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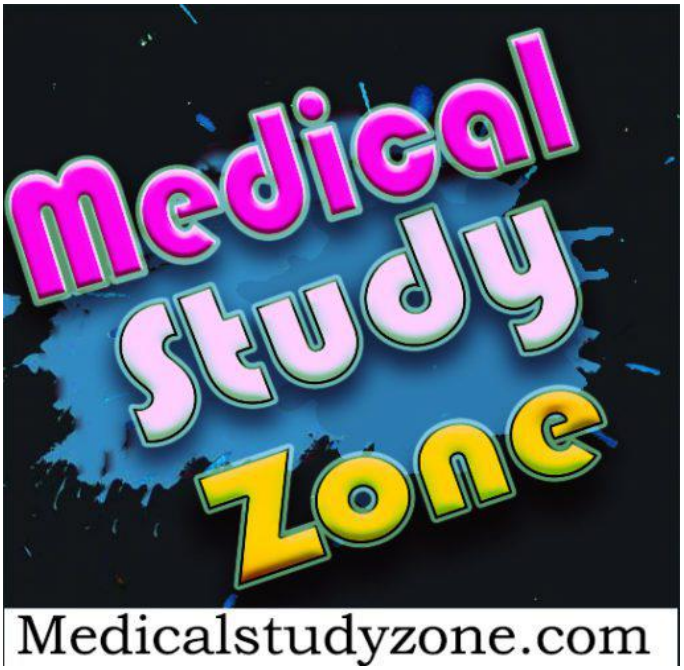


INTRODUCTION TO RADIOLOGY

Father of radiology	→ W.C. Roentgen [discovered X-ray on **8th Nov, 1895**] (8th Nov - International day of radiology) → Theme for 8th Nov, 2019 - Sports imaging
Father of radioactivity	→ Henry Becquerel
Father of Interventional radiology	→ Charles Dotter (Contributed for balloon angioplasty)

Important scientists in Radiology

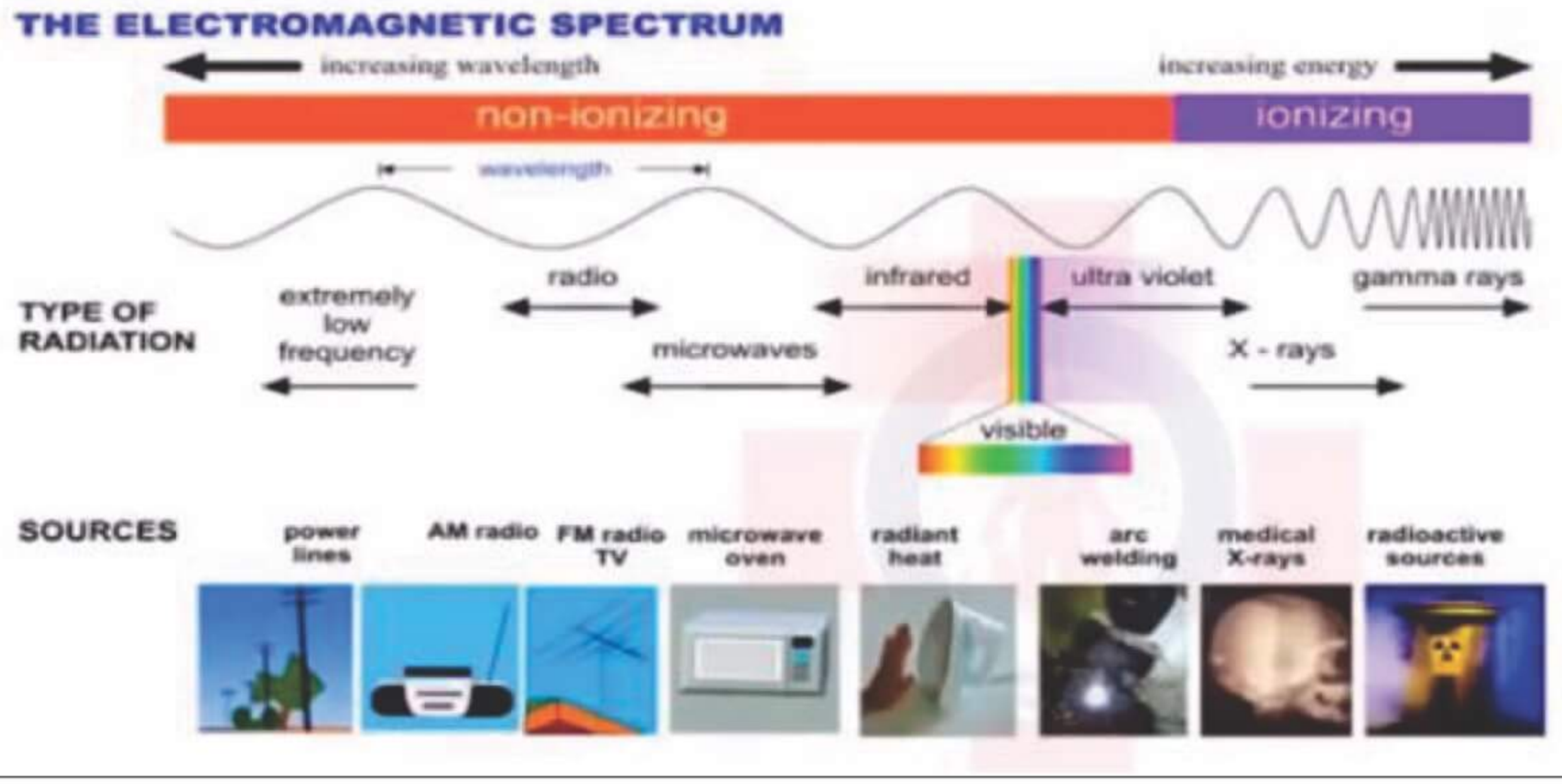
→ X-ray	W.C. Roentgen
→ CT scan	Sir Godfrey Hounsfield
→ Medical USG	John Wild
→ Obstetrics USG	Ian Donald
→ Medical MRI	Paul Lauterbur & Mansfield
→ Principal of NMR (Nuclear magnetic resonance)	Felix Bloch & Purcell

Basic Terminology

	White	Black
X-rays	Radio opaque	Radiolucent
CT scan	Hyperdense	Hypodense
USG	Hyperechoic	Hypoechoic
MRI	Hyperintense	Hypointense

Types of Radiation

Ionizing radiation	Non-Ionizing radiation
→ Electromagnetic • X-rays • γ-rays • Cosmic rays → Particulate beams • α-ray • β-ray • Protons • Neutrons	→ Electromagnetic • U.V rays • Visible light • Infrared rays (used in thermography) • Radio waves (used in MRI) • Microwaves



Q. X -rays differ from γ– ray in all the following except?

a) Wavelength b) Frequency

c) Energy d) Velocity

e) Origin

ANS: d) Velocity

Explanation

→ Wavelength, Frequency & Energy

- Frequency – γ rays > X rays
- Energy – γ rays > X rays
- Wavelength – X rays > γ rays

→ All electromagnetic radiations have the same Velocity (3×10^8 m/s)

→ Origin

- X rays – Extranuclear
- γ rays – Intranuclear

$E \propto \nu/\lambda$

→ E – Energy

→ ν – Frequency

→ λ – Wavelength

Diagnostic Modalities		
Non-ionizing Radiation	**Ionizing Radiation**	
• USG • Doppler • MRI • MRCP • Thermography	**γ– ray**	**X -ray**
	• Scintigraphy (Tc^{99m}/ Radioisotope) • Bone Scan (Tc^{99m} – MDP studies) • SPECT scan (Single photon emission computerized tomography) • PET scan (Positron emission tomography)	• Radiography • Fluoroscopy • Angiography • Mammography • CT scan • Bronchography • Barium Studies • DEXA scan (Dual Energy X-ray Absorptiometry) • IVP/ IVU (Intravenous pyelography/ Intravenous urography) • Hysterosalpingography (HSG) • Micturation cystography (MCU) • Retrograde urethrography (RGU) • Endoscopic retrograde Cholangio pancreatography (ERCP)

Wilhelm Conrad Roentgen

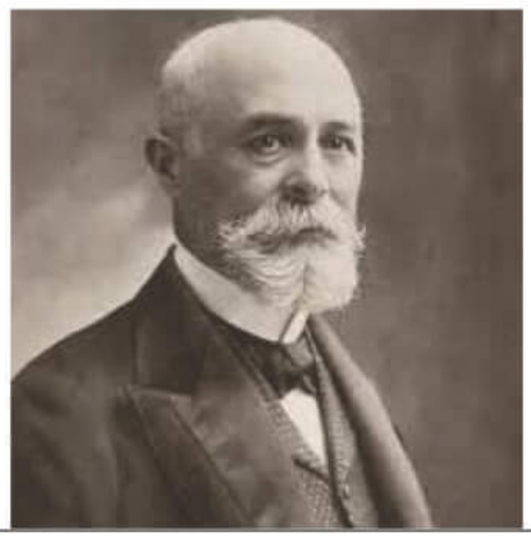
→ Father of radiology
→ German physicist
→ Awarded noble prize in 1901
→ Discovered X-ray on 8th Nov, 1895

Sir Wilhelm roentgen

1st X-ray taken was Roentgen's wife "Bertha's hand"

Henry Becquerel

→ Father of radioactivity



Ionizing power / Damaging power:

α- Rays > β -Rays > X-rays > ɣ-rays

Note

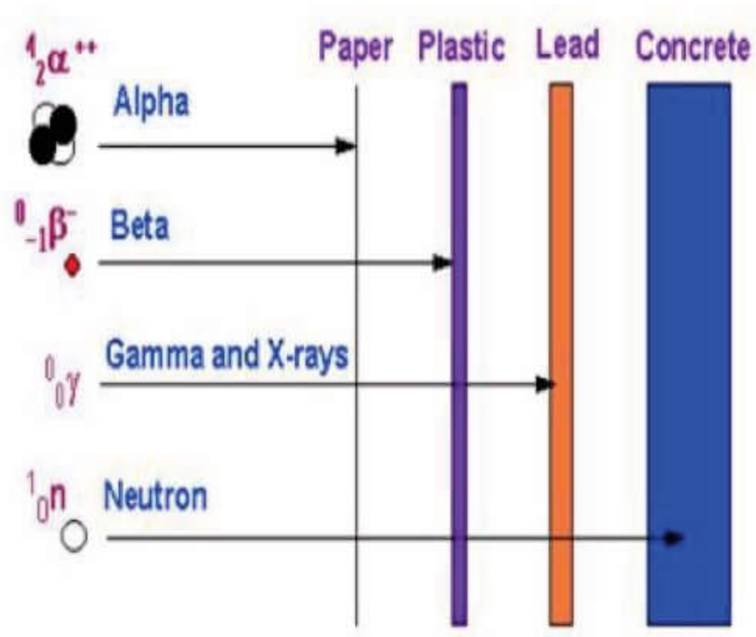
α - Rays → Maximum linear energy transfer

Penetration power

α -rays> X-rays >β – rays > α -rays

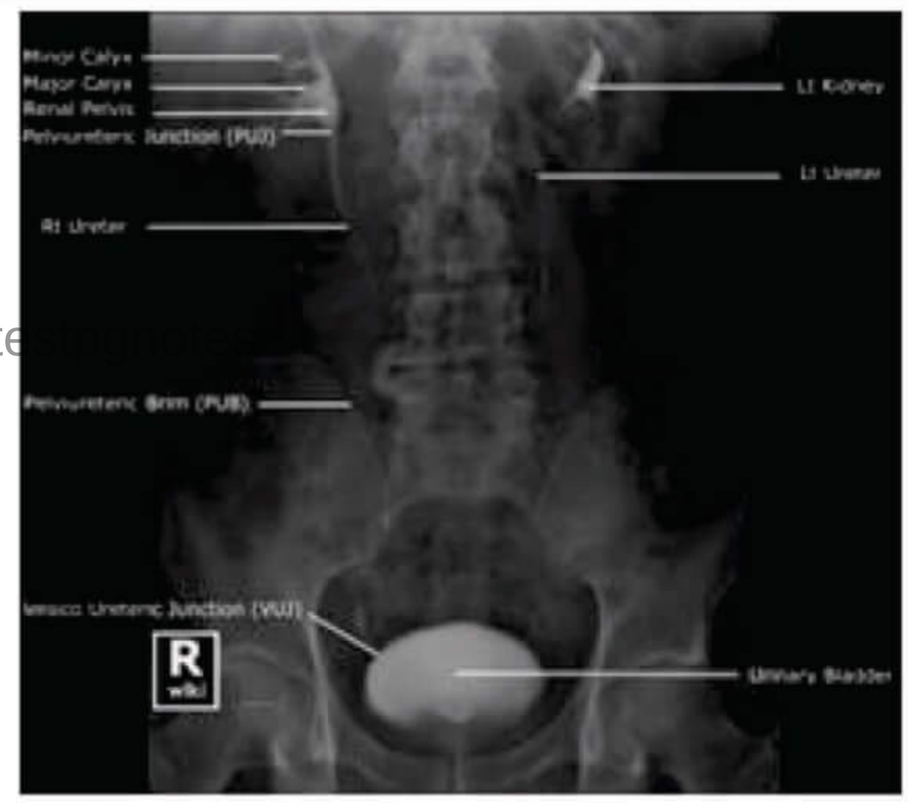
Note

If neutrons given in option then → n > ɣ > X >β > α rays



Identify the Investigation given below

Intravenous Pyelography

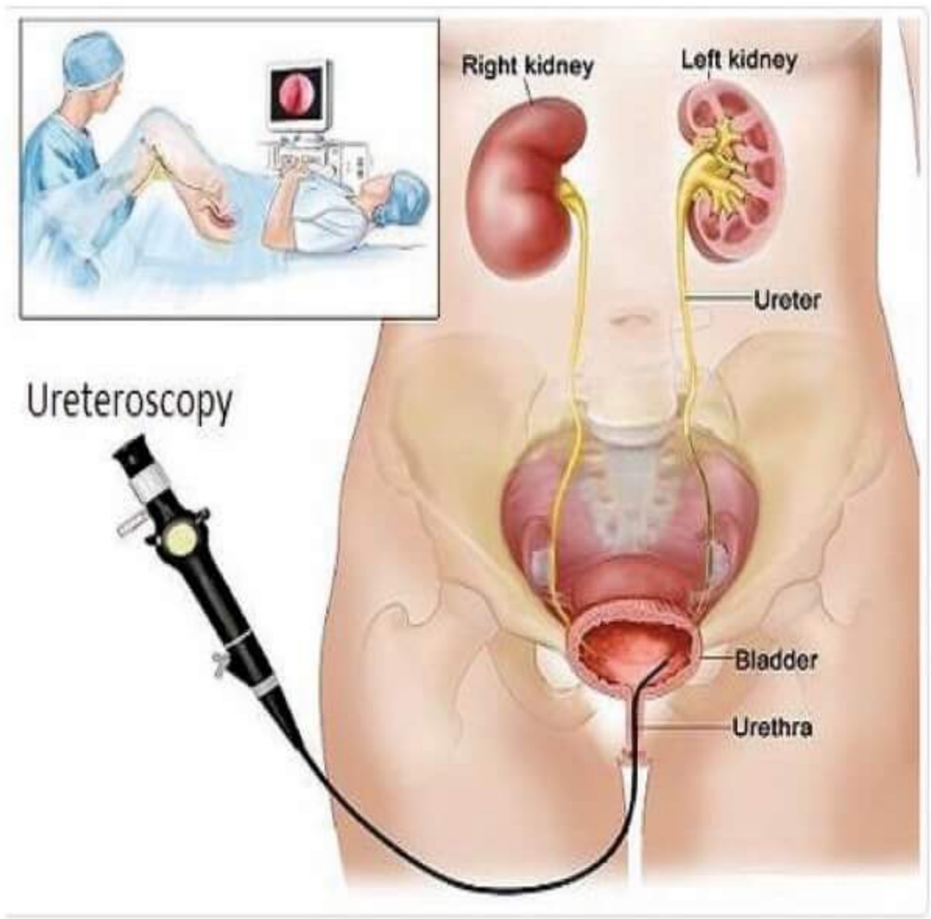


Pyelogram – Showing Minor & Major Calyx

Intravenous Urography

Nephrogram	Pyelogram
- Able to view Kidney shadow	- Able to view pelvic calyceal system & ureter
Note: In adult polycystic kidney disease ↓ Swiss cheese appearance – nephrogram	Note: In adult polycystic kidney disease ↓ Pyelogram Spider leg appearance on pyelogram
 Nephrogram	 Pyelogram

Identify the Investigation given below



Retrograde pyelogram

Identify the given plain X-ray image

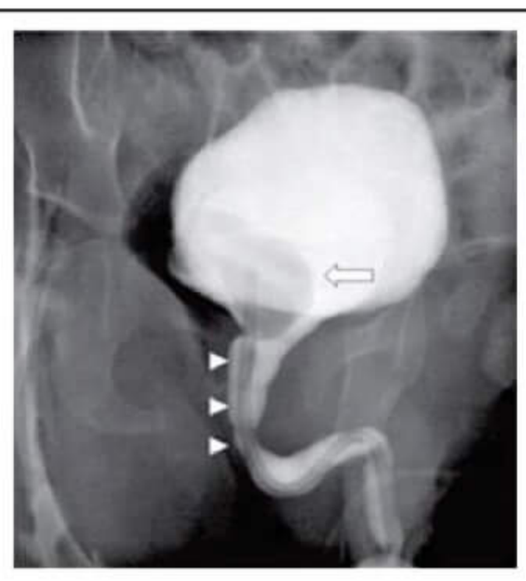
Staghorn calculi

Micturating cystourethrography:

→ Also known as voiding cystourethrography

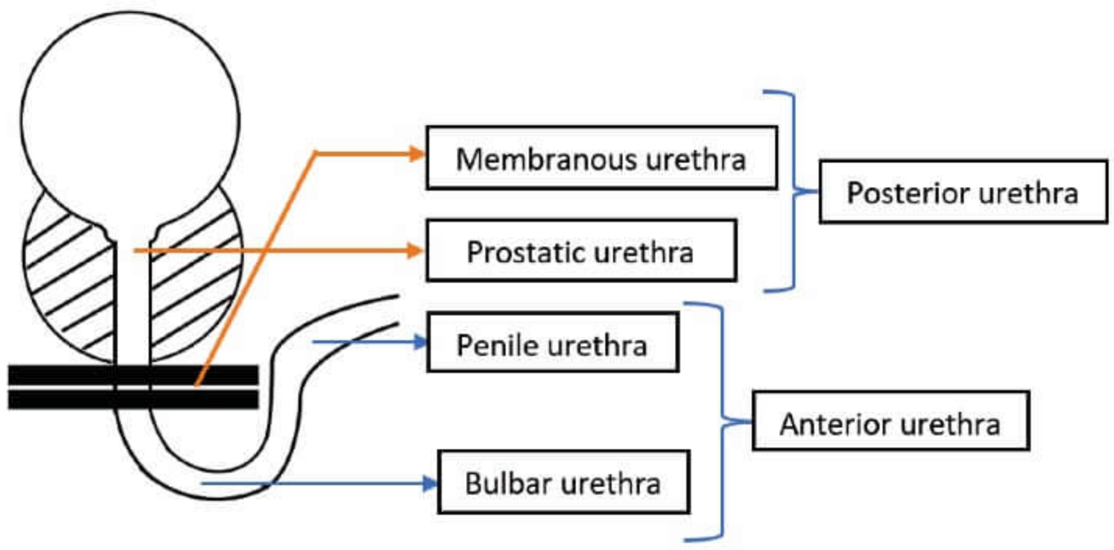
→ IOC for vesicoureteral reflex

→ Also used to evaluate **posterior urethra**



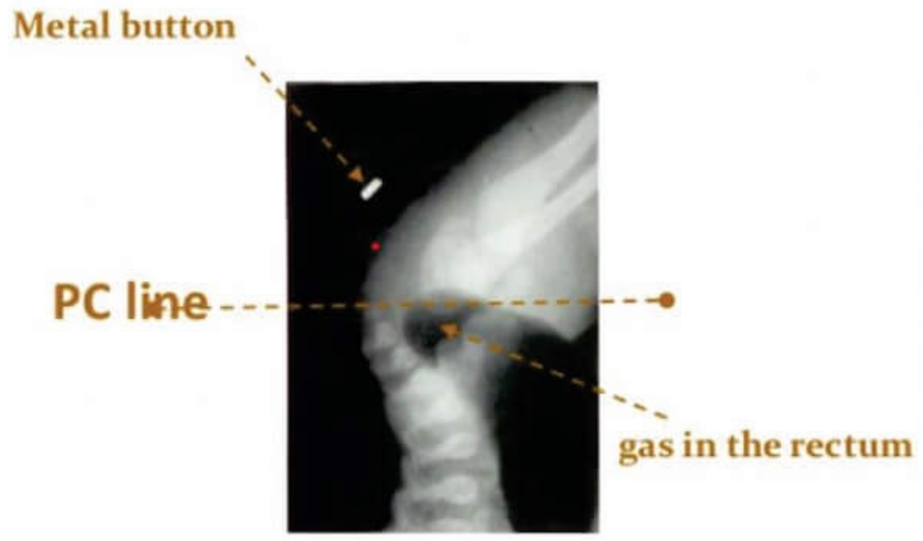
Identify the procedure being performed

Retrograde Urethrography



→ It is used to evaluate **anterior urethra**

Identify the investigation being performed



Invertogram

→ Used to evaluate anal atresia

→ To know high anal or low anal atresia

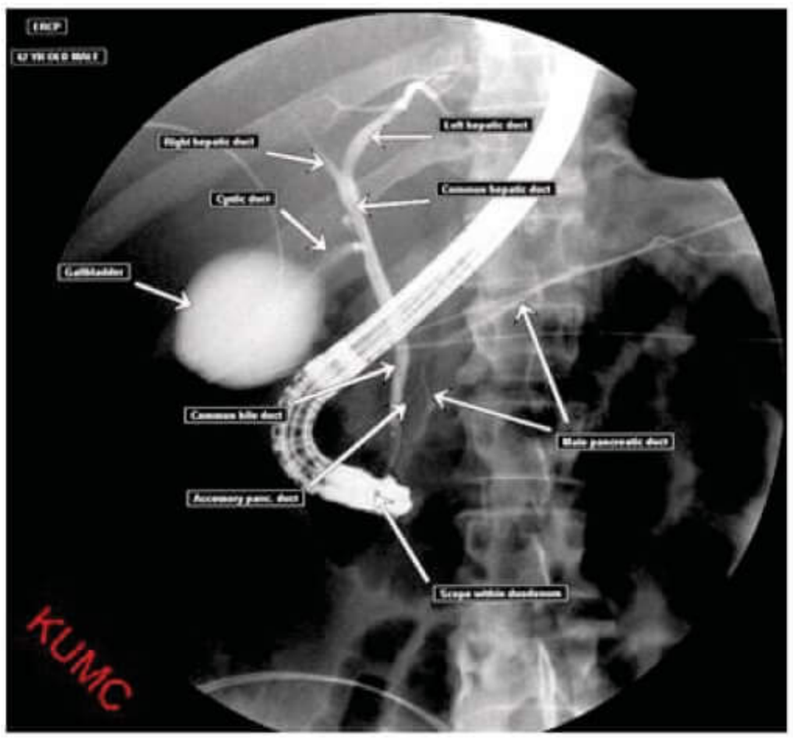
→ Done 18-24 hrs after birth with baby upside down position

→ Then the distance between metal button on anal dimple to air in rectum is measured

→ If distance is > 2 cm - high anal atresia

< 2cm - low anal atresia

Identify the investigation

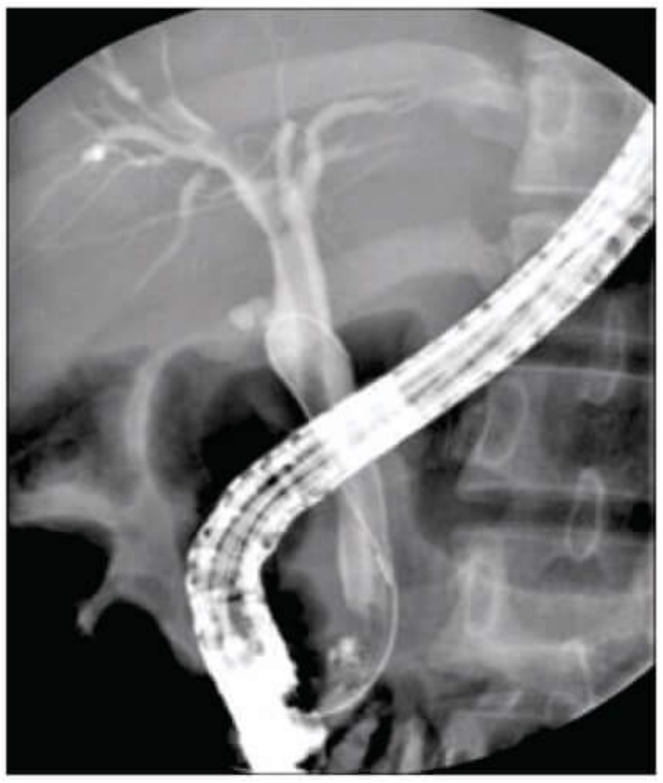


ERCP

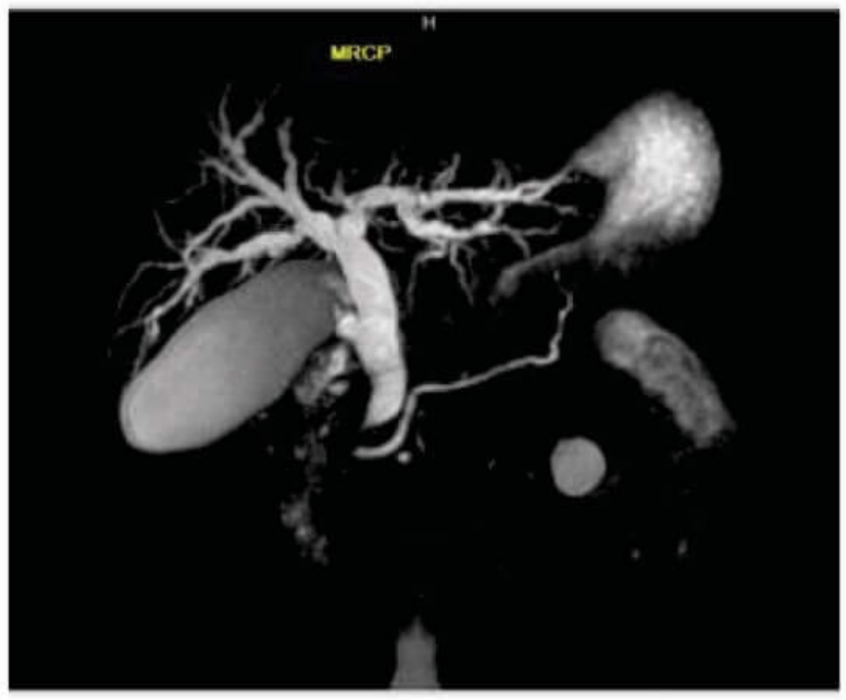
ERCP (endoscopic retrograde cholangiopancreatography)

→ After inserting endoscope dye is injected through the ampulla of Vater

→ If linear lucency is seen in CBD on ERCP indicates biliary ascariasis



ERCP showing linear lucency in CBD - Biliary ascariasis



MRCP

→ It is a non-contrast study

→ T_2 W image

Radiation Units

	Conventional	S.I
Exposure dose	Roentgen	Coulomb / kg
Absorbed dose	Rad	Gray → 1 Gray = 100 Rad → 1 Rad = 0.01 Gray
Equivalent dose	Rem	Sievert → 1 SV = 100 Rem → 1 Rem = 0.01 SV
Effective dose	Rem	Sievert
Radio activity	Curie	Becquerel → 1 Bq = 1 disintegration/sec → 1 curie = 3.7×10^{10} Bq

Equivalent dose

→ Takes into consideration the radiation quality factory (RQF)

Note:

- RQF for α-rays = 20
- RQF for X-rays & γ-rays = 1

Effective dose

→ Takes into consideration tissue susceptibility/ tissue weighting factor

PACS Stands for - Picture Archiving and Communication system

DICOM Stands for - Digital Imaging and Communication in Medicine

ALARA Stands for – As low as Reasonably Achievable

10 Days rule

→ It states all diagnostic modalities using ionizing radiation in a female of reproductive age group should be limited to first 10 days of her menstrual cycle to avoid injury to any undiagnosed pregnancy.

28 Days rule

→ Menstrual cycle varies, generally it is of 28 days. If a patient is to be exposed to ionizing radiation for diagnostic purposes & the patient is of child bearing age, she should be booked in the first 10 days of the menstrual cycle, when conception is unlikely to have occurred.

TLD Batch: (Thermoluminescent dosimeter)

→ Detect the amount of radiation an occupation worker has been exposed.

→ It is made up of lithium fluoride (LiF) or $CaSo_4$ Dysprosium.

→ It is worn under lead apron.

AERB guidelines for radiation protection

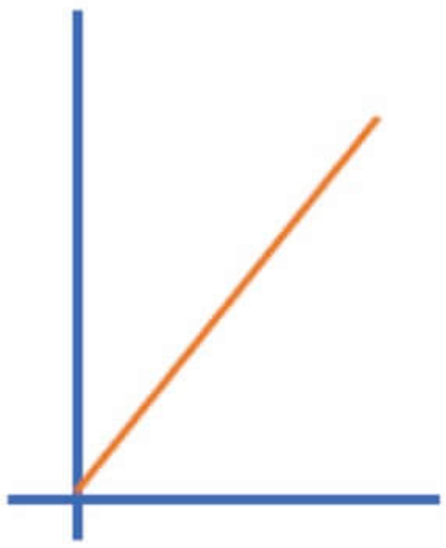
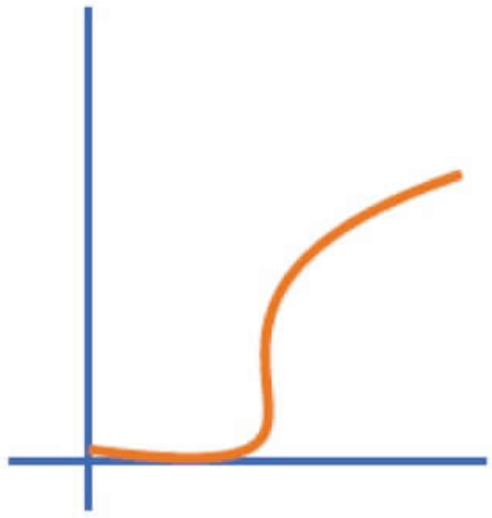
Dose Limitations		
Parts of the body	**Occupational Exposure**	**Public Exposure**
Whole body (Effective dose)	• 20 mSv/ year averaged over 5 consecutive years • 30 mSv in any single year	1 mSv/y
Lens of eyes (Equivalent dose)	150 mSv in a year	15 mSv/y
Skin (Equivalent dose)	500 mSv in a year	50 mSv/y
Extremities (Hands and Feet) Equivalent dose	500 msv in a year	
For pregnant radiation workers, after declaration of pregnancy 1 mSv on the embryo/ fetus should not exceed.		

Acute radiation syndromes

→ An exposure of 1-2 GY radiation can cause acute hematopoietic syndrome

→ An exposure of 6-10 GY radiation can cause acute GI syndrome

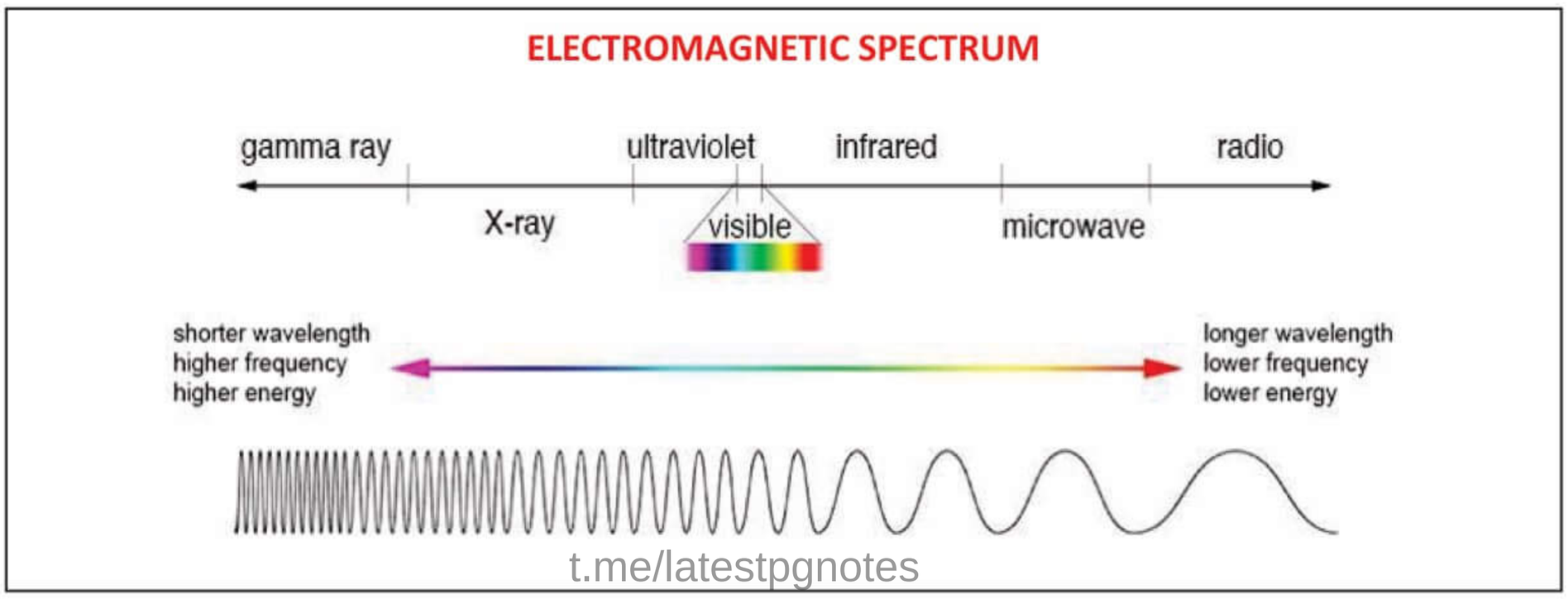
→ An exposure of 20 GY radiation can cause acute CNS syndrome

Stochastic	Deterministic (Non-stochastic)
→ They are not dose dependent	→ They are dose dependent
→ They have no threshold	→ They have a threshold
→ They can occur at low doses	→ They occur at high doses above threshold
→ Severity of effect is not related to dose, but probability of occurrence of stochastic effects increases as the dose increases	→ Severity of effect in directly proportional to the absorbed close
→ It has linear relationship between absorbed dose and probability of effect, with no threshold 	→ It has non-linear relationship with Threshold 
Examples: → Hereditary effects, cancers, genetic mutations, chromosomal aberrations	**Examples:** → Somatic effects like skin erythema, cataracts, infertility → Acute radiation syndromes like hematopoietic syndrome, gastrointestinal syndrome and cardiovascular syndrome

X-ray PART -1

Topic covered

- → Mechanism of X-ray generation
- → Components and function of X – Ray
- → Physic of X- Ray Generation
- → X-Ray views
- → Computerized radiography
- → Direct distal radiography



X -RAY

- → First discovered by: W.C. ROENTGEN 8th November 1895
- → **Properties of X- ray**
  - Electromagnetic radiation
  - Ionizing radiation
  - Wavelength: 0.1 – 1A° or 0.01nm -0.1nm
  - Speed (same for all electromagnetic radiation): 3 X 10^8 mt/sec

X-RAY TUBE

- → Vacuum containing glass tube made of - Pyrex glass
- → Cathode and target of anode made of – TUNGSTEN
- → TUNGSTEN
  - High melting point
  - High tensile strength
- → Thinning of glass tube allows X Rays to come out- Window of X – ray tube

→ Cathode gets heated up due to potential difference

↓

Ejects electron via thermionic emission

↓

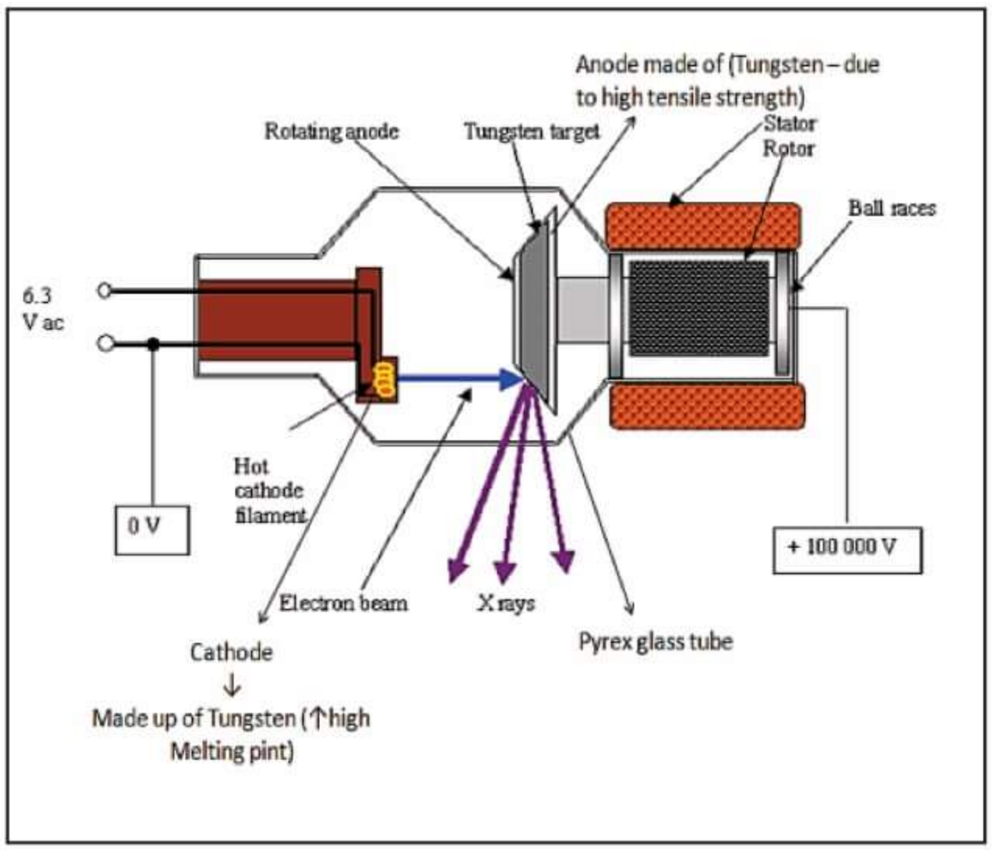
Attracted toward target of anode

↓

X Rays are generated

↓

Come out via window of X ray tube

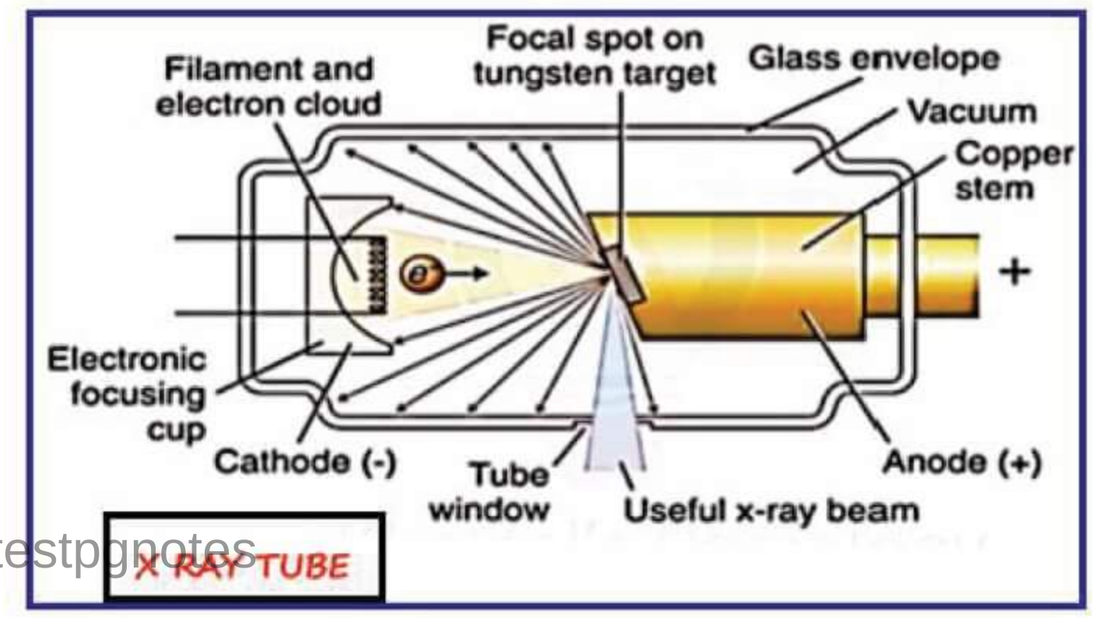


PARTS

→ Cathode – **Tungsten**

→ Anode / target – **Tungsten**

→ Focusing cup – **Nickel**

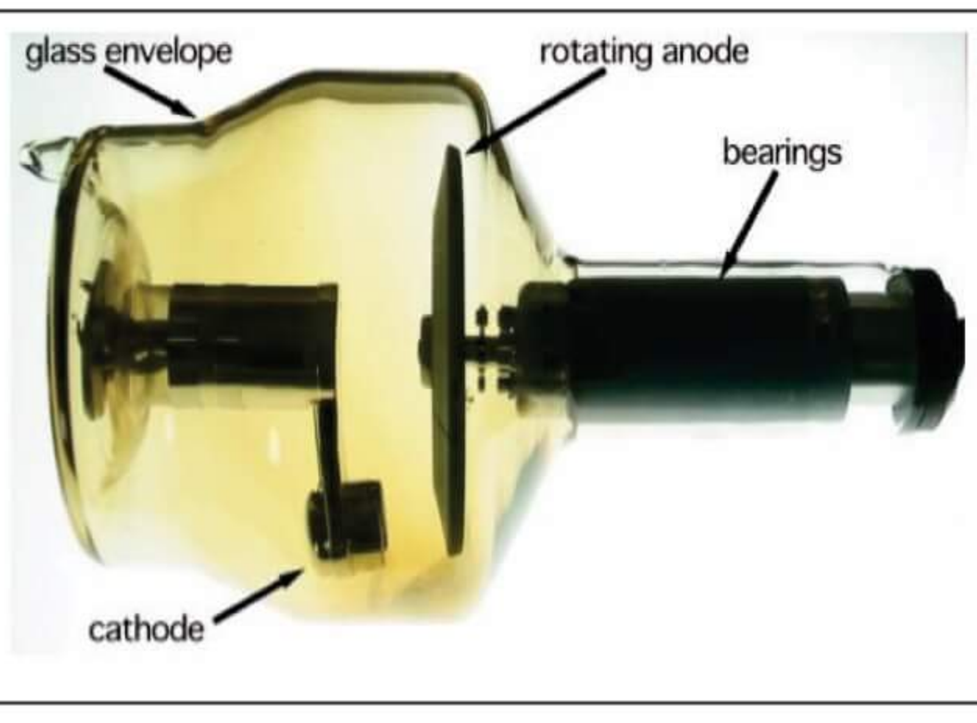


Modern X-ray Tube

→ **Motor attached** – creates rotatory anode

→ Target of Rotatory anode is made of **tungsten + Rhenium** (to increase tensile strength)

→ **Cathode** – made of **tungsten + thorium** (to increase melting point)



Q. Chief source of X – Ray generation in Radiology?

a) Thermionic emission b) Bremsstrahlung radiation

c) Photoelectric effect d) Compton effect

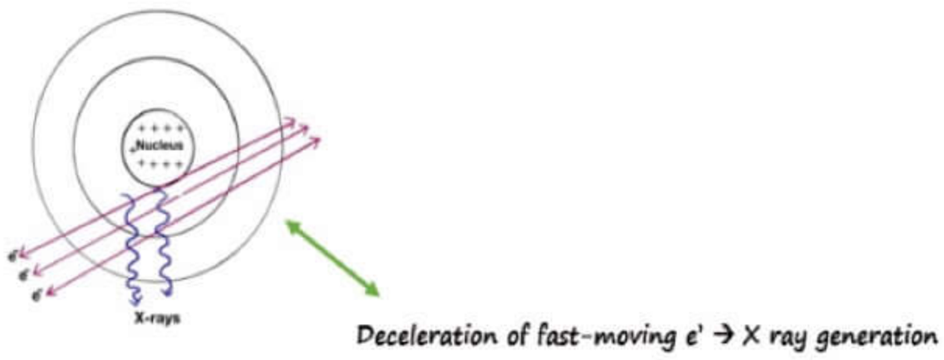
ANS: b) Bremsstrahlung radiation

Thermionic emission

→ At cathode

→ Generation of electron beam

Bremsstrahlung radiation / breaking radiation

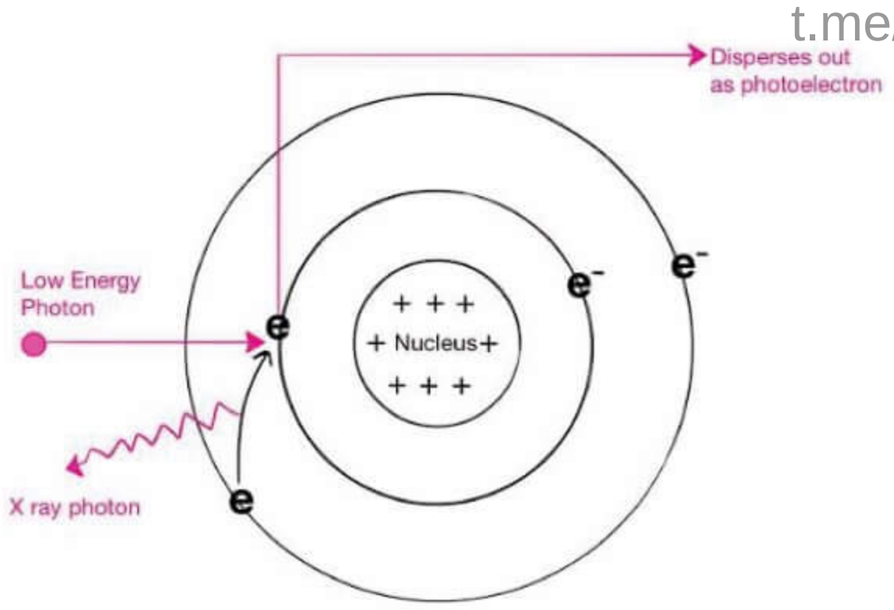


- Leads to generation of Continuous spectrum of varying energies of X Ray

Photoelectric effect

→ Low energy photon interaction with inner shell electron

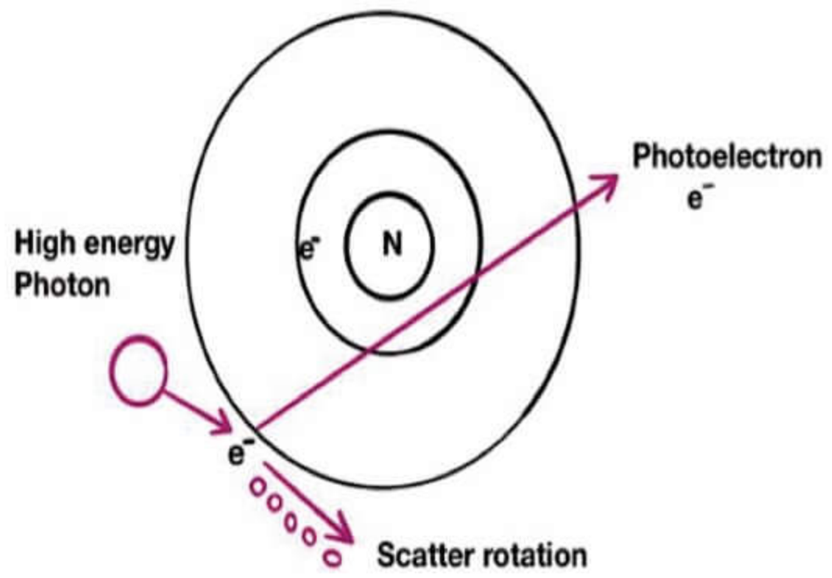
→ Leads to generation of Characteristic X- rays

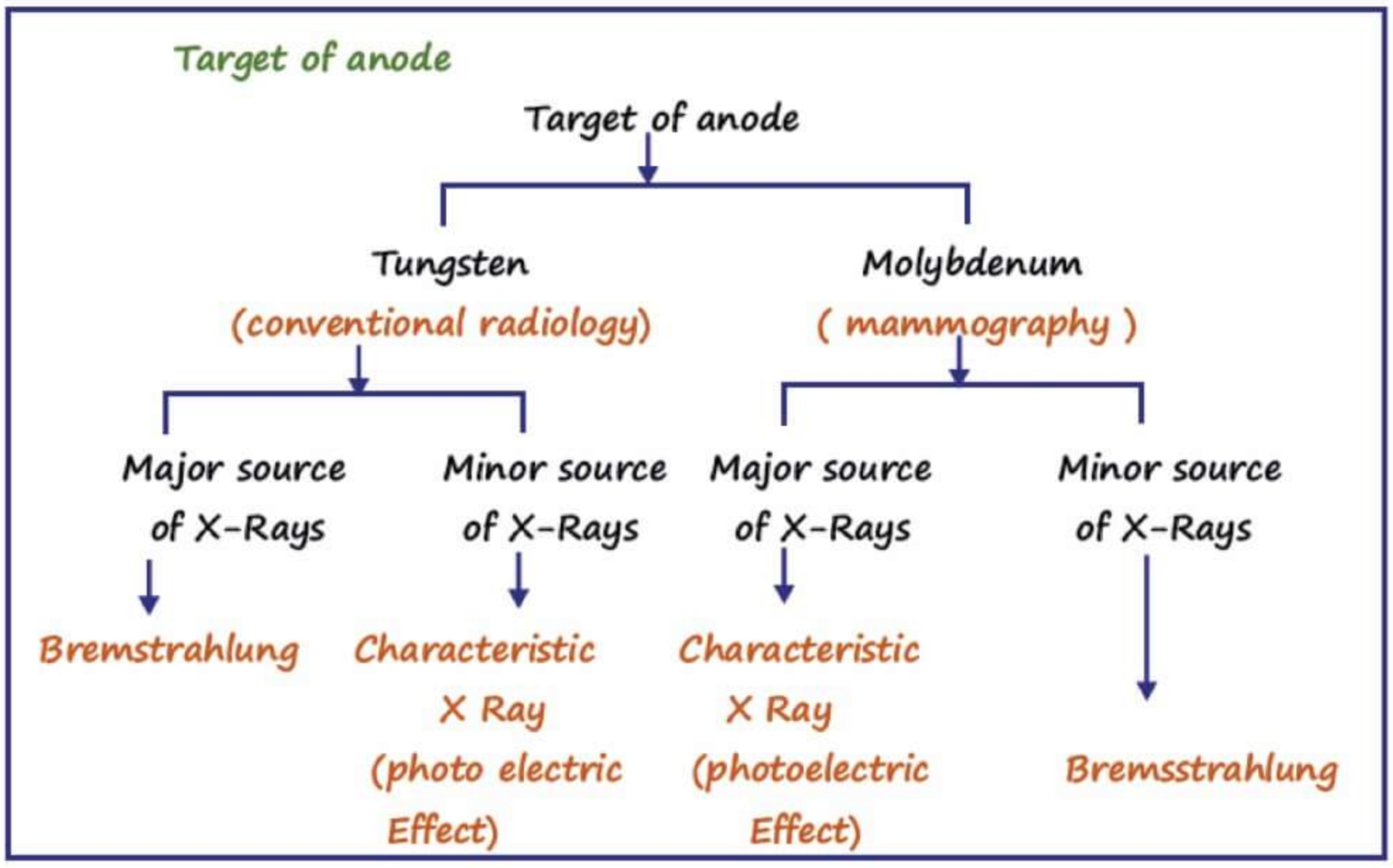


Compton effect

→ High energy photon interaction with outer shell electron.

