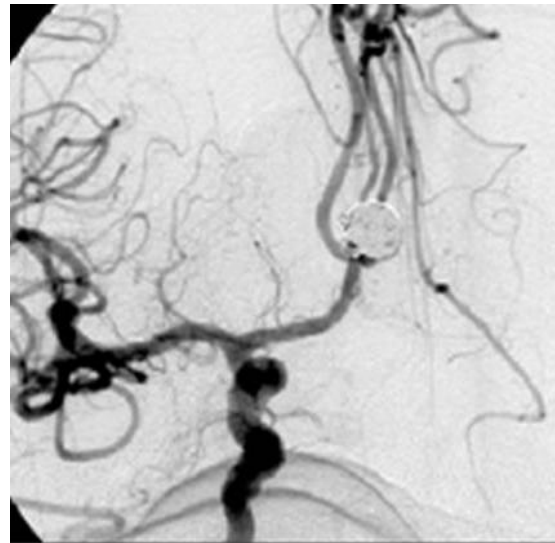


Internal carotid artery

Cerebral aneurysms

Carotid angiogram showing an aneurysm located in the AComA.

The embolization of aneurysm with metal coils is well demonstrated.



Percutaneous Needle Biopsy

Mostly used for deep peritoneal structures

Technique

- A needle is passed to the desired site and a small amount of tissue is removed.
- With a fine needle(20-22 gauge for aspiration, 14-18 gauge for soft tissues, 10-13 gauge for bone)
- material can be obtained for cytology.

Mass

Indications

- Diagnostic test for breast, lung and other cancers
- An alternative to surgical biopsy.



Percutaneous Drainage Of Abscesses And Other Fluid Collections

- CT scan with contrast
- Air and fluid → abscess

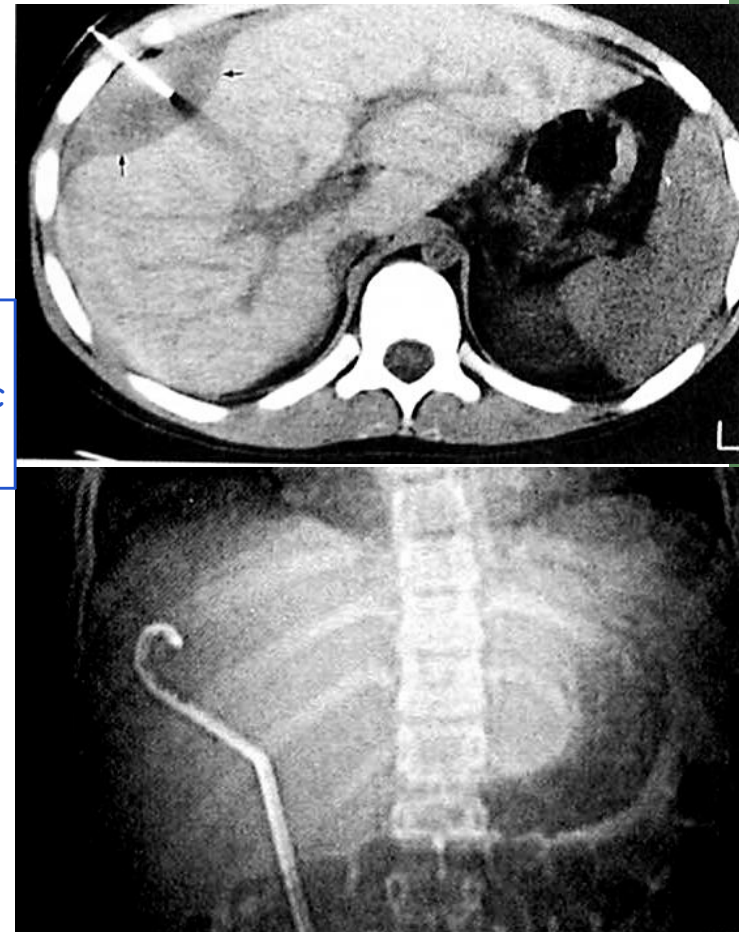
Technique

- The specially designed drainage catheters can be introduced percutaneously into abscesses avoiding the vital organ and allow the pus to drain for several days.

We can't use ultrasound bec of ribs

Indications

- Abdominal abscesses



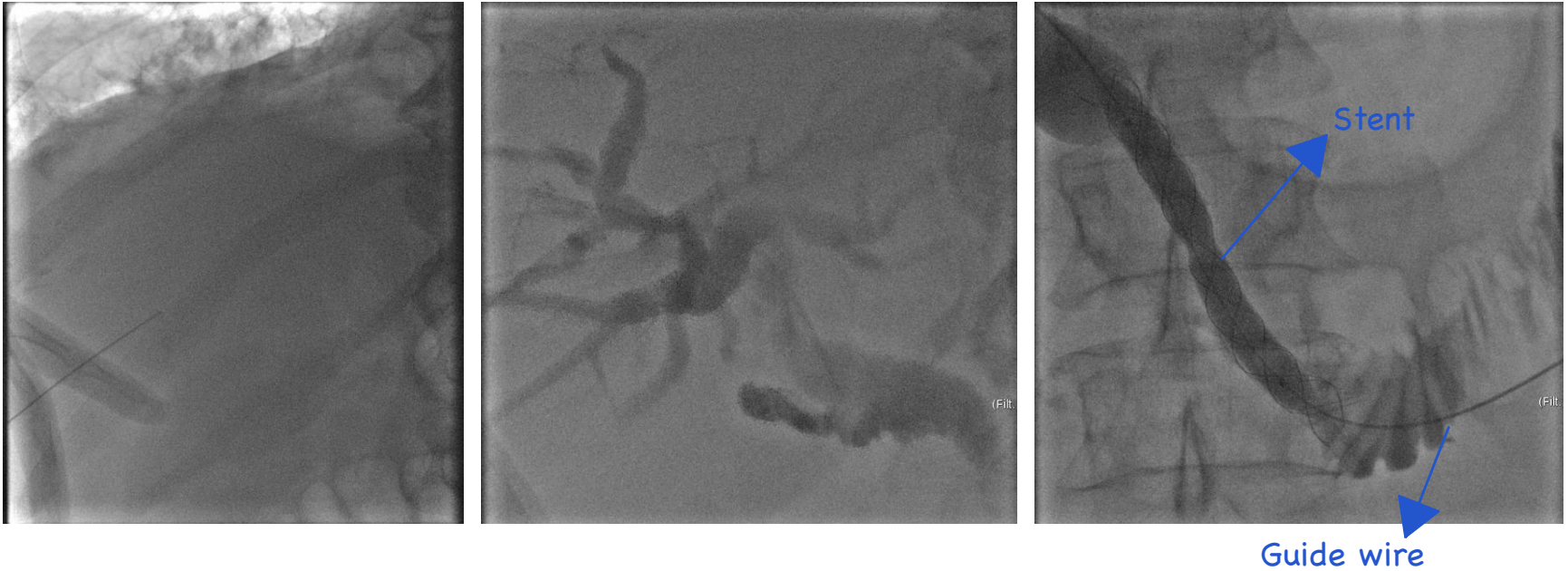
Drainage Of The Biliary System

Technique

- Uses a stent (small mesh tube) to open up blocked ducts and allow bile to drain from the liver.
- Stent helps to hold the bile duct open, which improves biliary flow and relieves symptoms caused by the obstruction.

Indications

- An obstructed biliary system due to tumors or stones



Percutaneous Insertion Of A Stent To Bypass An Obstruction In The Common Biliary Duct

Filling defect



Thank You !