→ Leads to generation of Scatter radiation in diagnostic radiology





→ Filter

- Made of Aluminum
- Filters out low energy X ray

→ Cones / collimation

- Made of lead
- Convert divergent X Ray beam to directional beam

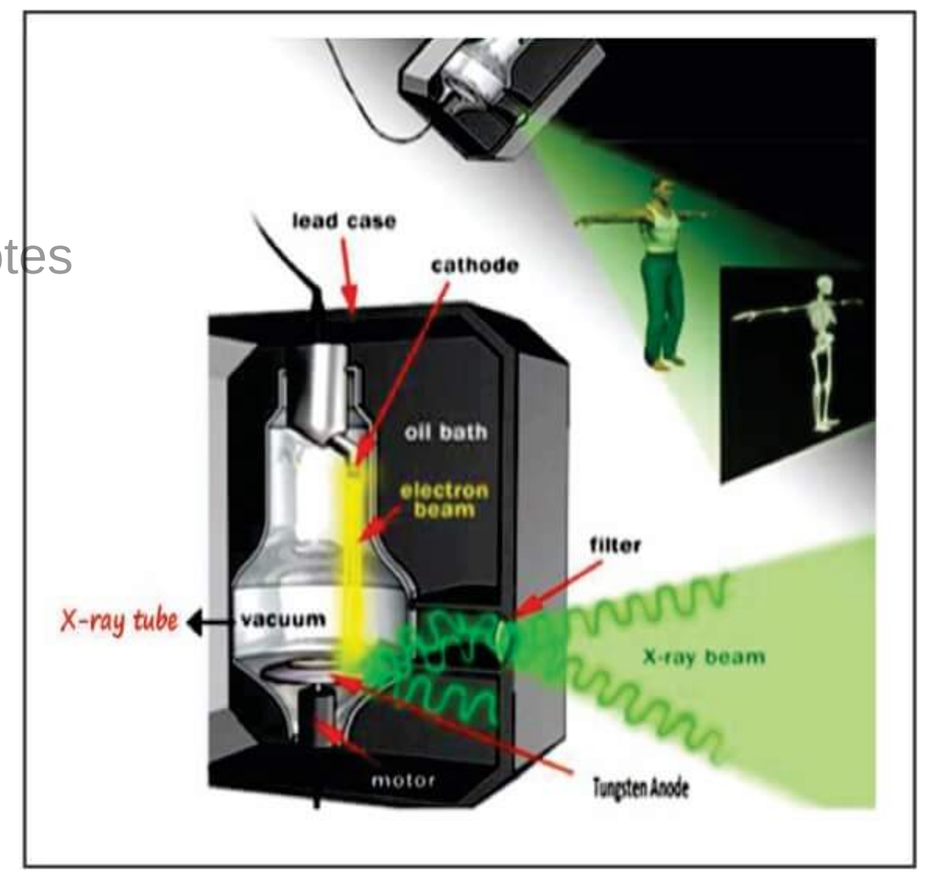
→ GRID

- Parallel lead lines kept behind patient and in front of them
- Prevents scatter radiation from falling on film

→ X ray film

- Made of Silver bromide or Silver halide

→ Safe light used in diagnostic radiology – Red light



KILO VOLTAGE PEAK (KVP)

→ KVP is

- Directly proportional to
  - Energy / quality of X Ray
  - Penetration power
- Inversely proportional to – Contrast

→ Chief determinant of contrast of X Ray film – KVP

→ Therefore, to improve contrast - decrease KVP

$$KVP \propto energy \propto Quality\ of\ X\text{-}rays \propto penetration \propto \frac{1}{contrast}$$

X RAY PART 2

MILLIAMPERE SECOND (mas)

Current i.e number of electron /unit area	exposure time

→ Milliampere – Current (no. of electrons/unit area)

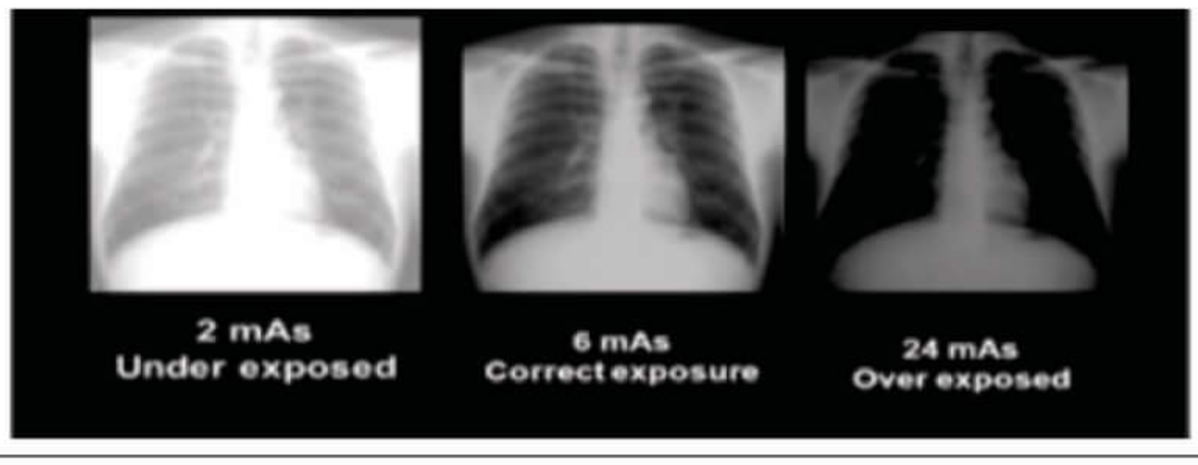
→ Seconds – Exposure time

→ Mas ∝ quantity
∝ number of X Ray
∝ blacking of film
∝ contrast

NOTE:

→ To improve contrast of an X-ray film - ↓KVp

→ To improve contrast of an X-ray film in a morbidly obese patient - ↑mas



	Quality	Quantity
KVP	↑ (primarily)	↑
mAS	No change	↑ (primarily)
Time	No change	↑
filtration	↑	↑

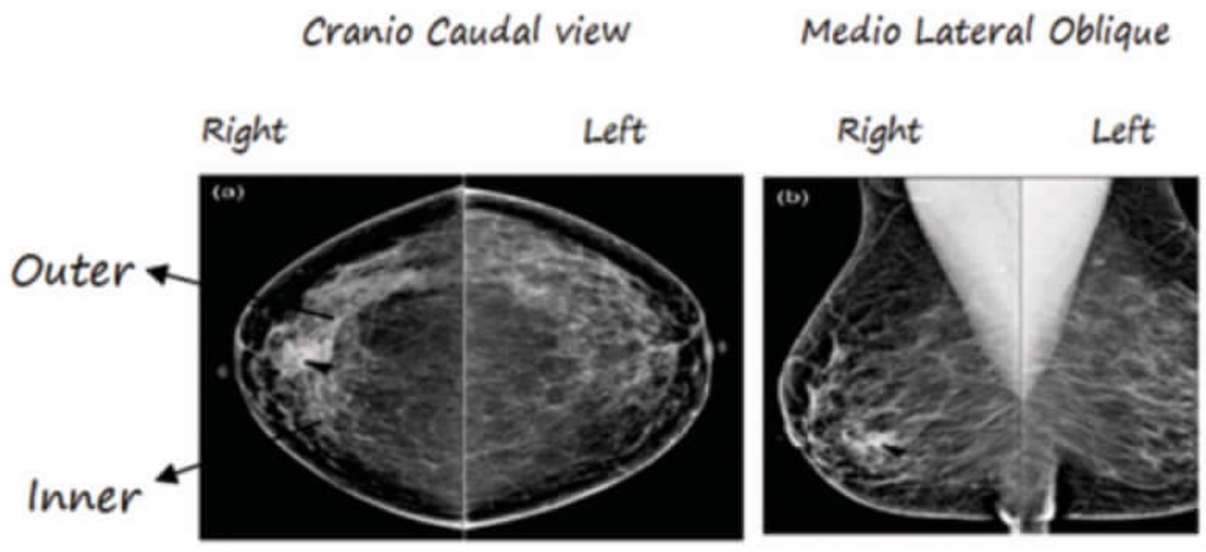
Difference between Mammography & Conventional X-Rays

Feature	Mammography	Conventional X Rays
Anode	Molybdenum	Tungsten
Filter	Molybdenum	Aluminum
Exit window	Beryllium	Glass

MAMMOGRAPHY

→ 2 views from each breast
- Right craniocaudal view
- Right mediolateral view

- Left craniocaudal view
- Left mediolateral view



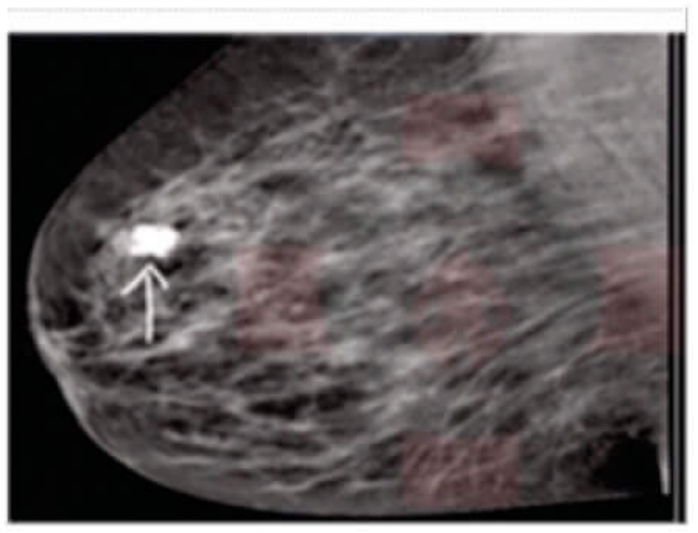
→ Maximum breast tissue is seen in Mediolateral oblique view

→ **Features of malignancy on mammography**
- Irregular borders
- Architectural distortion
- Microcalcification clusters (<0.5mm; >10 in numbers)

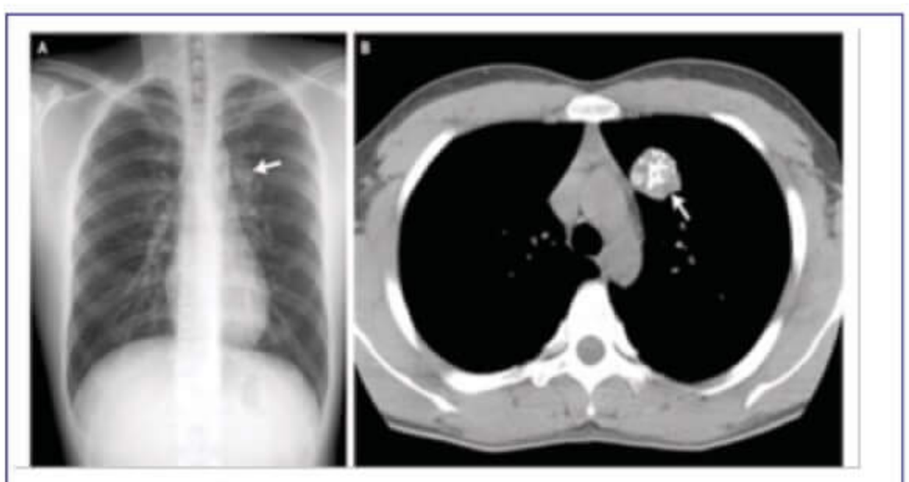
→ Cluster of microcalcification on Mammography
- suggests **Malignant breast lesion**

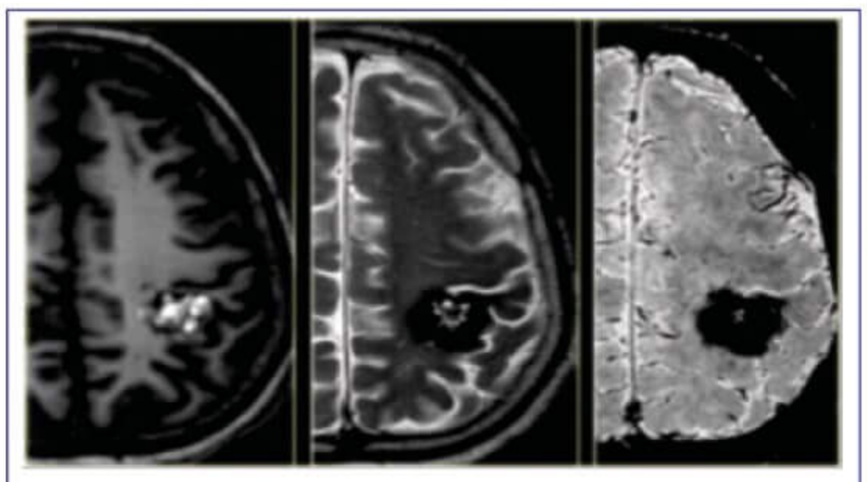
Cluster of microcalcification

→ **Features of benign lesion on mammography**
- Well defined regular border
- Fat content present (e.g. Lipoma, galactocele)
- Macrocalcifications


Popcorn calcification Fibroadenoma

→ Popcorn calcification on mammography → feature of Fibroadenoma
→ Dense POPCORN Calcification on chest X ray → Pulmonary hamartoma
→ POPCORN calcification on MRI – BRAIN → Cavernous angioma
→ POPCORN calcification on pelvic radiograph → Chondrosarcoma

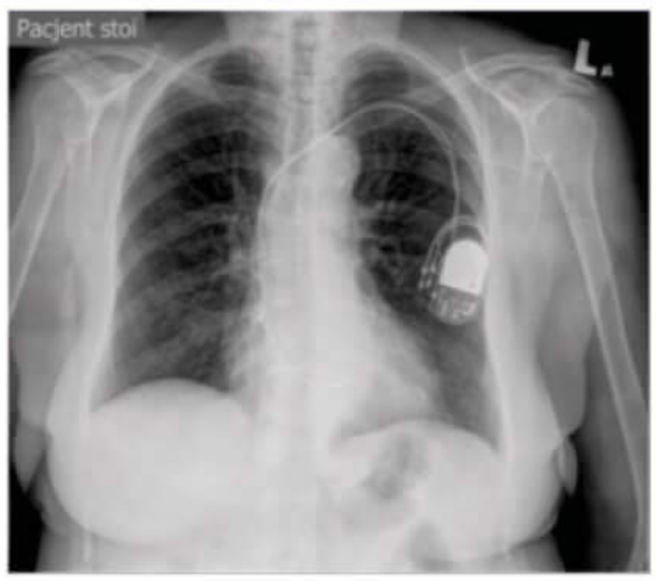

Pulmonary hamartoma


Cavernous angioma

Different densities according to differential attenuation:

- 5 X ray densities
  - Air
  - Fat
  - Soft tissue
  - Bone
  - metal
- Most radio opaque- metal (white)
- Most radio lucent- air(black)

Mitral valve replacement X-ray



Cardiac pacemaker X-ray

Gingko leaf sign on chest X ray

→ Radiating Lucencies along Pectoralis muscle in CXR – Gingko leaf sign

→ Seen in Subcutaneous emphysema / Surgical emphysema

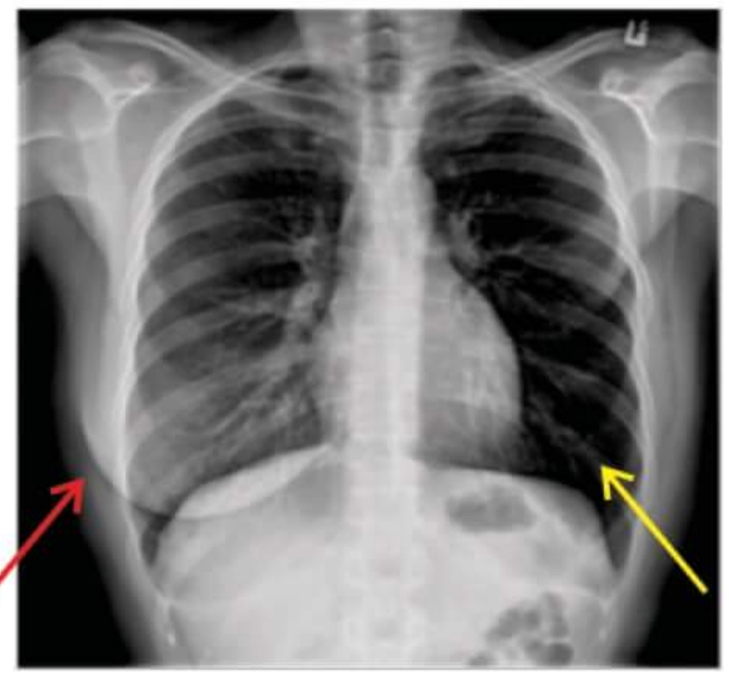
Gingko leaf sign

POLAND 'S syndrome:

→ Absence of pectoralis muscle/breast tissue on one side

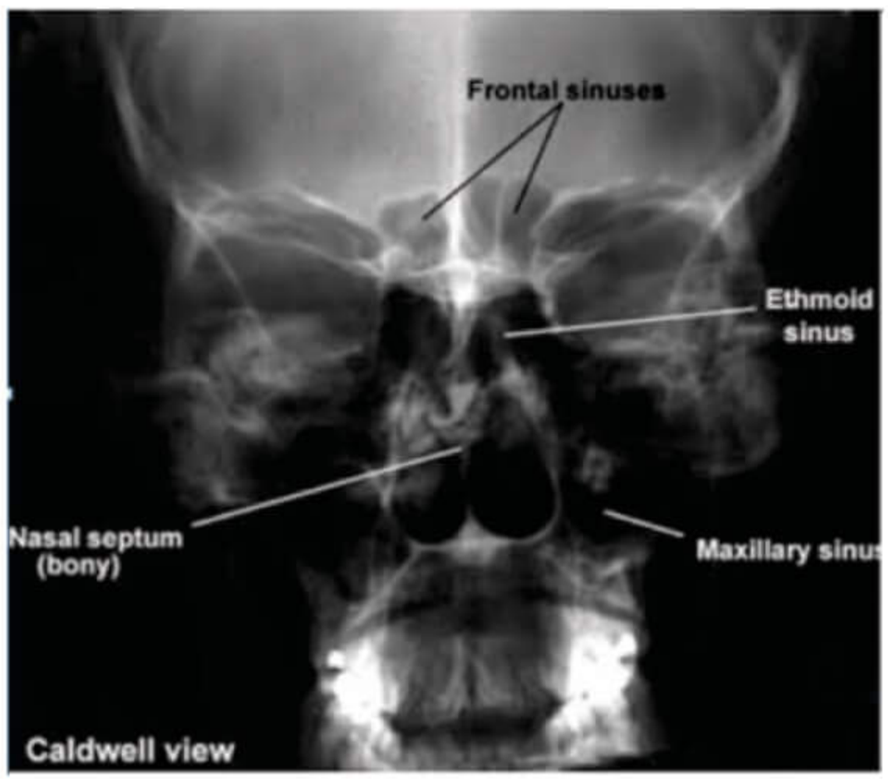
→ On CXR- absent breast shadow on one side

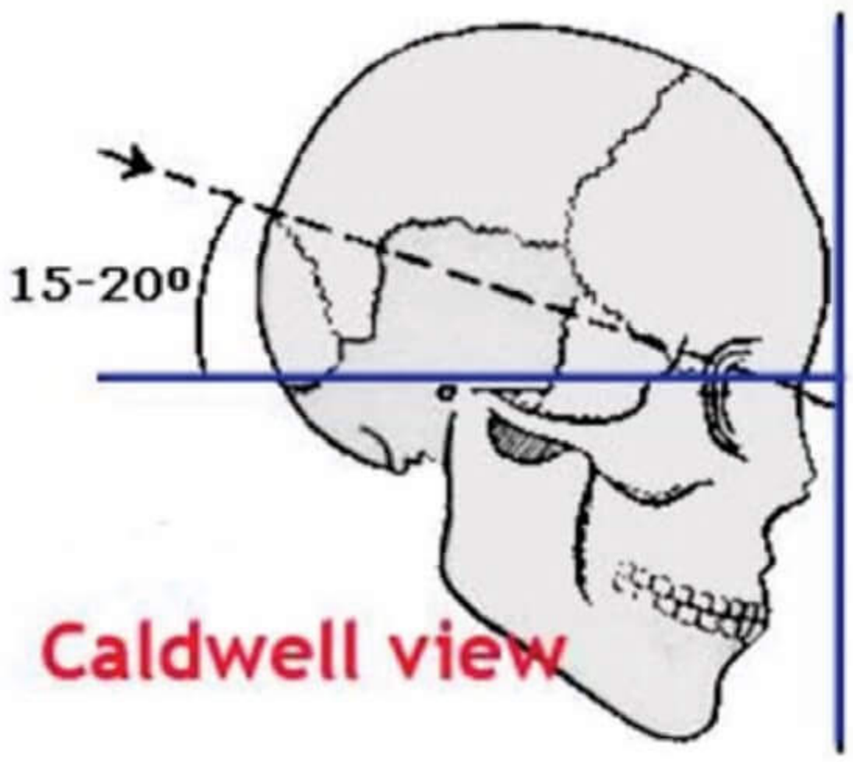
(can also be Postmastectomy status)



CALDWELL view (occipito-frontal view)

Best view for frontal sinus

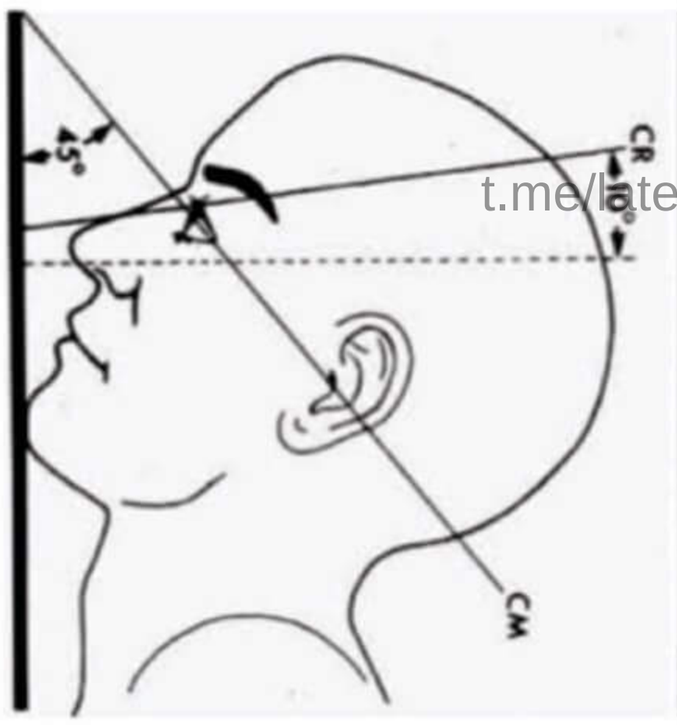


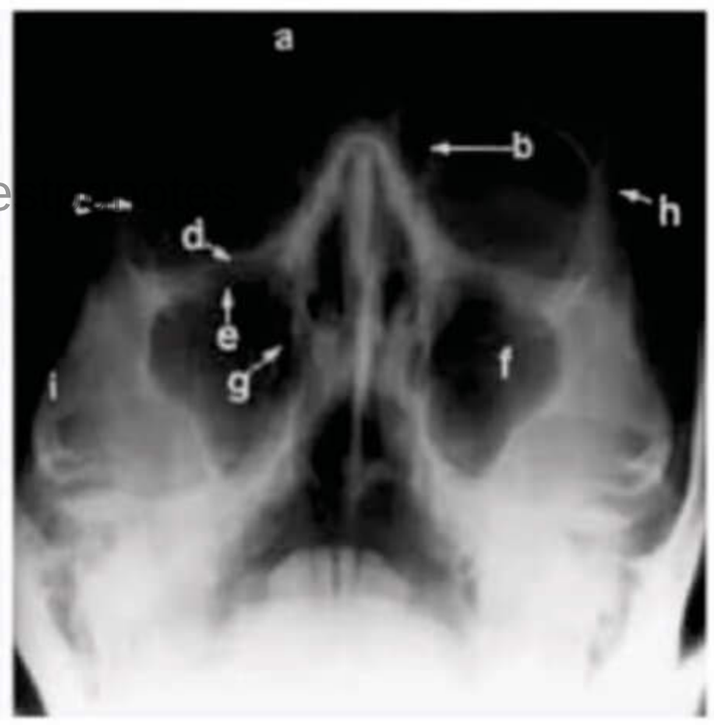


WATER view (occipito mental view)

→ Best view for maxillary sinus

WATERS VIEW: Waters projection is created by placing the chin of the patient on the x-ray cassette with the canthomeatal line (the line that connects the lateral canthus and the external auditory meatus) at 37 degrees to 45 degrees





IMPORTANT POINTS:

→ Most commonly performed X ray - Chest X ray Erect PA view in full inspiration

→ For Trauma patients – Chest AP view

→ For Pneumothorax patients - Expiratory film

→ For Pleural effusion
- ipsilateral lateral decubitus (best X-ray view)
- But IOC is Ultrasound

→ For Pneumoperitoneum i.e. air under diaphragm:
- Best X-ray view – Chest X ray erect
- 2nd best – left lateral decubitus
- IOC – CT scan

POINTS TO REMEMBER

Area	View
Superior orbital fissure	Caldwell view
Inferior orbital fissure	Townes view
Orbital floor	Water view
Opti former/canal	Rhese view

Note:-

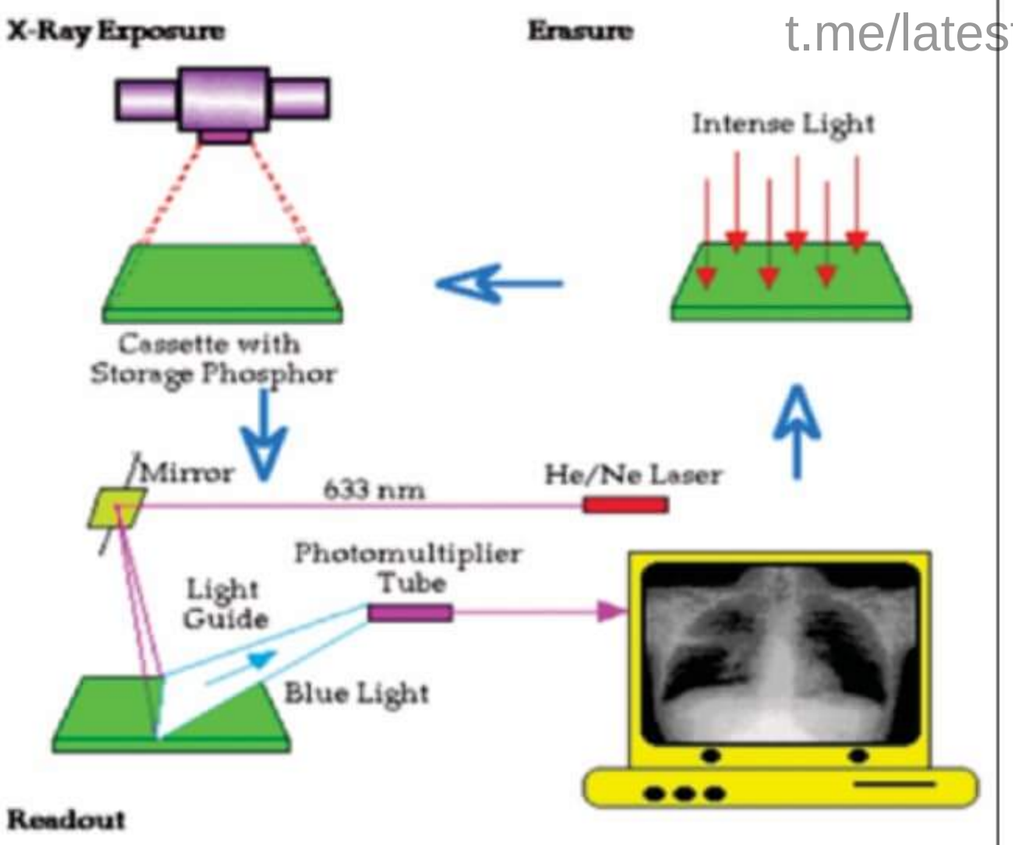
→ Hill Sach's lesion (posterior lateral aspect of humerus)- **Stryker view**

→ Patella- **Skyline view**

→ Acetabulum- **Judet view**

Computerized radiography Vs Direct digital radiography

Computerized radiography	Direct digital radiography
• Phosphate plate used – captures image • It is then subjected to laser beam and converted to electronic image • Slower work flow	• Fixed Electronic panel is used • It converts X-rays directly to Electronic image • Faster work flow



Computerized radiography

Direct digital radiography

CT SCAN PART-1

CT SCAN:

→ Invented by Sir Godfrey Hounsfield in 1972
→ It works on the principle of linear attenuation of X-ray

Hounsfield unit:

→ CT scan is based on linear attenuation of X-ray
→ Linear attenuation is measured in Hounsfield units

Hounsfield unit

	-1000	Air	Hypodense (Black)
	-50-100	Fat	
Reference Value	0	CSF/Water	
	60 - +70	Acute Bleed	Hyperdense (White)
	130	Contrast	
	200- +250	Calcifications	
	400 - +1000	Cortical Bone	

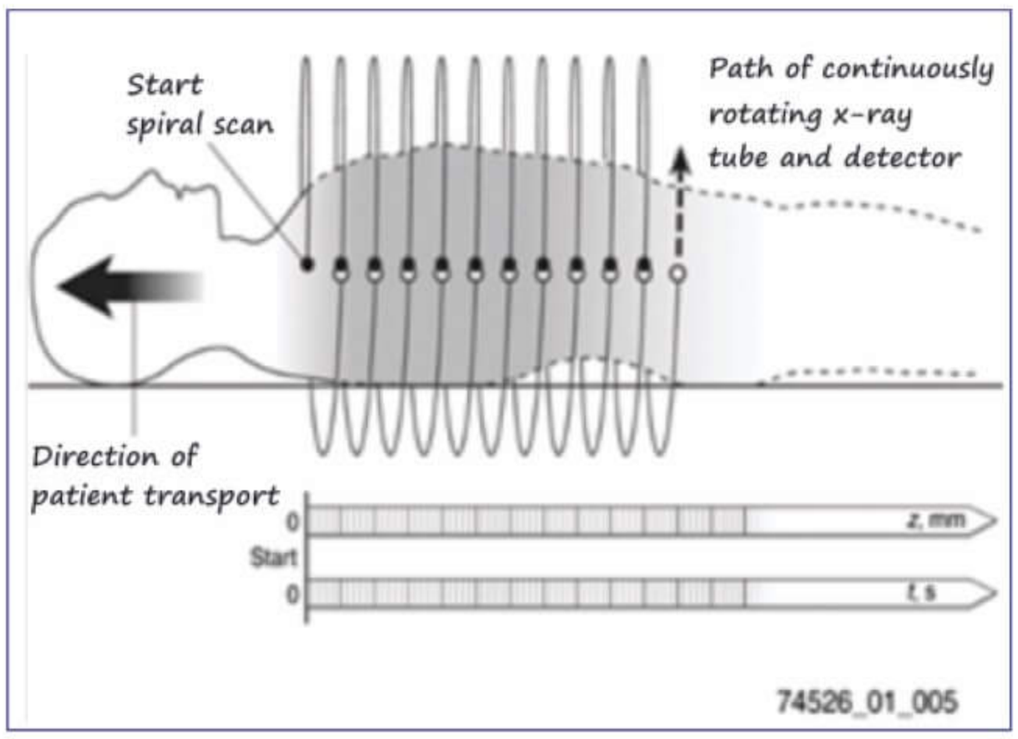
Components of CT scan:

(1) Gantry
(2) Couch
(3) X-ray tube → beam of x-ray pass through patient and goes to detector
(4) Detectors → transfer of digital data

Generations of CT:

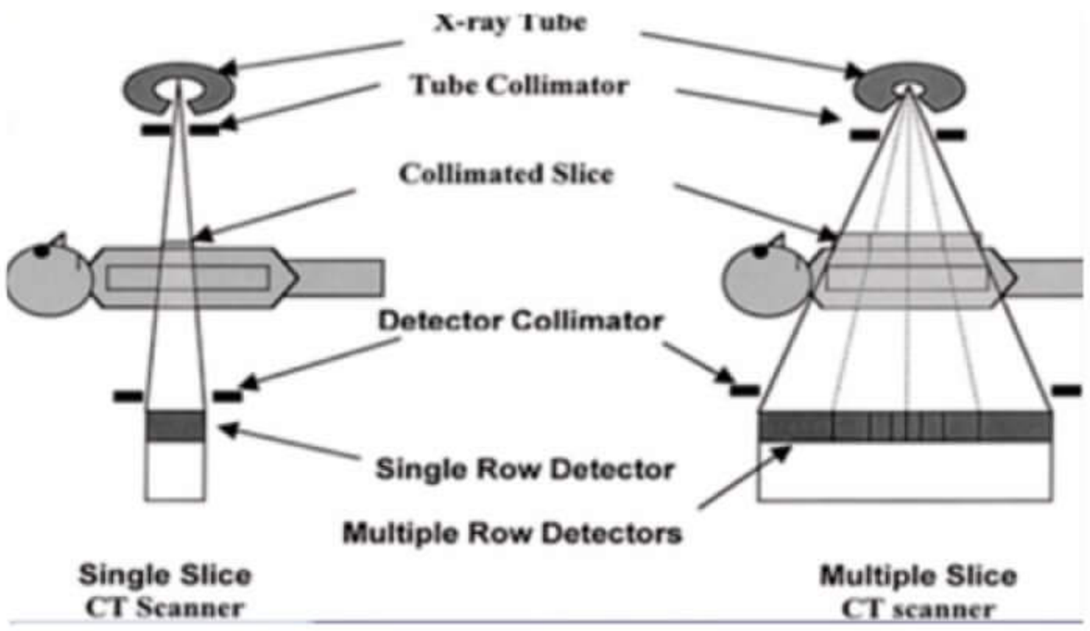
→ **Conventional CT:**
- Time consuming and manually operated
- Uses pencil beam of X-ray
- Used only for head CT

→ **Spiral CT:**
- Uses slip ring technology
- Has simultaneous power supply between Gantry and Couch
- Imaging of trunk in a single breath hold is possible.



→ **Multidetector CT(MDCT):**

- have cone beam of X-ray
- have many detectors behind the patient (for better and faster imaging)
- Used for cardiovascular imaging



NOTE:

→ IOC for Pulmonary Thromboembolism → **CT angiography** (MDCT with contrast)

→ IOC for Acute aortic dissection → **CT angiography** (MDCT with contrast)
→ **Transesophageal echocardiography** (If patient is unstable)

→ **Plain MDCT** is used for coronary calcification scoring (AKA Agatston scoring)

→ **HRCT (high resolution CT scan):**

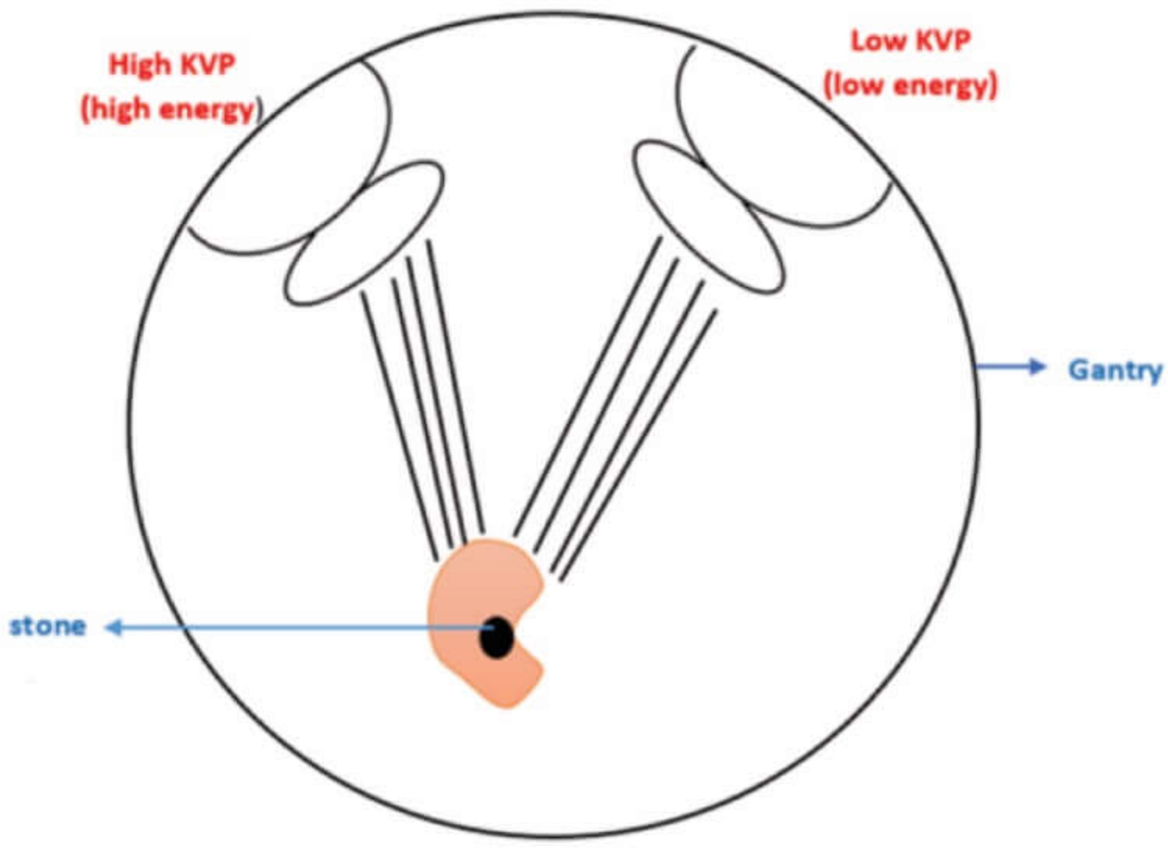
- Uses thin slices (1-3 nm)
- Uses bone algorithm software (helps to increase sharpness of image)

NOTE:

- HRCT is the IOC for ILD
- HRCT is the IOC for Bronchiectasis
- HRCT is used in CT cisternography (technique used to investigate CSF rhinorrhea)
- HRCT is used in fractured temporal bone (cause ear ossicle chain disruption leading to conductive hearing loss)

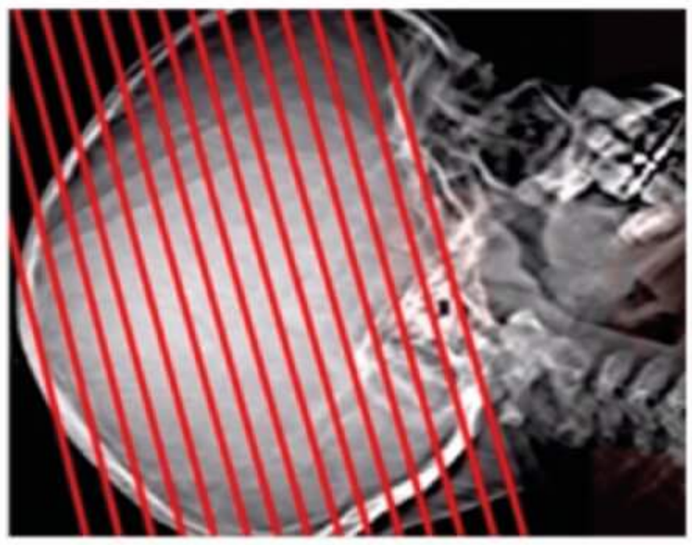
→ **Dual energy/ dual source CT scan:**

- used to characterize the type of kidney stone
- It is a virtual non-contrast CT scan



Scout film:

Tell which body part is imaged and how slices are taken from that area.

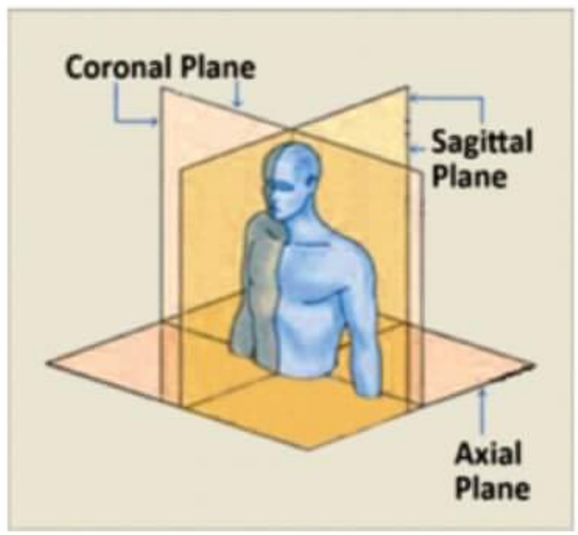


Planes of CT:

(1) Sagittal Plane –divides body into right and left halves

(2) Coronal plane – divides body into anterior and posterior halves

(3) Axial plane – divides body into upper and lower parts



NOTE:

If cortex of bone appears densely white – CT scan image

If cortex of bone appears black – MRI IMAGE

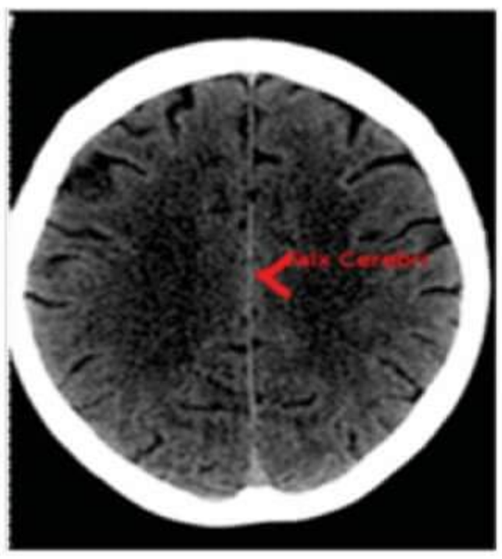
NOTE:

In CT scan,

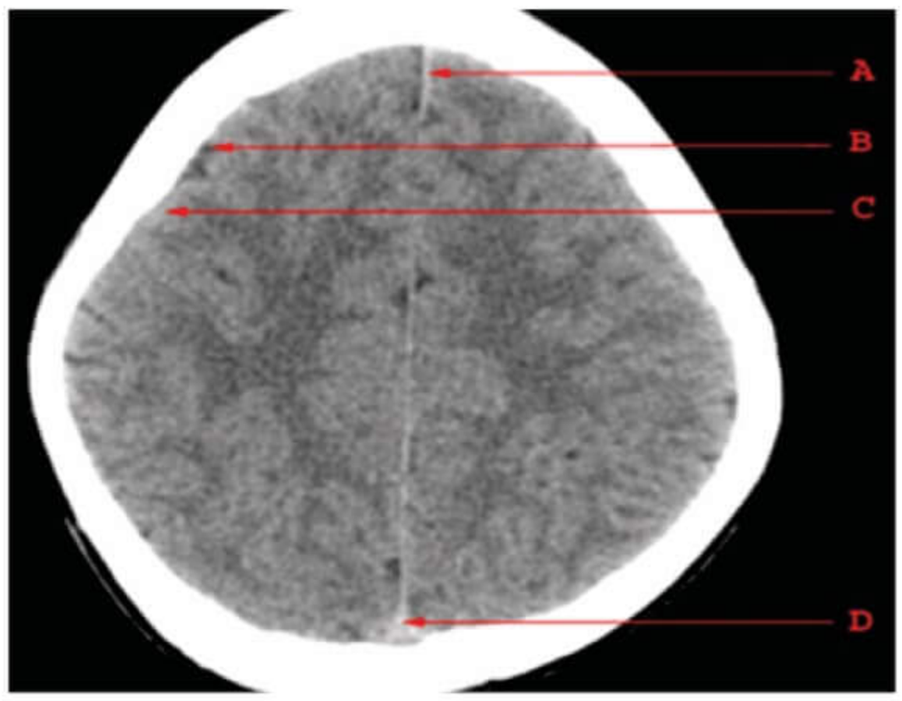
→ Outer gray matter appears white

→ Inner white matter appears black

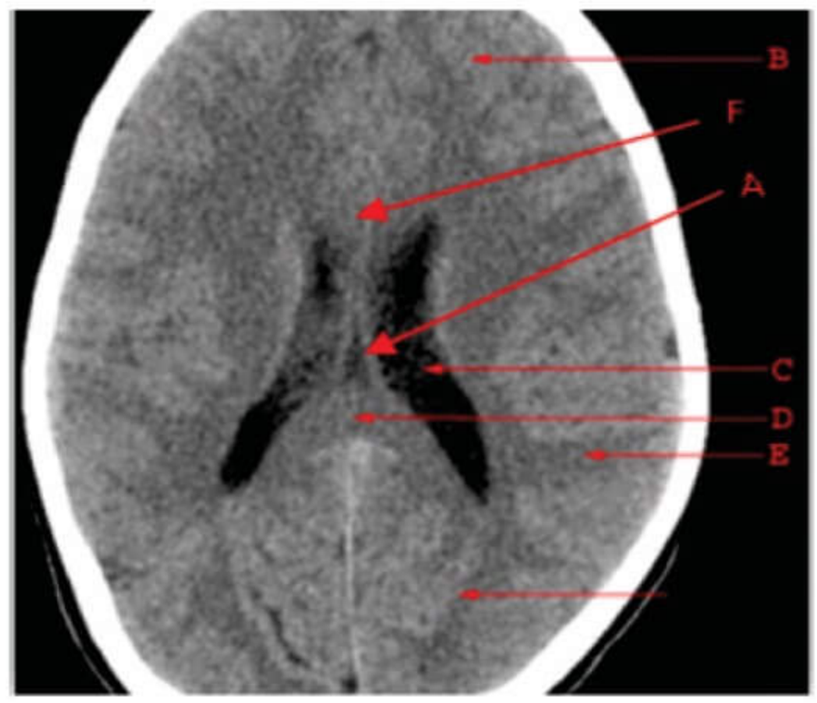
→ Sulcal spaces appear hypodense



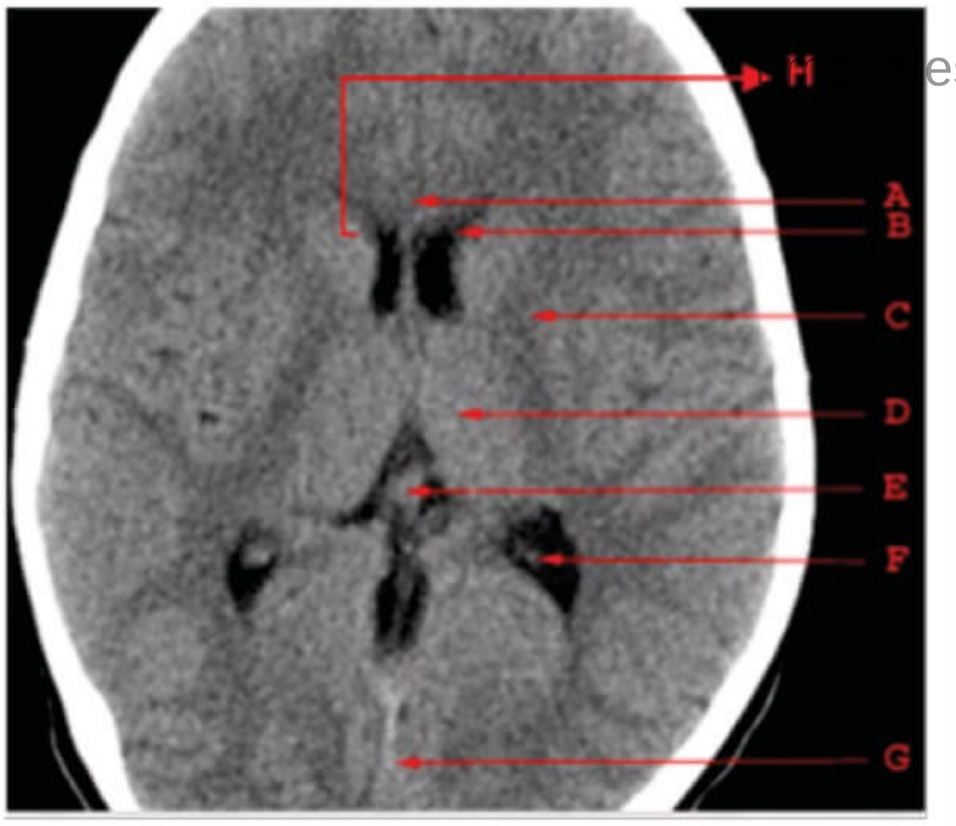
Normal anatomy on CT scan at different level of skull



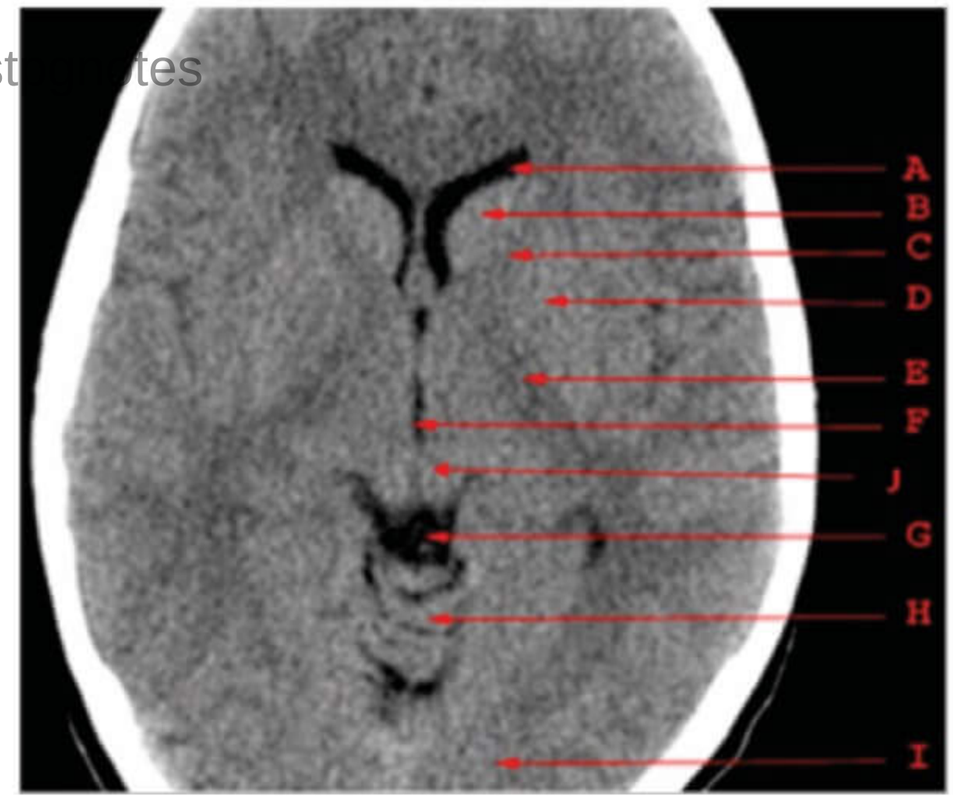
A – Anterior Falx
B – Sulcal spaces
C - Gray mater
D – Posterior Falx



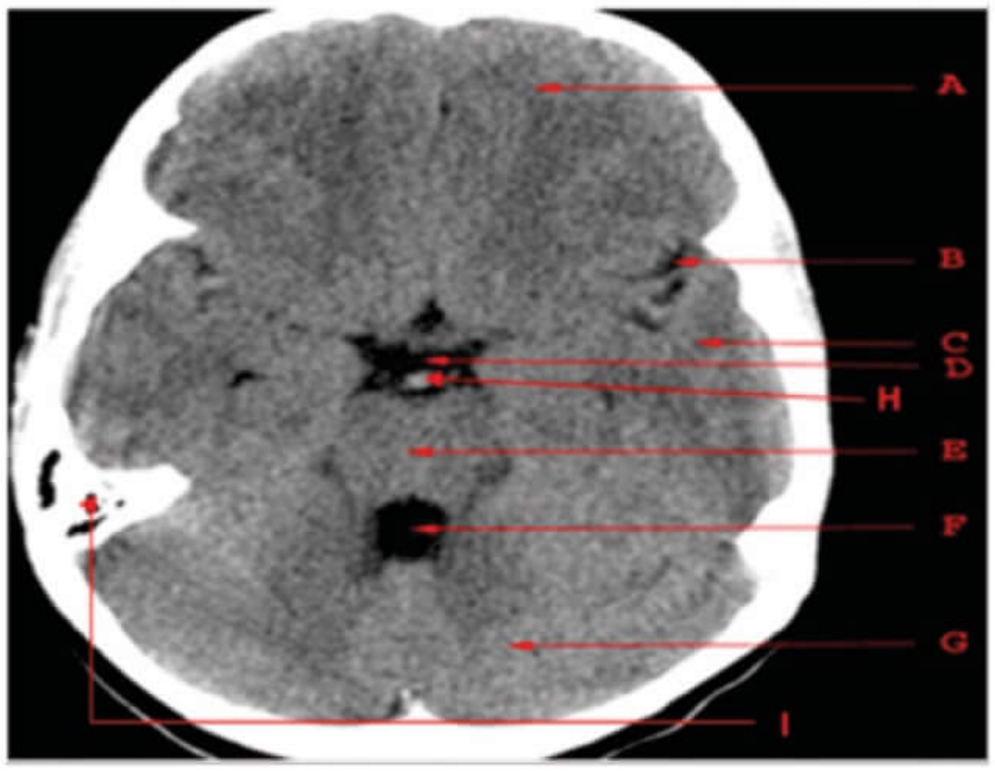
A – Fornix
B – Gray mater
C – Ventricles
D - Splenium of Carpus callosum
E – White mater
F – Genu of Carpus callosum



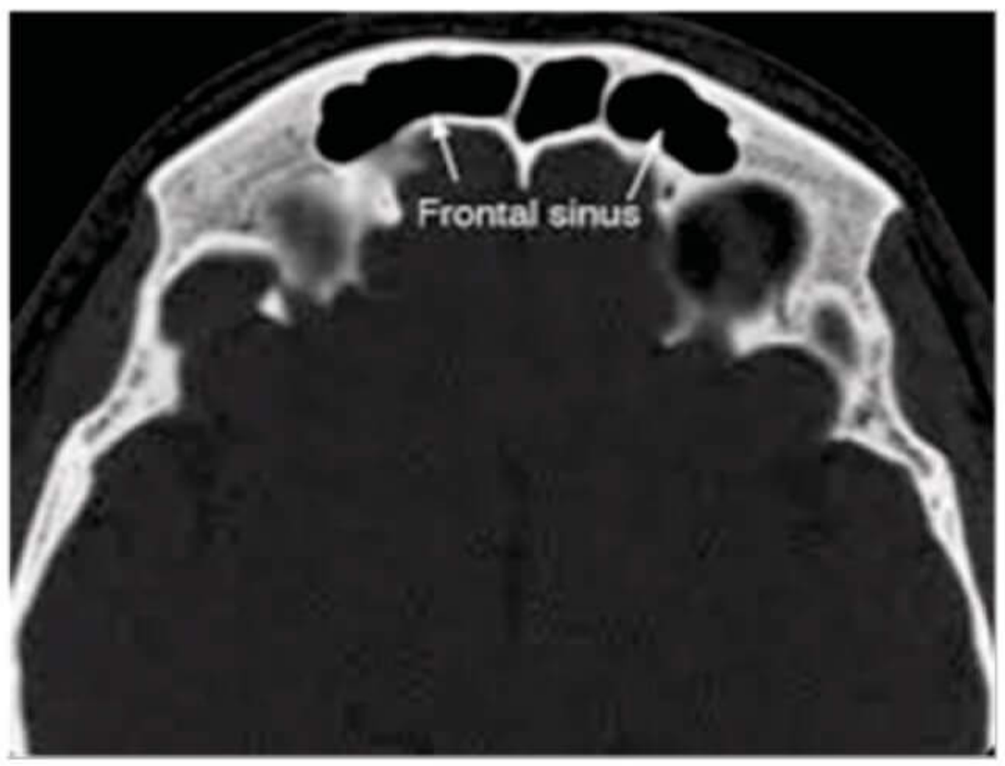
A - Genu of Carpus callosum
B – Lateral ventricle
C – Lentiform nucleus
D – Thalamus
E – Pineal gland
F – Choroid plexus
G - Posterior Falx
H – Caudate nucleus



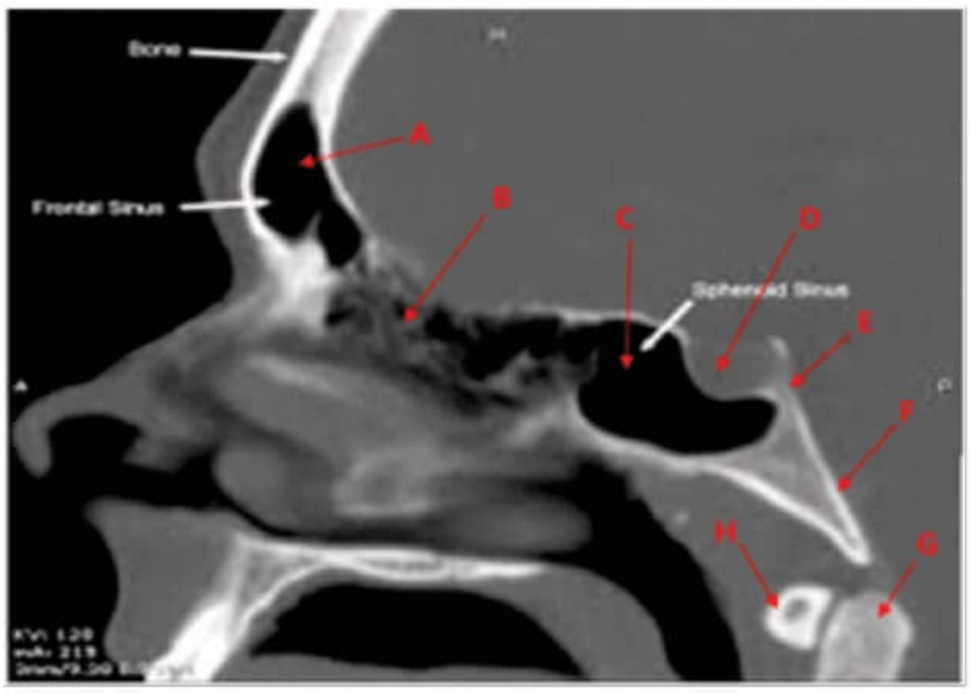
A – Frontal horn of Lateral ventricle
B – Caudate nucleus
C – Anterior limb of Internal capsule
D – Lentiform nucleus
E – Posterior limb of internal capsule
F – Third ventricle
G – Quadrigeminal cistern
H – Vermis
I – Occipital lobe
J – Mid brain



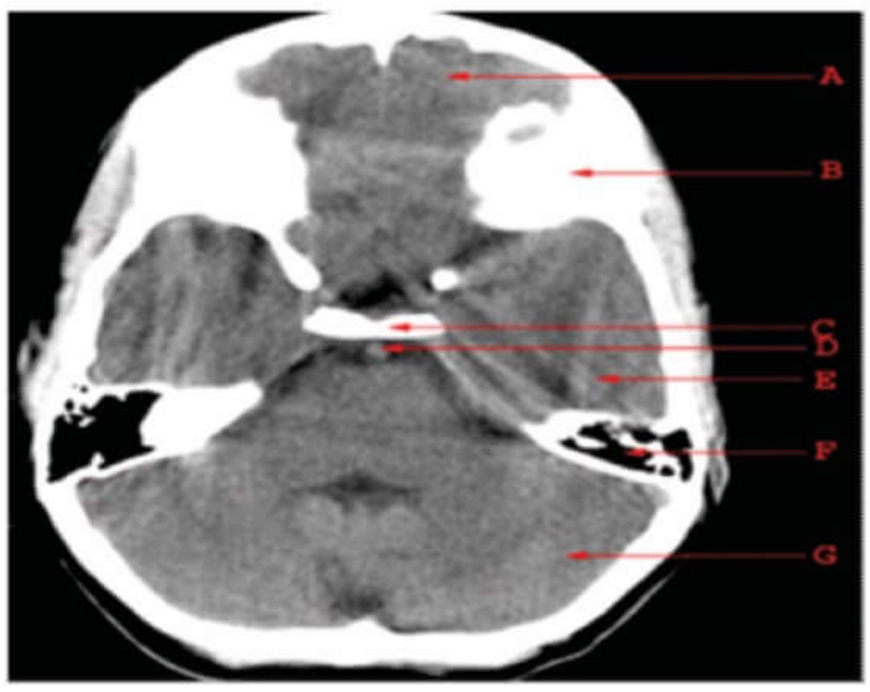
A – Frontal lobe
B – Sylvian fissure
C – Insula
D – Prepontine cistern
E – Pons
F – 4th ventricle
G – Cerebellum
H – Basilar artery
I – Mastoid air cell



Normal Frontal sinus – contains air inside that appears **hypodense** on CT



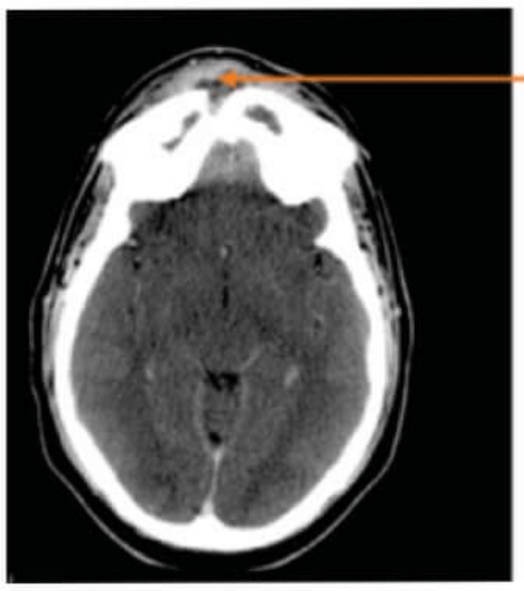
A – Frontal sinus
B – Ethmoidal sinus
C – Sphenoid sinus
D – Sella
E – Dorsum sella
F – Clivus
G – Dens of Axis
H – Atlas



A – Frontal lobe
B – Roof of orbit
C – Dorsum Sella
D – Basilar artery
E – Temporal lobe
F – Mastoid air cells
G – Cerebellar hemispheres

Points to remember:

CT scan at the level of frontal Bone:



→ Subperiosteal abscess in frontal sinusitis is Pott's puffy tumor

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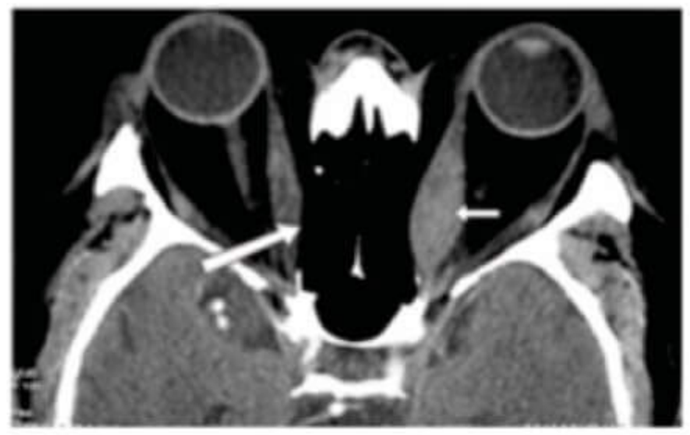
CT scan at the level of orbit:

→ Coco Cola bottle appearance of extraocular muscle due to its fusiform dilatation of medial Rectus
-Thyroid Ophthalmopathy



CT scan with metallic object in orbit:

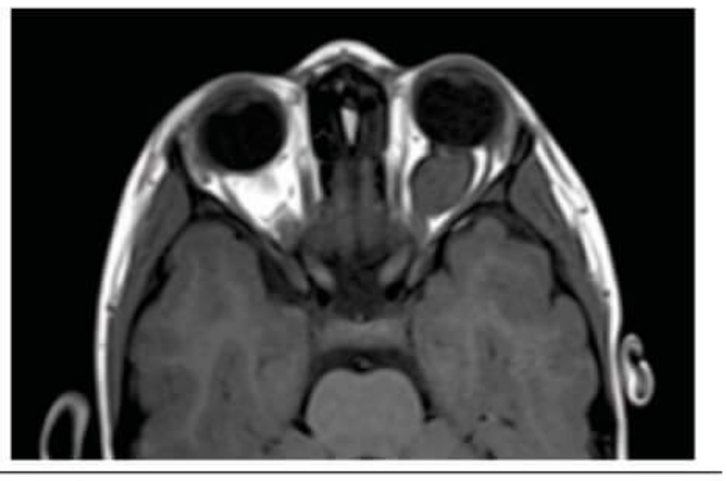
→ IOC for ocular metallic foreign body is CT scan

→ MRI is contra-indicated

CT scan at the level of orbit:

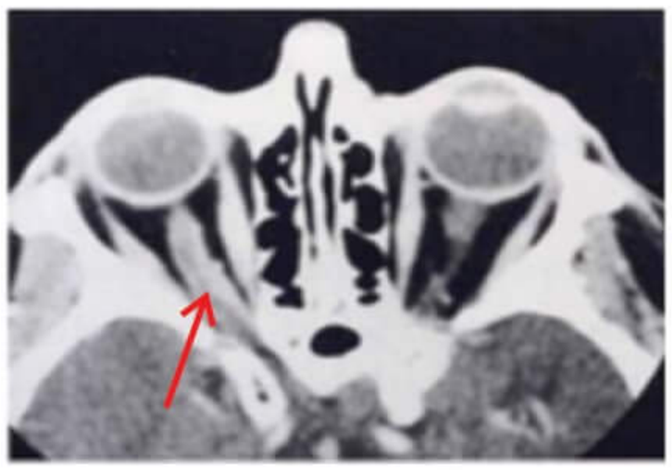
→ Fusiform or saccular dilatation of Optic nerve – Optic Glioma

→ Optic glioma is associated with NF-1

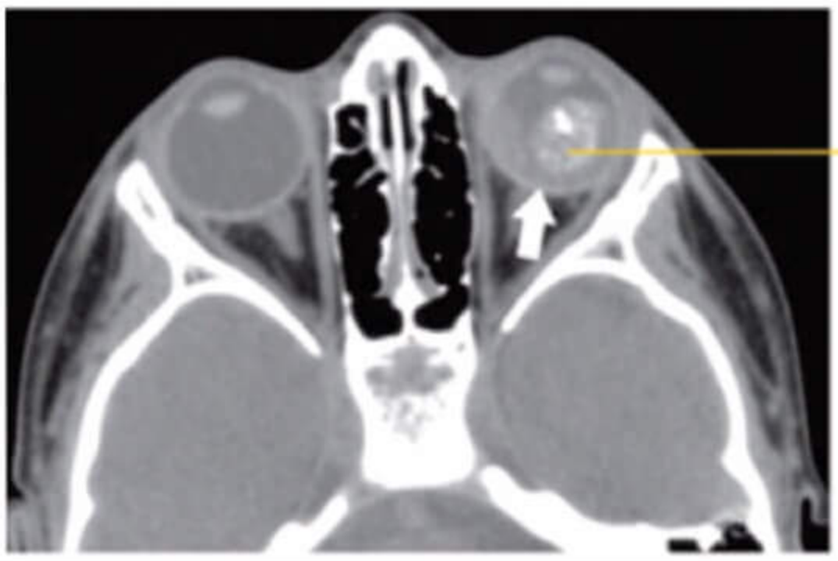


→ In a contrast study, if the image shows Tram track appearance of Optic nerve

→ Optic nerve sheath Meningioma



Tram track appearance of Optic nerve
Optic nerve sheath Meningioma



→ Intra-orbital calcification is a feature of **Retinoblastoma**

→ **Onodi cells:** – These are posterior ethmoidal cells closely related to optic nerve.

Note

→ IOC for paranasal air sinuses is CT scan

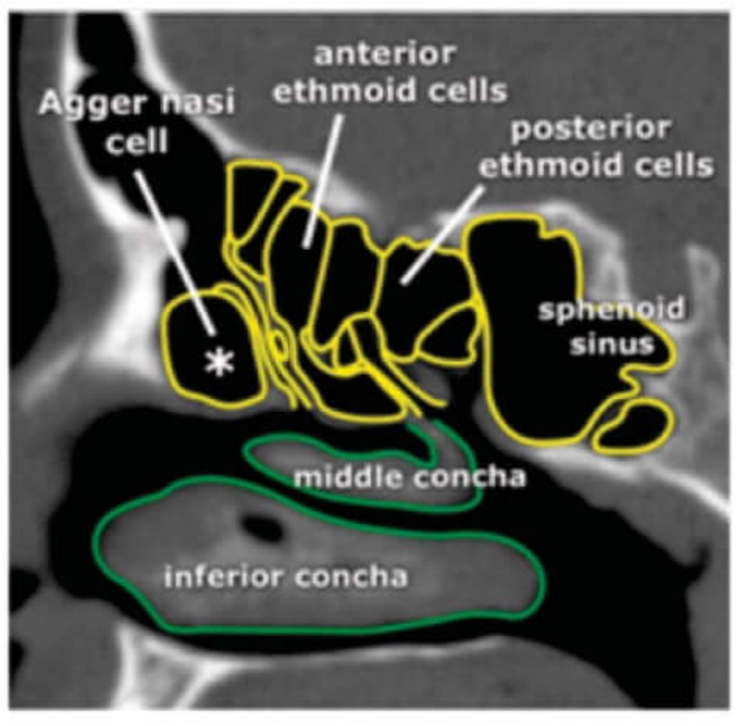
→ IOC for calcifications is CT scan

→ IOC for air anywhere is CT scan

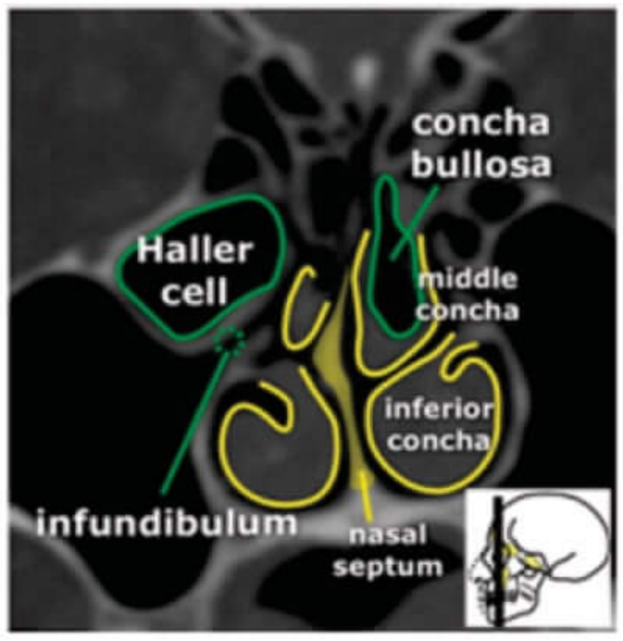
→ Example:

1. Pneumocephalus
2. Pneumothorax
3. Pneumomediastinum
4. Pneumoperitoneum
5. Paranasal air sinuses
6. Mastoid air cells

→ **Agar nasi cells:** – These are Anterior most anterior ethmoidal cells

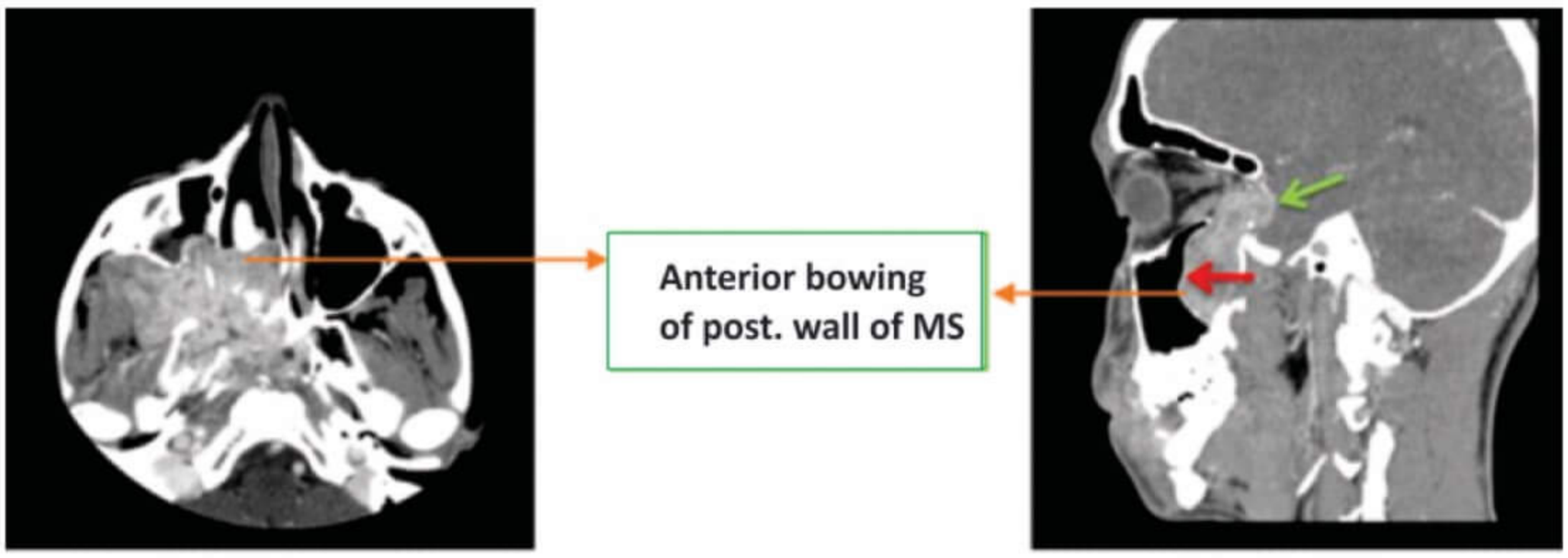


→ **Haller cells:** – These are infra-orbital ethmoidal cells
– It is infero-medial to floor of orbit



coronal section CT

→ Anterior bowing of posterior wall of Maxillary sinus is known as **Holman miller sign/Antral sign**
– It is seen in **Juvenile Nasopharyngeal Angiofibroma**

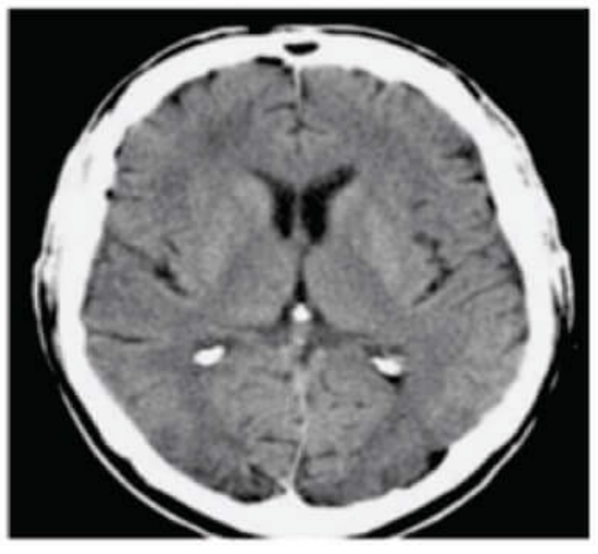


Axial View

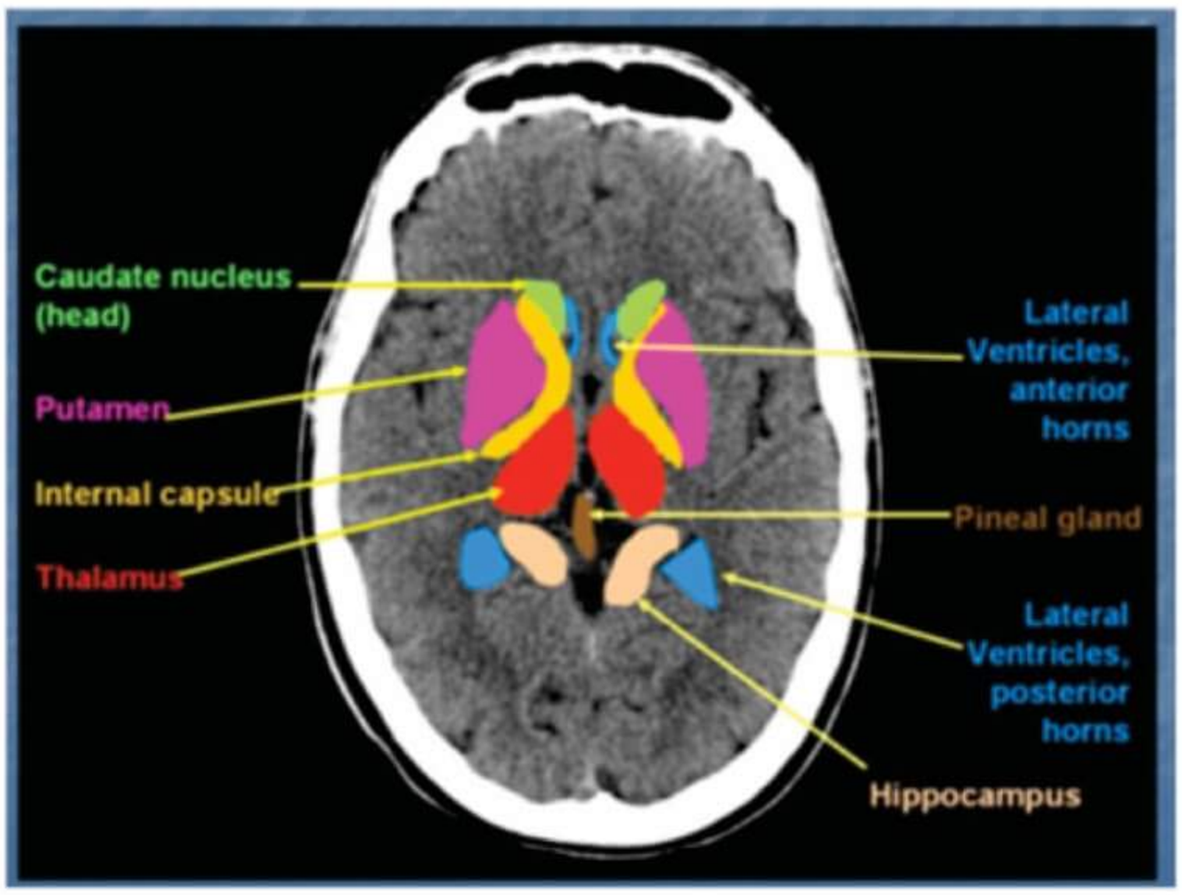
Sagittal View

→ Sites which normally have calcifications without any pathology
– Choroid plexus
– Pineal gland and sometimes falx

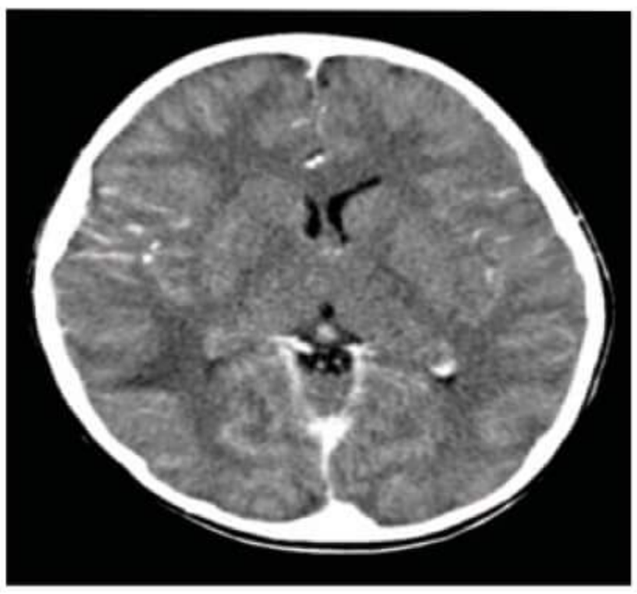
CHOROID PLEXUS AND PINEAL GLAND CALCIFICATIONS

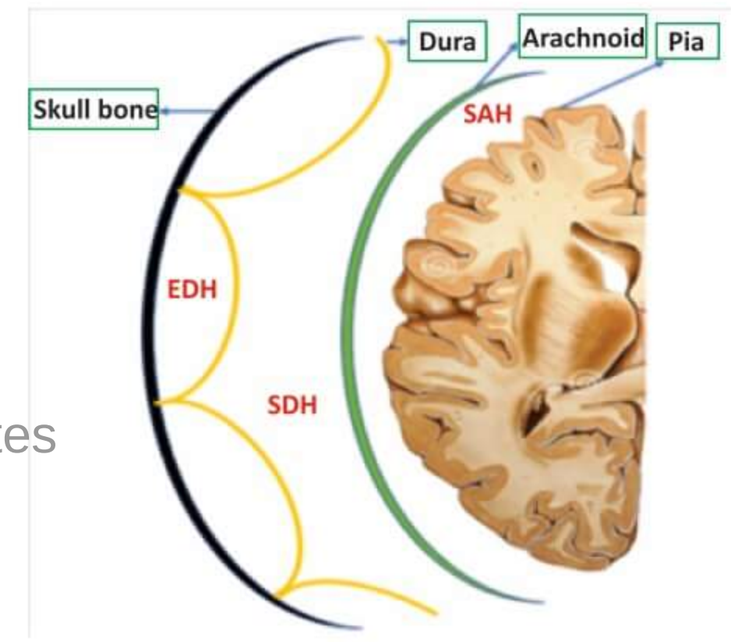


CT SCAN-II



Contrast Enhanced CT Scan (CECT)



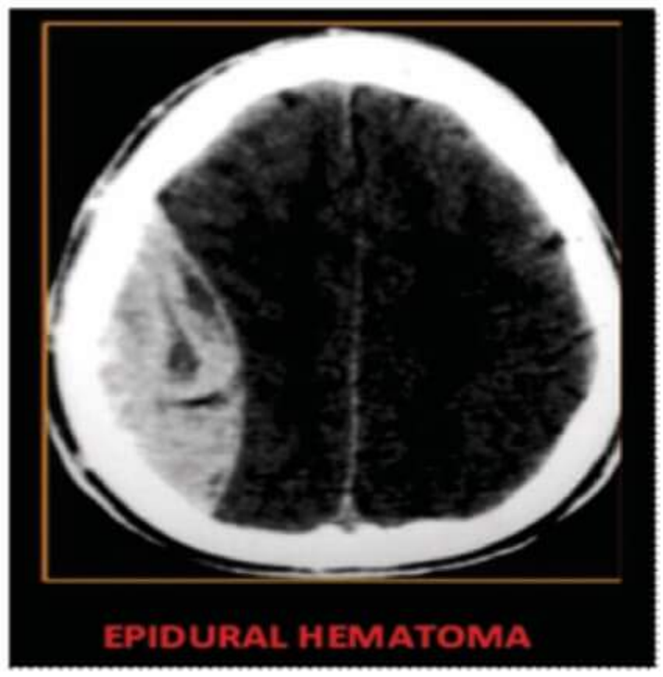


NOTE:

→ IOC for Head Trauma: NCCT

Epidural Hematoma

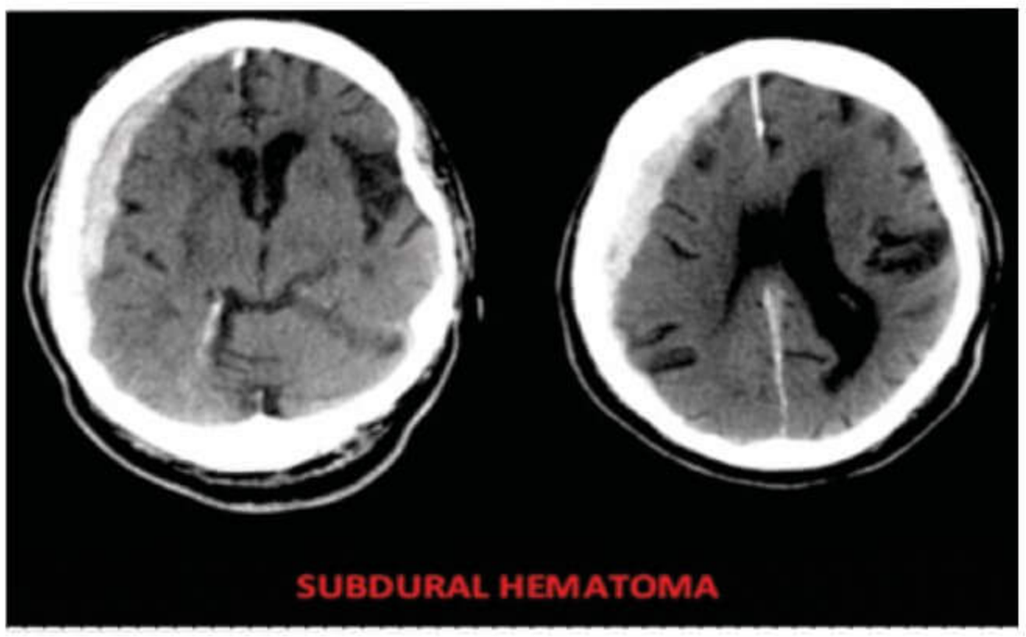
→ AKA Extradural hematoma
→ Biconvex/lentiform hyperdensity seen
→ Due to rupture of middle meningeal artery
→ Happens due to # of Pterion (H shaped suture)
→ Causes UNCAL HERNIATION
→ Cause brain stem hemorrhages called Duret Hemorrhage
→ Causes 3rd nerve palsy.
→ Has lucid interval
→ Does not cross suture.



Subdural Hematoma

→ Concavo- convex or crescentic shaped.
→ Cross suture line, doesnot cross midline
→ Happens due to rupture of **Bridging Veins.**
→ Seen with
- chronic old trauma
- Cortical atrophy
- Alzheimer's ds
- Punch Drunk Syndrome
- Battered Baby Syndrome

(BBS also has metaphyseal corner #)



Subarachnoid Hemorrhage

→ MCC of subarachnoid hemorrhage is: TRAUMA
→ MCC of spontaneous SAH is due to rupture of BERRY ANEURYSM
→ Classical complaint pts come with is THUNDER CLAP HEADACHE

→ **Shows Hyperdensity in:**
- Sylvian fissure
- Basal cisterns
- Sulcal Spaces
- Anterior Interhemispheric area


SUBARACHNOID HEMORRHAGE

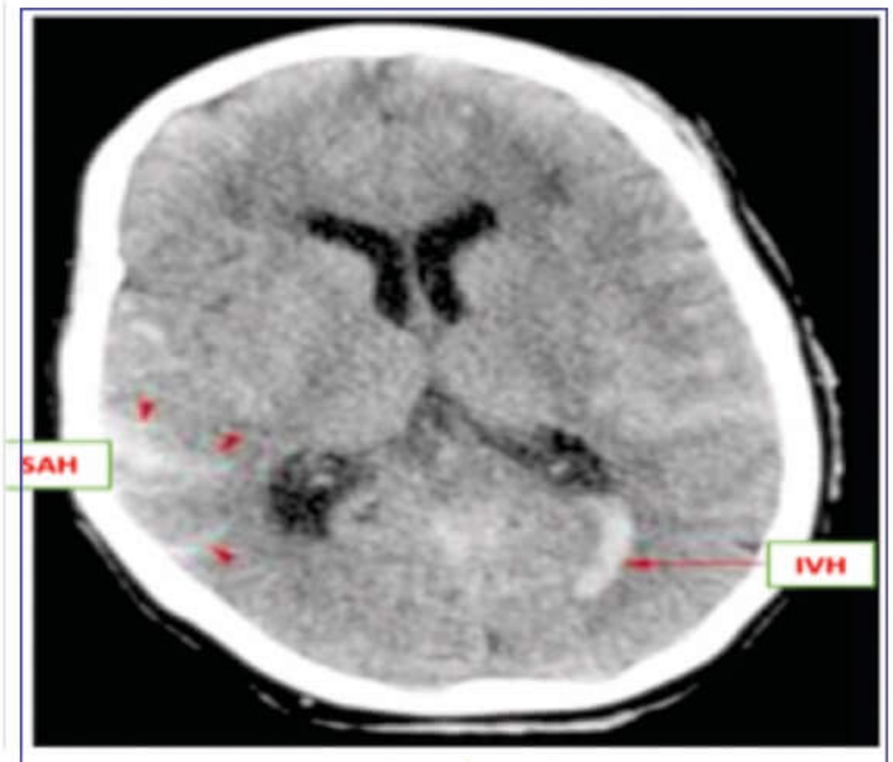
→ IOC for Acute SAH is NCCT
→ IOC for Chronic SAH is MRI.
→ IOC to know the cause of SAH is 4 VESSEL ANGIOGRAPHY- (for that catheterize 2 ICA and Left Vertebral artery.)

NOTE:
→ Acute Bleed - Hyperdense
→ Chronic bleed - Hypodense


Intra parenchymal haemorrhage → Left Putamen

→ Most common site of hypertensive bleed is putamen

Intraventricular bleed:

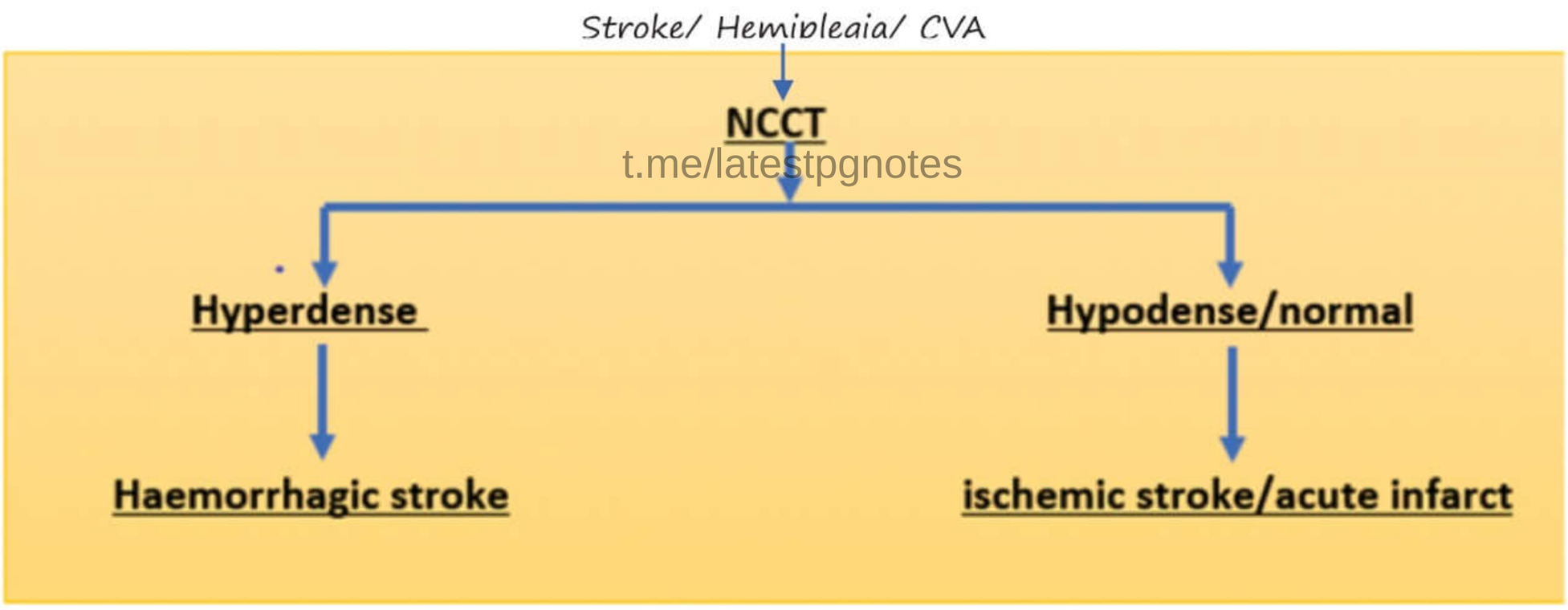


Intraventricular bleed → occipital horn of lateral ventricle

Stroke:

→ IOC for stroke NCCT

→ IOC for acute infarct/ischemic stroke is MRI (Diffusion weighted MRI)

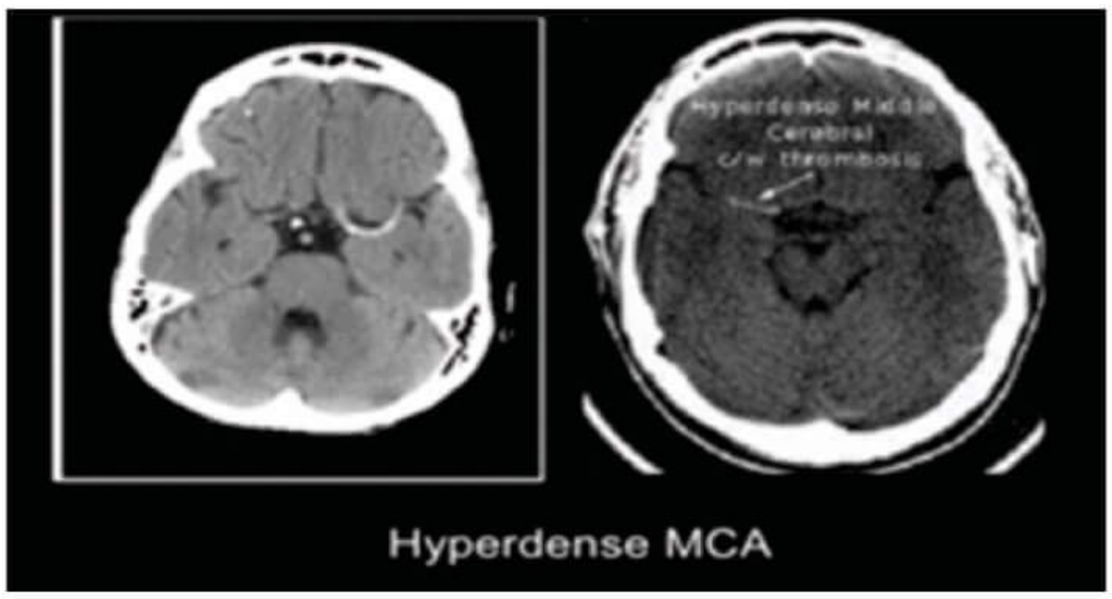


Radiological signs of acute Infarct on CT scan

→ Hyperdense MCA

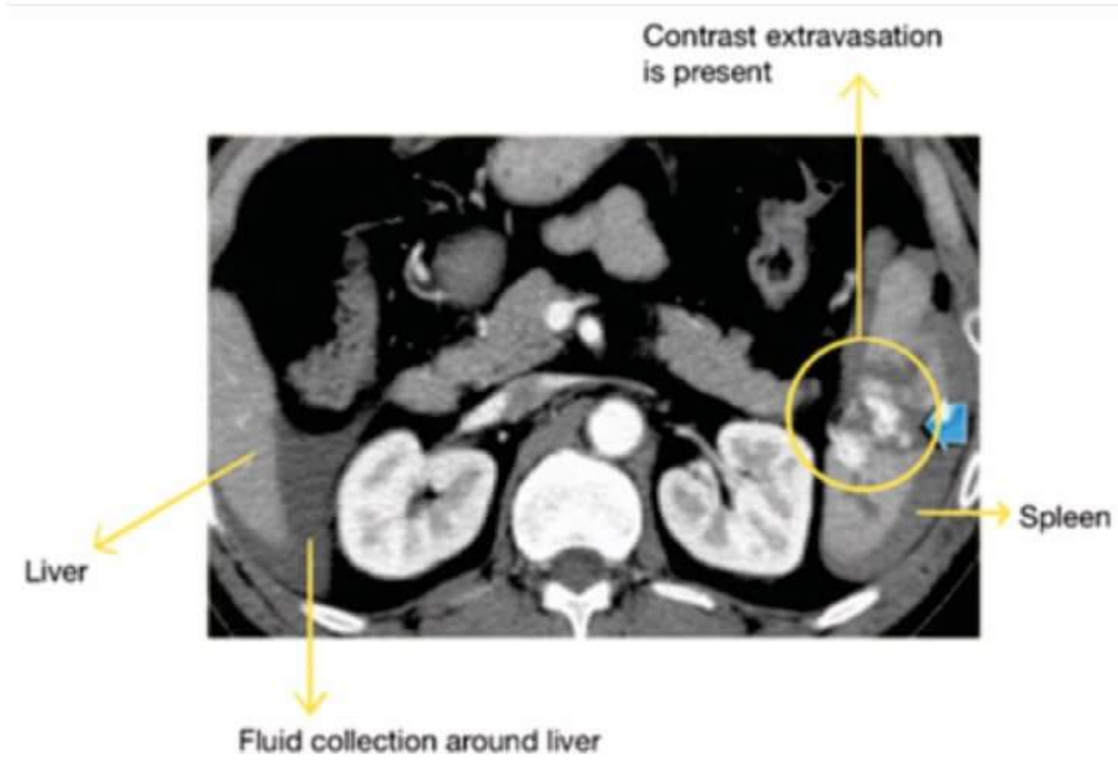
→ Obscuration of lentiform nucleus

→ Absent in Insular ribbon sign



Hyperdense MCA

CECT of Abdomen:



→ Extravasation of contrast from spleen suggest
- tive of active bleeding from spleen

Note

→ IOC for abdominal trauma is CECT

NOTE:

Abdominal Trauma

↓

FAST (initial step)

(Focused assessment with sonography for trauma)

Hemoperitoneum (+)

↓

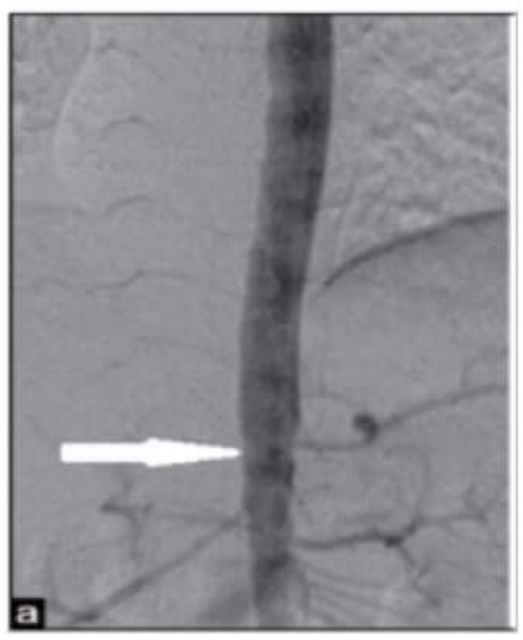
VITALS

Stable → **CECT(IOC)**

unstable → **Emergency LAP**

Hemoperitoneum (-)

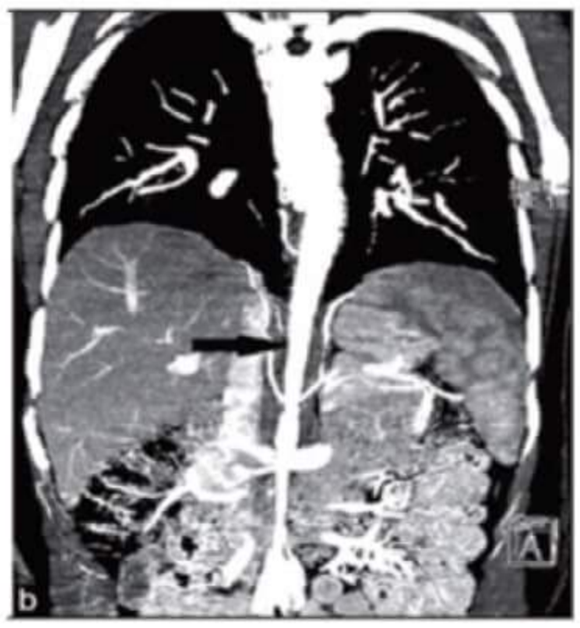
Digital substraction Angiography



→ Pre-contrast image & Post-coontrast image is digitally substracted

→ Gives contrast opacifed vessels

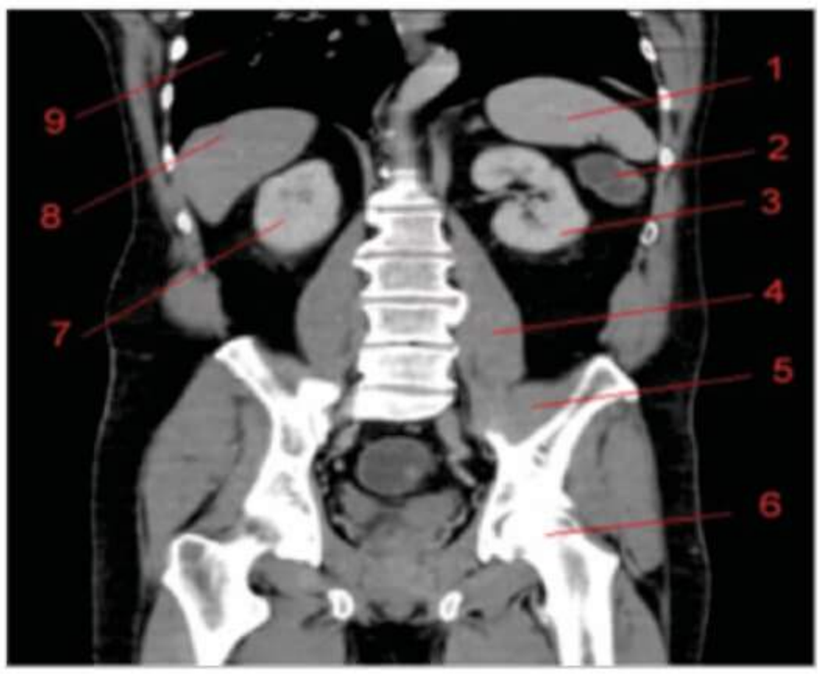
CT Angiography



→ Shows

- Bones – white
- Vessels – Contrast opacified

Coronal CT



1 – Spleen

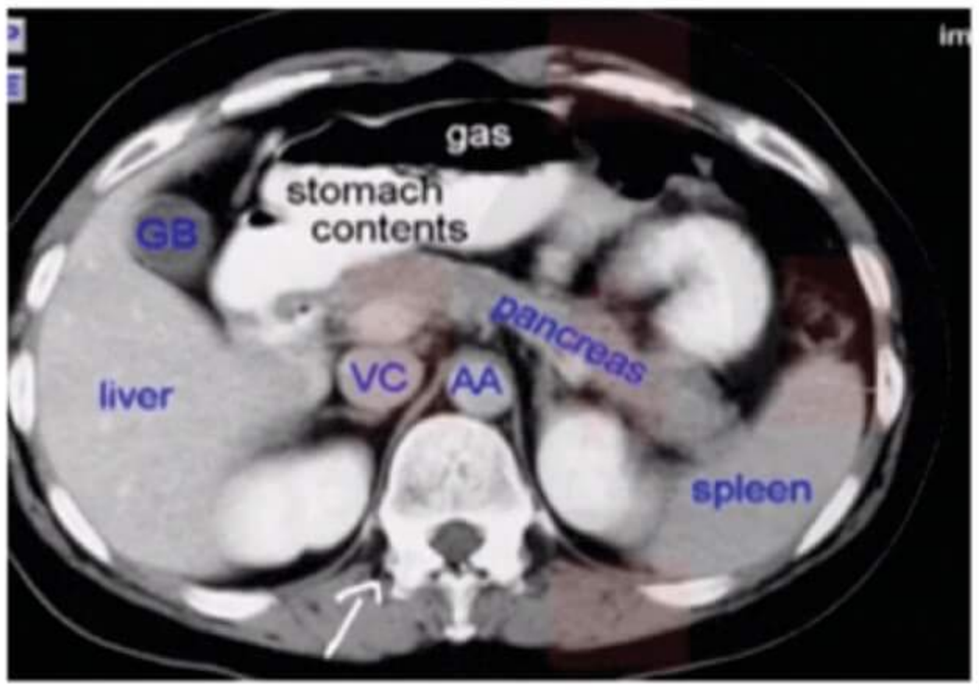
2 – Part of Bowel

3 – Left kidney

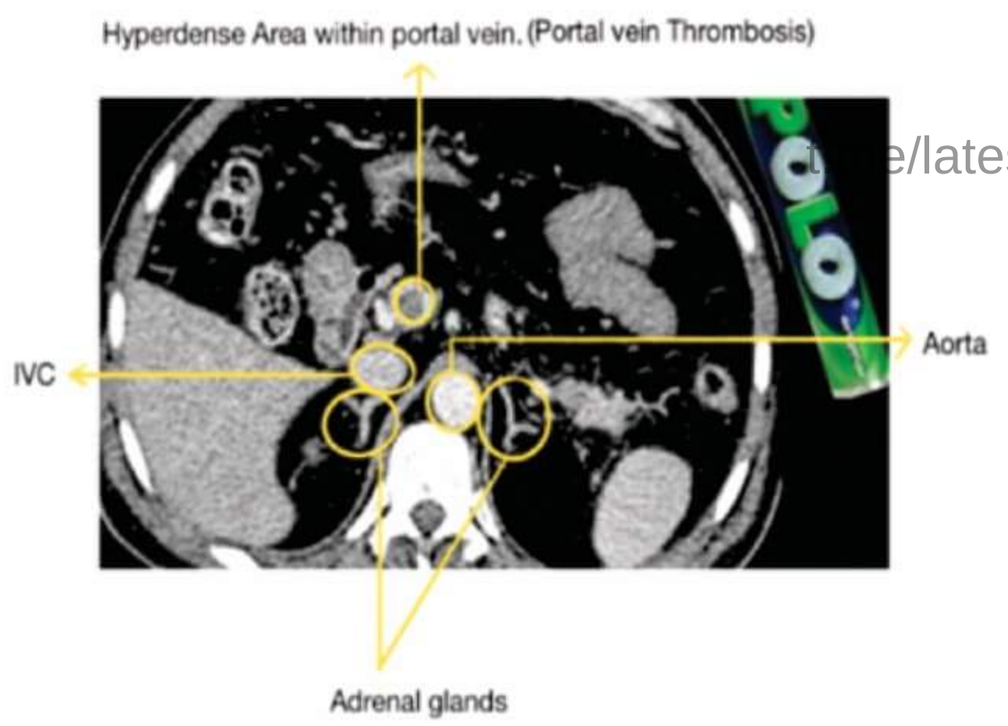
4 – Psoas major

5 – Iliacus

CT Abdomen: (NORMAL)

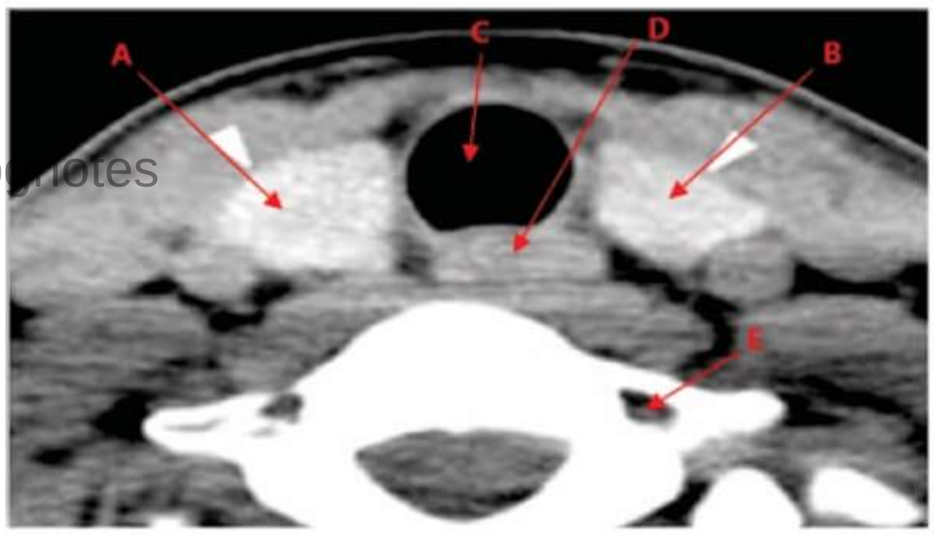


Portal vein Thrombosis:



→ In venous thrombosis we can see a filling defect known as "POLO MINT sign"

CT @ the level of neck:



A – Right lobe of Thyroid

B – Left lobe of Thyroid

C – Trachea

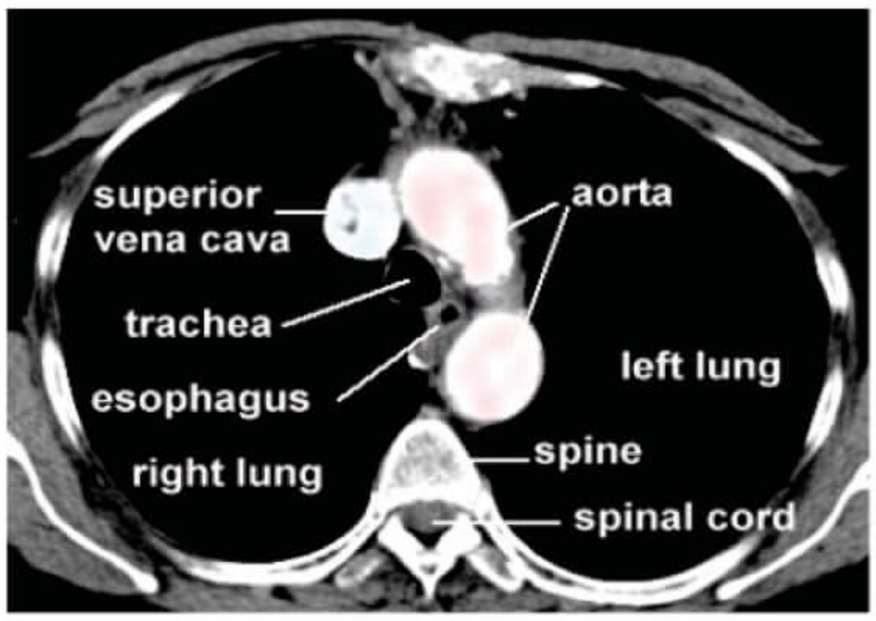
D – Esophagus

E – Foramen Transversarium (Vertebral artery passes through it)

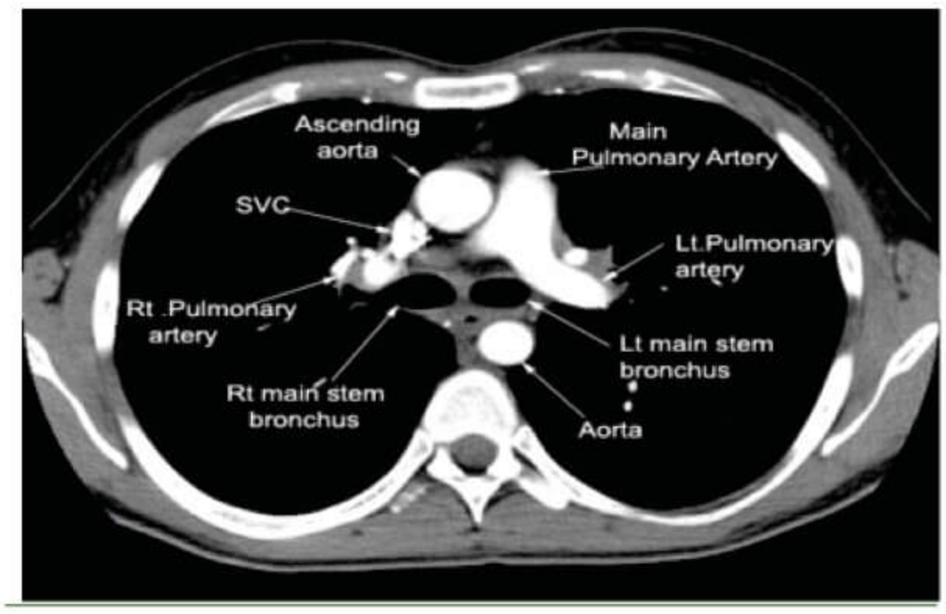
→ Most hyperdense soft tissue at the level of neck – Thyroid

CT mediastinum region

@ level of Arch of aorta

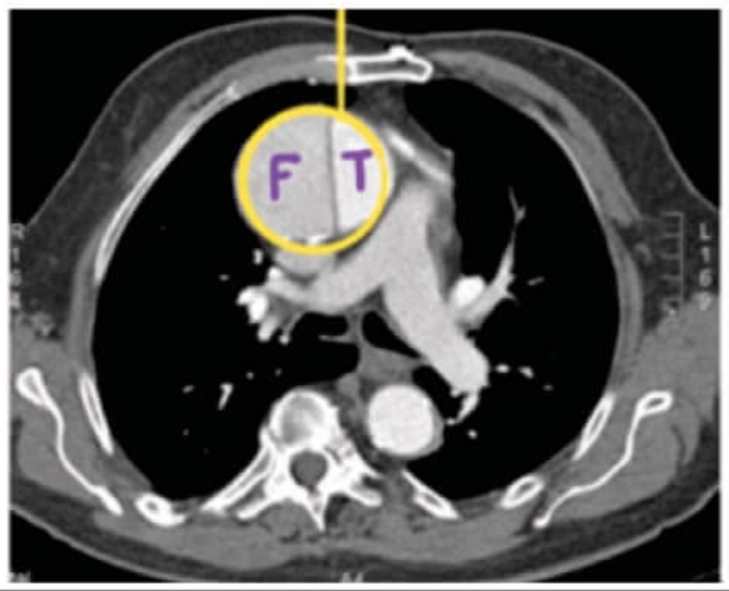


below Arch of aorta



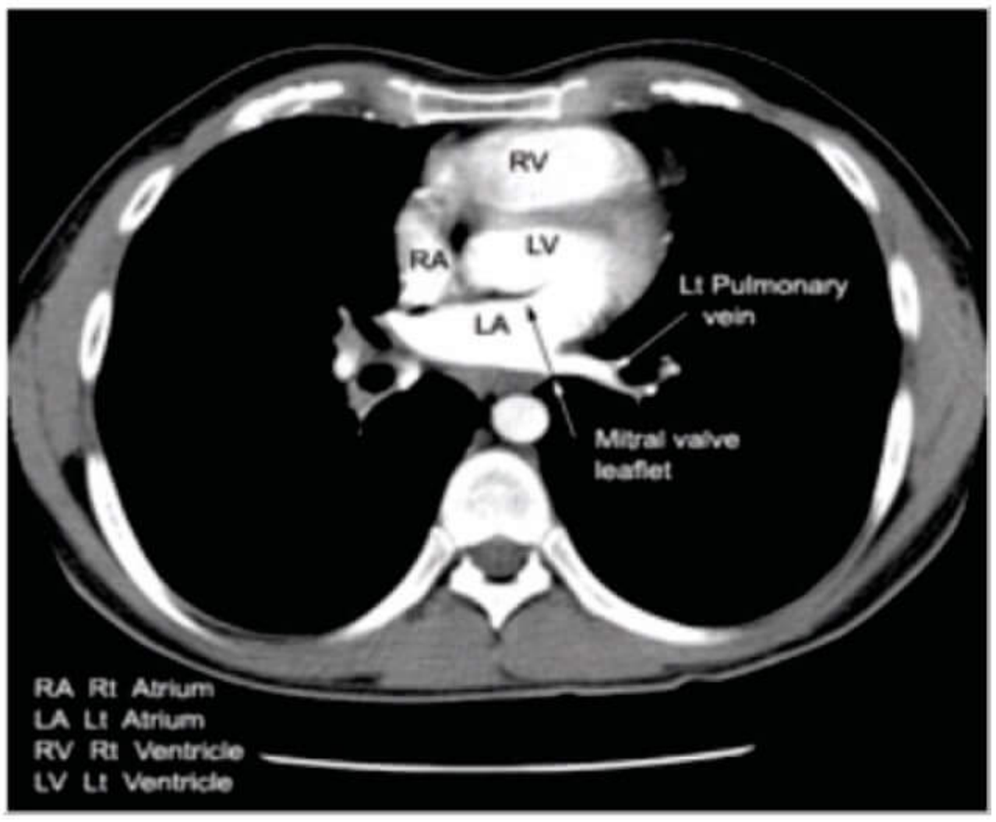
Aortic dissection:

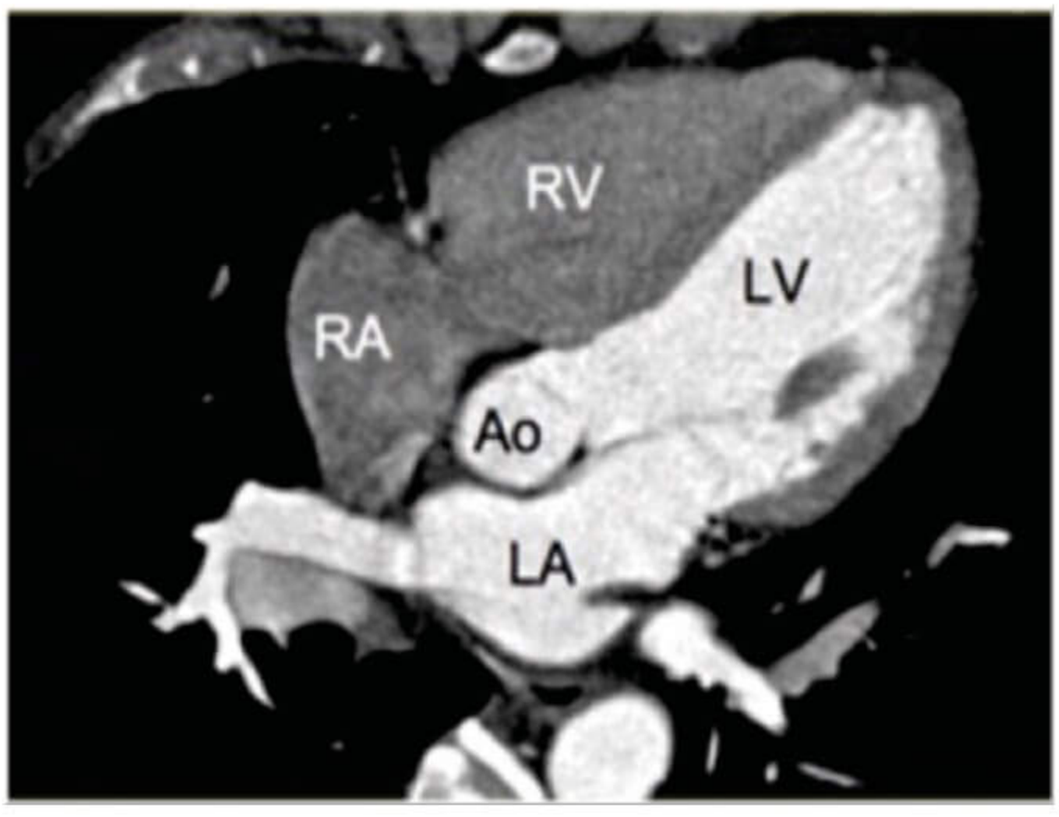
- → M/C site of aortic dissection is Ascending aorta
- → Intimal flap with double lumen is seen
- → IOC for acute aortic dissection → CT angiogram (stable pt.)
  → TEE (unstable pt.)



Important points to know:

- → Left atrium is the posterior most chamber
  (if LA is hypertrophied esophagus gets indented)
- → Right ventricle is the anterior most chamber (if RV is hypertrophied Retrosternal space gets obliterated)

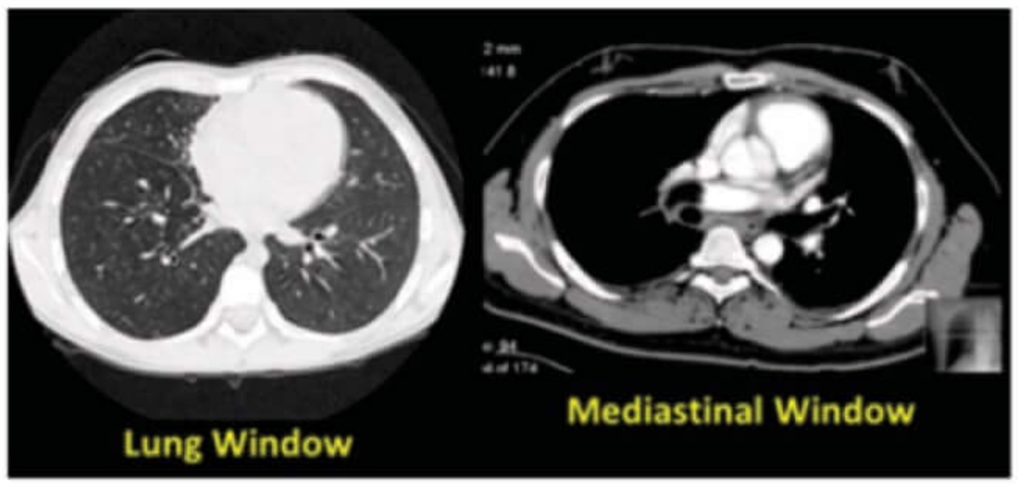


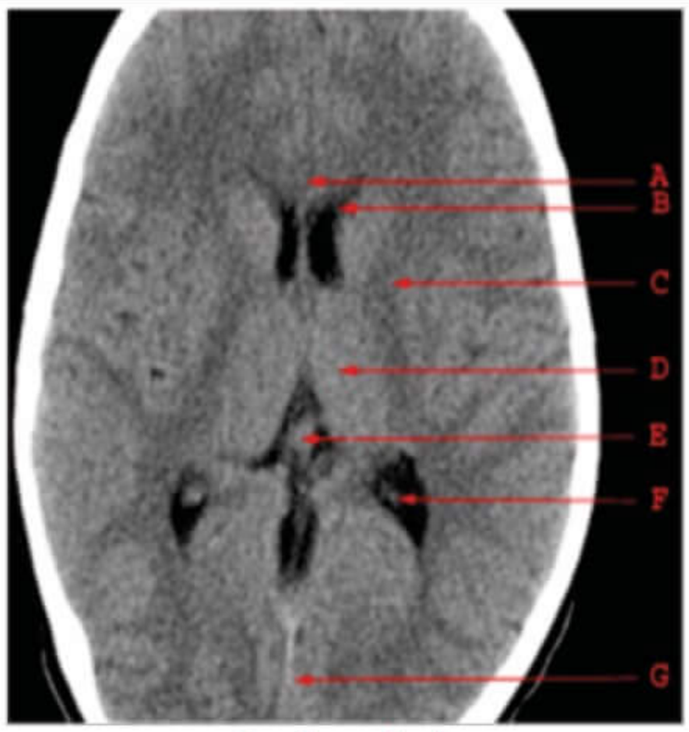


CT at the level of Heart

Imaging windows of CT:

a) Lung window
b) Mediastinal window
c) Bore window
d) Brain window





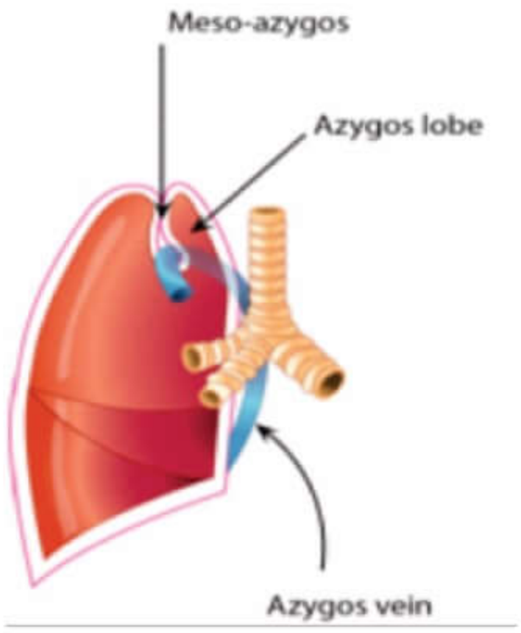
Brain window

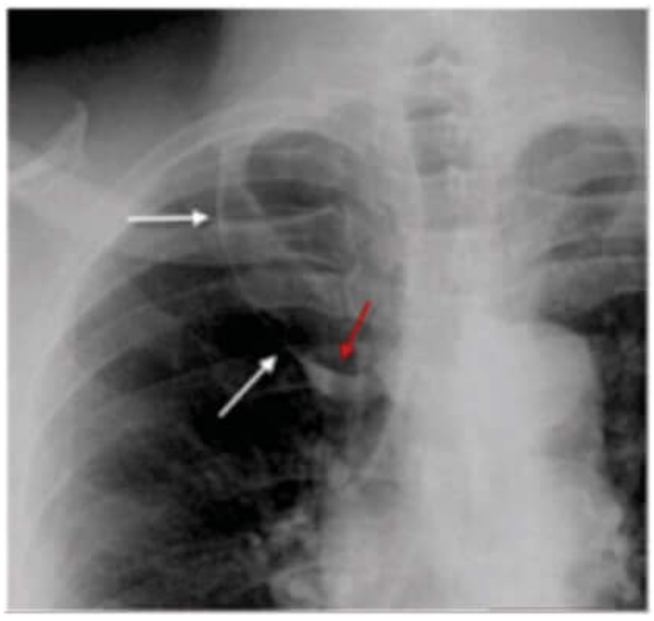
Lung window

Azygos fissure:

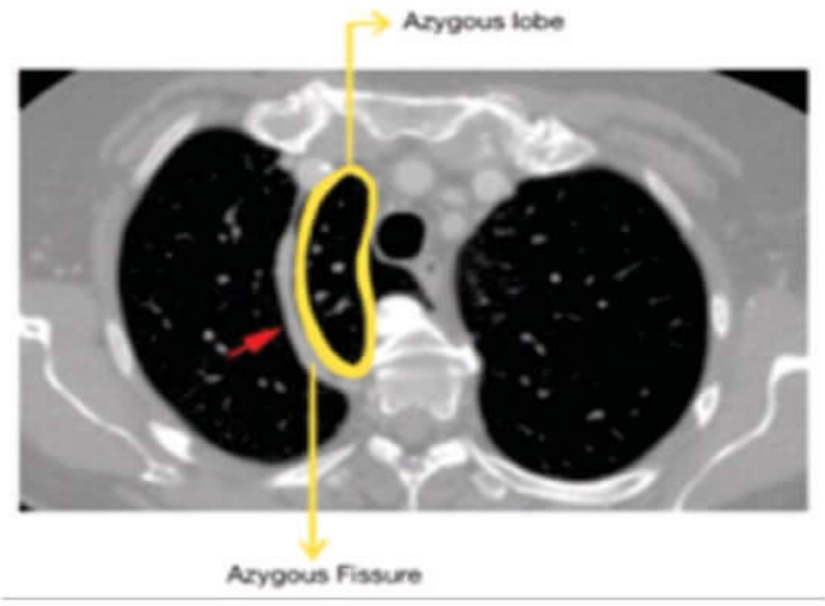
→ Is formed due to arching of displaced azygos vein which forms a Fissure at the apica; segment of right upper lobe.

→ This creates azygos lobe





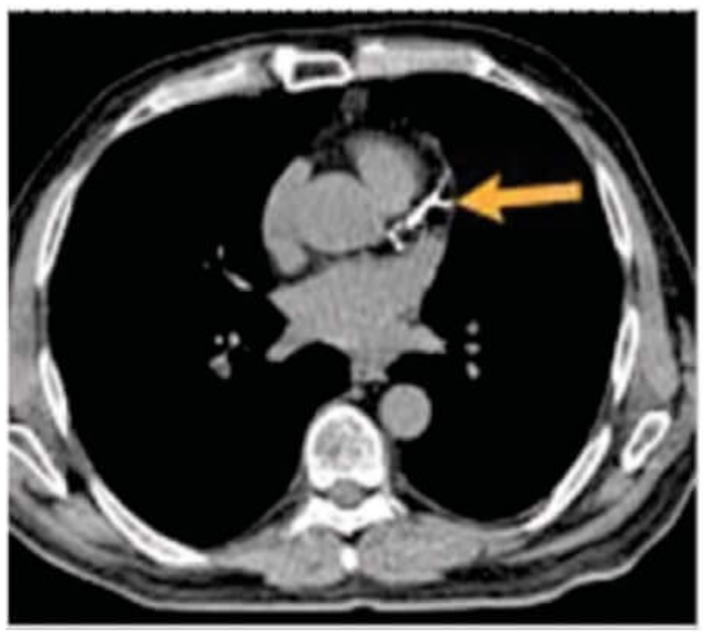
Azygos fissure X-ray



Azygos fissure -CT

Agatston scoring system:

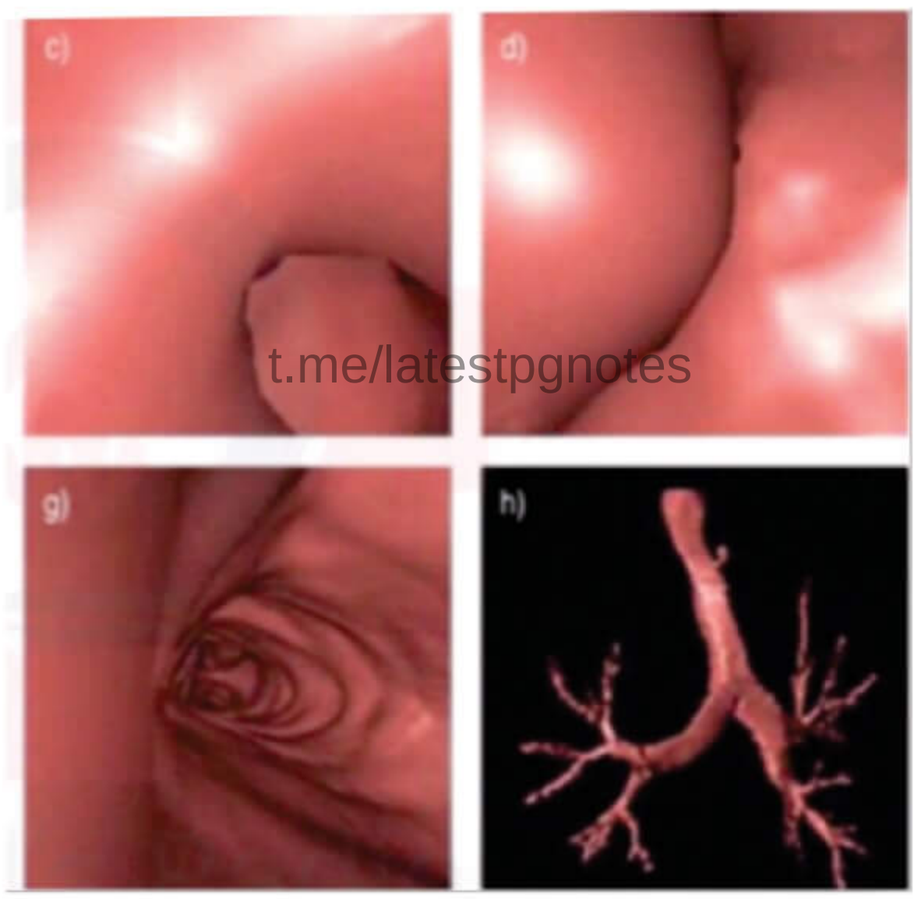
- → AKA Coronary calcium scoring
- → It uses MDCT
- → A score of **>400** - high risk for Coronary artery disease



CT scan showing Calcification in Left Anterior Descending Artery

Virtual Bronchoscopy:

- → It is a non-invasive 3D-CT technique
- → Gives endoluminal view and post stenotic areas can be seen
- → Used to see bronchial webs or atresia



Virtual Bronchoscopy

ULTRASOUND – Part 1

→ USG is not an electromagnetic wave but a Sound wave

Advantage
Non ionizing
Portable
Cheap
Easily available
Real time imaging
Safe in pregnancy

Disadvantage

operator dependent

→ **Medical USG** – Pioneered by **John wild**

→ **Obstetric USG** – Given by **Ian Donald**

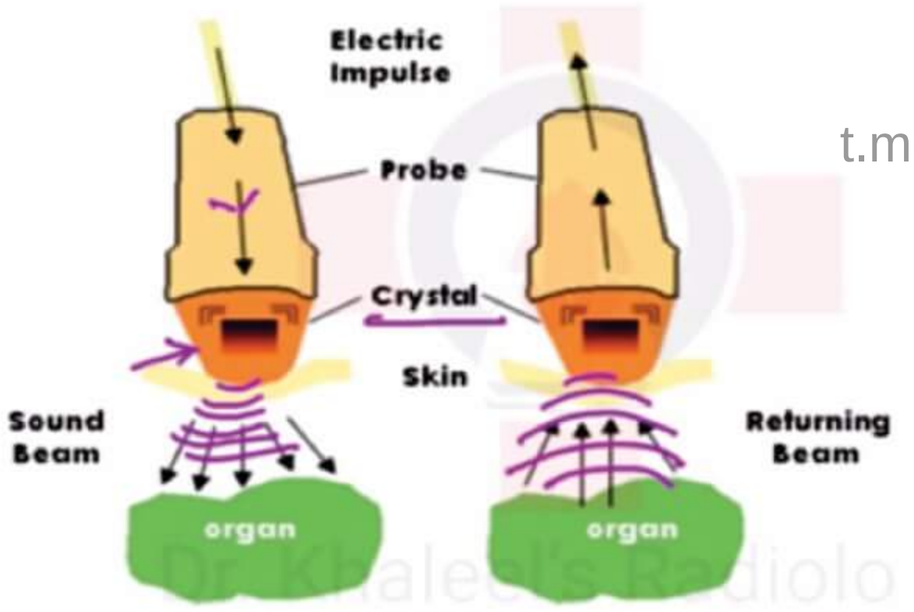
→ velocity of USG in human tissues – **1540 m/s**

→ Diagnostic USG uses sound wave of frequency **2-20 MHZ**

(i.e. increased frequency = better image resolution)

Principle of ultrasound

→ Works on **Pulse-Echo principle**

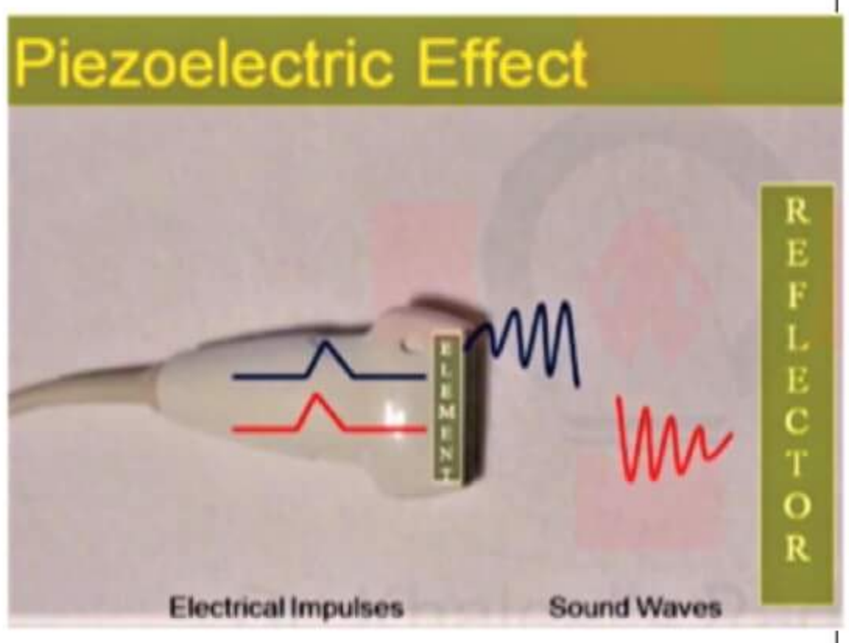


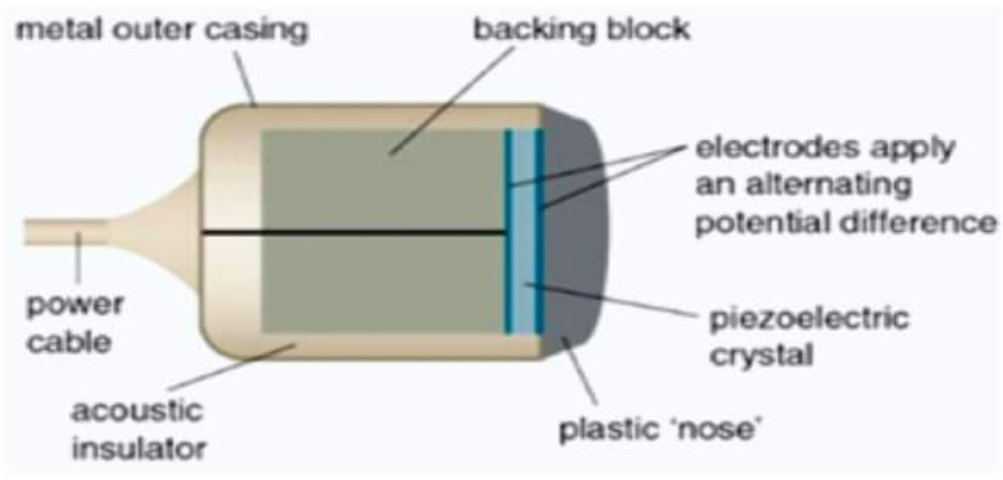
- Probe sends the acoustic pulse and the reflected echo is imaged

→ USG Uses **Piezo electric effect**

- Conversion of electrical energy into sound energy and vice versa.

→ Ultrasound probe / transducer – has Piezoelectric crystal which is made up of Lead zirconate titanite





Different types of Probes / transducers

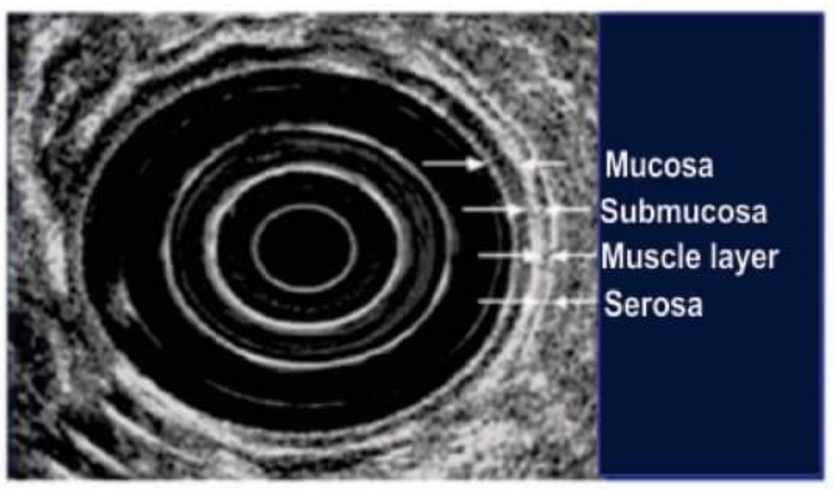
Curvilinear probe	Linear probe	Endocavitary probe
• 3-5 MHz (Low frequency) • Greater wavelength • Greater penetration • Poor resolution • Used for imaging deep structures e.g kidney, ovary, fetal parts etc.	• 10-12 MHz (high frequency) • low wavelength • poor penetration • Good resolution • Used for superficial structures e.g. thyroid, breast, scrotum etc.	• 7- 10 MHz (Good frequency • TVS (Transvaginal sonograpgy) • TRUS (Transrectal ultrasound) • TEE (Trans esophageal echocardiography)

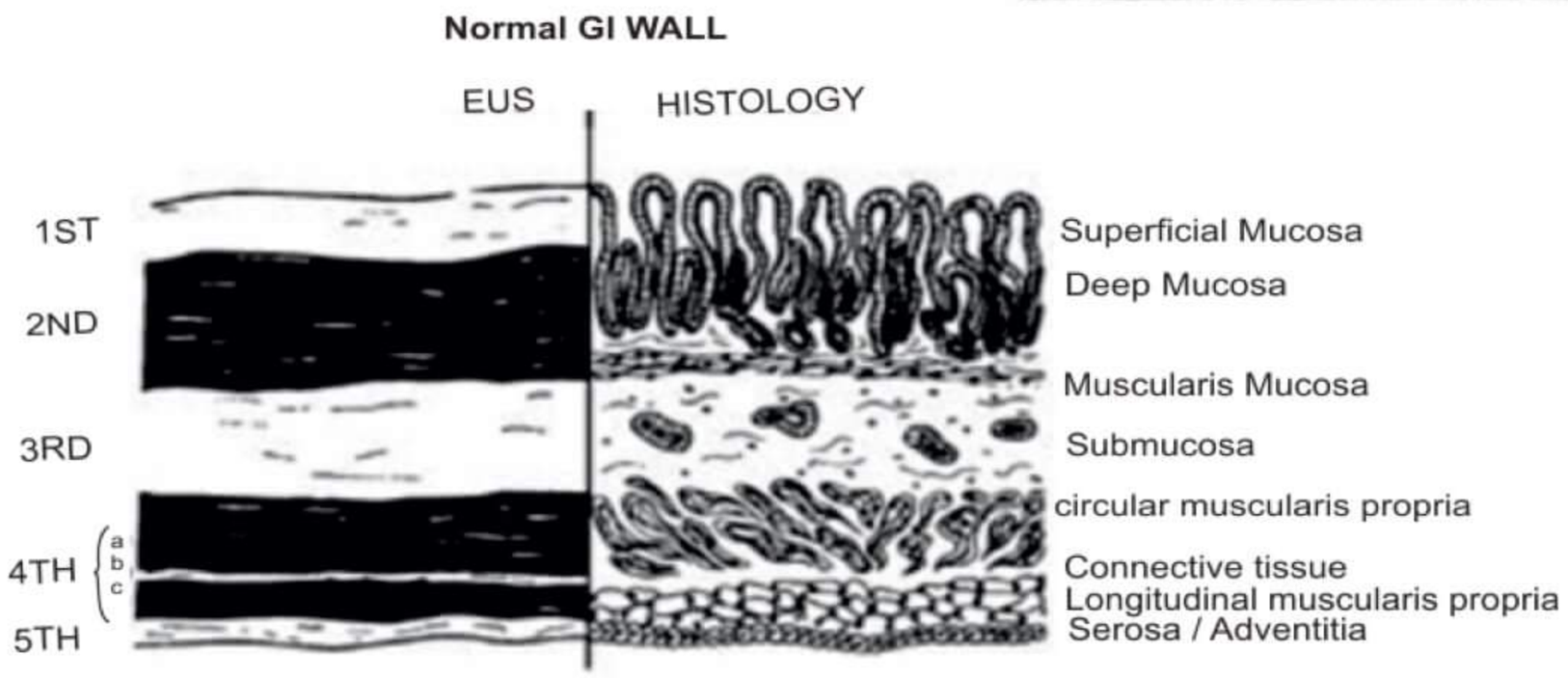
- TVS (Transvaginal sonograpgy)
  - IOC for Ectopic pregnancy
  - Bladder must be empty before doing TVS

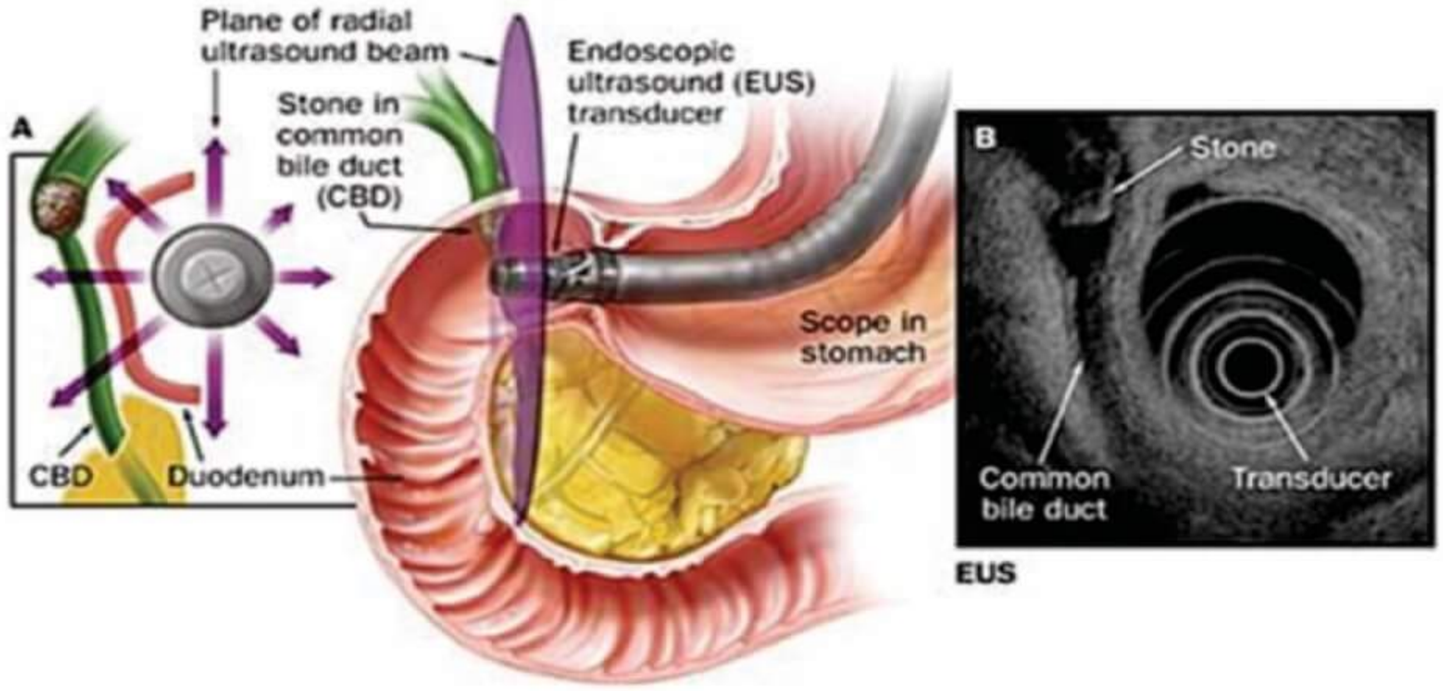
→ **Endoscopic Ultrasound (EUS)**

- Uses frequency of 20 MHZ
- Very good resolution
- Divides gut wall into 5 layers
- EUS is the **IOC for local invasion or T staging of early esophageal cancer**

(IOC for Advanced esophageal Carcinoma - **CECT**)







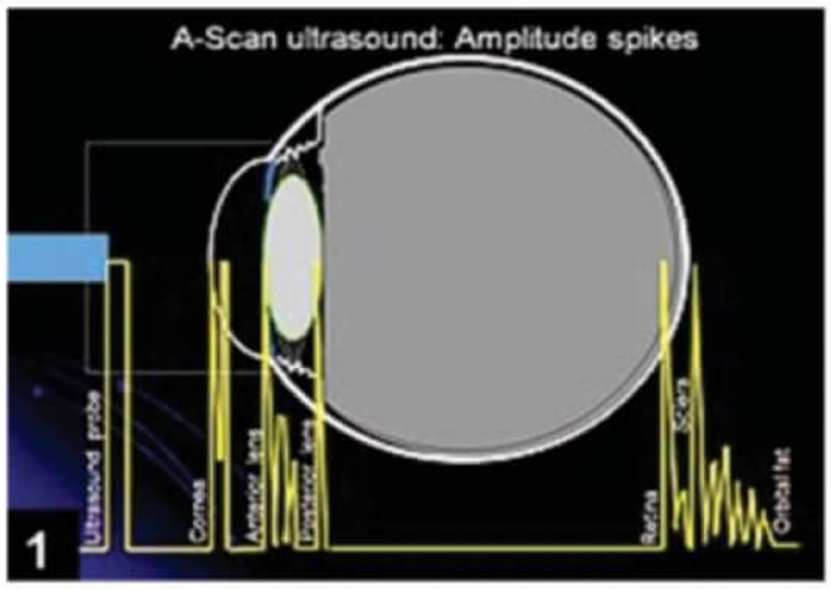
Modes of USG

1) **A mode (Amplitude mode)**

→ Each interface gives one echo which are displayed as spikes projecting from baseline displaying depth on X axis & echo intensity on Y axis

→ **Used for**

- Ophthalmology
- Orbital Biometry
- Midline displacement of the brain in Trauma & brain tumors



Measuring the distance between **Amplitudes** – the distance between individual structures & the entire length of the eyeball can be measured

2) **M mode (Motion mode)**

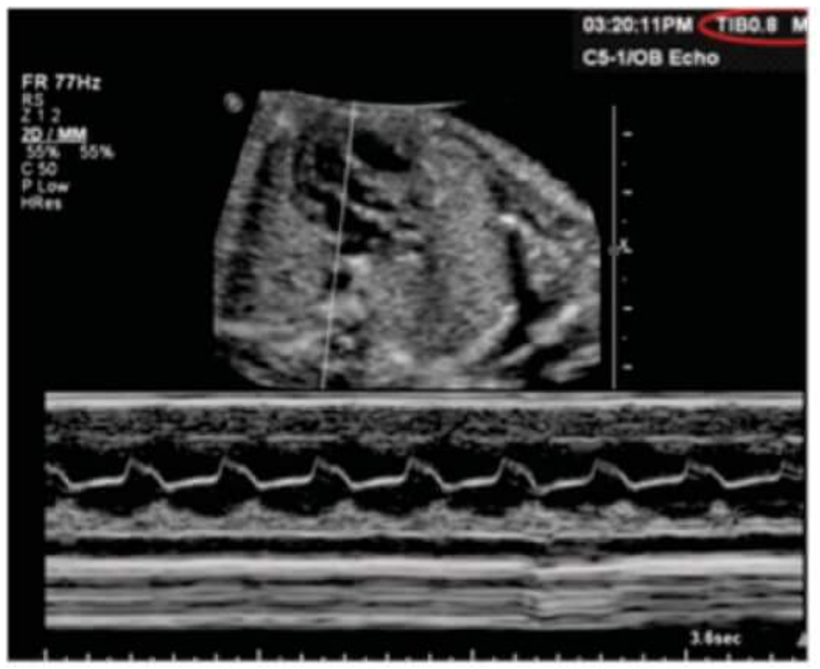
→ Gives excellent resolution of motion patterns displaying time on X axis

→ **Uses**

- Evaluation of Cardiac valve motion
- Echocardiography

3) **B mode (Brightness mode)**

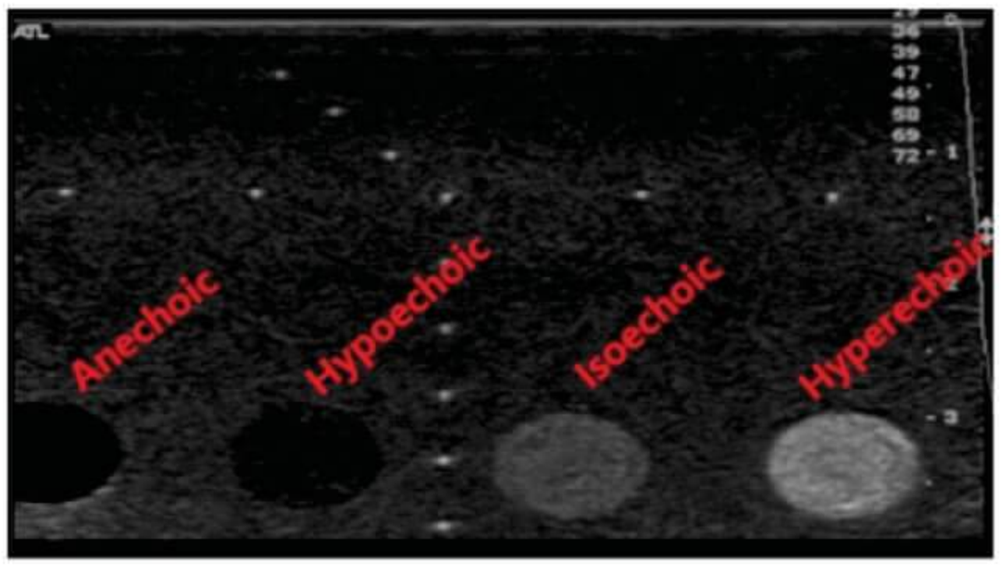
→ Used in all routine application



M mode – Fetal heart

USG appearances

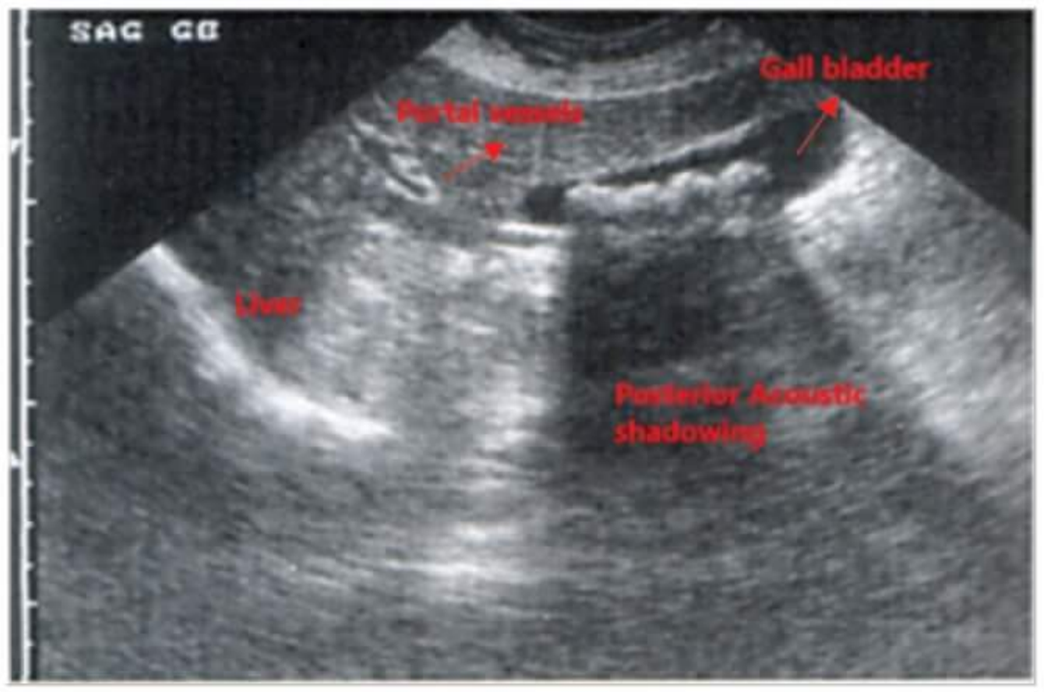
Anechoic	→ Cysts → Gall bladder → Urinary bladder
Hypoechoic	→ Muscle → Complex cyst → Thyroid malignancy
Isoechoic	→ Resembles surrounding Parenchyma
Hyperechoic	→ Hemangioma



Posterior Acoustic shadowings

→ **Seen with**

- **Air** – Gives dirty shadow (Most waves are reflected allowing some waves to pass through)
- **Bone** – Gives dark clean shadow (Waves are completely reflected)
- **Calcifications**

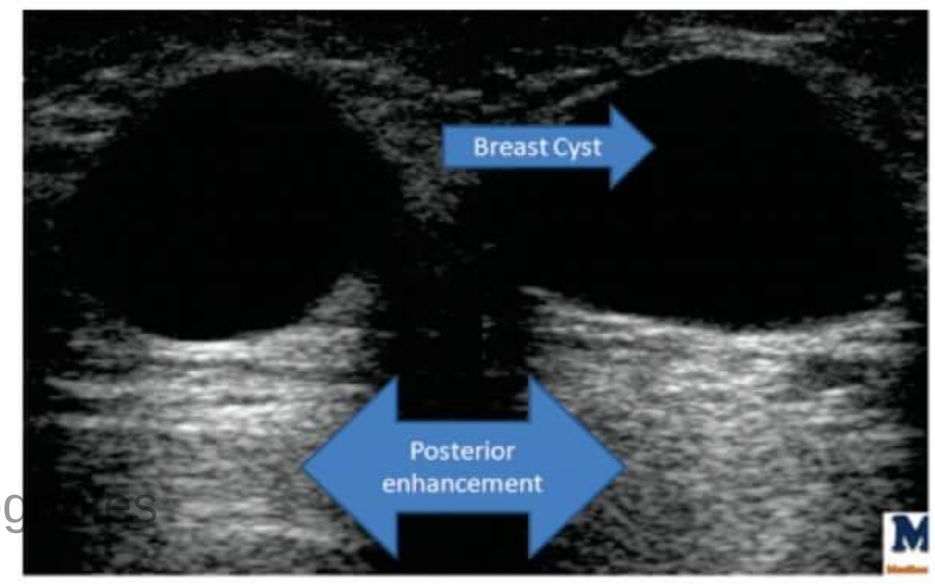


Emphysematous Pyelonephritis

→ Shows **Dirty shadowing**

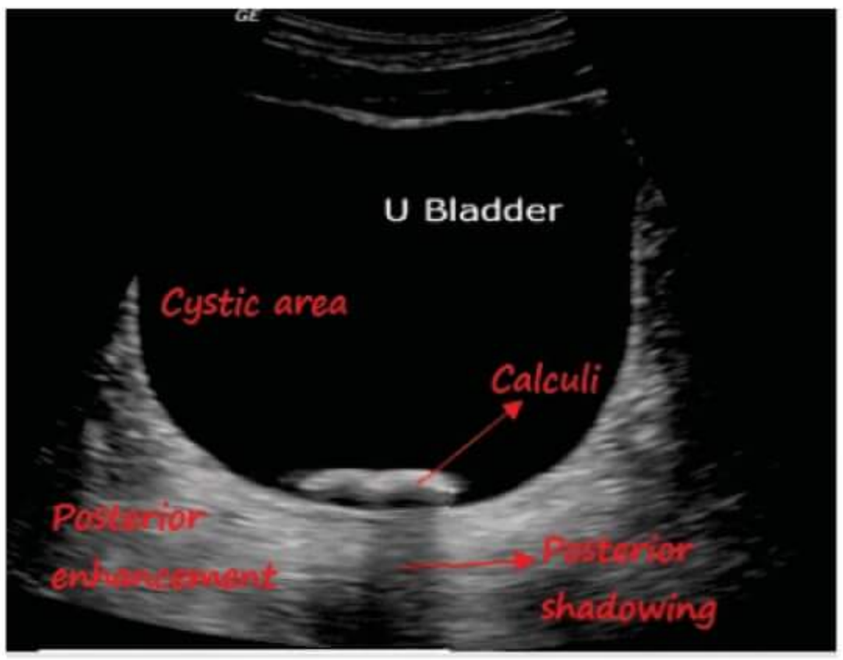
→ Air is **Hyperechoic** on USG

Breast cyst



→ **Posterior acoustic enhancements** are seen with **Cystic lesions**

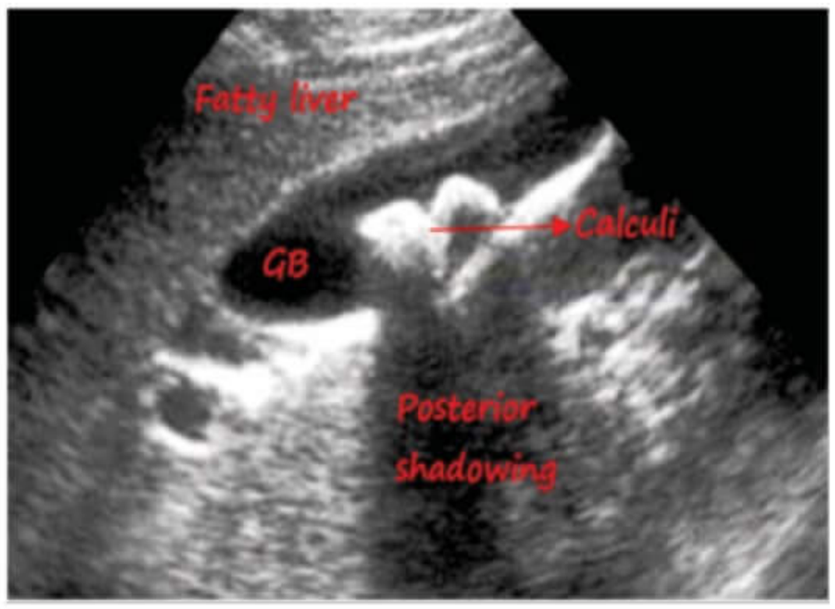
Vesical calculi



Wall- echo-shadow sign (WES sign)

→ Seen in **Chronic calcific cholecystitis**

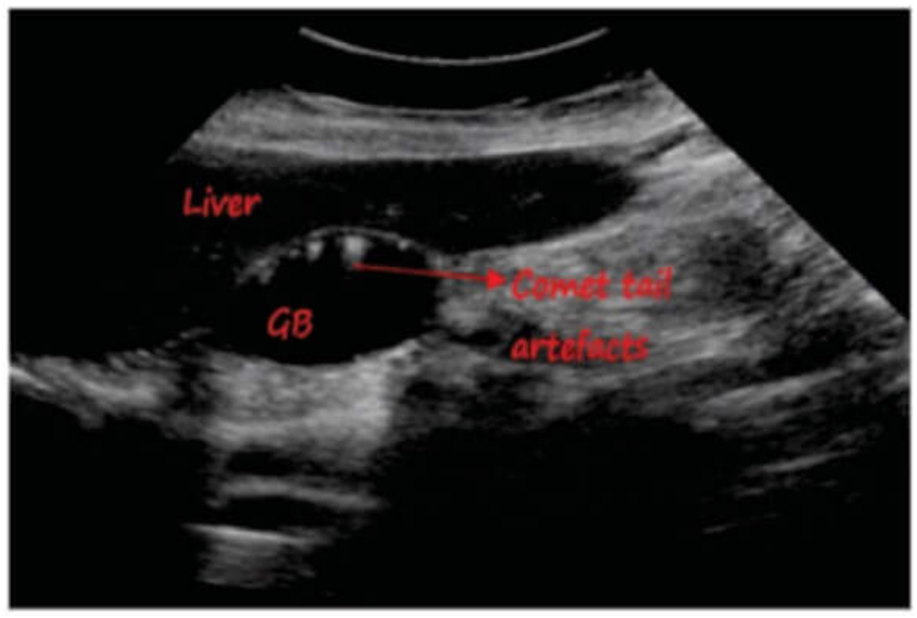
Cholelithiasis



→ **FAT** – Hyperechoic on USG

→ **Calculi** – Hyperechoic on USG

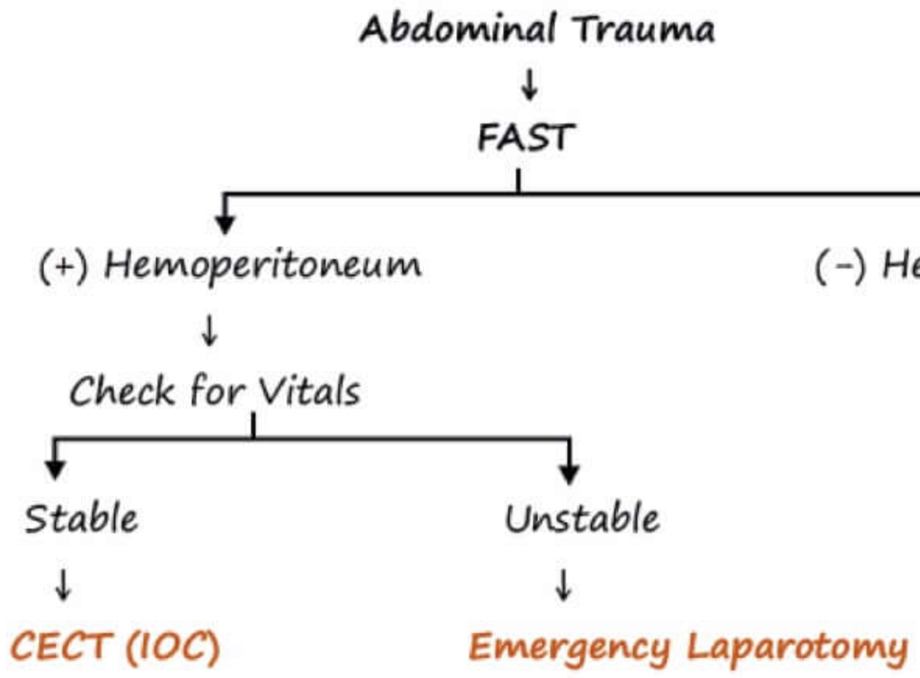
Comet tail artefacts



→ Feature of **GB Adenomyomatosis**

ULTRASOUND – Part 2

FAST (Focused Assessment with Sonography for Trauma)



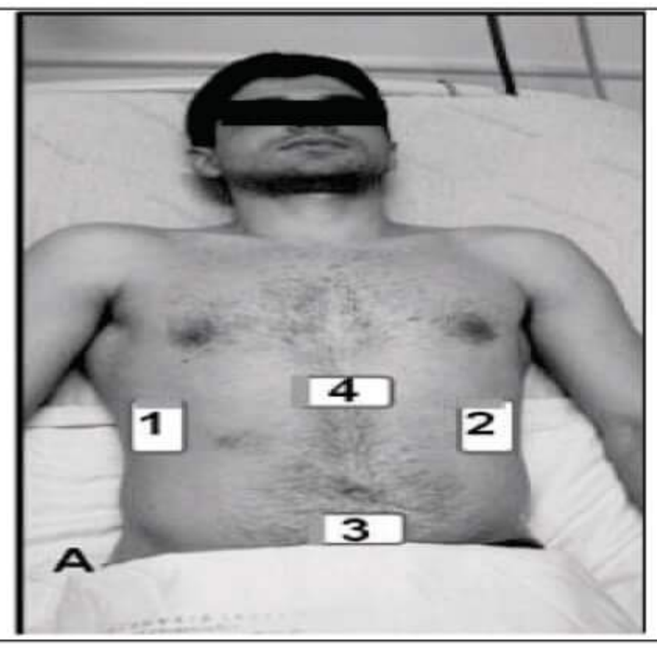
E -FAST (Extended FAST)

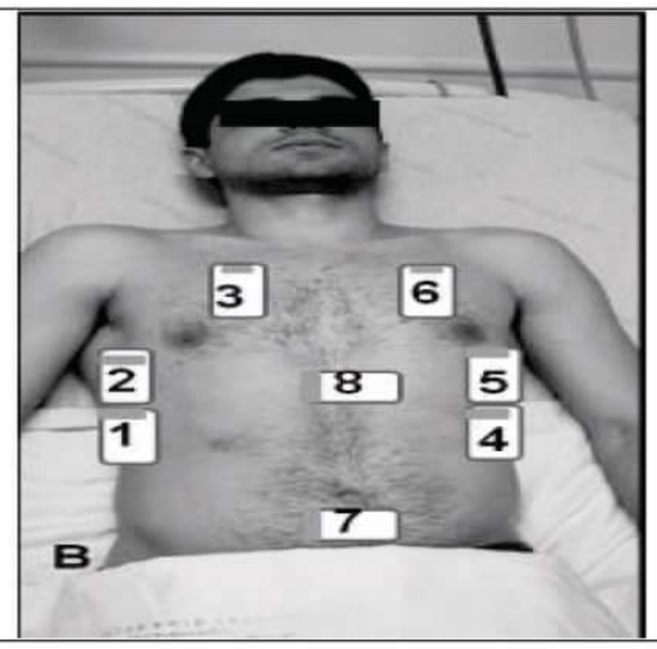
→ Used to evaluate

- Hemoperitoneum
- Pericardial effusion
- Hemothorax
- Pneumothorax

Difference between FAST & E-FAST

FAST	E-FAST
→ Evaluate Hemoperitoneum → Pericardial effusion	→ Evaluate • Hemoperitoneum • Pericardial effusion • Hemothorax • Pneumothorax
→ Probe is kept in 4 areas • Pericardial sac • Perihepatic region • Peri-splenic region • Pelvis	→ Probe is kept in 6 areas Pericardial sac Perihepatic region Peri-splenic region Pelvis Right thoracic view Left thoracic view





Ultrasound Elastography

→ Evaluates stiffness of the tissue by color coding

→ **Evaluates by 2 methods**

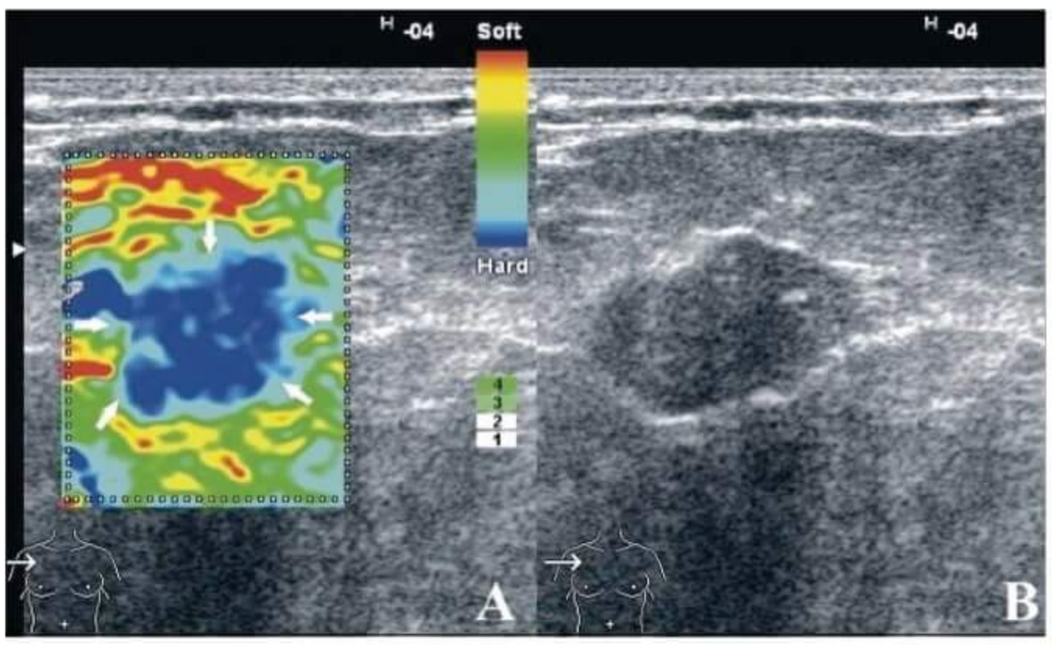
- **Strain elastography** – Physical compression used (for superficial lesion / soft & elastic tissue)
- **Shear wave elastography** – High intensity acoustic impulse used (for deep lesion / Hard fibrotic tissue)

→ **Fibroscan**

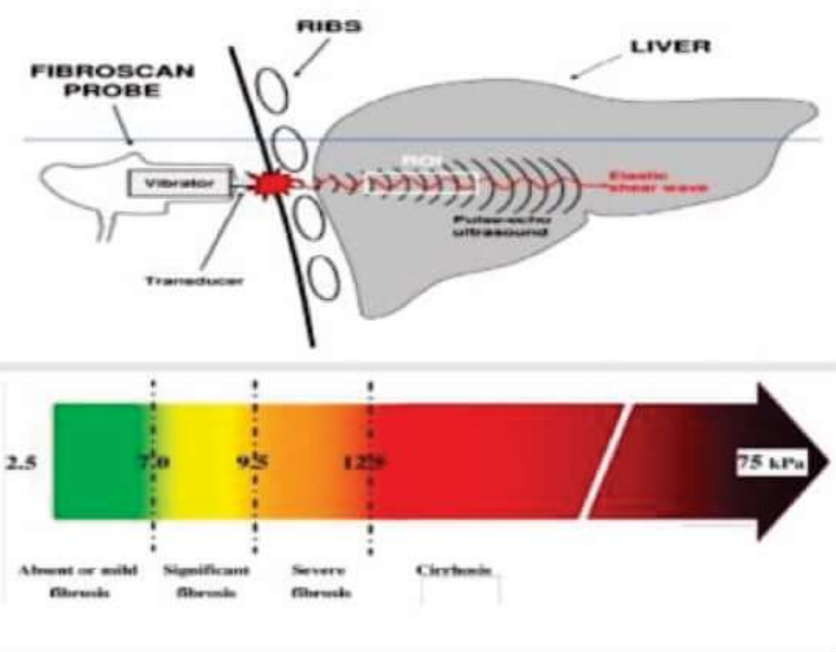
- Uses Ultrasound elastography technique
- It is non-invasive, Painless, repeatable technique for assessing liver fibrosis
- Used for evaluating diffuse liver disease, fibrosis, cirrhosis, Portal hypertension & Non-alcoholic fatty liver disease uses ultrasound elastography

→ **Ultrasound Elastography used for**

- Fibroscan
- Breast mass
- Cervical ripening
- Guide FNAC / Biopsies



Ultrasound Elastography



Fibroscan

Tissue harmonic imaging (THI)

→ Difference in propagation velocity of sound through fat & tissues produces phase aberrations causing distortion, noise & clutter

→ THI decreases the phase aberrations

→ Harmonics are integral multiples of original frequency, the second harmonic is generally needed

→ **Uses**

- ↓se artifacts
- ↓se clutter, noise & improves resolution

3D USG

→ Uses Volume data

→ Used to assess

- Fetal facial features
- Uterine anomalies

3D USG

4D USG

→ Real time acquisition of 3D data

Color Doppler

→ It is based on the principle of **frequency shift**

→ **Color coding** on color doppler is based on **direction of flow**

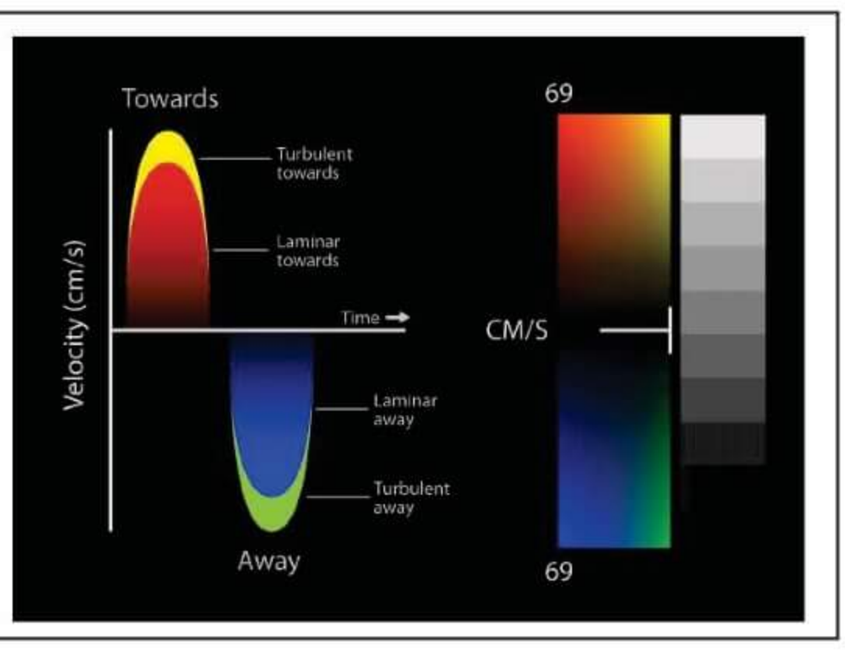
- Flow **TOWARDS** the probe - **RED**
- Flow **AWAY** from probe - **BLUE**

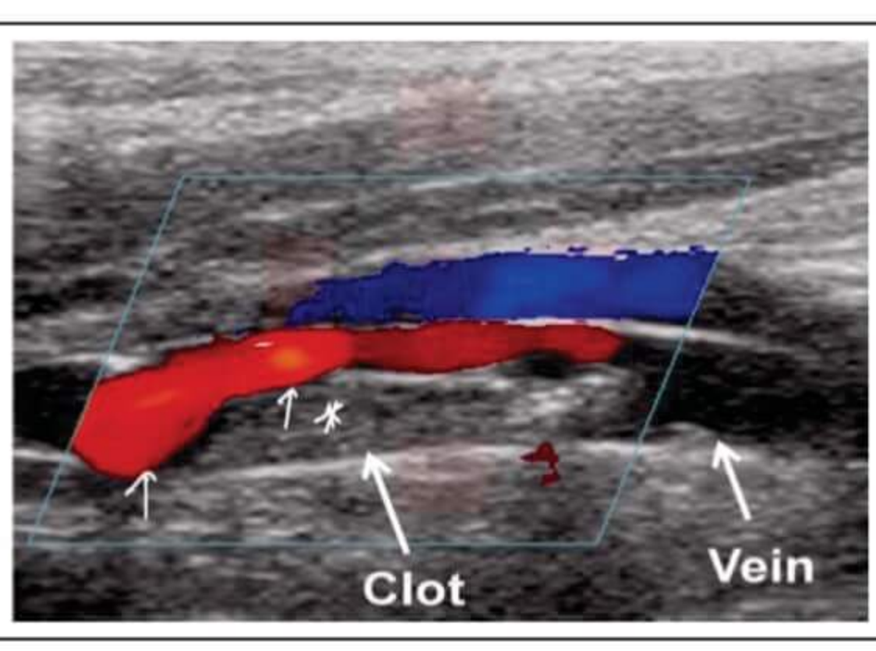
→ Doppler shift is the difference between incident frequency & reflected frequency

→ Ideal doppler angle should be **0 degree** **(Never 90°)**

→ In practice **45-60°** is the optimal doppler angle

→ Intensity of color depends on **velocity of flow**

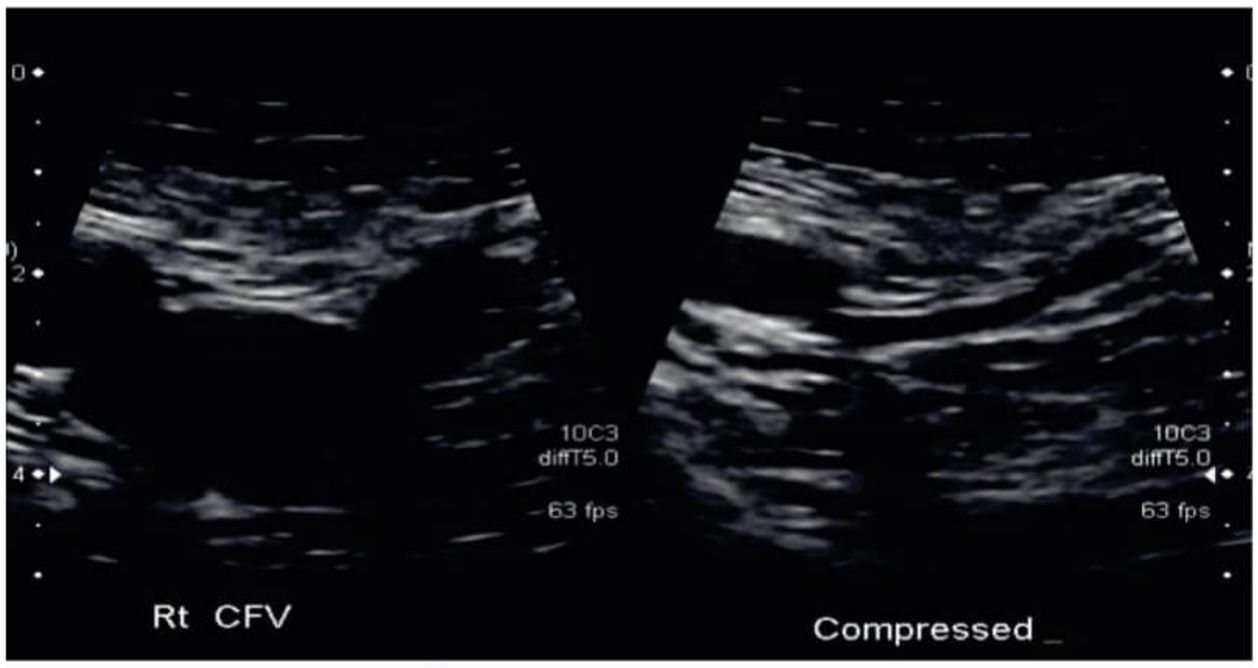




Winking sign

→ It is the **normal compressibility of veins**

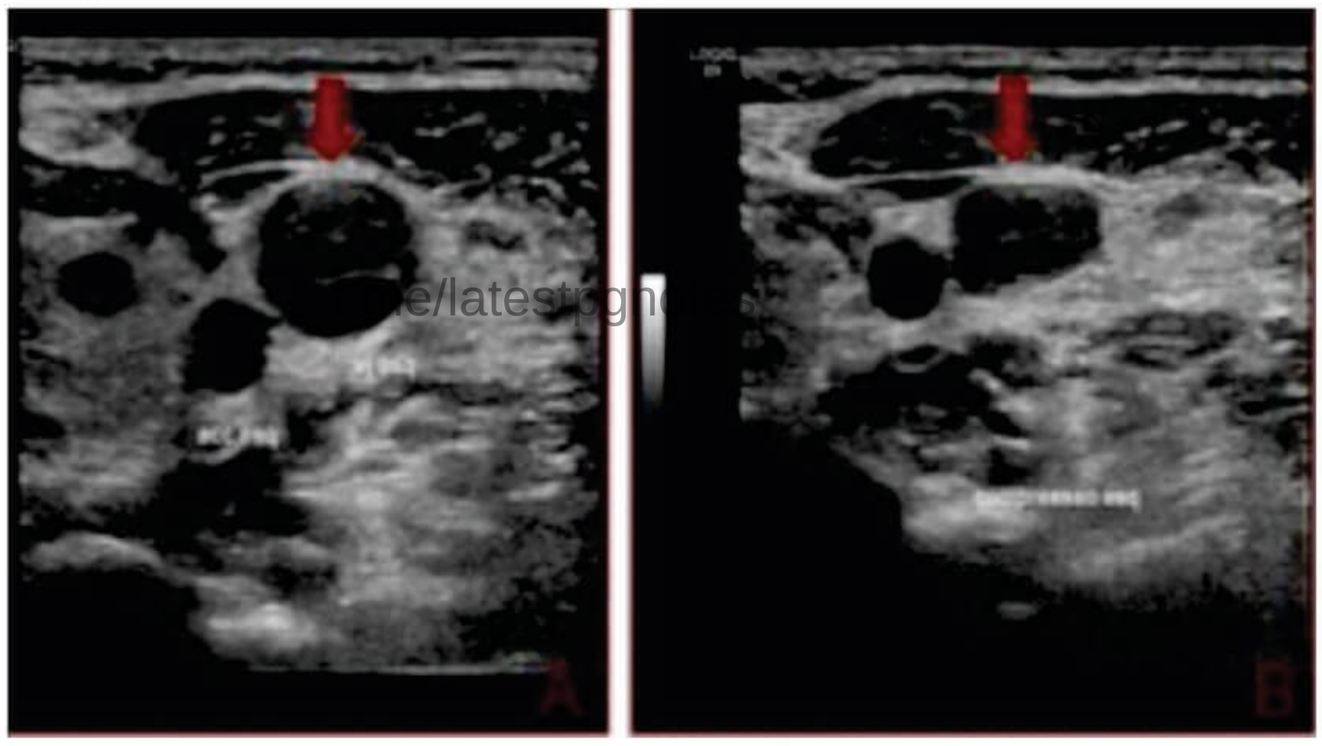
→ Arteries do not compress by probe due to high pressure but veins get compressed



Winking sign

Absent winking sign

→ Lack of compressibility of veins – seen in **DVT**



DVT – absent winking sign

Power doppler

→ Directional assessment is not done

→ Color display is based on amplitude of returning echoes

→ High intensity for low flow volume

Duplex scanning

→ It is a B mode real time USG & Pulsed Doppler

→ Color flow imaging giving 2D visual display of moving blood over a gray scale image

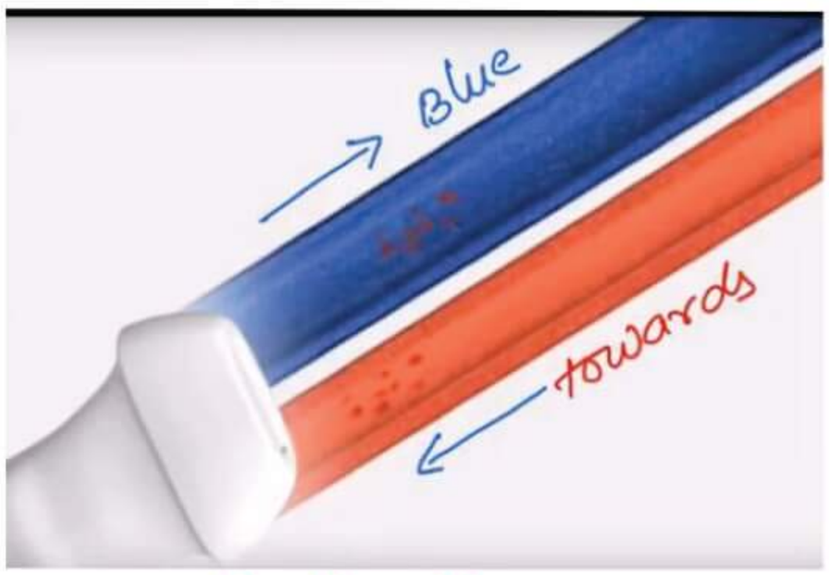
Q. Characteristic of venous blood flow of lower limb in duplex Doppler is?

1. **Monophasic**
2. Biphasic
3. Triphasic
4. Non phasic

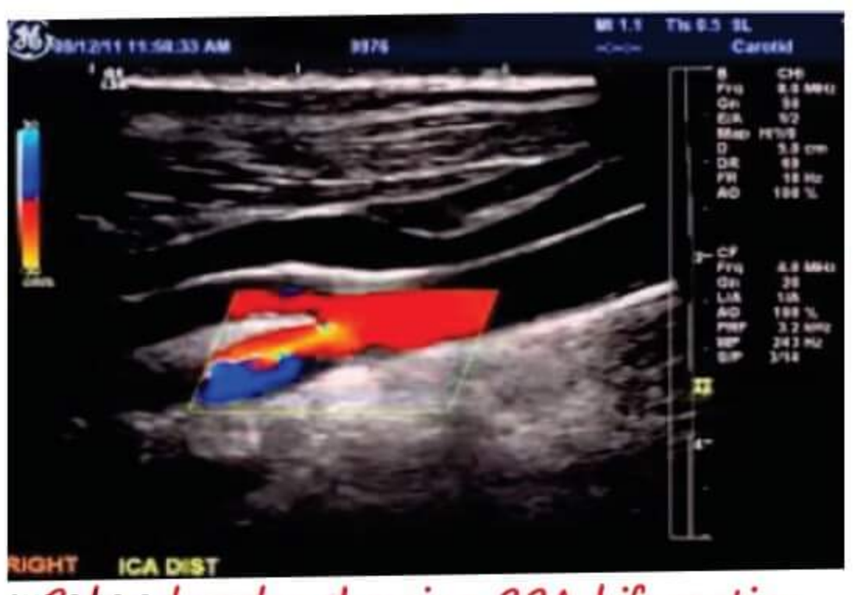
Answer: 1

Explanation

- Doppler is based on frequency shift and color coding depends on the direction of blood flow
- **Direction of blood flow:**
  - Flow towards the probe → **Red**
  - Flow away from probe → **Blue**

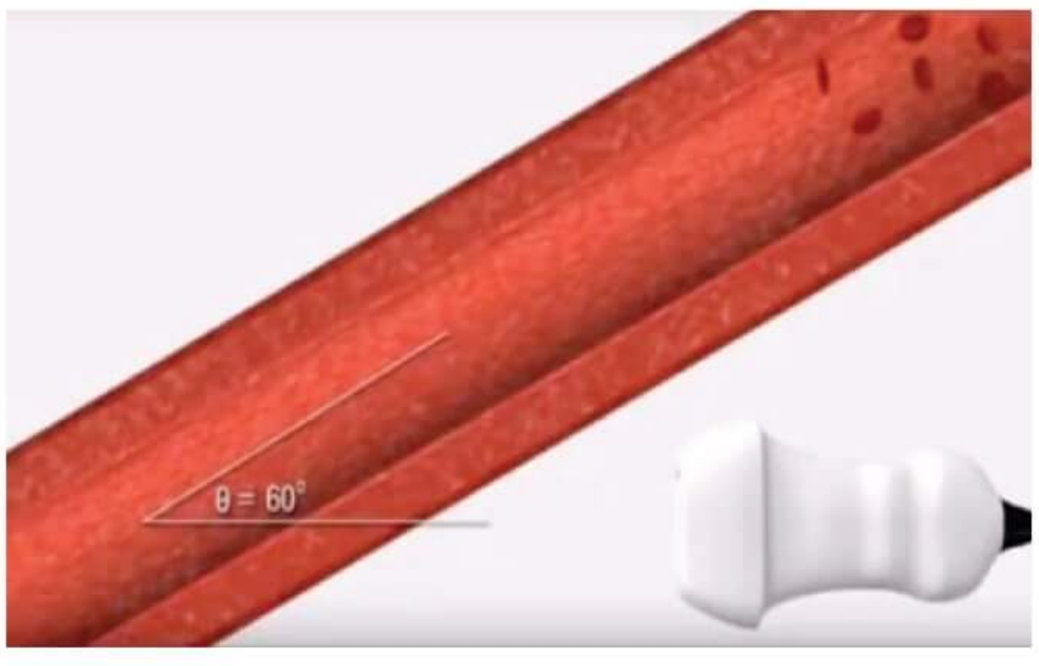


Direction of flow

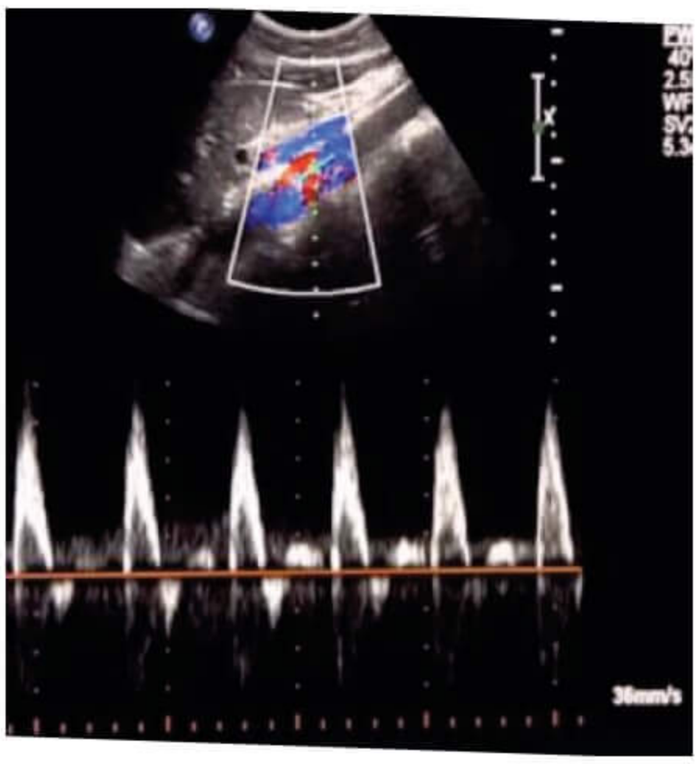


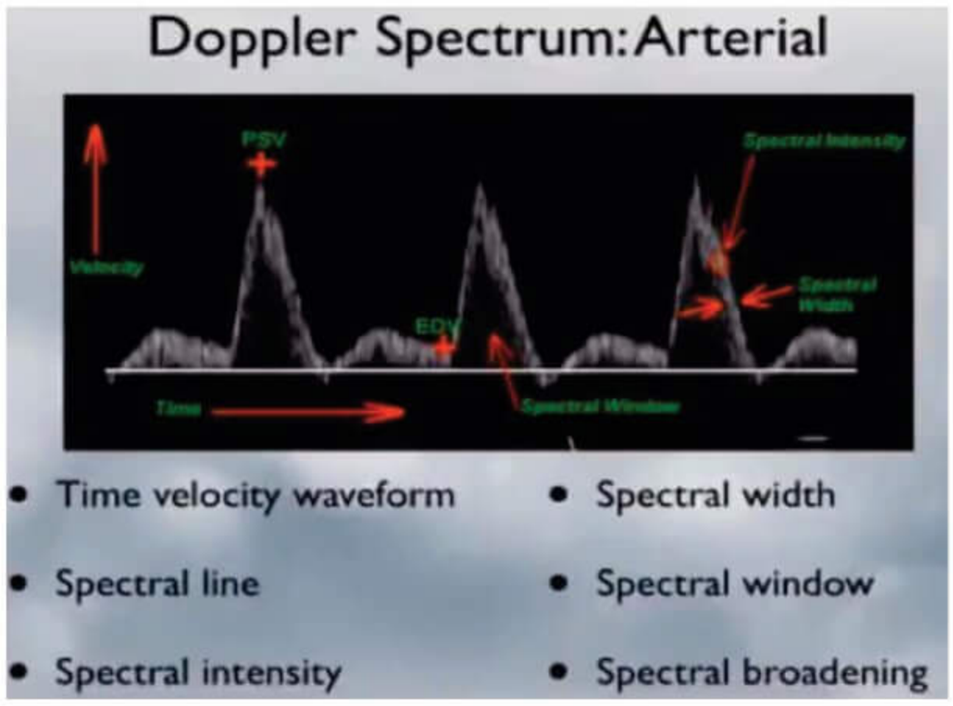
Color doppler showing CCA bifurcation

- **Spectral doppler:**
  - Cursor is placed on the area of blood vessel we want to trace and its velocity is measured
  - An angle has to be maintained to obtain a proper image
    - → Ideal angle = **0°** (practically not possible)
    - → Optimal angle = **45°-60°** (never 90°)



- *Spectral doppler is a Time – velocity graph that shows different velocity during cardiac cycle*





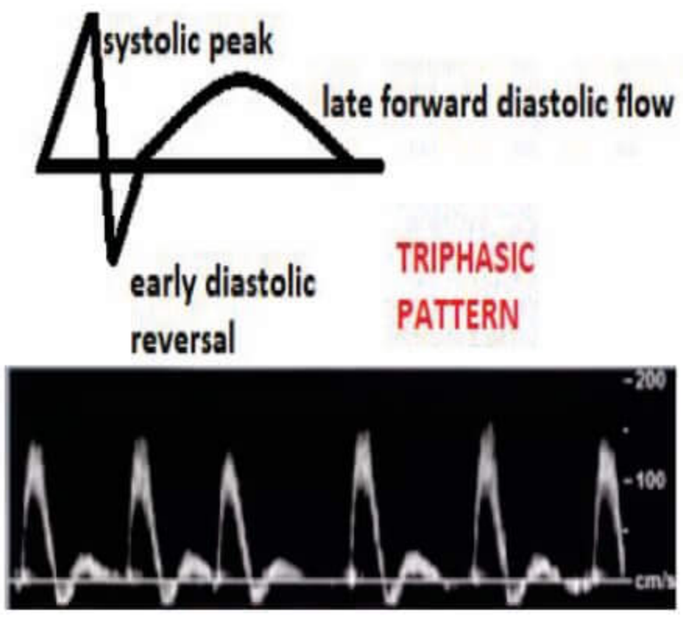
Spectral doppler

Arteries

High Resistance (Peripheral arteries)

- Extremities
  - → Femoral A.
  - → Popliteal A.
  - → Axillary A.
  - → Brachial A.

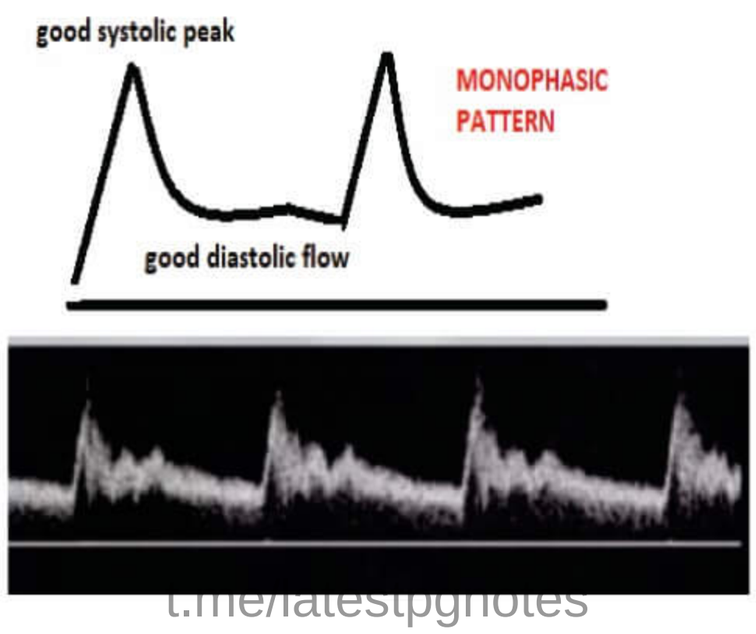
- Shows **Triphasic pattern**



Low resistance (Visceral arteries)

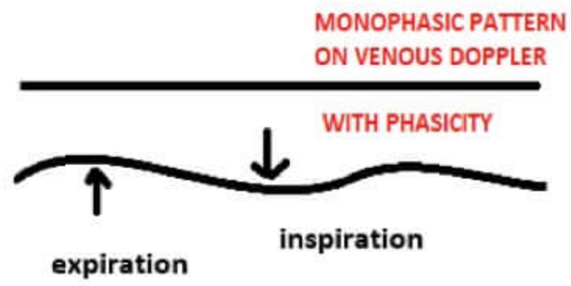
- Brain arteries
  - → ICA
  - → CCA
  - → VA
- Renal arteries

- Shows **Monophasic pattern with Pulsatility**



Veins

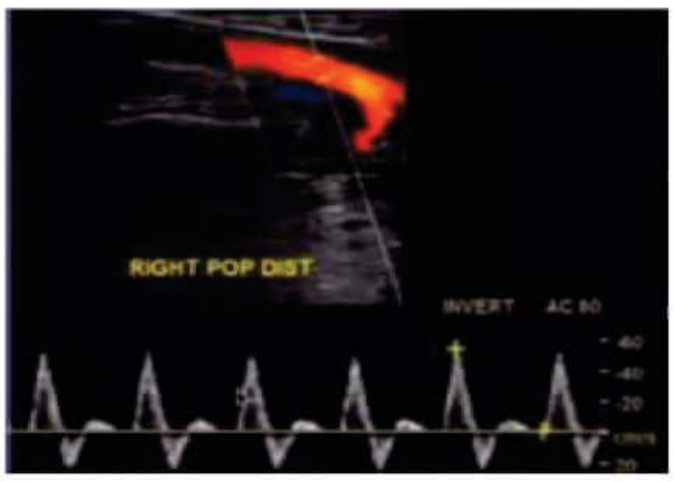
- Shows **Monophasic pattern with Phascity**



Triphasic waveform

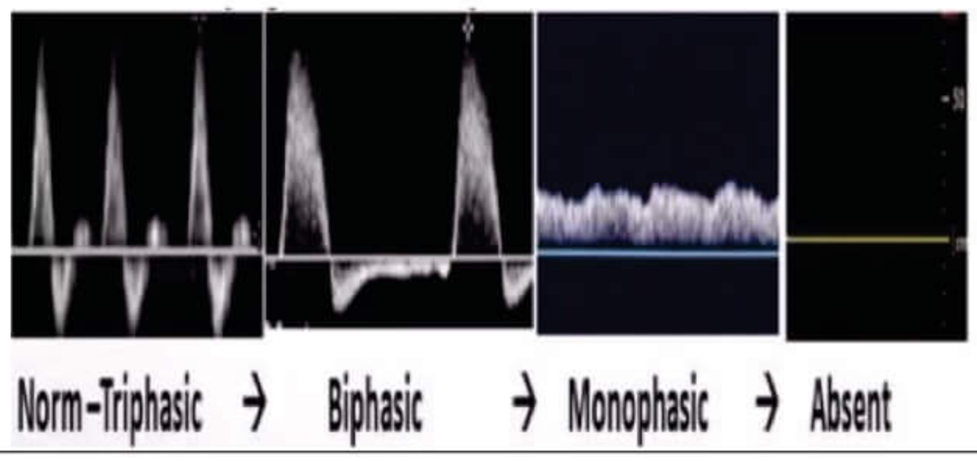
→ **Has 3 components**

- Initial high velocity forward flow component
- Early diastolic reverse flow component
- Late diastolic forward flow component



→ **Waveform based on the Grade of stenosis in Peripheral vessels**

- Triphasic pattern – Normal
- Biphasic pattern – Mild to Moderate stenosis
- Monophasic pattern – Moderate to severe stenosis
- Absent waveform - Thrombus

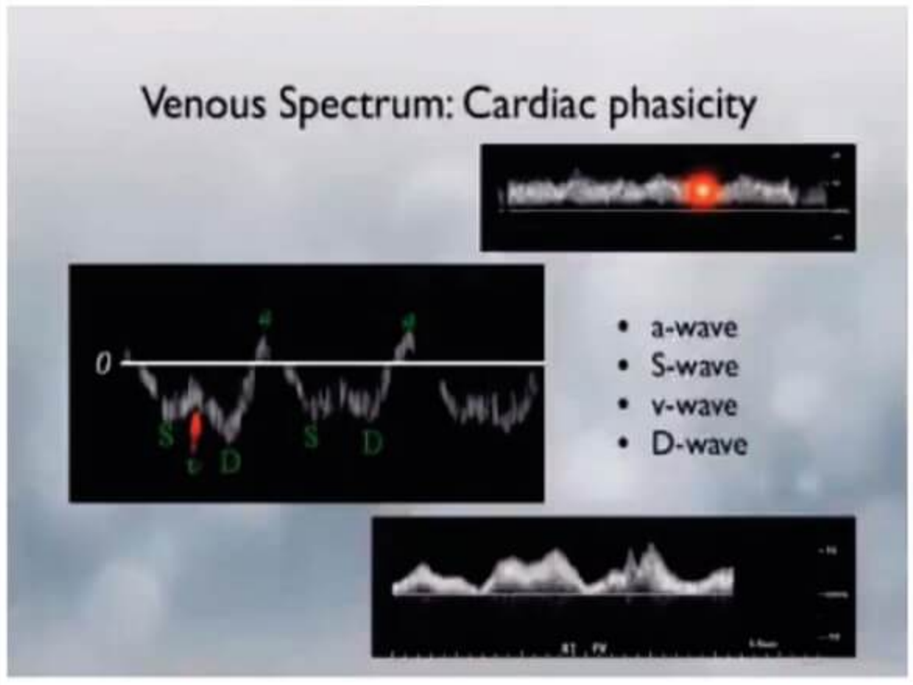


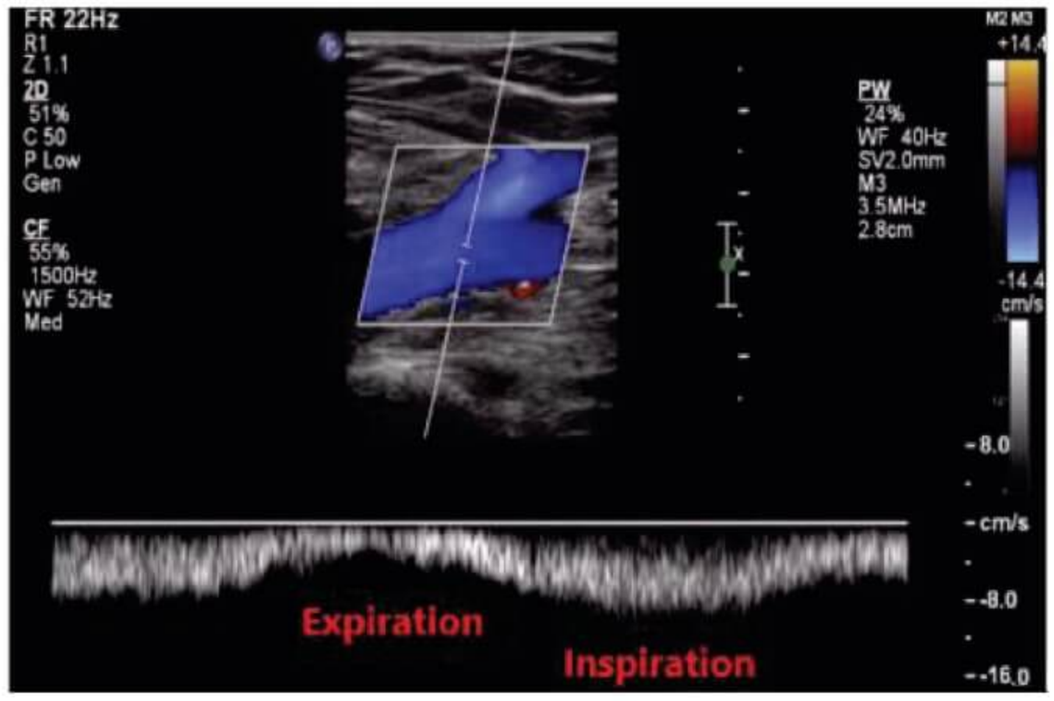
Venous doppler

→ Shows **Monophasic pattern with Phasicity** – during free breathing variations in amplitude due to Cardiac & Respiratory phasicity

→ Absence of Cardiac & Respiratory phasicity – Indicates diseased Vein

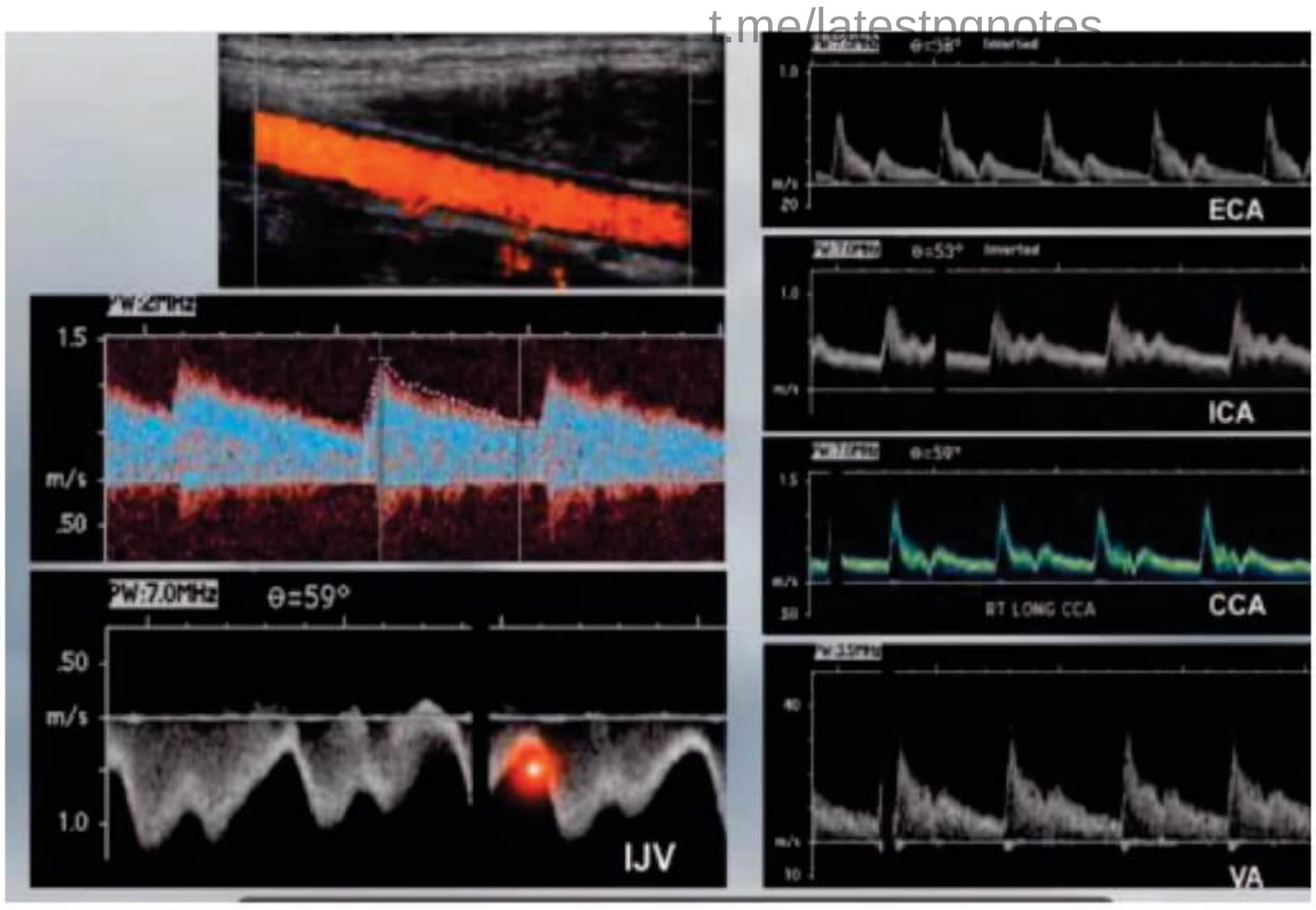
→ In breath hold – Pressure changes of Right atrium are reflected back in the major veins giving JVP like curve





Important Points to know

Head & Neck vessels

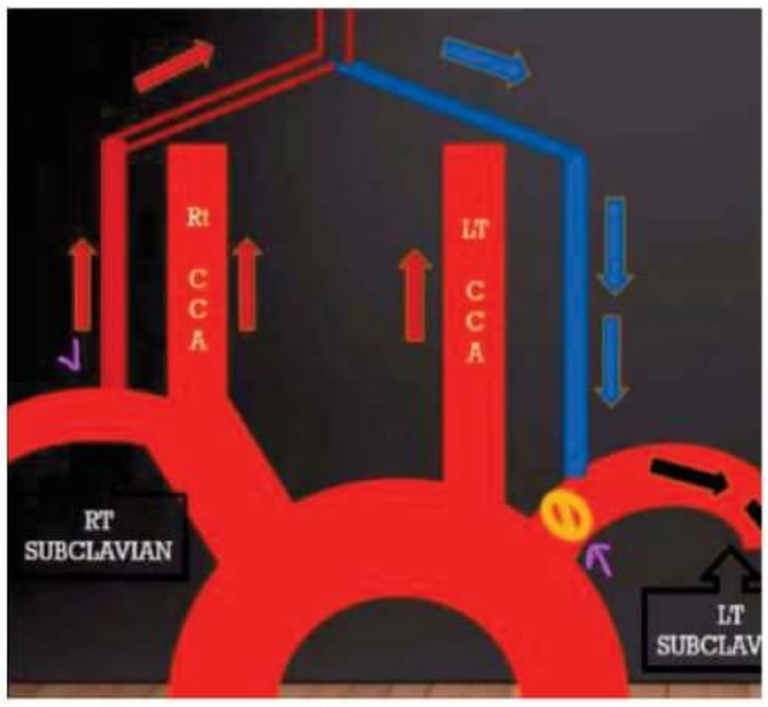


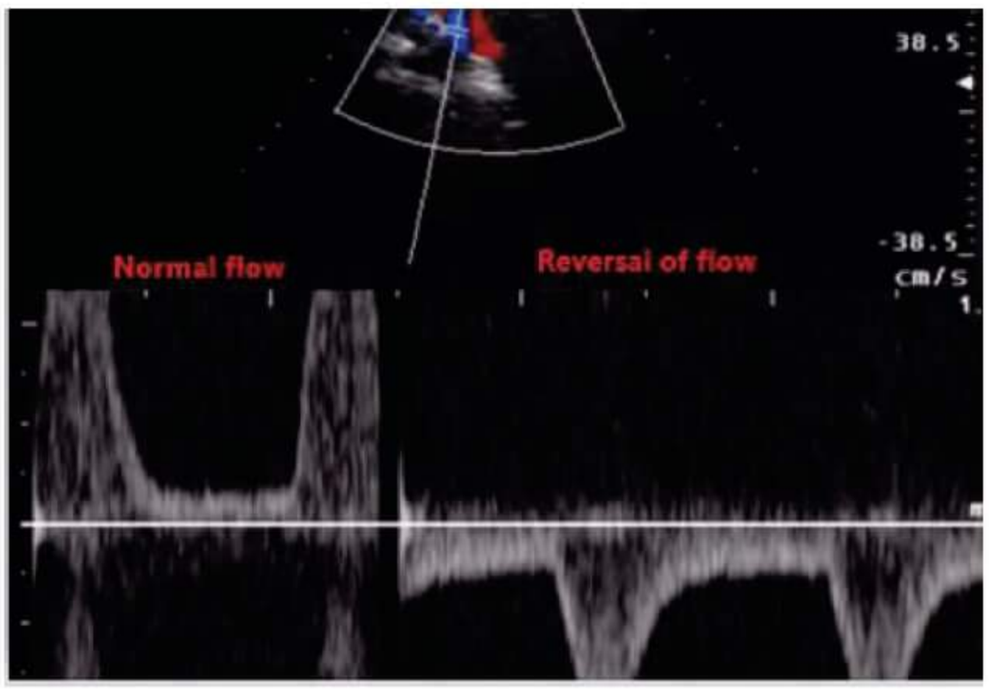
- **ECA** – Triphasic pattern
- **ICA** – Monophasic pattern with Pulsatility
- **CCA** – Monophasic pattern with Pulsatility
- **VA** – Monophasic pattern with Pulsatility
- **IJV** – Monophasic pattern with Phasicity

Subclavian steal syndrome

→ **Normal** – Flow of VA is same as CCA

→ **Stenosis of SCA** – Flow reversal in VA





Yin – Yang Pattern

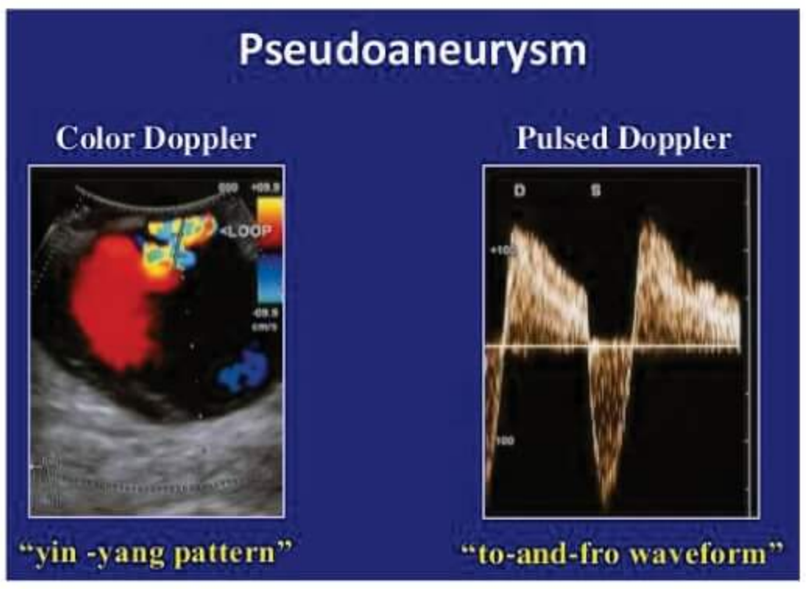
→ Caused due to bidirectional blood flow

→ **Seen in**

- Pseudoaneurysm (or)
- Large aneurysm

→ Pseudoaneurysms shows

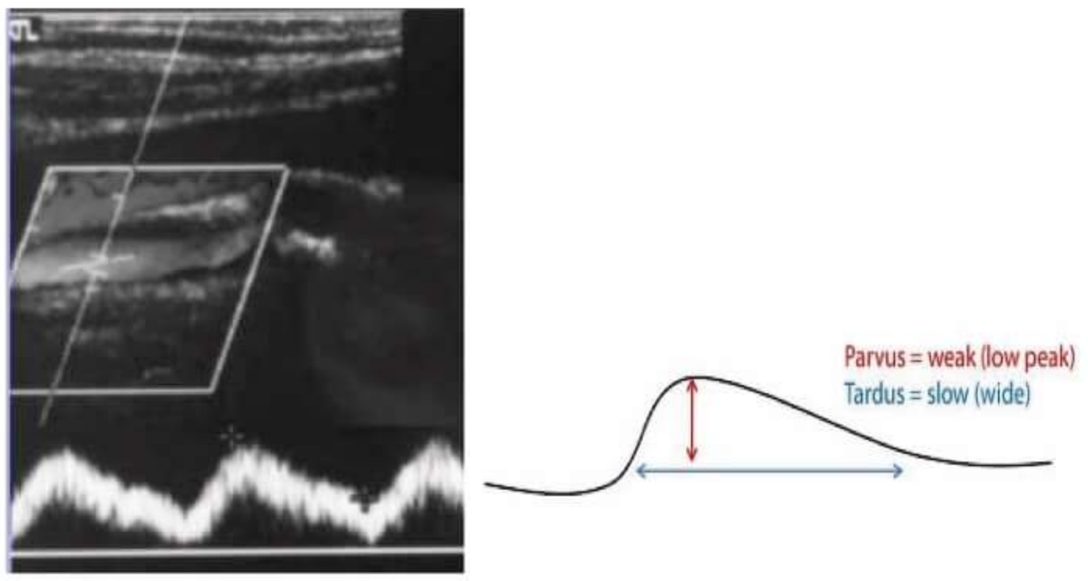
To-and-fro waveform in **Spectral doppler**



Tardus – Parvus waveform

→ Seen in Spectral doppler at Post-stenotic zone distal to site of stenosis

- **Tardus** – Prolonged systolic acceleration (i.e Slow uptake)
- **Parvus** – Small systolic amplitude & rounding of systolic peak



Tardus – Parvus waveform

Umbilical artery Doppler

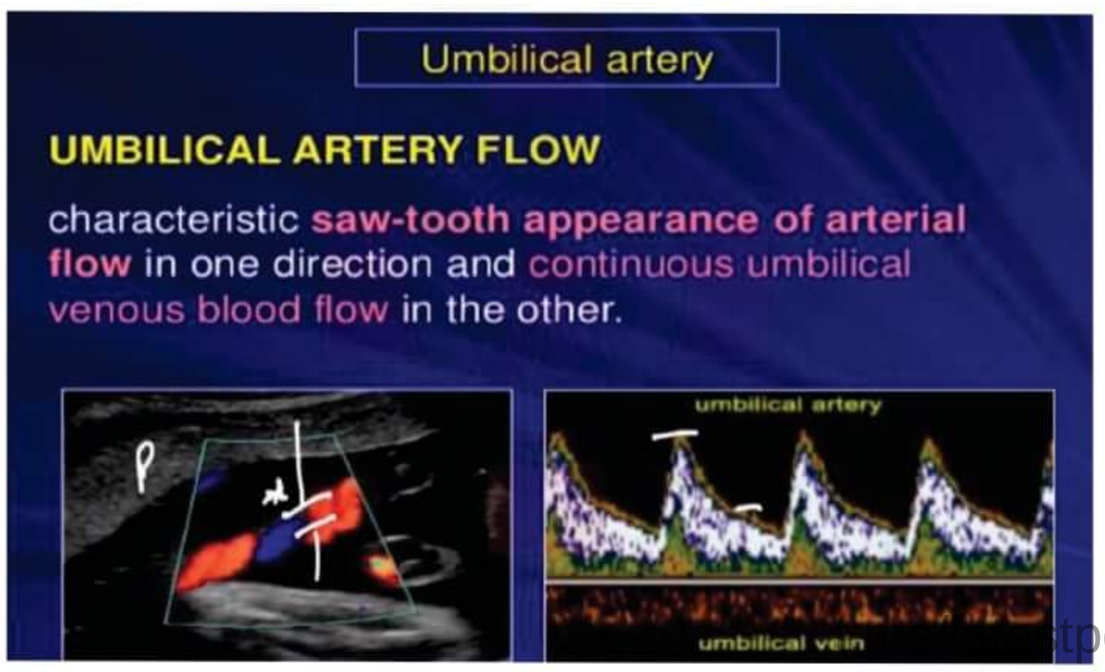
→ **Normal umbilical artery**

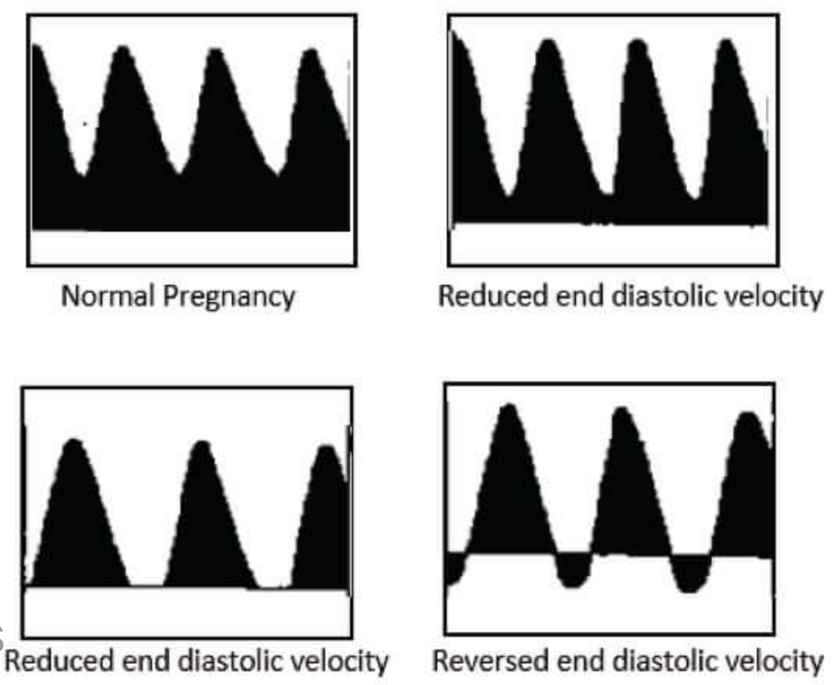
- Shows Good systolic and good diastolic velocity above baseline
- Umbilical artery S/D ratio < 3
- Umbilical artery S/D ratio < S/D ratio of fetal MCA

→ If diastolic flow decreases, absent or reverses (OR)
If S/D ratio of UA increases (OR)
If S/D ratio of UA > S/D ratio of fetal MCA

} **All these suggest** IUGR or impending fetal demise

→ If S/D ratio of UA > 3.5 – Terminate Pregnancy as early & get the baby out

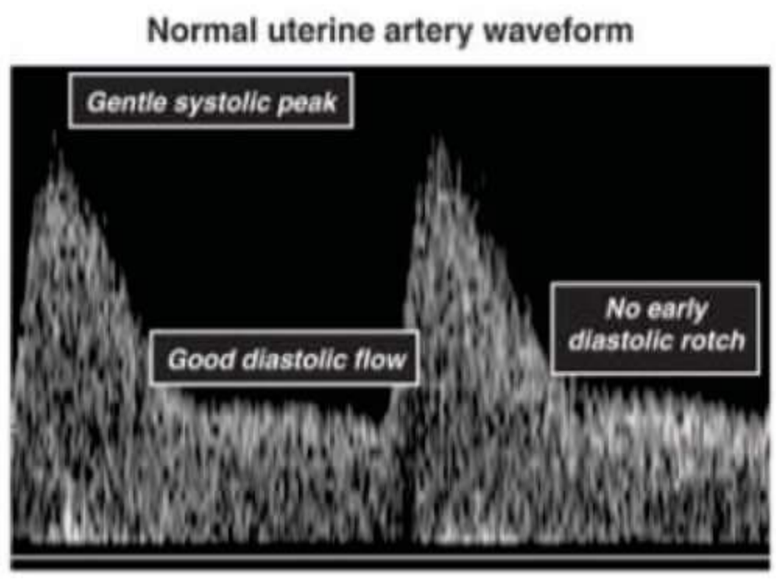




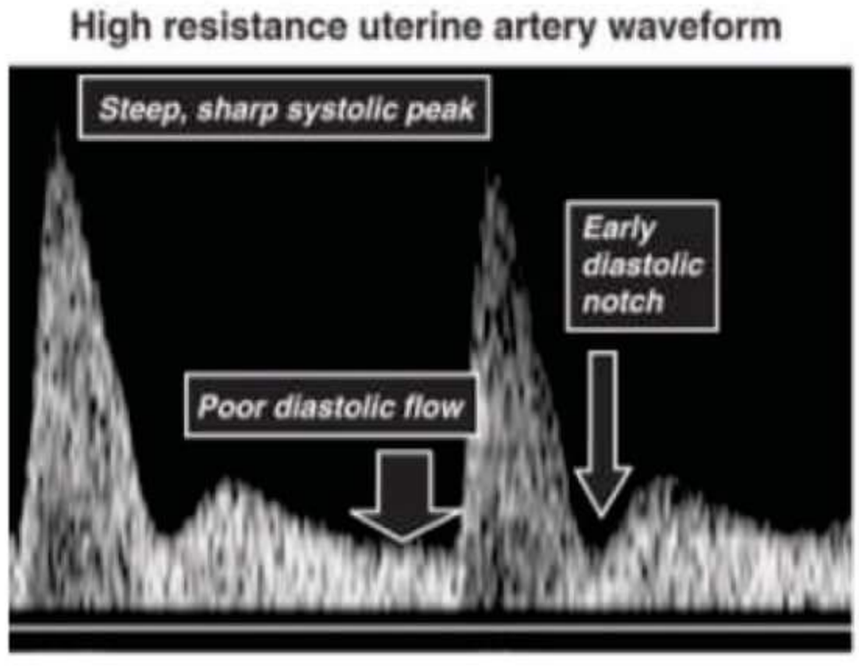
Uterine artery dopple

→ **Normal Uterine artery**

- Shows good systolic flow
- Absent diastolic notching beyond 22 weeks of Gestation
- Good diastolic flow above base line



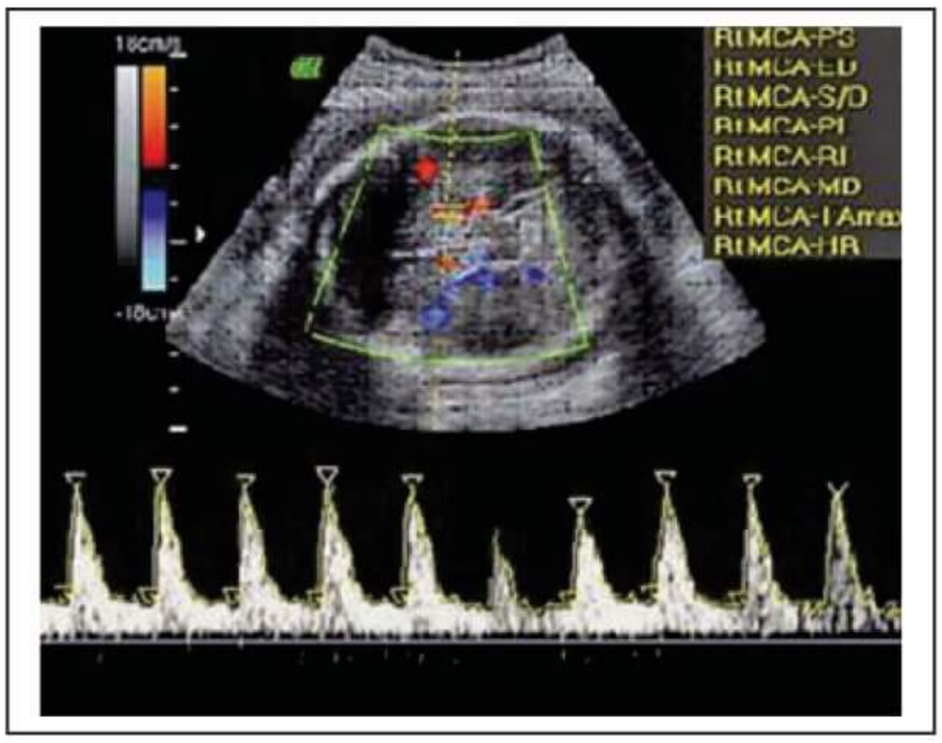
→ Persistence of early diastolic notching with decreased diastolic flow beyond 22 Weeks of gestation – suggests **Pre-eclampsia**



Fetal MCA doppler

→ Increase in peak systolic velocity in fetal MCA doppler - Suggests **Fetal hypoxia/ Fetal anemia / Hydrops fetalis**

→ It is due to "**Head sparing effect**" seen in fetal hypoxia



ULTRASOUND PART -3

Double Bleb sign

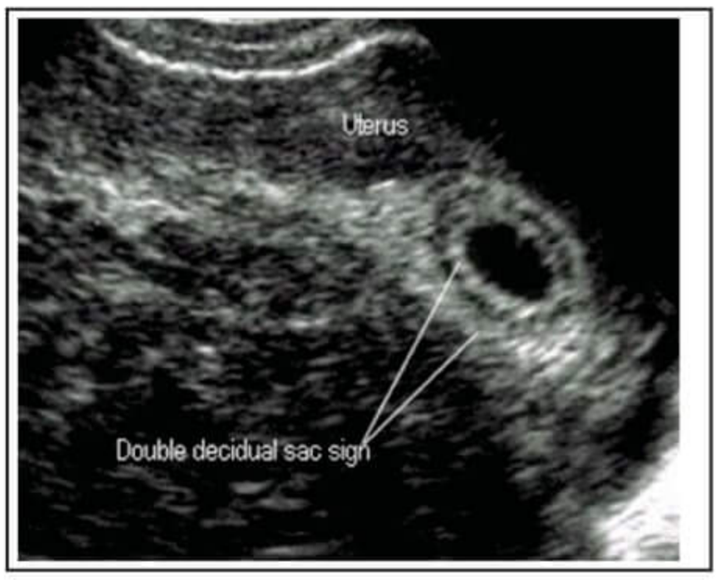
→ It is suggestive of true gestational sac

→ These blebs are made of amnion & yolk sac

Double Decidual sac sign

→ It is also suggestive of true intrauterine gestational sac

→ Made of Decidua capsularis & Decidua parietalis



Lambda sign

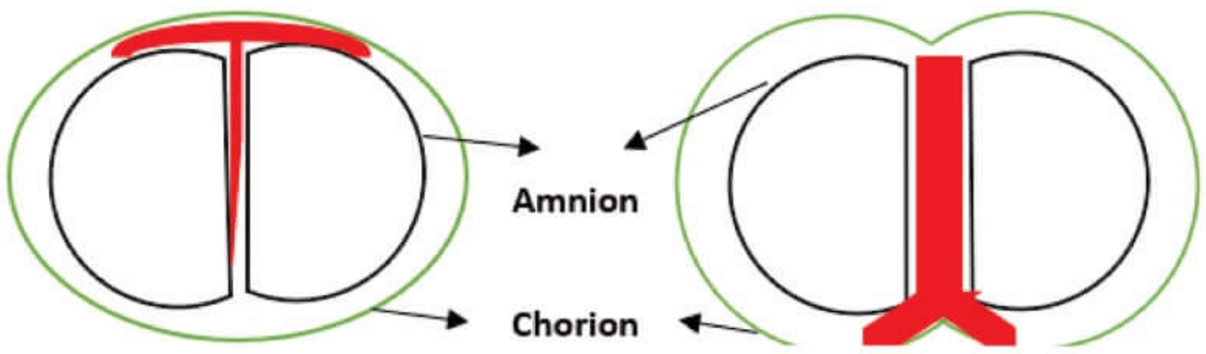
→ Seen in Diamniotic Dichorionic twin gestation

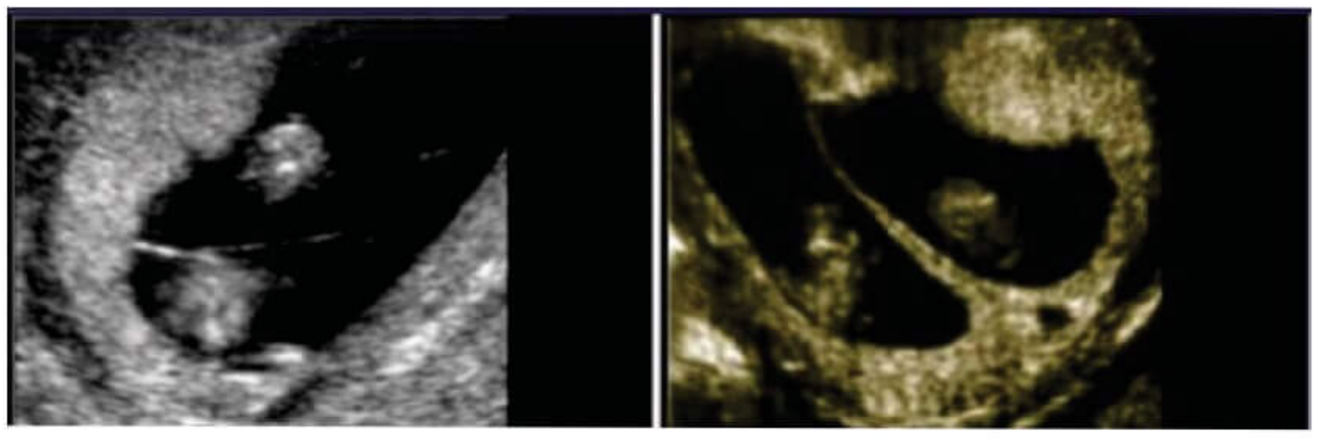
→ Has Thick intervening septa

T SIGN

→ Seen in Diamniotic Monochorionic twin gestation

→ Has thin intervening septa



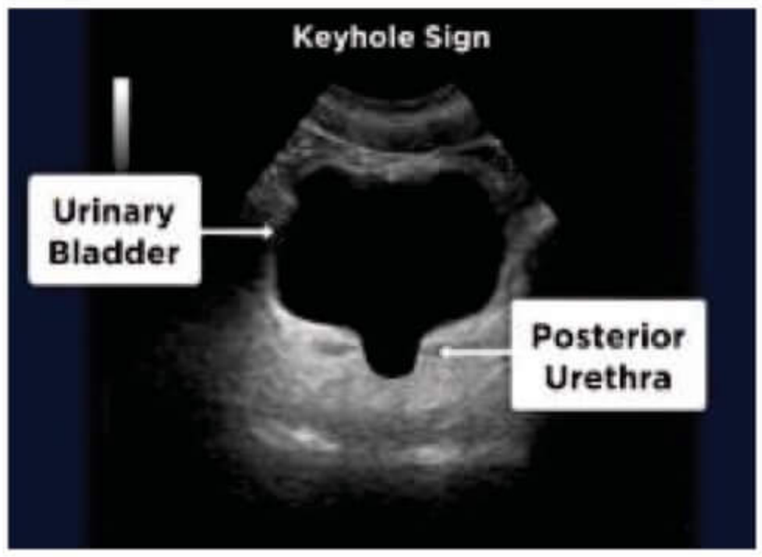


T- sign

Lambda sign

KEYHOLE appearance on antenatal scan

→ It is a feature of **Posterior urethral valve**



SNOWSTORM appearance on USG

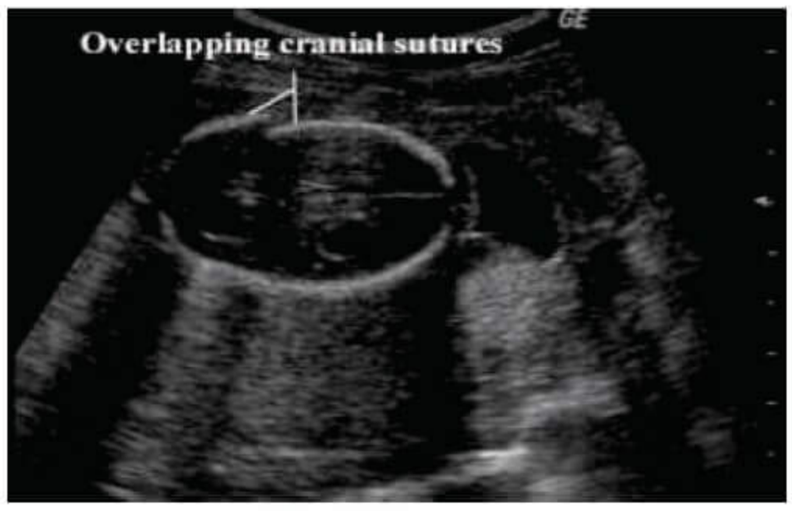
→ It is a feature of **Molar pregnancy / Hydatidiform mole**

Snowstorm appearance on USG

Spalding sign

→ Overlapping sutural bones on USG

→ It suggests **Intrauterine death (IUD)**

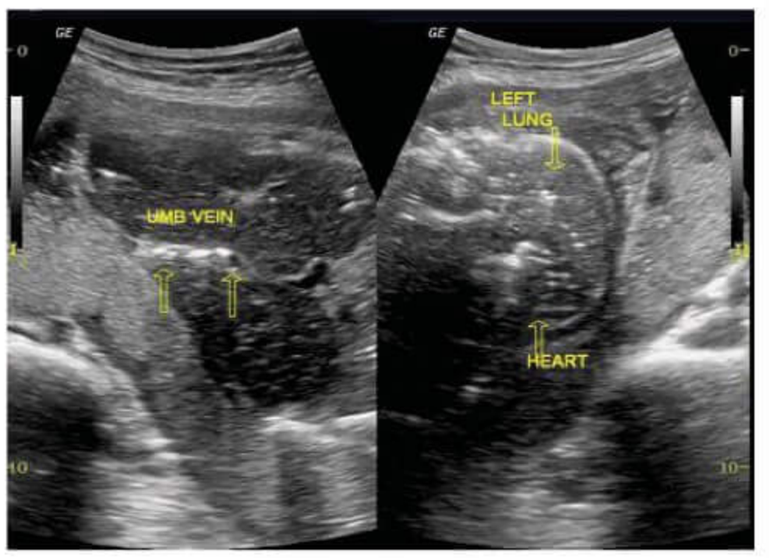


Spalding sign

Robert sign

→ **On antenatal scan** - Hypoechoic area inside the heart and great vessels like umbilical vein suggest the presence of air

→ This is seen in **Intrauterine death (IUD)**



Robert's sign

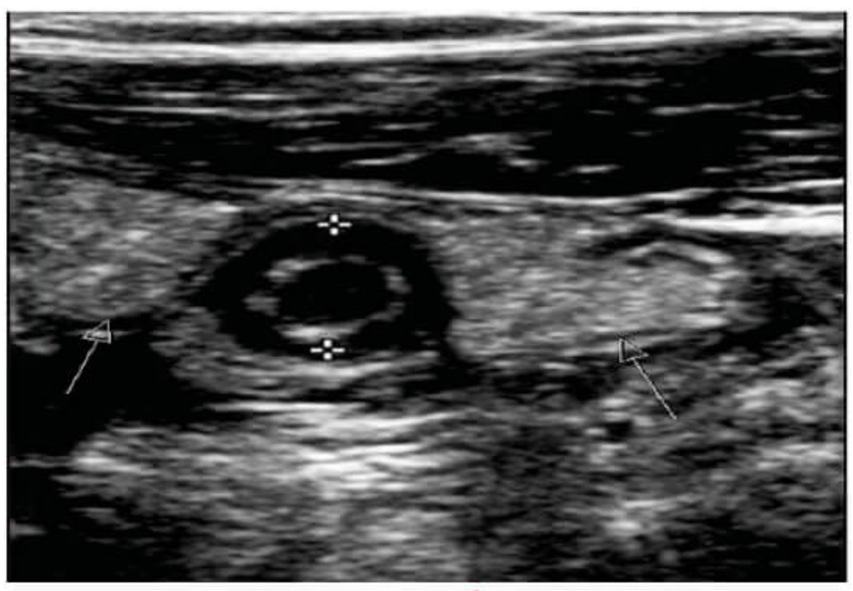
Acute appendicitis

→ IOC in children – **USG**

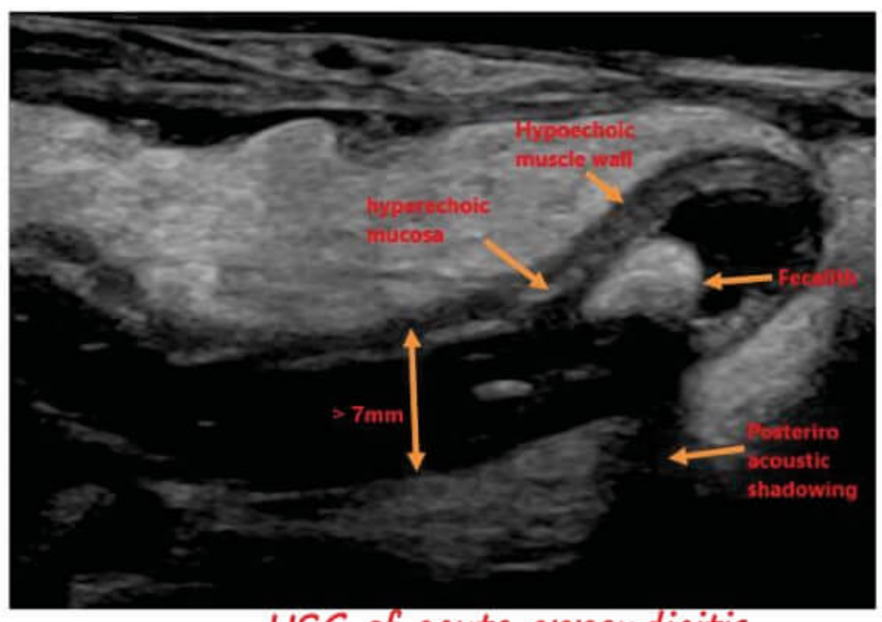
→ IOC in adults – **CECT (more sensitive)**

→ **On USG**

- Shows **Target sign** on USG – Hyperechoic mucosa surrounded by Edematous wall of bowel
- Acute appendicitis appears as **blind ending, tubular, non-compressible, aperistaltic structure with luminal diameter > 7mm**
- Show Appendicolith/Fecalith with posterior acoustic shadowing



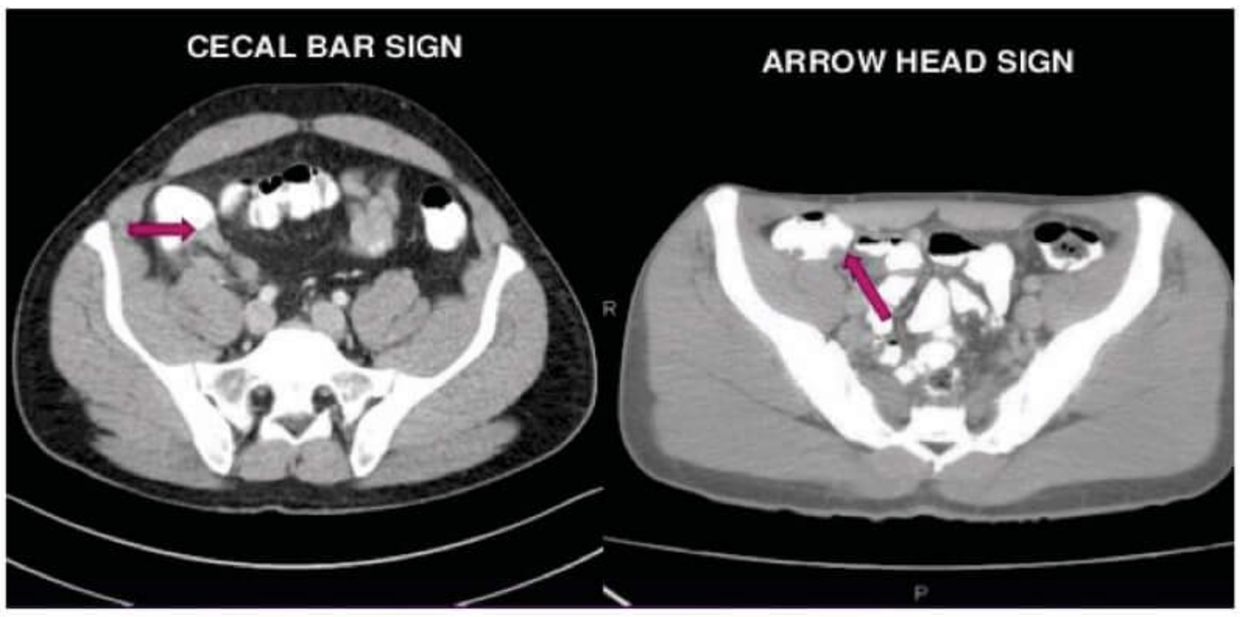
Target sign



USG of acute appendicitis

→ **On CECT**

- Luminal diameter **> 6mm**
- Thickened inflamed soft tissue at base of appendix separating appendix from the contrast filled cecum – **Cecal bar sign**
- Contrast entering the appendix tapers down and does not fill the entire length of the lumen due to mucosal edema – **Arrow head sign**

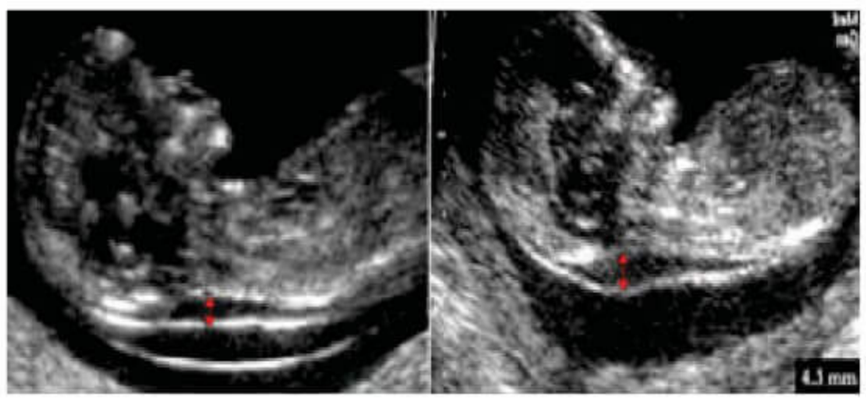


Nuchal Translucency

→ Best measured at **11 – 13.6 weeks**

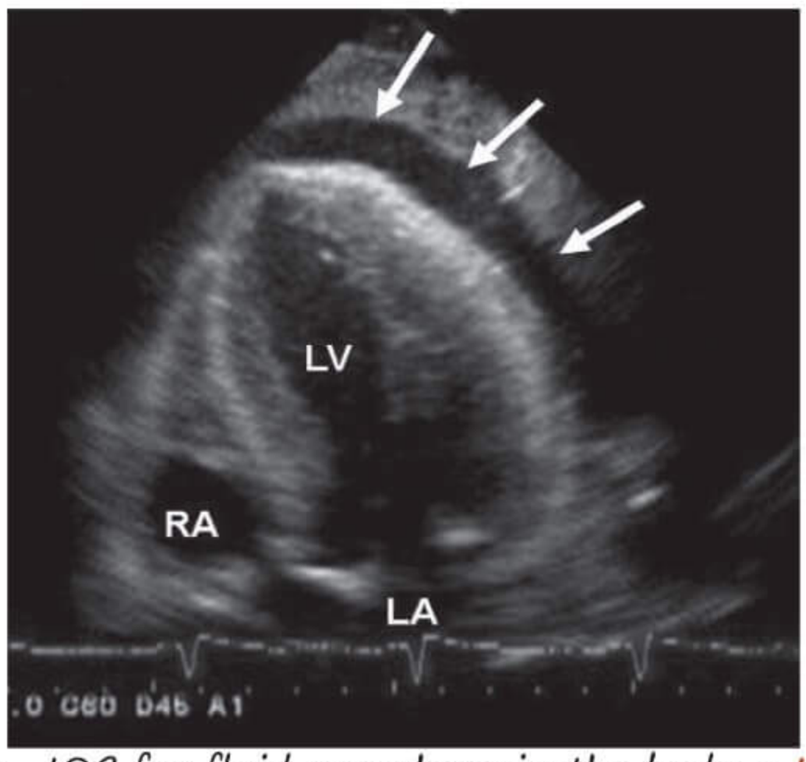
→ It is reliable only when the **CRL is 45–84 mm**

→ Exclude amniotic membrane



(a) Normal NT (b) Abnormal NT

Pericardial effusion



→ IOC for fluid anywhere in the body - **USG**

Pleural effusion

→ IOC for minimal Pleural effusion – **USG**

→ Best X-ray view for Pleural effusion – **Lateral decubitus view**

Ectopic pregnancy

→ The placental tissue around fallopian tube is very vascular

↓

Gives **Ring of fire appearance** in Color doppler

HIFU (High Intensity Focused Ultrasound)

→ High power ultrasound focused on target tissue to be Healed & Coagulated

→ It uses Thermal effect, Mechanical effect & Cavitation effect

→ **Uses:**

- Fibroids
- Liver tumors
- Prostate cancers
- Phacoemulsification
- Breaking kidney stones

- Disrupts BBB for drug delivery

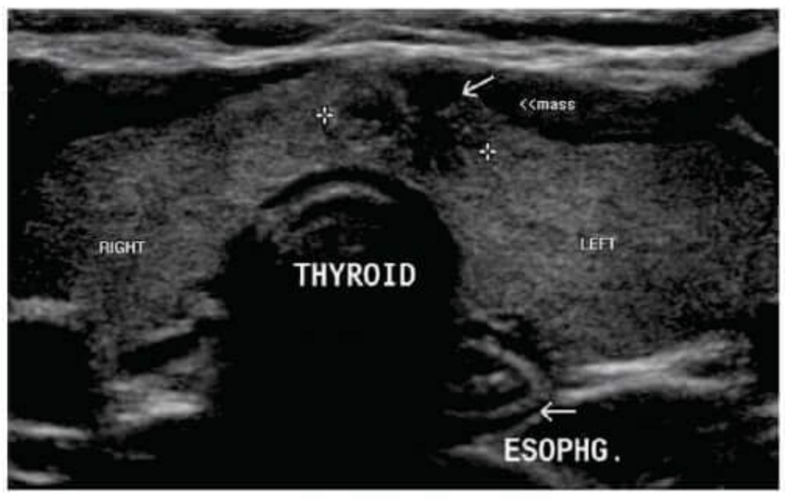
→ MR guided Transcranial focused HIFU – used for

- Essential tumors
- Neuropathic pains
- Parkinsonism

USG of thyroid gland

→ **Linear probe** is used

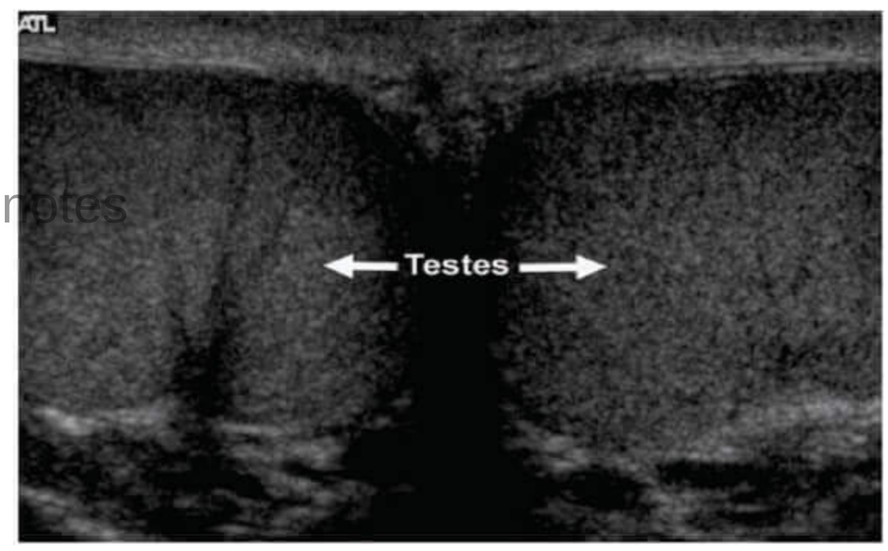
→ Thyroid malignancies on USG
  - Hypoechoic
  - lesions are Taller than wide
  - Stippled calcification



USG of Thyroid

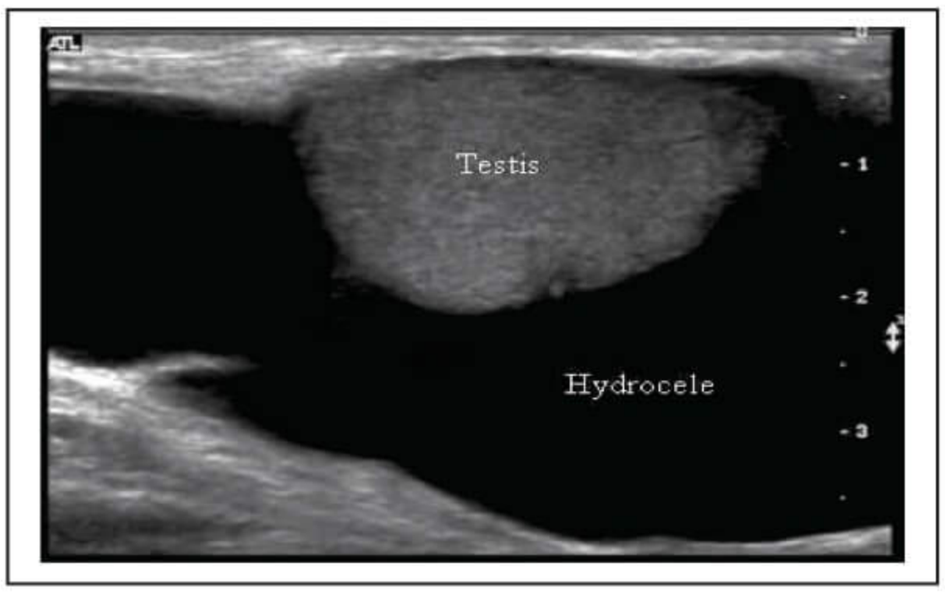
USG of scrotum

→ **Linear probe** is used

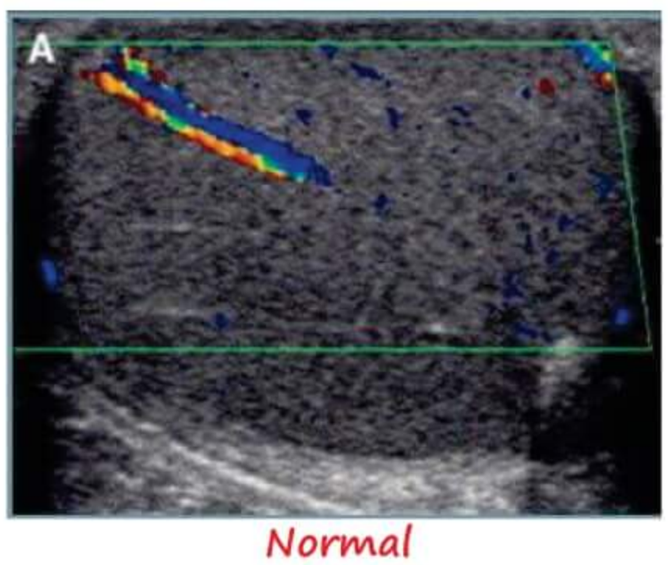


→ Presence of fluid around the testis - suggest **Hydrocele**

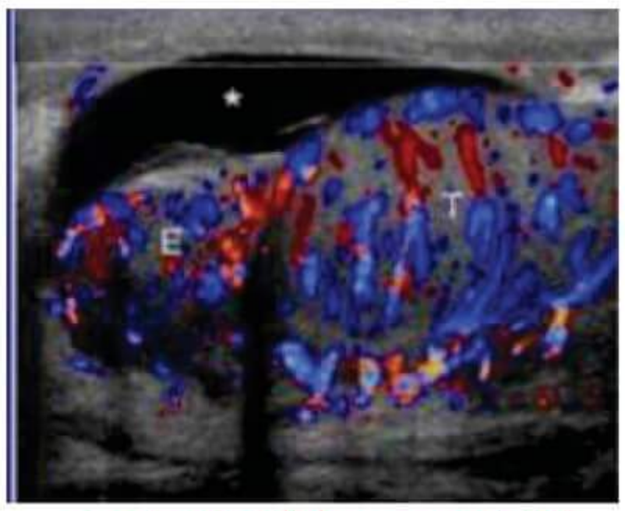
→ IOC for hydrocele – **USG**



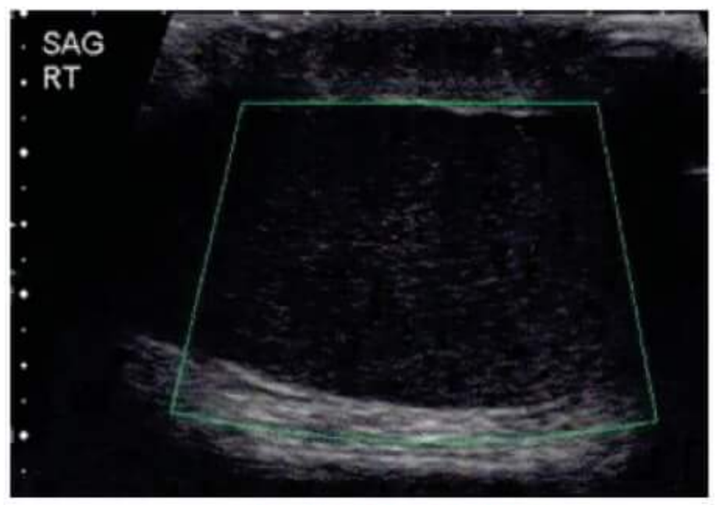
Acute Epididymo-orchitis	Testicular torsion
• Occurs in young individuals	• Occurs in young individuals
• Have acute onset of scrotal pain	• Have acute onset of scrotal pain
• **On Examination:** – Lifting the testis subsides the pain	• **On Examination:** – Lifting the testis doesn't have effect and the pain still persist
• **On Color doppler** – Shows more flow of blood through Testis & Epididymis	• **On Color doppler** – Absence of flow through Testis & epididymis



Normal



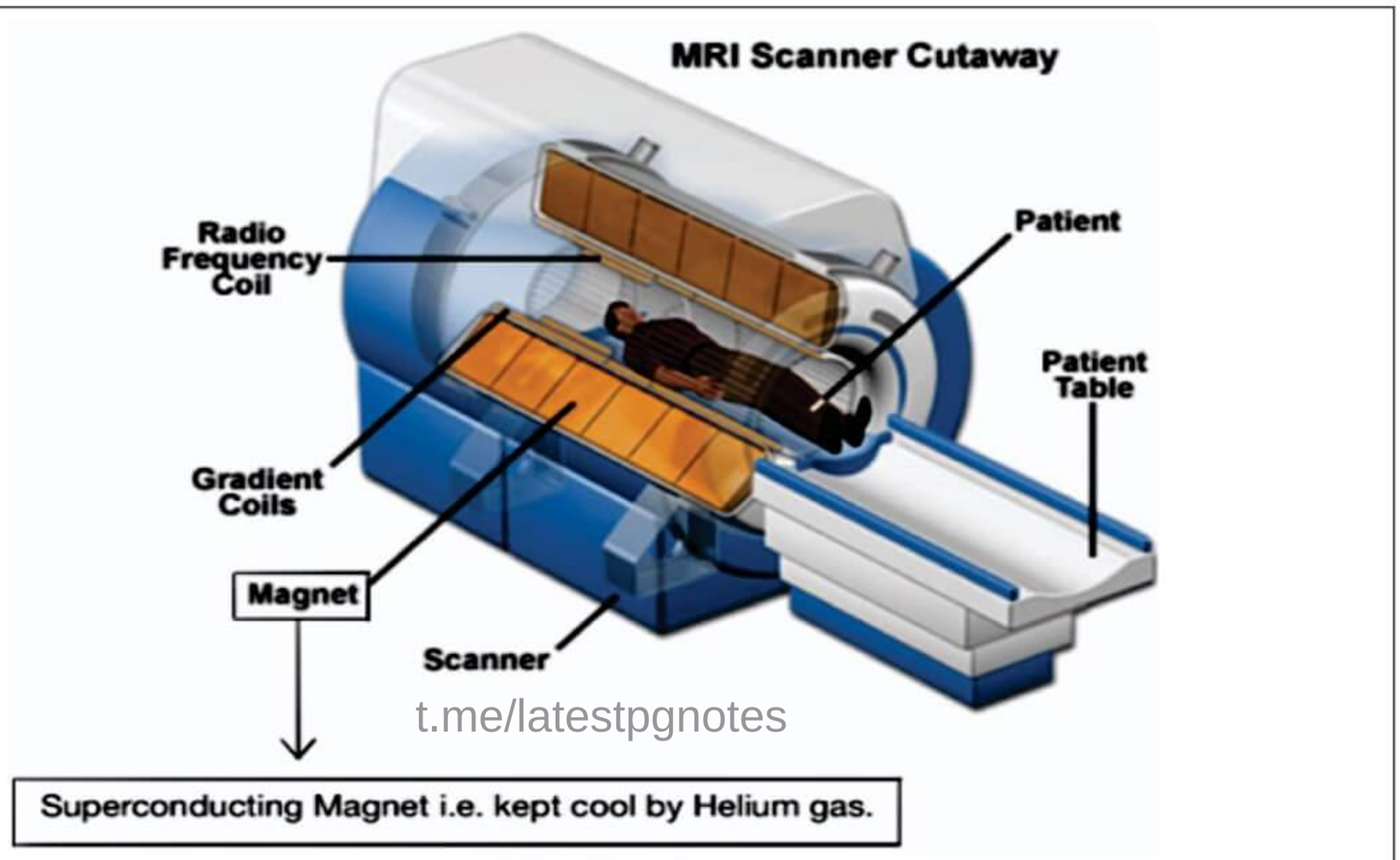
Acute Epididymo-orchitis



Testicular torsion

MAGNETIC RESONANCE IMAGING (MRI) PART 1

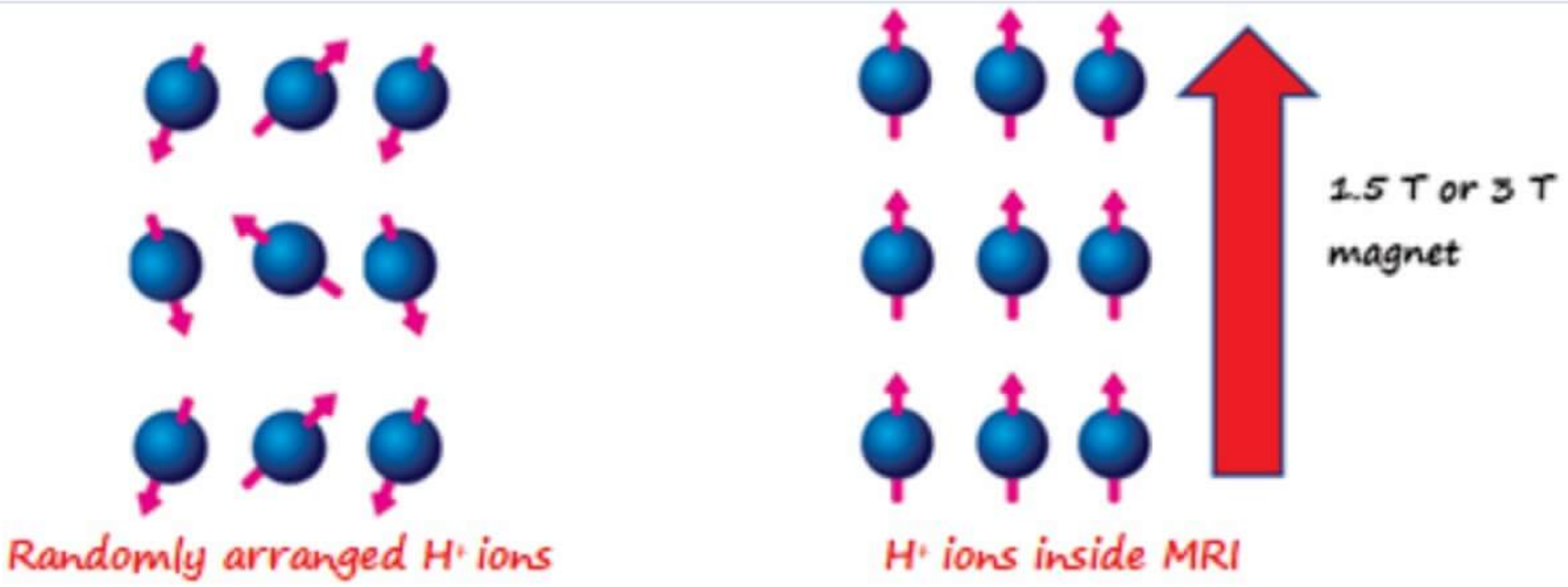
→ Medical MRI was developed by – Paul Lauterbur & Mansfield
→ Principle of MRI – NMR (Number Magnetic Resonance) was given by Felix Bloch & Purcell
→ MRI is based on – Gyromagnetic property of H^+ ion
→ MRI has a special Magnet – Superconducting magnet (kept cold by Helium gas)
→ MRI also has a Radiofrequency coil – it produces Radio frequency wave known as RF pulse
→ MRI Gives Multiplanar image acquisition



MRI SCANNER PARTS

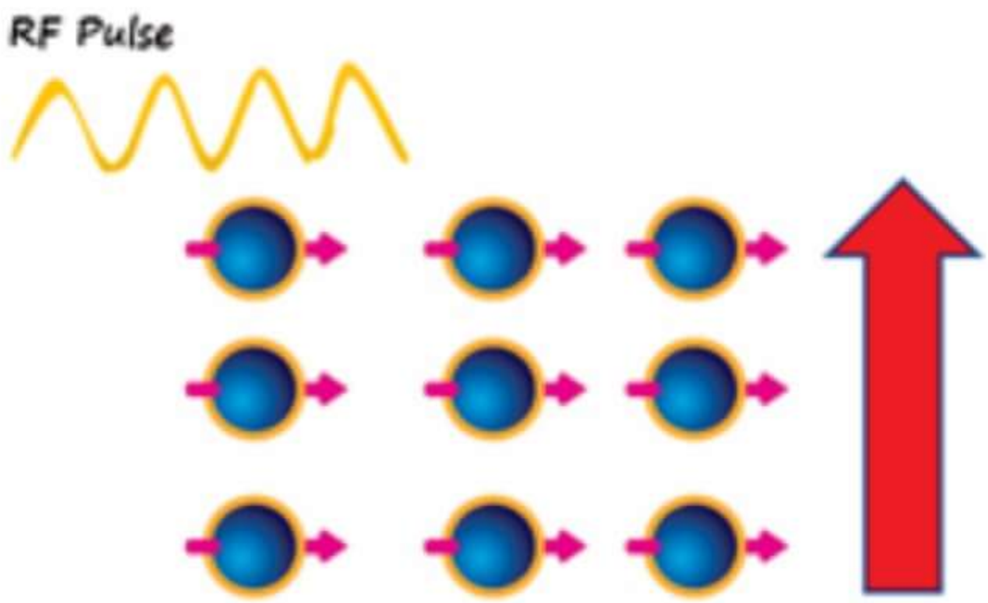
MRI working mechanism

→ In body H^+ ions are present in water, fatty acids & organic acids in varying amount which are randomly arranged with no net magnetisation
→ These H^+ ions when exposed to a strong magnet (1.5 T or 3 T magnet) starts aligning according to the original magnet
→ When RF pulse is given, using the energy of this pulse the H^+ ions are deflected to Transverse axis
→ On stopping RF pulse the H^+ ions in transverse axis tends to relax back to longitudinal axis
→ This Relaxation time is different for water (relax faster) & fatty acids (relax slowly). By this mechanism the signal obtained from water & fatty acids can be differentiated and studied

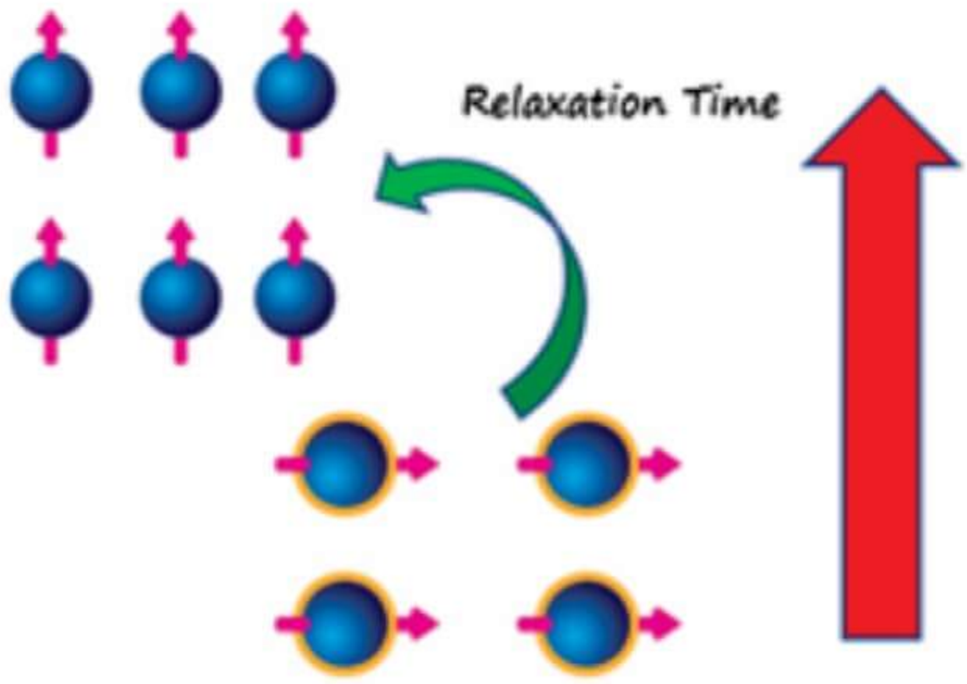


Randomly arranged H^+ ions

H^+ ions inside MRI



Alignment of H^+ ions in transverse axis after RF pulse given



Relaxation of H^+ ions back to Longitudinal axis on stopping RF pulse

MRI working mechanism

IMPORTANT POINTS TO KNOW

- T_1 – to look anatomy
- T_2 – to look for Pathology (Water appears white on T_2)

Most pathologies are **HYPOINTENSE on T_1** and **HYPERINTENSE on T_2**

- **Hyperintense on T_1W**
  - Fat e.g. lipoma
  - Proteinaceous substance
  - Subacute Hemorrhage (meth Hb stage)
  - Melanin
  - T_1 hyperintense metastasis is **MELANOMA** (most of the metastasis are hypointense in T_1)
  - Gadolinium (paramagnetic substance)

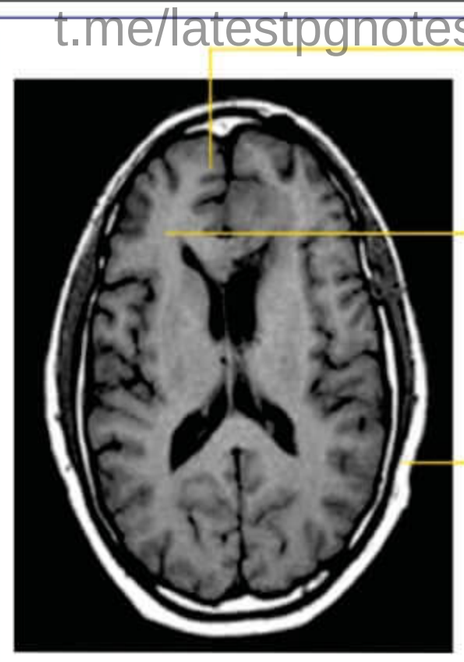
- **Structures that are Hypointense / dark on both T_1 & T_2**
  - Air
  - Bone
  - Calcification
  - Dense fibrous tissues (E.g. ligaments, tendons)
  - Flowing blood

Cine MRI

- Most accurate investigation for Cardiac ventricular function

→ T_1 weighted image (for anatomy)

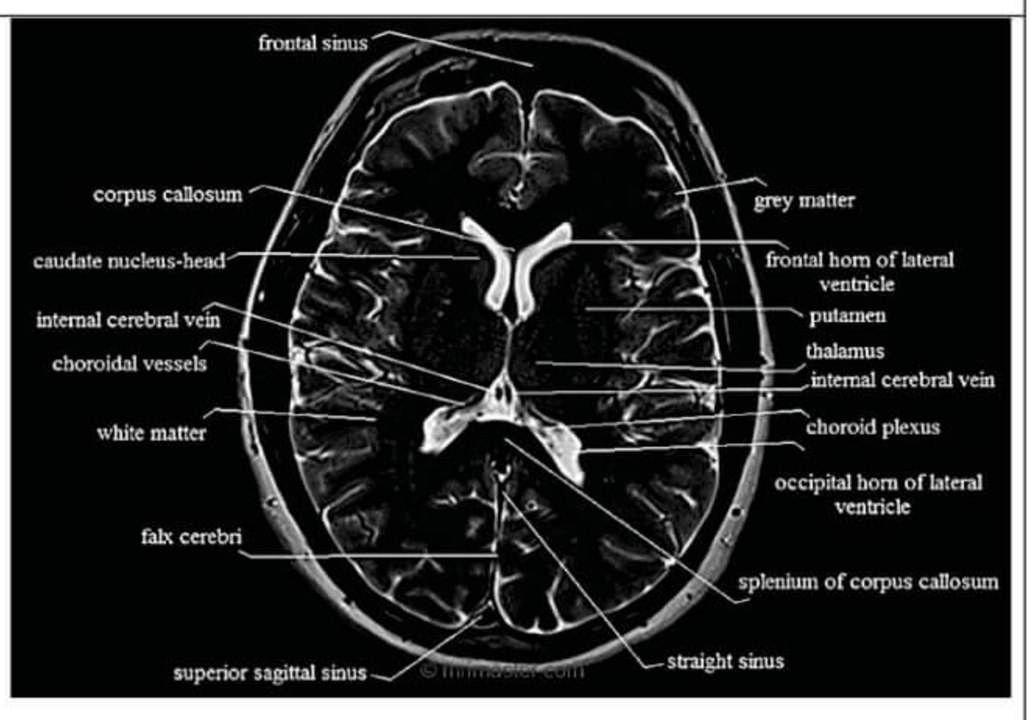
- CSF → Hypointense
- Grey matter → black
- White matter → white



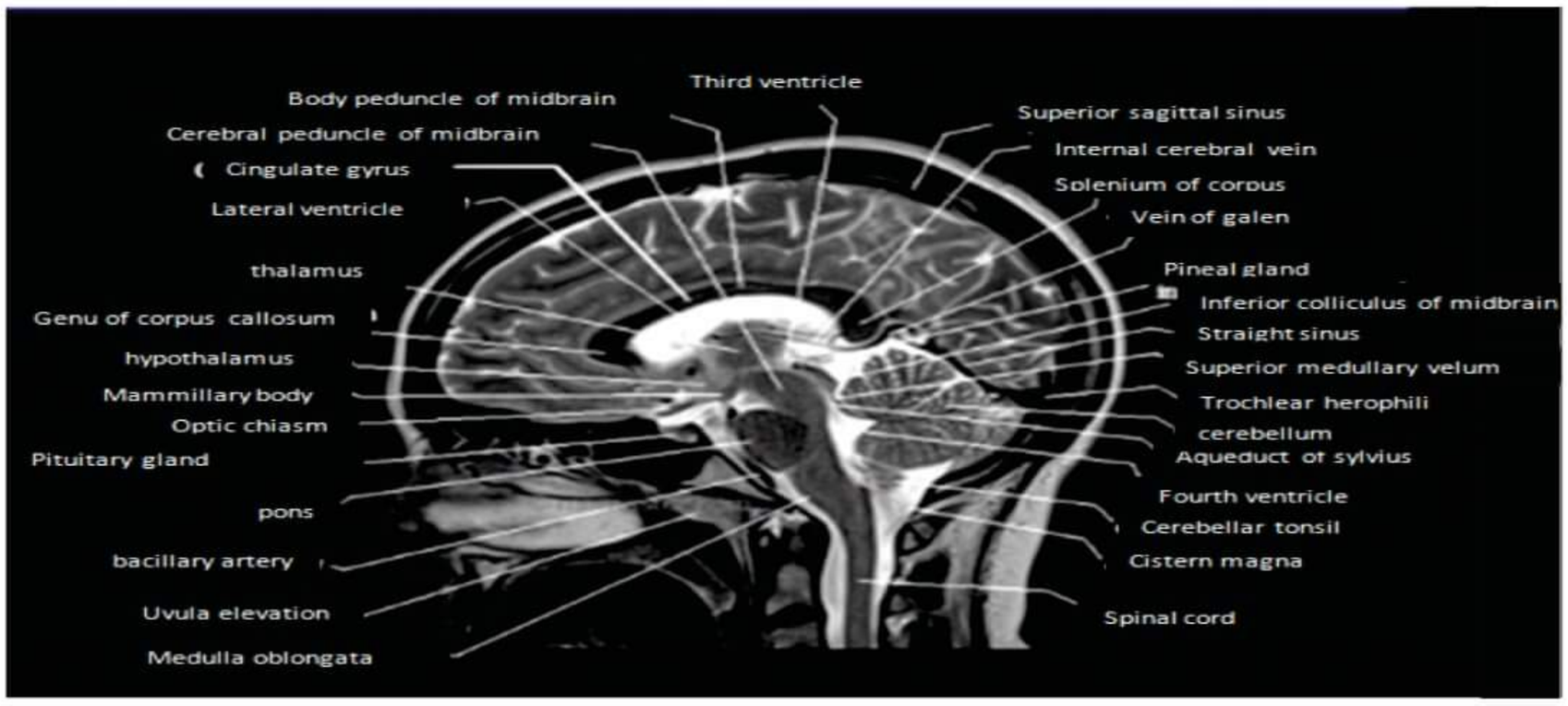
Axial T_1 W MRI

→ T_2 weighted image (for pathology)

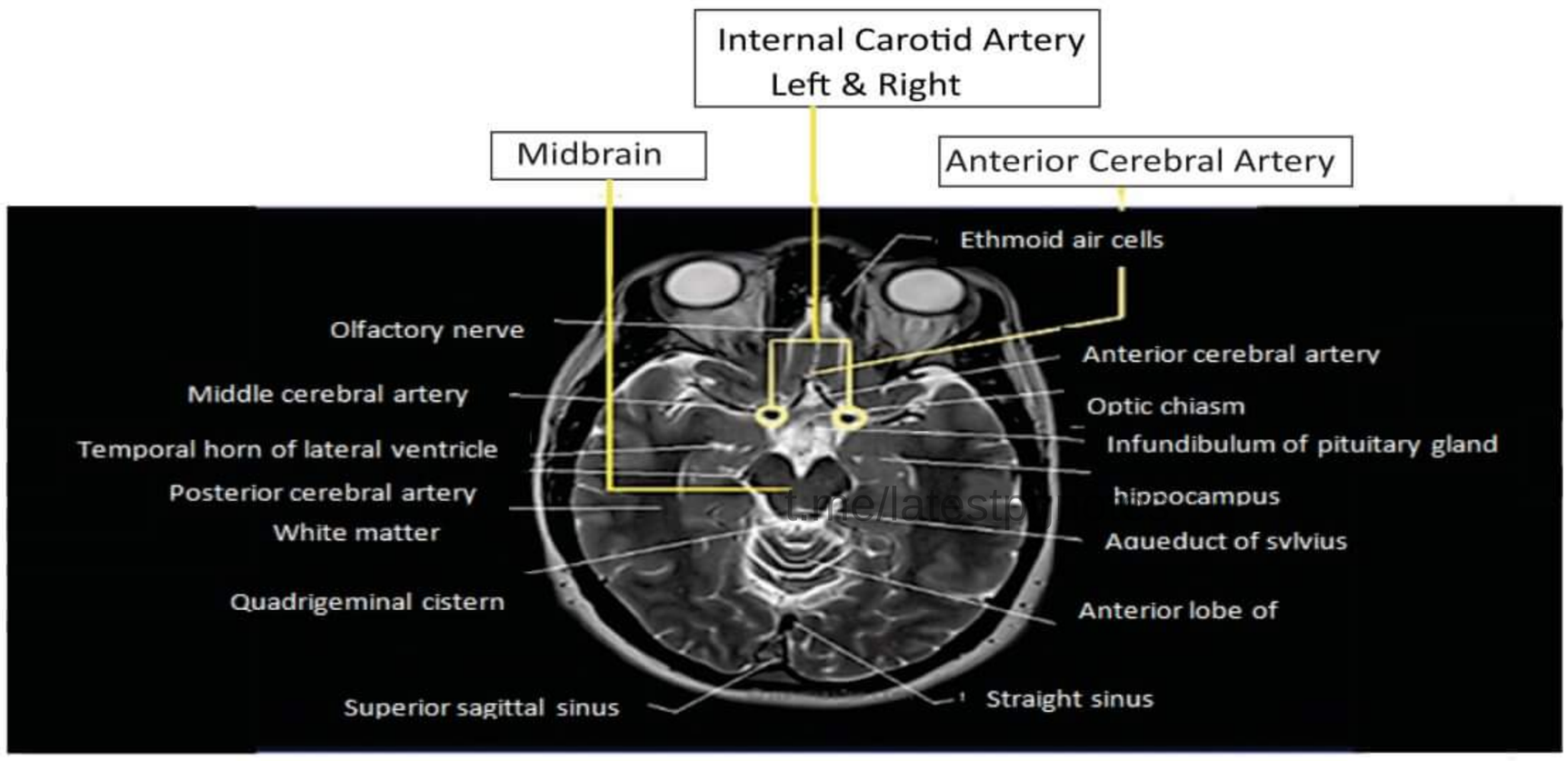
- CSF → Hyperintense
- Grey matter → white
- White matter → black



Axial T_2 W MRI

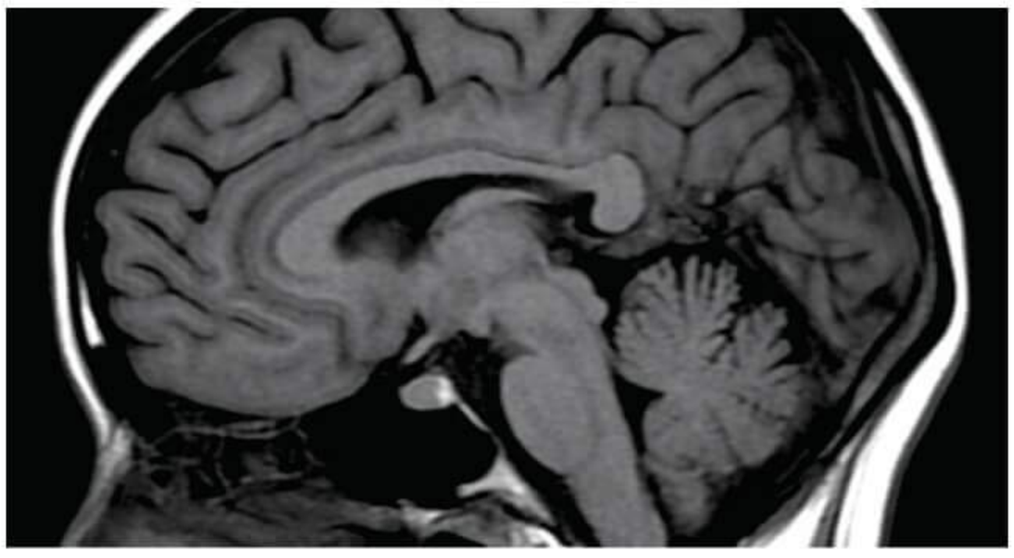


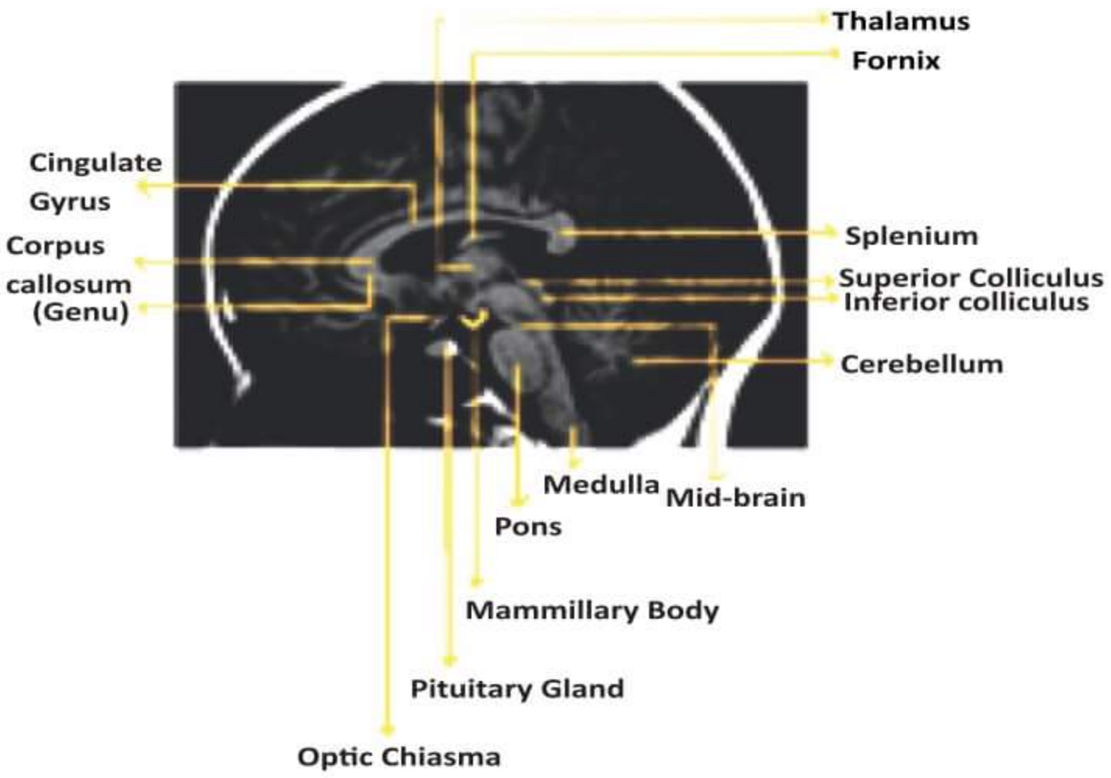
Sagittal T_2W – MRI

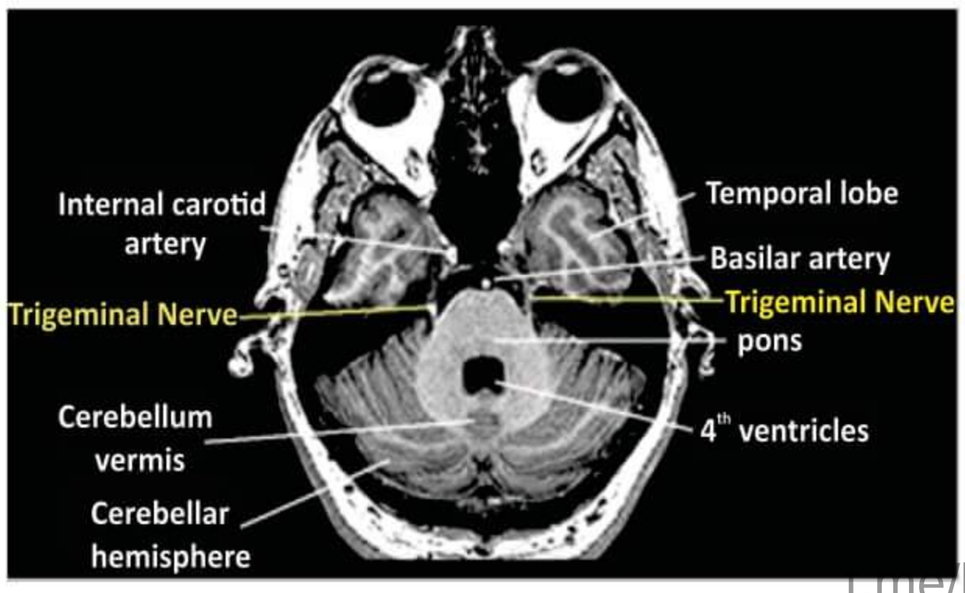


Axial T_2W – MRI at level of Orbit

Coronal T_2 W – MRI







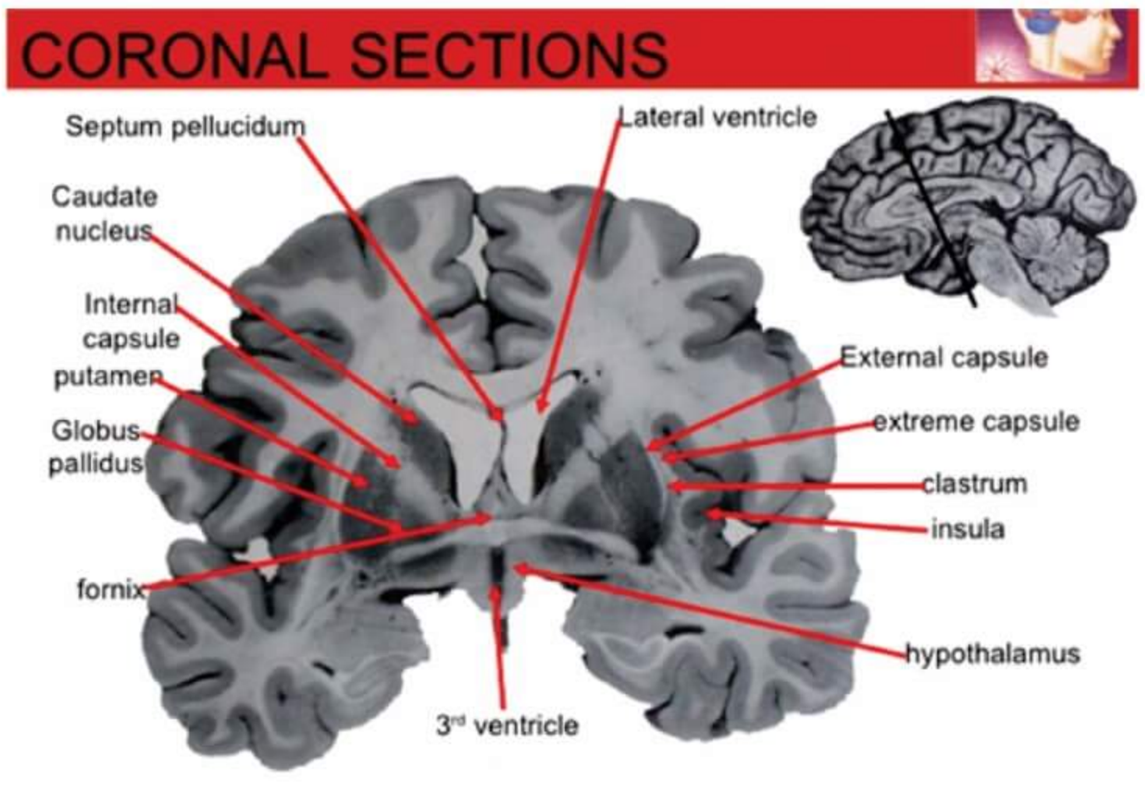
Axial T_1 W MRI

→ *Hippocampus*

- *Better seen on Oblique coronal MRI*
- *Hippocampal atrophy can occur in two conditions*

In Dementia case → *Alzheimer*

In Epilepsy case → *Mesial temporal sclerosis*



→ **Parinaud syndrome**

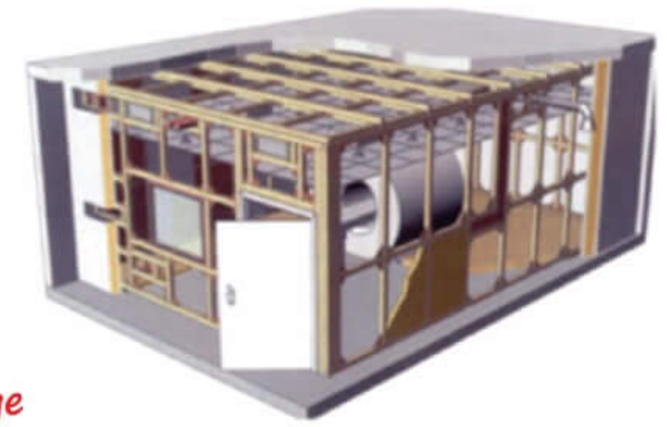
- it is a pineal gland tumors (Germinoma) compressing superior colliculus and causes vertical gaze palsy.

Faradays cage

→ It is a copper containing cage in which MRI is kept

→ It prevents electromagnetic interference in MRI room

→ Also used in EEG room



Faradays cage

FLAIR – MRI (Fluid Attenuation Inversion Recovery)

→ It is a Fluid suppressing sequence

→ It is Similar to T_2 with fluid suppression. In FLAIR

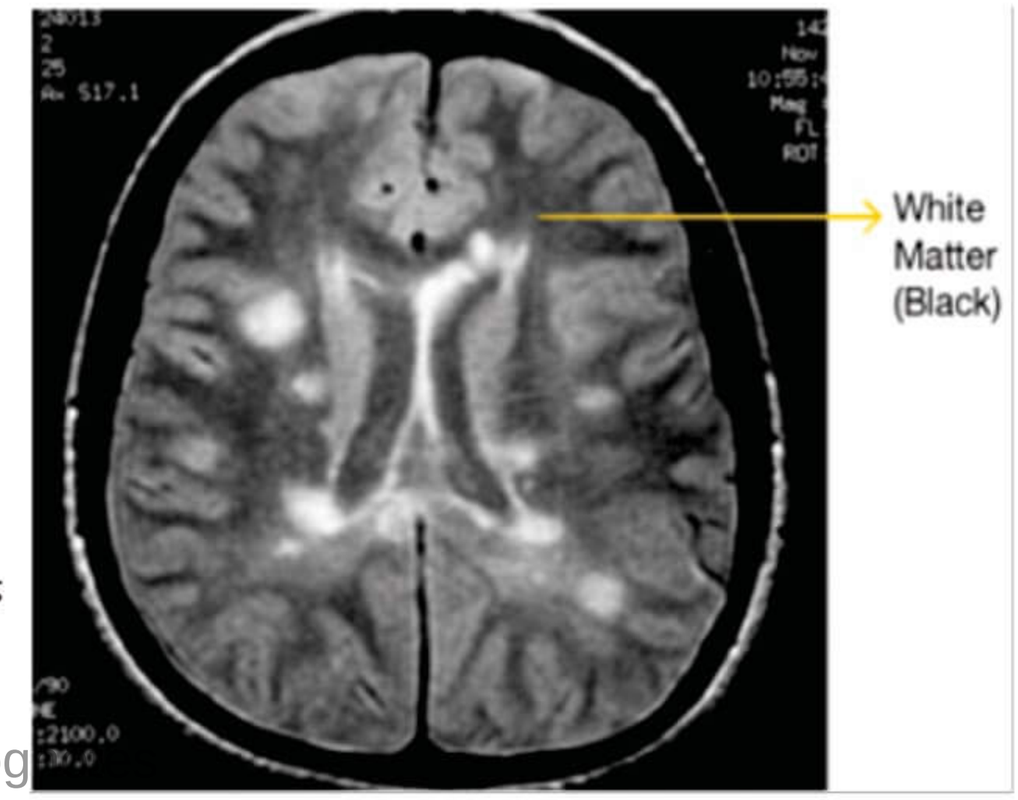
- CSF → Hypointense
- Grey matter → white
- White matter → Black

→ **FLAIR MRI is used**

- To evaluate brain edema
- To evaluate Periventricular hyperintensities (feature of Multiple sclerosis)
- Best sequence to diagnose plaques of MS

→ Multiple Sclerosis has involvement of

- Corpus Collosum
- Calloso septal interphase



FLAIR MRI of Multiple sclerosis (MS)

STIR – MRI (Short Tau Inversion Recovery)

→ It is a Fat suppressing sequence

→ Fat appears Hypointense (fat is hyperintense in both T_1 & T_2)

→ **STIR – MRI is used**

- To evaluate Bone marrow edema
- In evaluation of Ankylosing spondylitis, Avascular necrosis, Acute osteomyelitis etc.
- STIR MRI is the IOC for Ankylosing spondylitis

Diffusion Weighted MRI

→ It is based on Brownian movements (random free movement of molecules)

→ When there is Diffusion restriction DW-MRI gives bright signal and has low Apparent Diffusion Coefficient (ADC value)

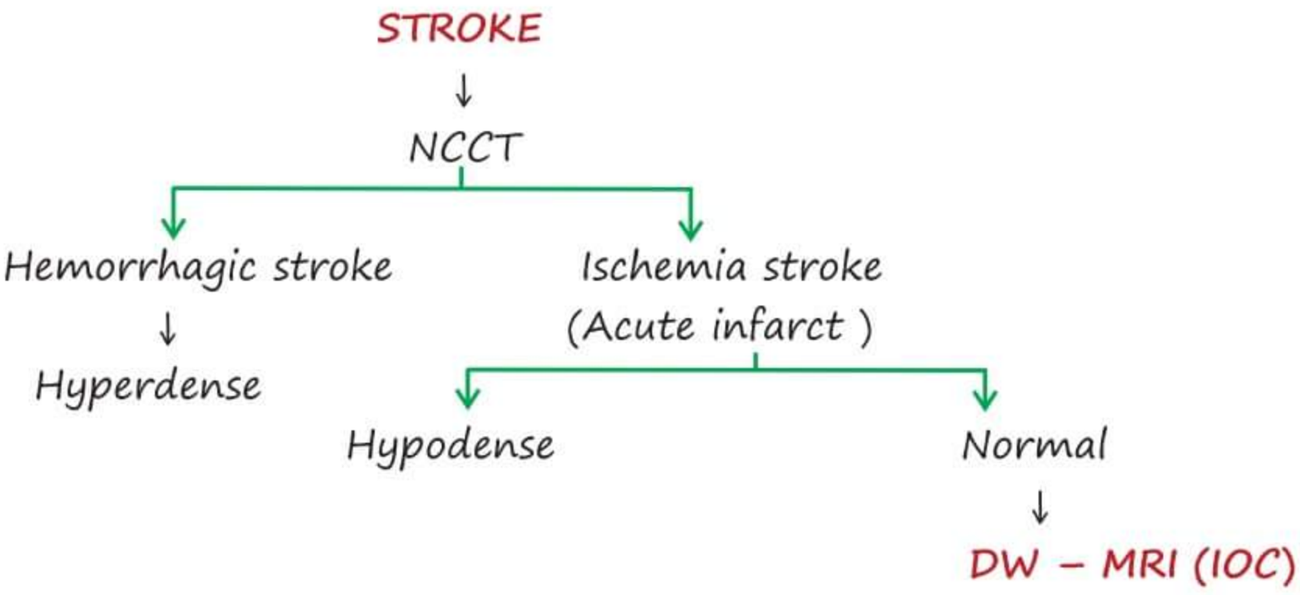
→ DW-MRI detects Cytotoxic edema before a Vasogenic edema develops

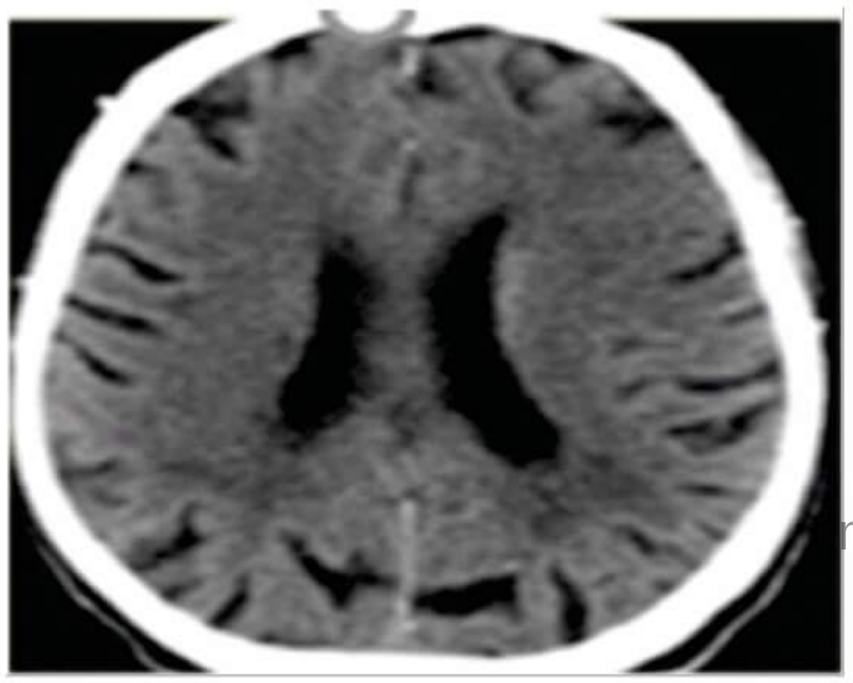
→ **Lesions that shows Diffusion Restriction**

- Infarct (acute infarct) – IOC is Diffusion Weighted MRI
- Abscess
- Medulloblastoma & other high cellularity tumors
- Epidermoid cyst

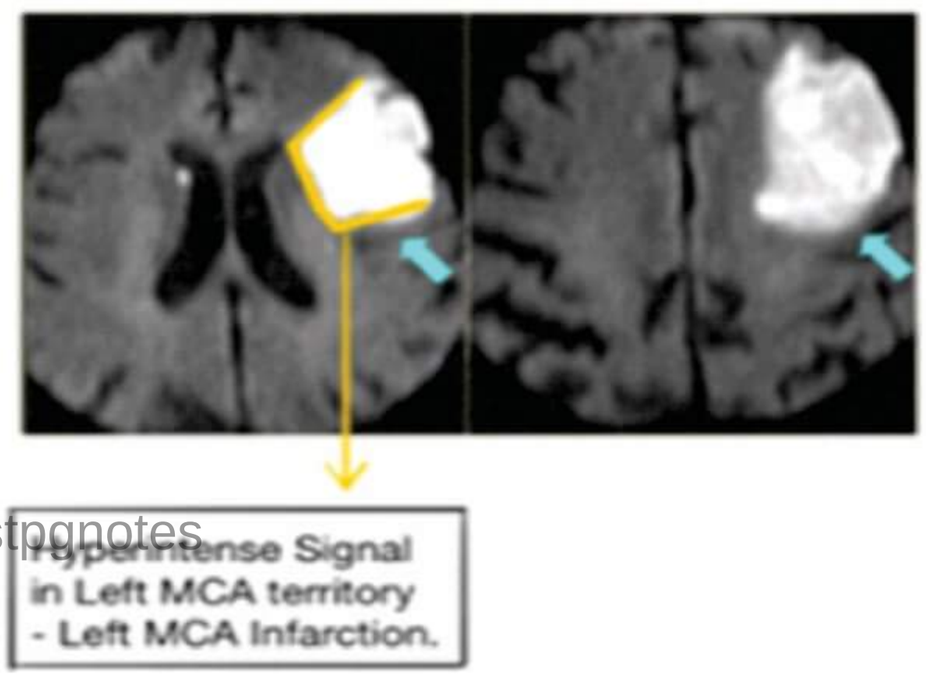
→ IOC for Stroke – **NCCT**

→ IOC for ischemic stroke – **DW MRI**





Acute infarct in CT – can appear normal



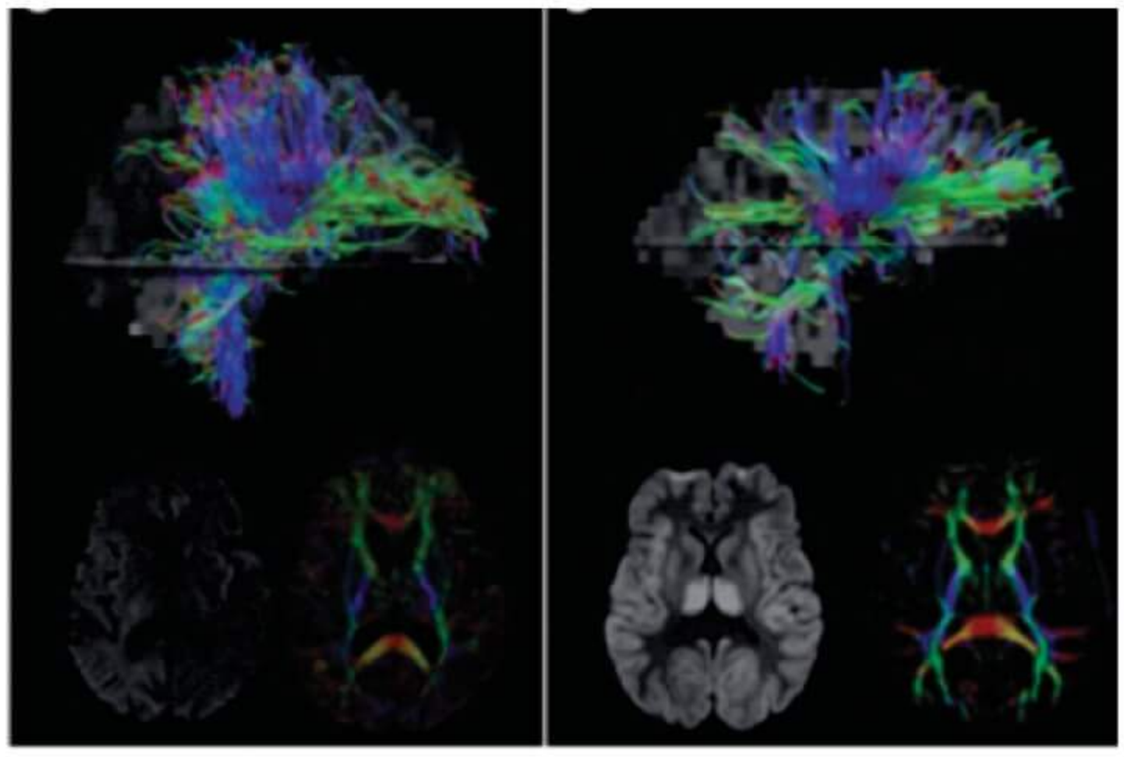
Acute infarct in DW-MRI

Diffusion Tensor Imaging

→ Also known as **Tractography**

→ Imaging technique to evaluate white matter tracks

→ It is based on Anisotropic movement



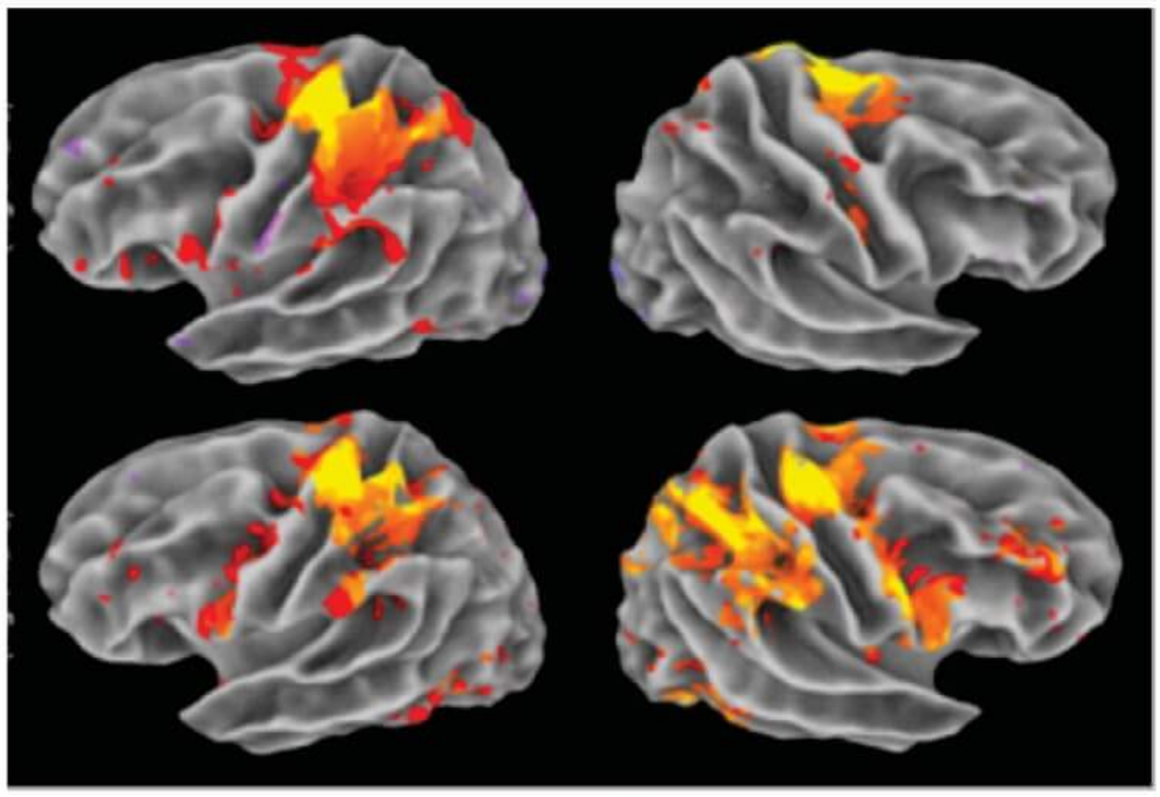
Tractography

Functional MRI (fMRI)

→ It is Based on **BOLD** technique
(**B**lood **O**$_2$**L**evel **D**ependent)

→ Used to evaluate

- Speech centre
- Fine motor areas
- Brain mapping



Functional MRI

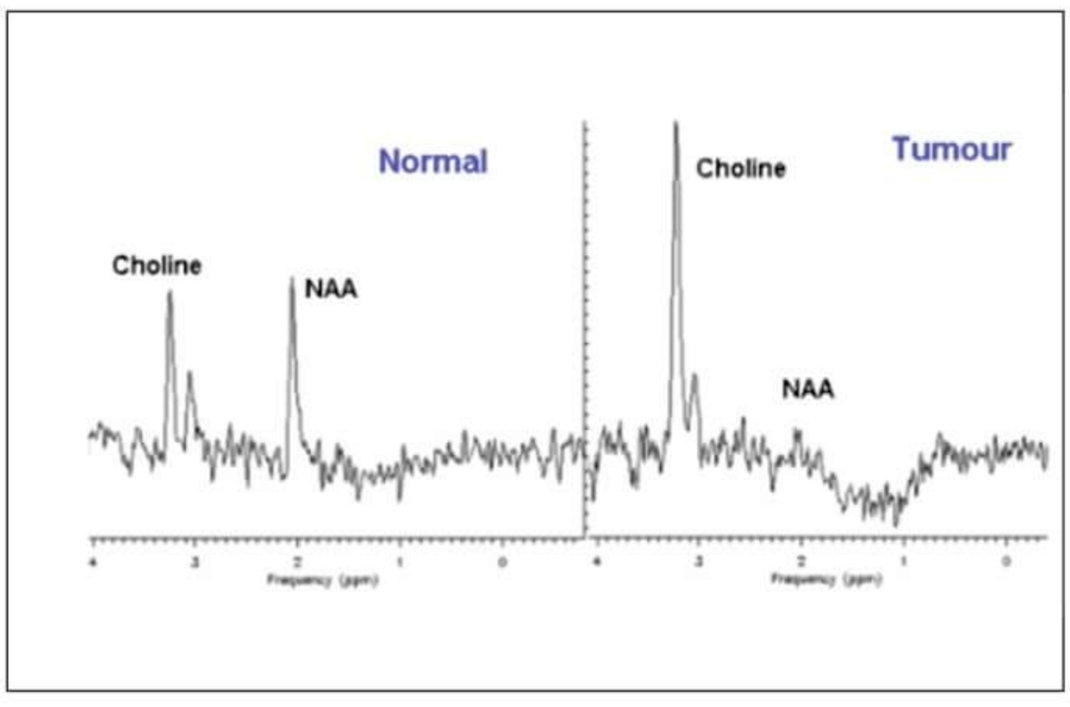
MR- Spectroscopy

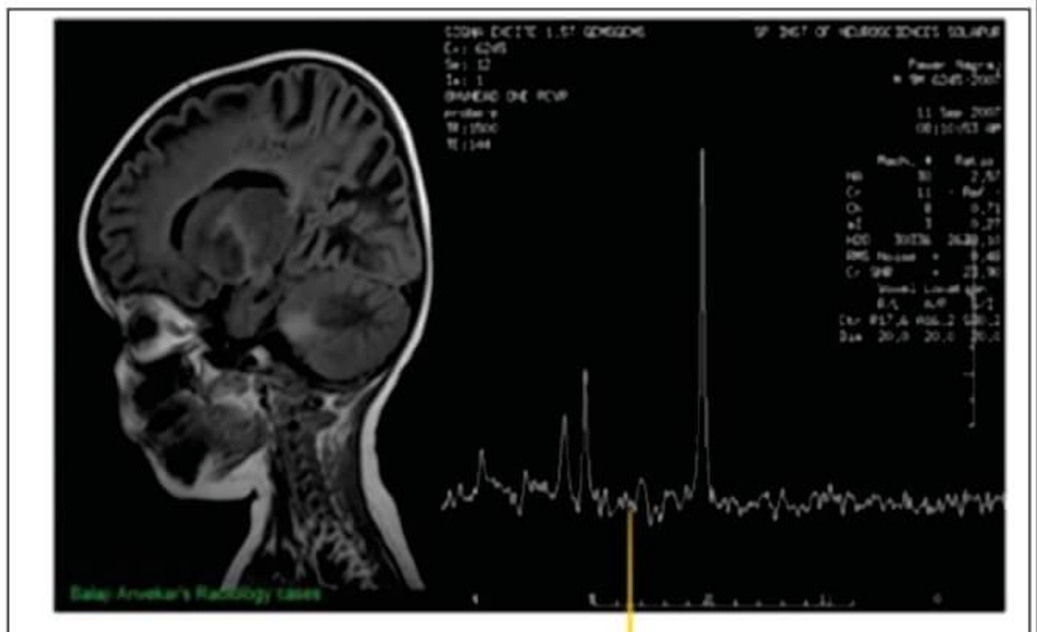
→ Used to evaluate chemical metabolites of a lesions

→ MR- Spectroscopy normally shows

Chemical Metabolite	MR Frequency (parts per million (ppm))
• Lipid lactate	1 ppm
• N – acetyl aspartate (NAA)	2 ppm
• Creatine	3 ppm
• Choline	3.2 ppm
• Alanine	1.4 ppm

• Lipid lactate peak	Tuberculoma
• N-acetyl aspartate peak	Canavan's disease
• Choline peak	Tumors
• Alanine peak at	Meningioma



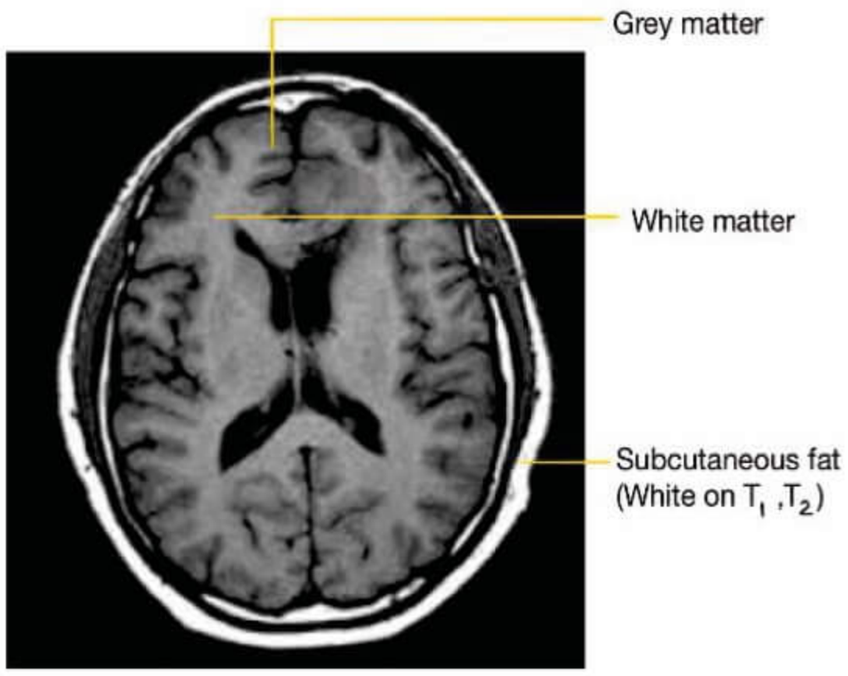
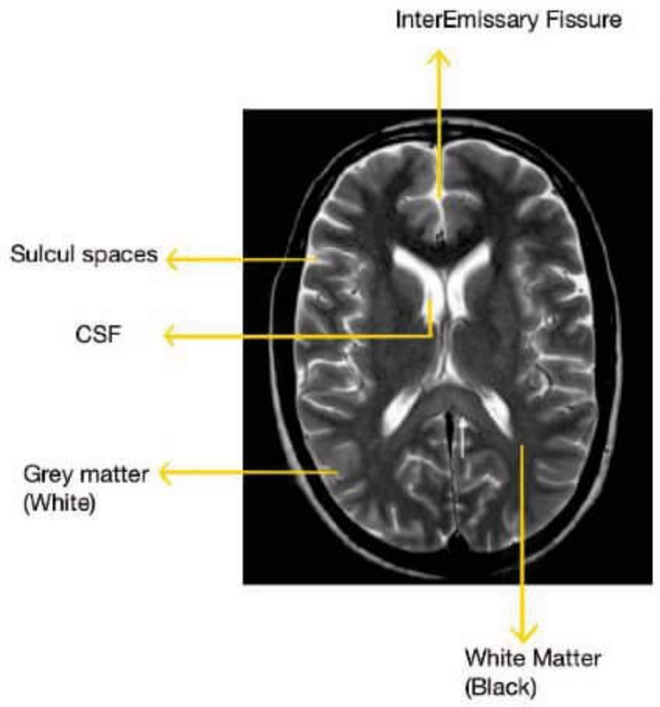


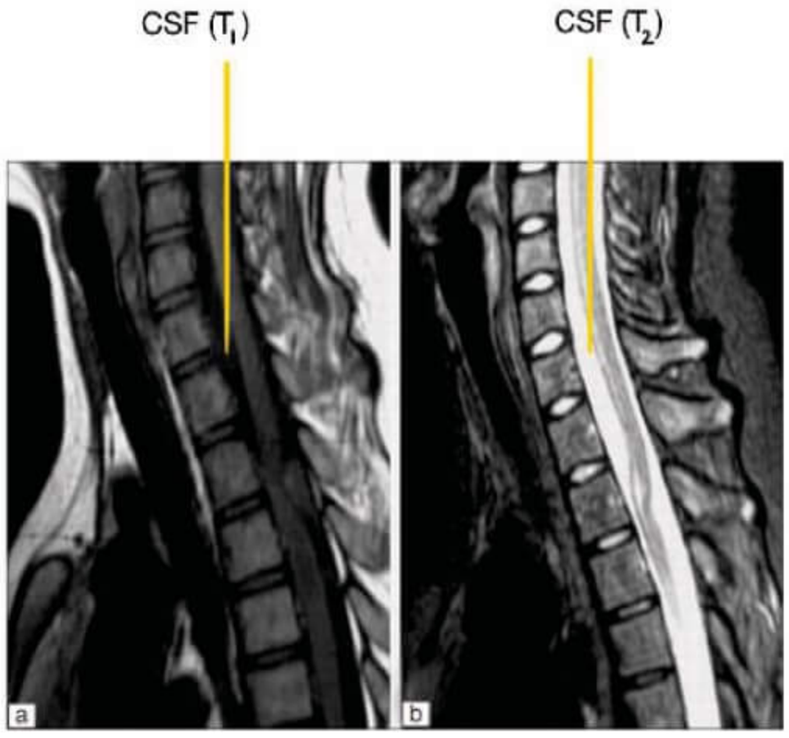
2ppm peak- NAA peak
Seen in Canavan's Disease.

MRI -Part 2

Basic sequence of MRI

→ Spin- Echo sequence

T_1 weighted	T_2 weighted
• It is the time taken to gain 63% of longitudinal magnetization.	• It is the time taken for 37% of transverse magnetization to be left (loss of transverse magnetization)
• T_1 happens in Z axis.	• T_2 happens in X-Y axis.
• Has Spin- lattice interaction	• Has Spin-spin interaction
• Has Short time to echo & Short time to repeat	• Has Long time to echo & Long time to repeat
• It mainly looks at anatomy.	• It mainly looks at pathology.
• CSF → Hypointense • Grey matter → grey/black • White matter → white • Bone → black • Fat → white (more white on T_1 than T_2)	• CSF → Hyperintense • Grey matter → white • White matter → grey/black • Bone → black • Fat → white
	



IOC for Spinal Imaging- MRI

- Contrast MRI is better done in T_1 weighted
- Most pathologies appear hypointense on T_1 and hyperintense on T_2.

Structures appearing hyperintense on T_1

1. Fat
2. Proteinaceous substances (e.g. craniopharyngiomas)
3. Subacute haemorrhage (e.g. venous infarcts)
4. Gadolinium
5. Melanin – 'T_1 hyperintense metastasis'
   ↓
   melanoma

Structures dark (hypointense) both on T_1 and T_2

1. Air
2. Bone
3. Calcification
4. Flowing blood

} Signal voids

5. Dense fibrous tissues (e.g. ligaments, tendons)

- To look at flowing blood= MR Angiography → with contrast
  ↓
  Without contrast- 'Time of flight' technique= to see incoming signal intensities

Advantages of MRI

→ Multiplanar imaging

→ Has good soft tissue resolution

→ Neuroimaging

→ IOC for-

- Neurological diseases – MRI
- Brain tumors - Contrast enhanced MRI
- spinal metastasis – MRI
- ventricular function/ventricular masses = CINE-MRI
- Preferred for Bone Marrow evaluation (bone cortex is better evaluated by CT)

→ **MRI is the IOC for**

- Acute osteomyelitis
- Ankylosing spondylitis / sacroiliitis
- Avascular necrosis of head of femur
- Perthes disease
- Stress fracture & March fracture

} STIR-MRI

→ **MRI is the IOC for**

- Posterior Fossa pathologies
- Potts spine (to evaluate extent of involvement)
- Posterior mediastinum (has neurogenic masses)
- Pancoast tumors (it is an apical lung tumor)
- Pregnant female with upper abdominal mass
- Paraplegia (traumatic)
- Perthes disease (AVN in young)
- Parameningeal rhabdomyosarcoma

→ MRI is the IOC for Breast implants

→ To differentiate Post op scarring from Residual / Recurrence of breast Ca = Contrast enhanced MRI is used.

↓

- Post op scarring – shows no enhancement
- Residual / Recurrence of breast Ca – shows Ductal enhancement

Breast implant rupture

Intracapsular

↓

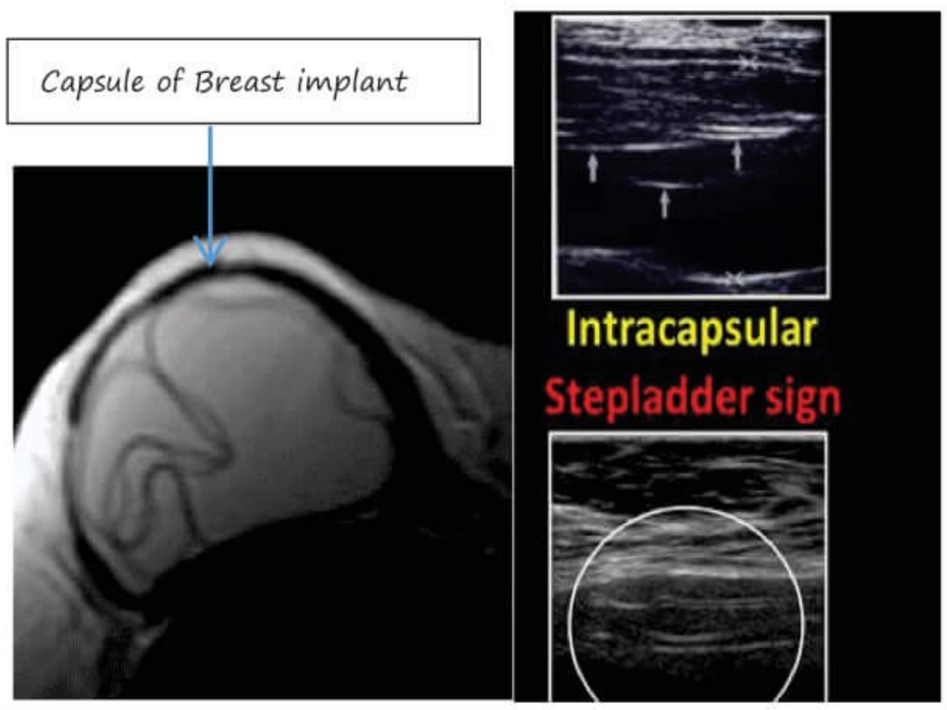
On MRI shows

→ Keyhole sign

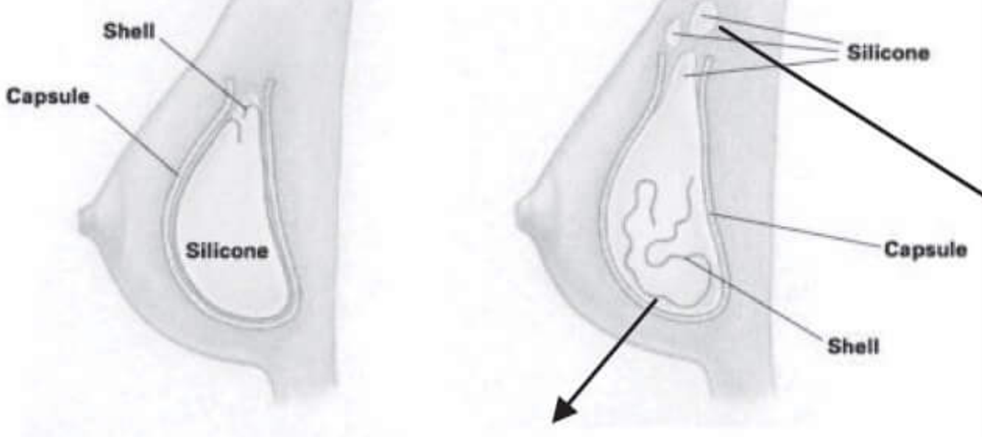
→ Linguine sign

On USG shows

→ Step ladder pattern



Linguine sign



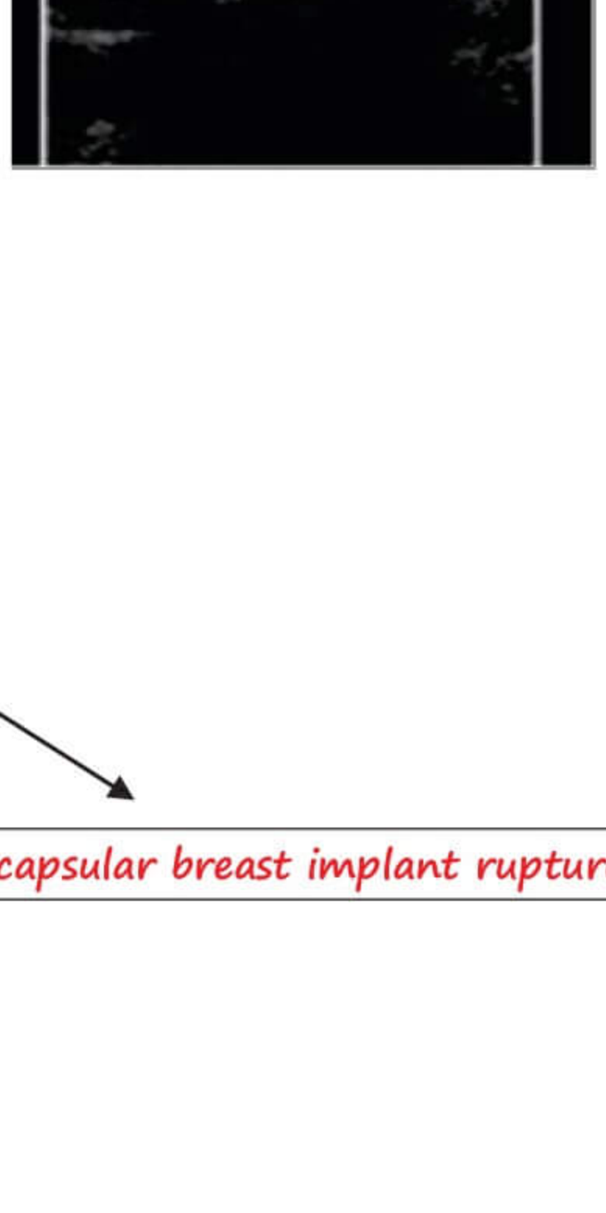
Intracapsular breast implant rupture

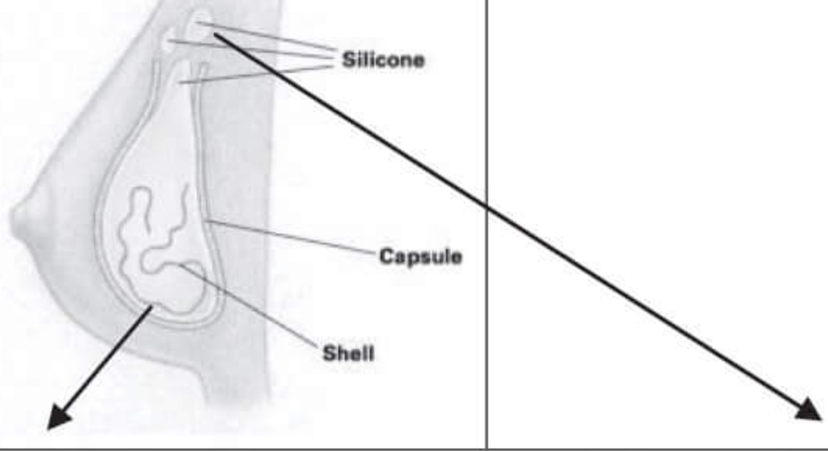
Extracapsular

↓

On USG shows

→ Snowstorm appearance





Extracapsular breast implant rupture

Disadvantages of MRI

→ Long acquisition time (so cannot be used in acute settings)

→ **Relative contraindication**

- Claustrophobia

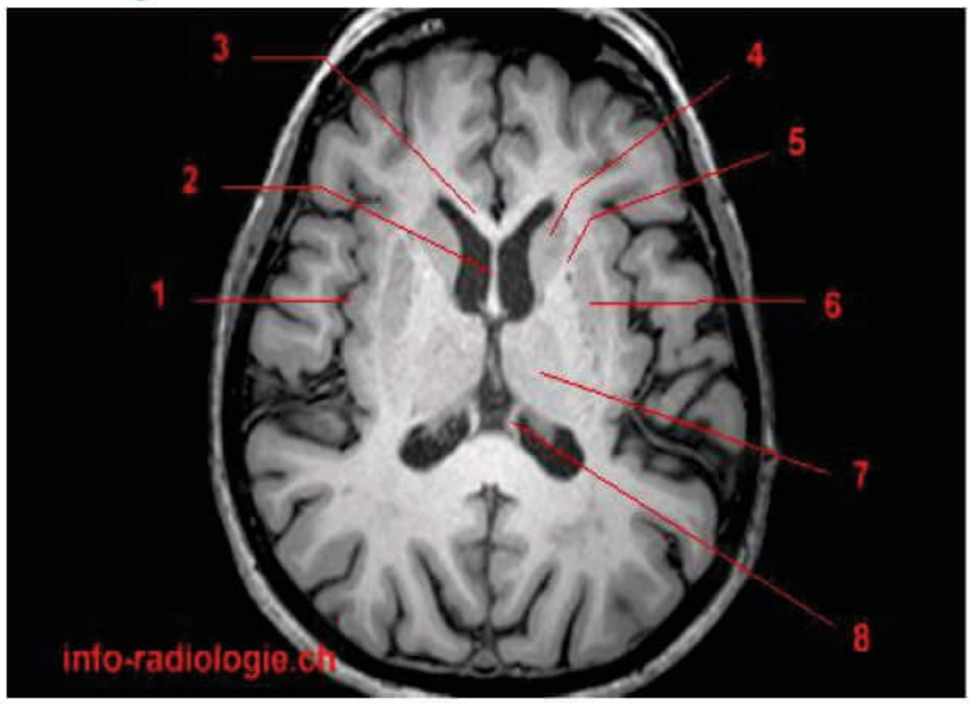
→ **Absolute Contraindication**

- Cardiac pacemakers
- Metallic prosthetic heart values
- cochlear implants
- aneurysmal clips
- Ocular metallic foreign body (IOC is CT)
- Swan – Ganz catheter
- Recent orthopaedic implants

→ **Not a Contraindication**

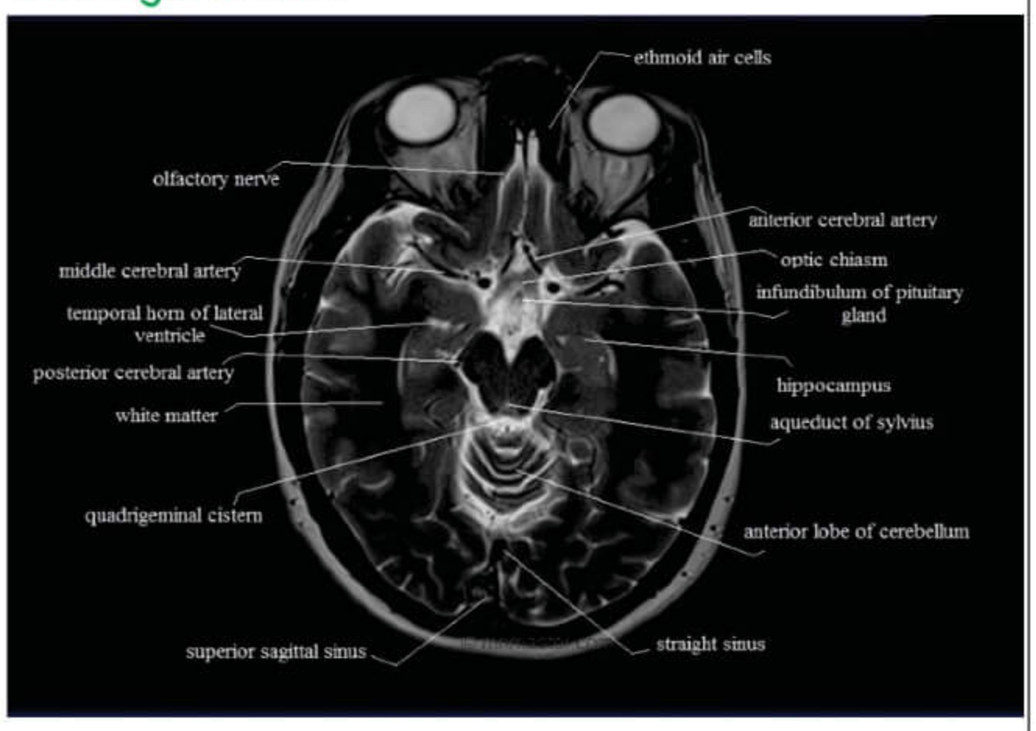
- Coronary stents
- IUD's
- Orthopedic implants (titanium based)
- Pregnancy
- Dental filings
- Foley's catheter, Ryle's tube

T_1 weighted MRI

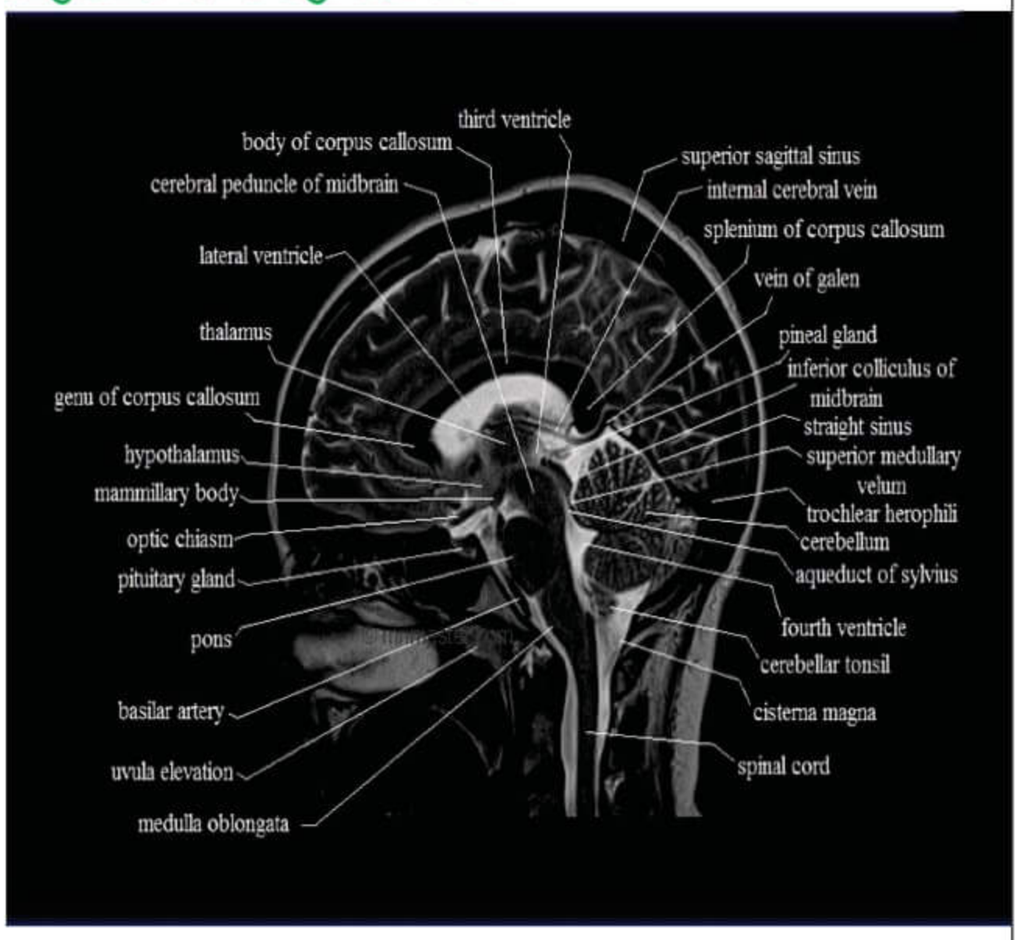


1. Sylvian fissure (insular)
2. Septum pellucidum
3. Genu of Corpus callosum
4. Caudate nucleus
5. Anterior limb of internal capsule
6. Lentiform nucleus
7. Thalamus
8. Fornix

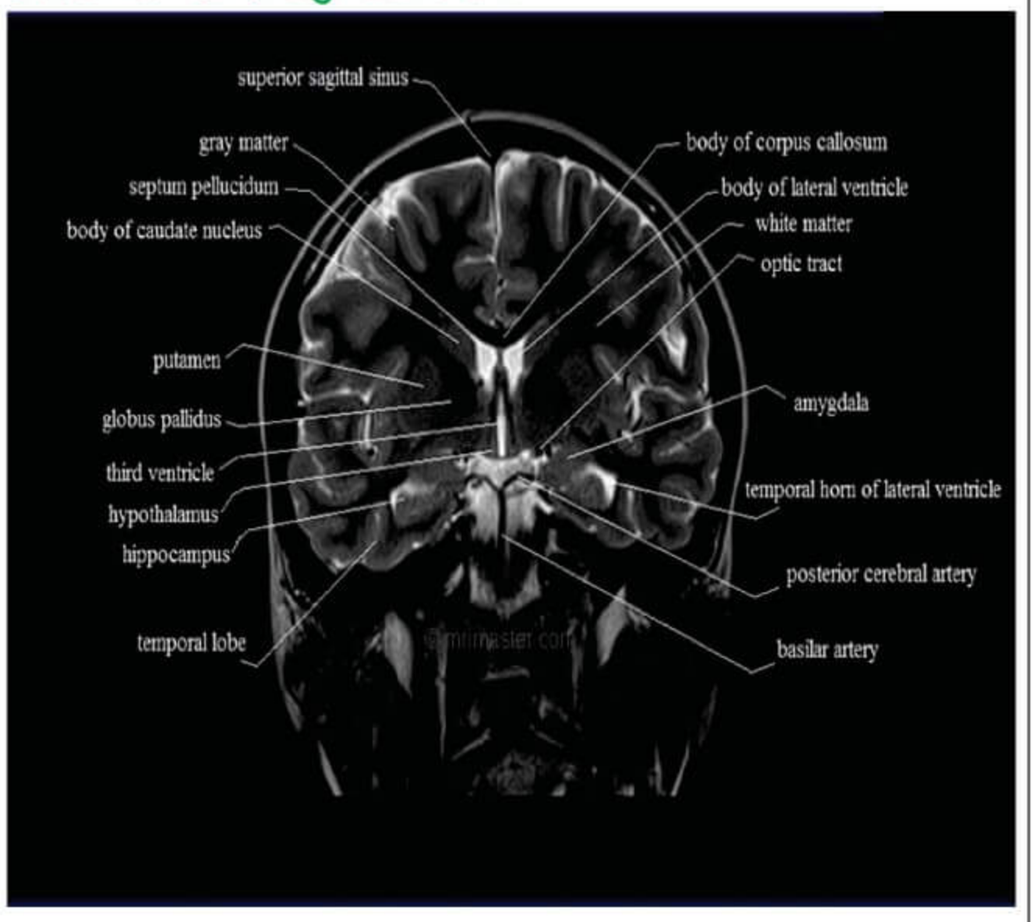
T2 weighted MRI



Sagittal T2 weighted MRI



Coronal T2 Weighted MRI



Hippocampal Atrophy → Dilatation of temporal horn of lateral ventricle

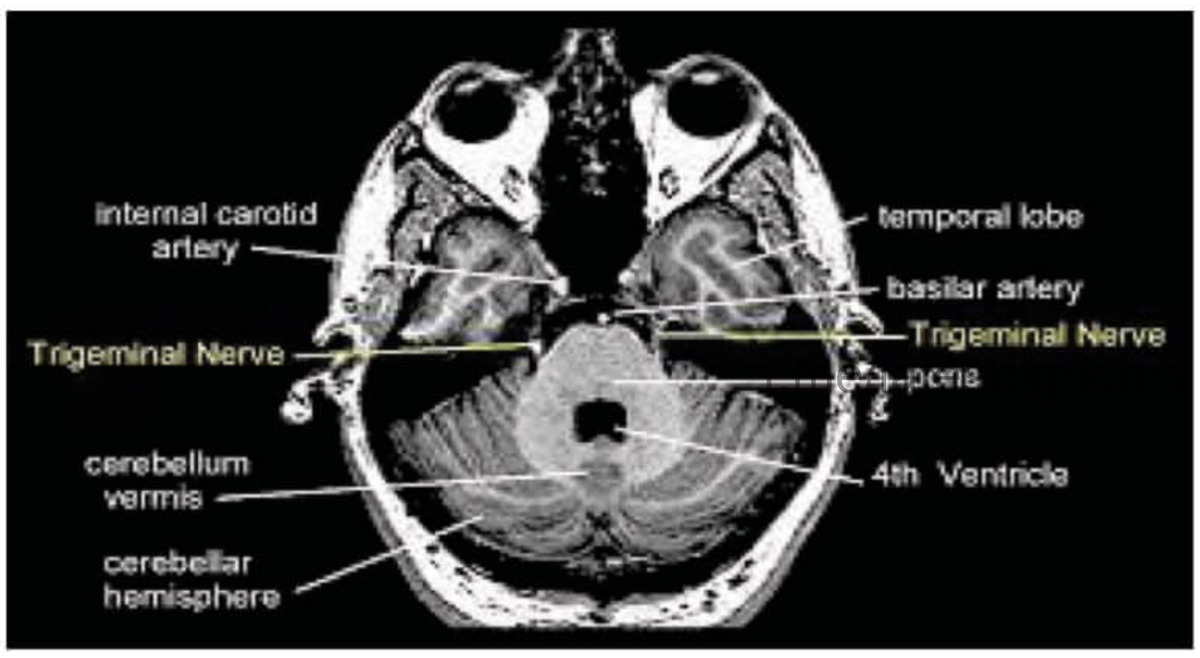
Important sign of hydrocephalus

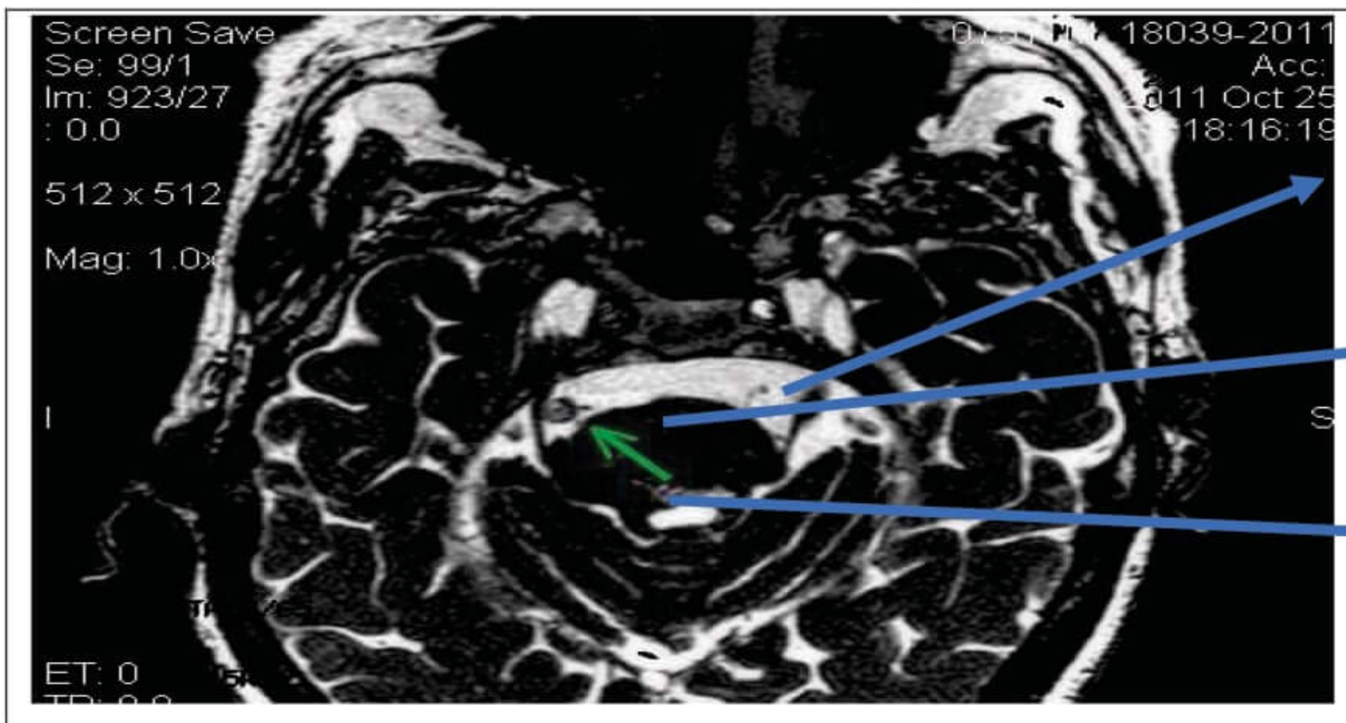
Alzheimer's → Dementia

Mesial temporal sclerosis → Epilepsy

- Hippocampus is best visualized in oblique coronal MRI

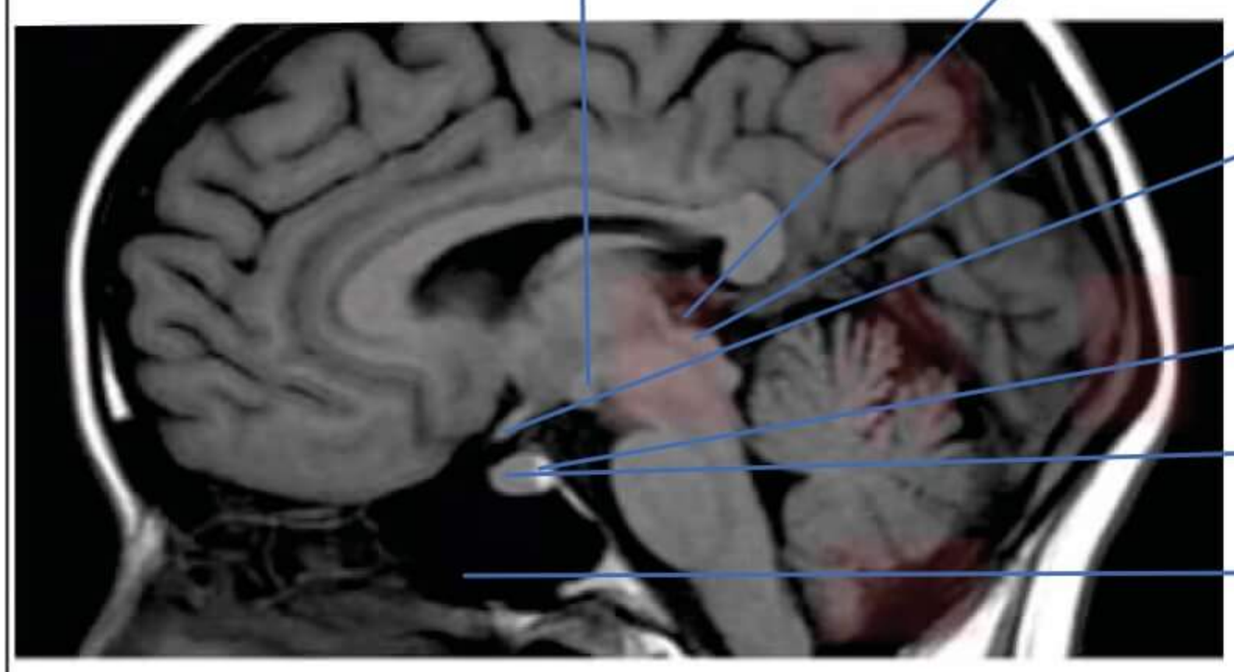
Axial MRI





Green arrow- Trigeminal Neuralgia

Sagittal MRI



- Absence of this bright spot of posterior pituitary= Central Diabetes Insipidus
- In case of Pituitary enlargement (e.g. pituitary adenoma) = Compression of optic chiasma
  ↓
  Bitemporal heteronymous hemianopia
- Pineal gland tumor = Compression of Superior colliculus = Upward gaze palsy
  ↓
  Parinaud Syndrome

  ↓
  Most common- Germinoma

To Prevent electro-magnetic interference in MRI Machine

↓

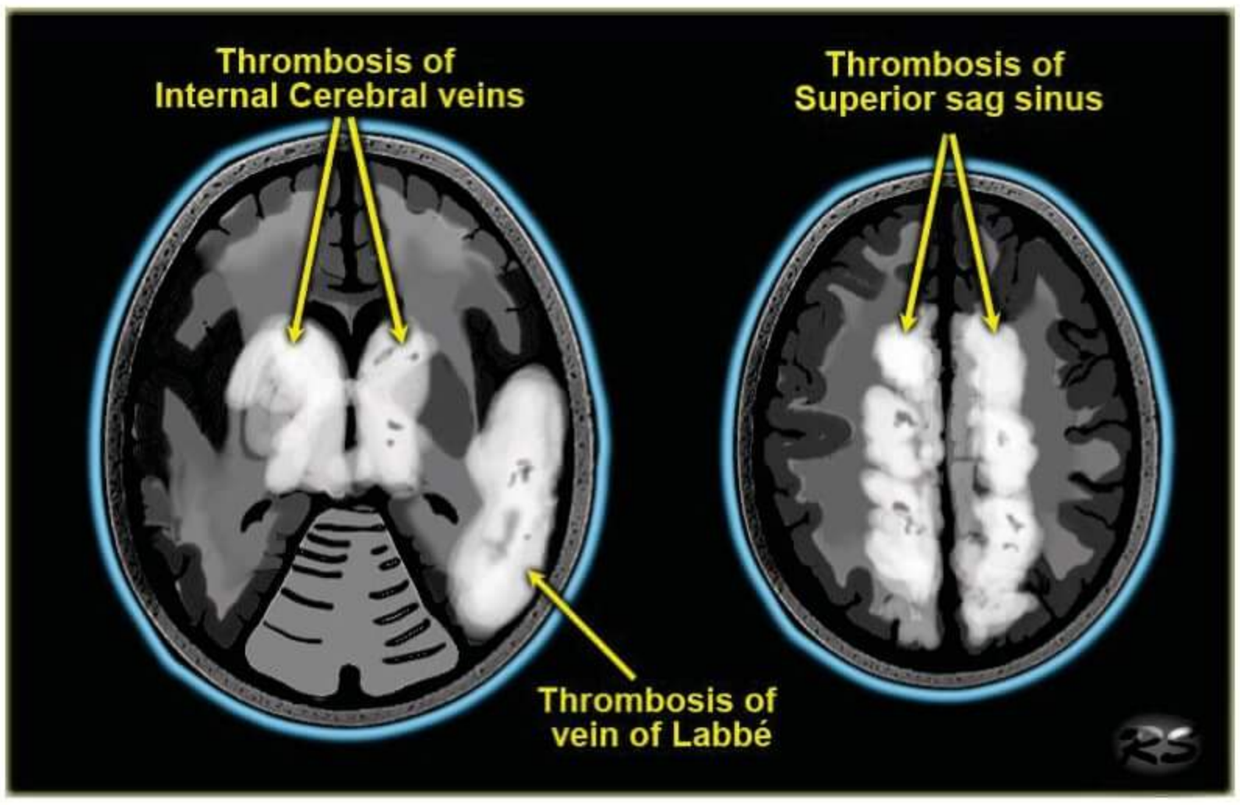
The machine is coated by a Copper Containing Cage

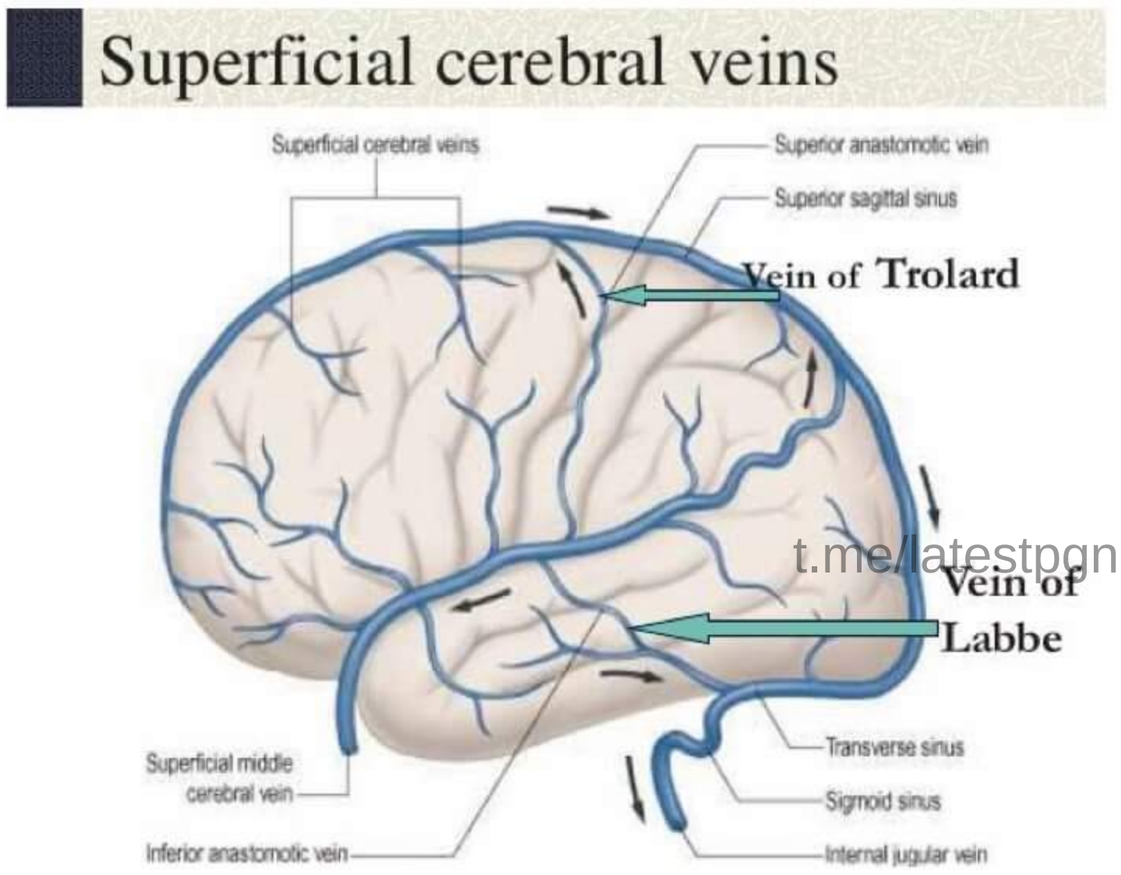
↓

Known as FARADAY 's CAGE

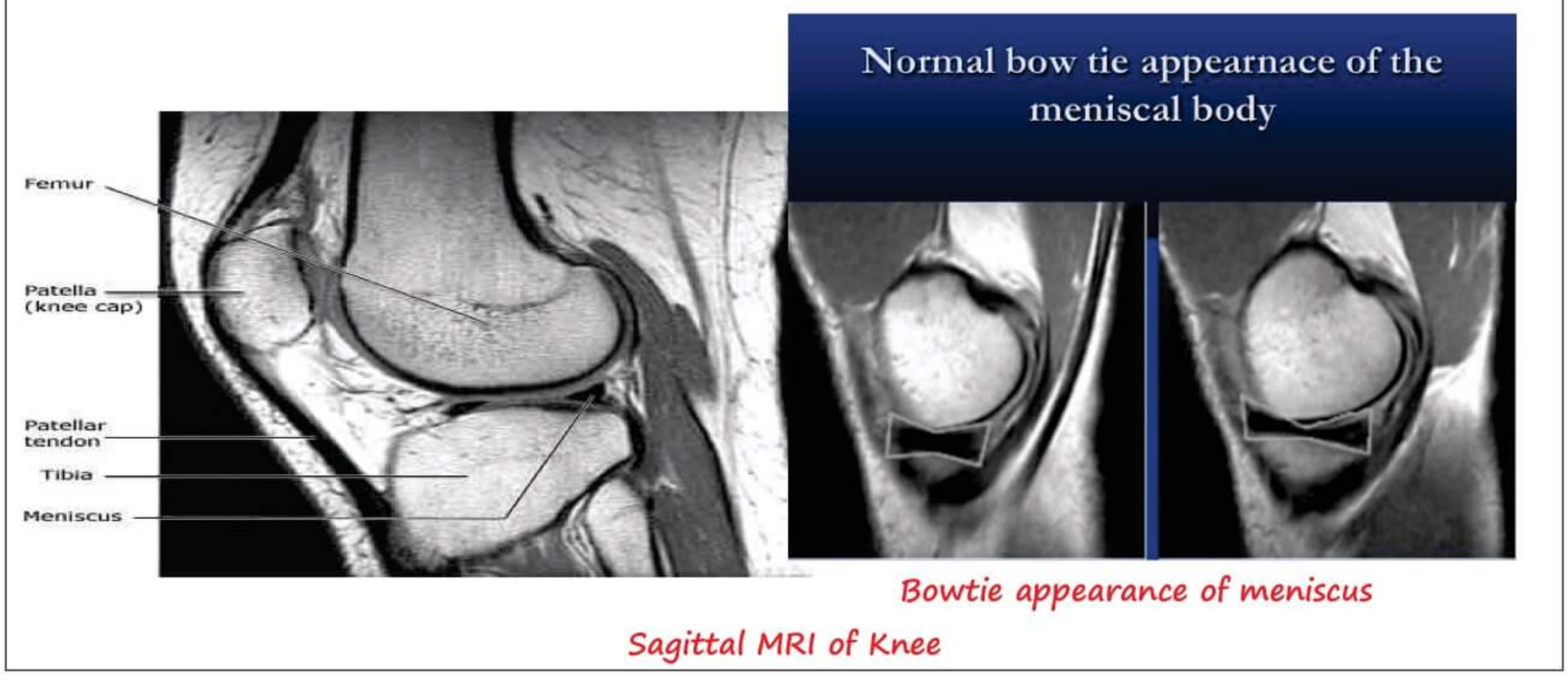
↓

Used in both EEG & MRI rooms



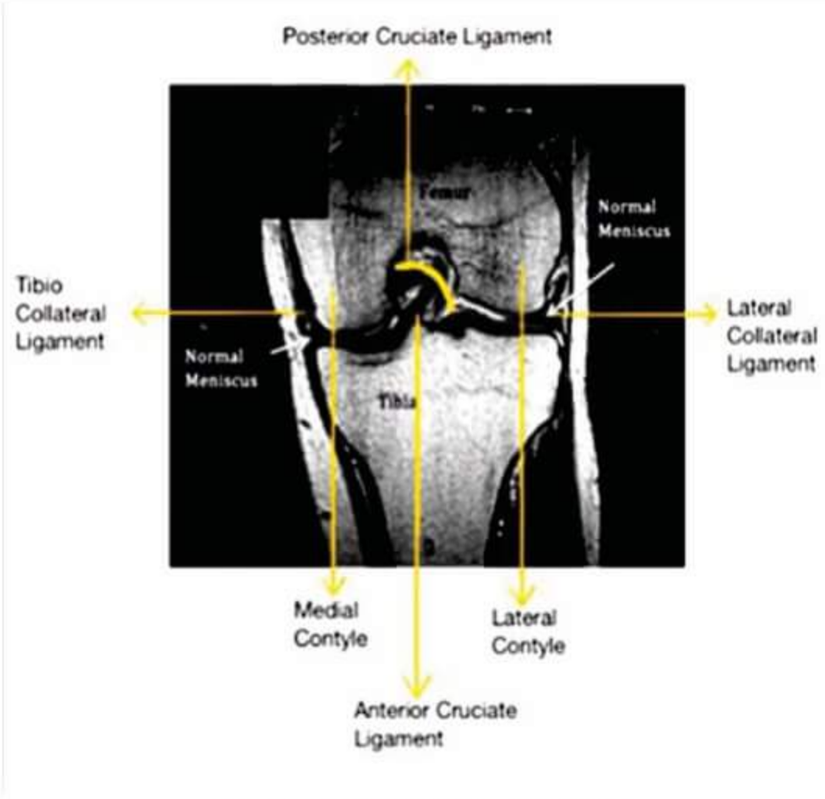


MRI of Knee

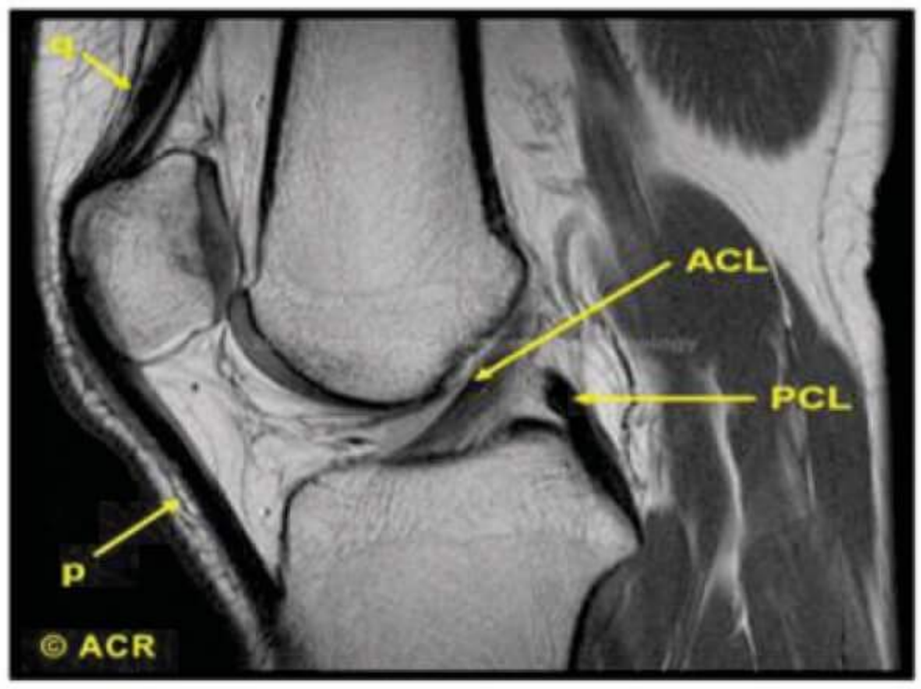


Bowtie appearance of meniscus

Sagittal MRI of Knee



Coronal MRI of Knee

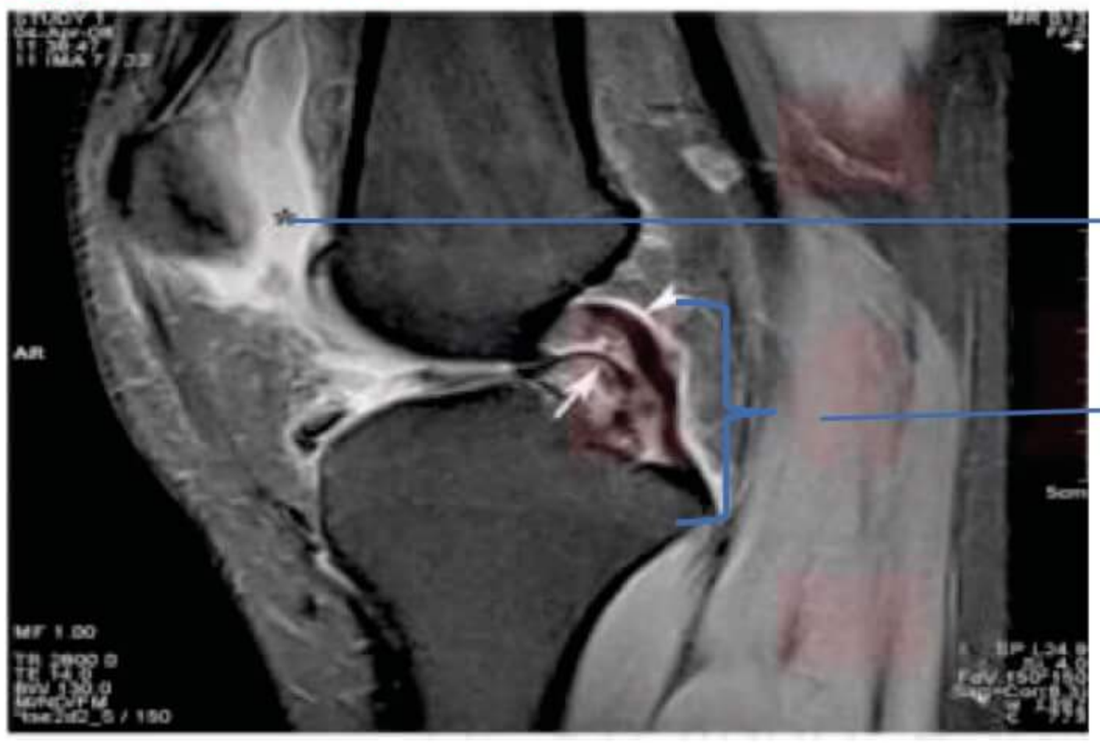


Sagittal MRI of Knee (normal)

Sagittal MRI of Knee

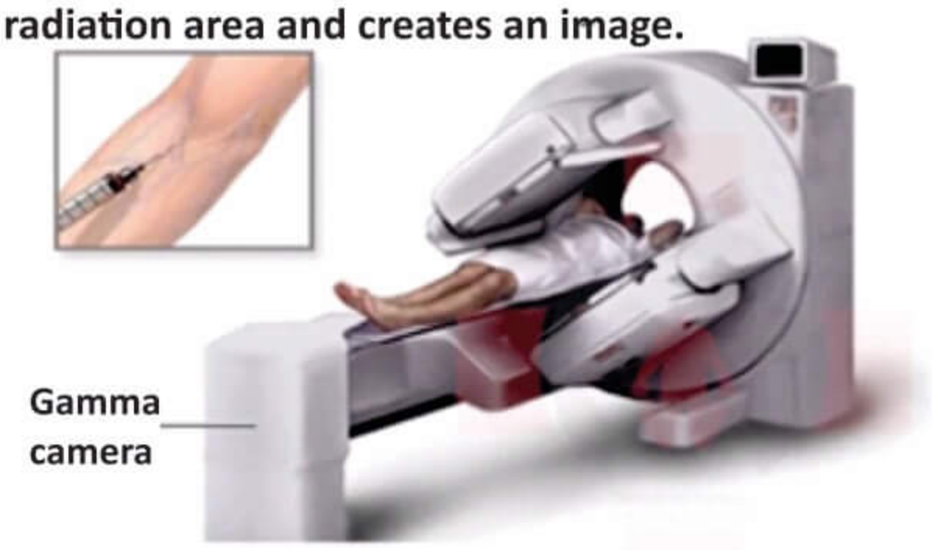
→ Ligaments are hypointense in MRI and gives hyperintense signals only when injured

Sagittal MRI of knee



NUCLEAR MEDICINE -1

The radiotracer, injected into a vein, emits gamma radiation as it decays. A gamma camera scans the radiation area and creates an image.



Scintigraphy / Radioisotope Study	SPECT (Single photon emission CT)	PET (positron emission tomography)
• Tc^{99m} isotope used	• Tc^{99m} isotope used • 360 revolving Gamma cameras • 3D images	• 18F • 11C • 13N isotopes

Scintigraphy study:

Mo^{99} (Molybdenum) $\xrightarrow{\beta - decay}$ Tc^{99m} $\xrightarrow{\gamma - decay}$ Tc^{99}

Tc^{99m} → metastable isomer

→ Parent component of Tc99m is Mo^{99}

→ $T_{1/2}$ of Tc^{99m} is 6hrs

→ Tc^{99m} is binded to ligands based on organ of interest

Ex: 1) Tc^{99m} + DMSA → kidney
2) Tc^{99m} + Pertechnetate → Gastric mucosa
3) Tc^{99m} + MDP → Bone

→ Gamma camera / anger camera /scintillation detector

- detects the gamma rays emitted from the organ

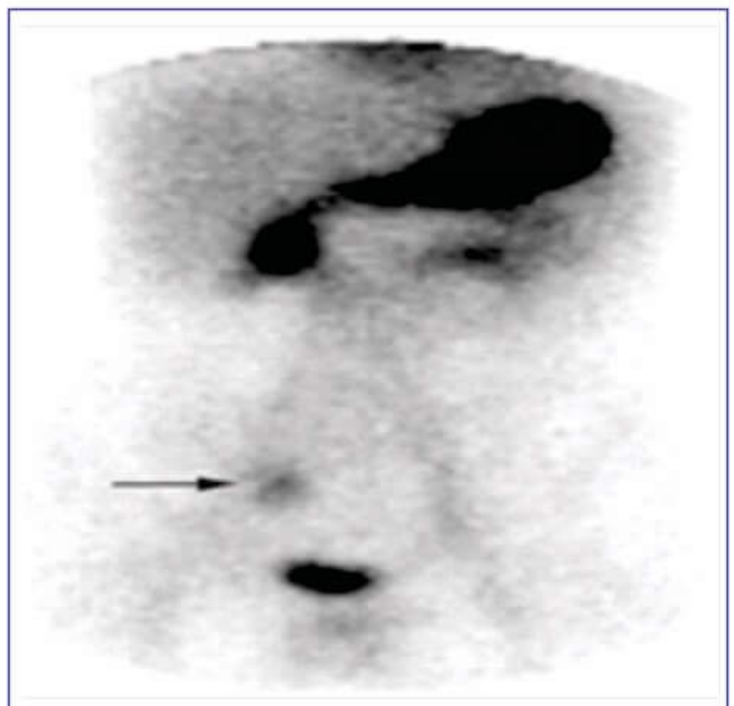
99m-Tc-Pertechanate:

Uses:

→ Thyroid scintigraphy

→ Salivary scintigraphy

→ Meckel's diverticulum



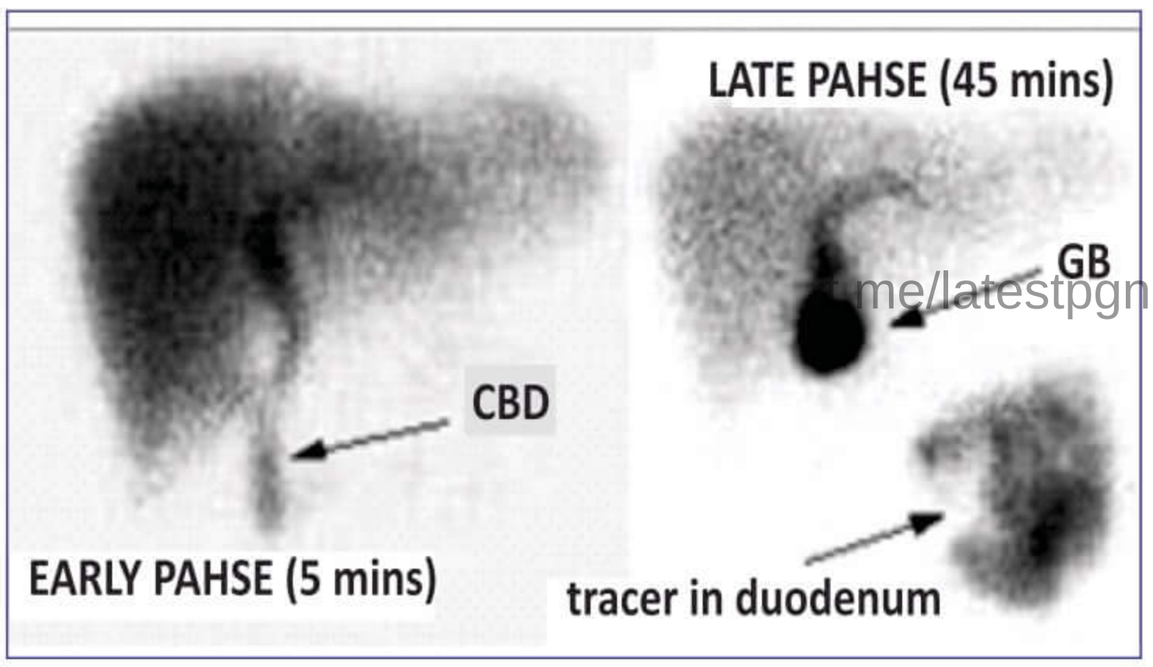
Meckel's diverticulum

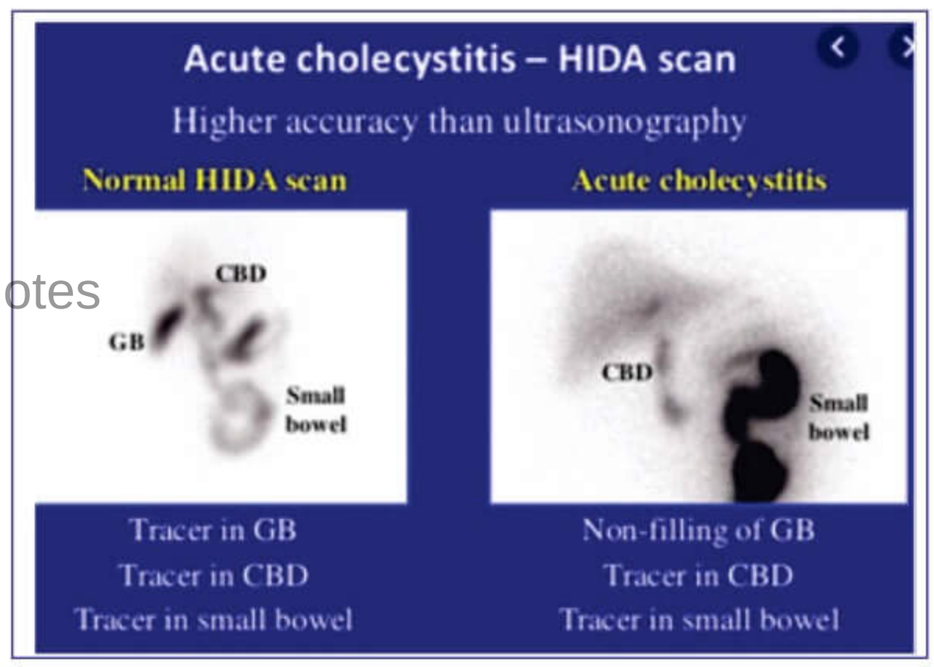
HIDA scan:

→ It is the most accurate investigation for acute cholecystitis (but IOC for acute cholecystitis is USG)

→ Non-visualization of gallbladder in HIDA scan is suggestive of acute cholecystitis

→ Used to exclude the diagnosis of biliary atresia





Myocardial perfusion imaging:

→ Isotopes used:

- Thallium 201
- Tc ^{99m} Tetrofosmin
- Tc^{99m} Sestamibi, MIBI scan

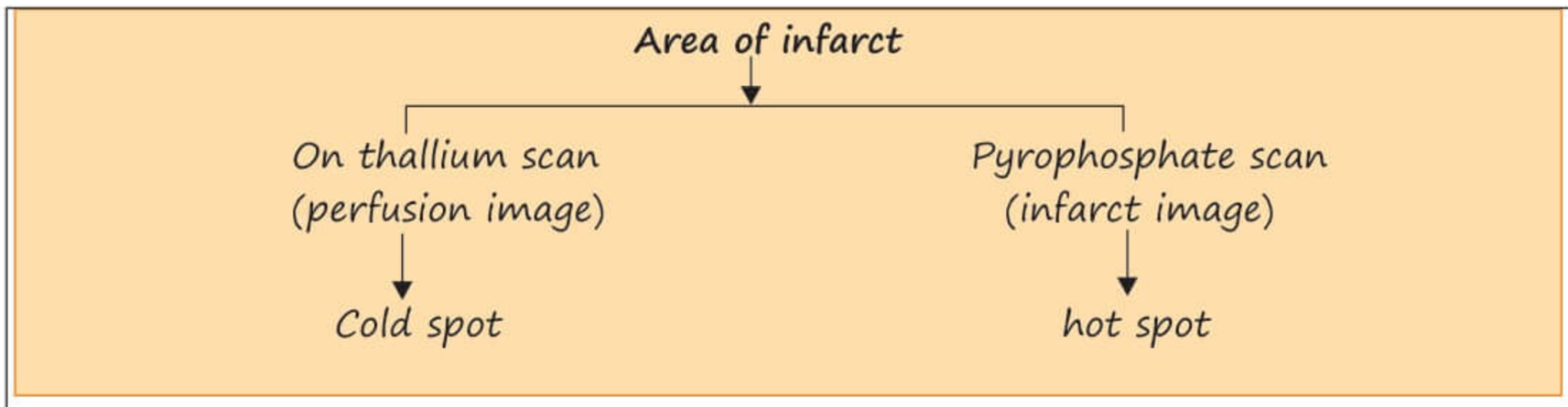
→ Stress thallium study increase sensitivity

Note:

→ N-13 ammonium PET has greater sensitivity for myocardial perfusion.

Myocardial infarct imaging:

→ Tc 99m pyrophosphate is used to localize the area of infarct in heart.



MUGA scan (Multi-gated acquisition scan):

→ Tc 99m labeled RBC is used

→ Evaluate ventricular function / ejection fraction- Cardiac ventriculography
(but most accurate investigation for ventricular function is **Contrast-MRI**)

→ Tc^{99m} labeled RBC is very sensitive investigation for detecting minimal lower GIT bleeding (as low as 0.1 ml per minute)

Bore scan:

→ **Done with:** 1. Tc^{99m}-MDP (Methylene diphosphonate)
2.Tc^{99m} Medronate

→ **Hot uptake** on bone scan indicates osteoblastic activity

→ **Cold uptake** on bone scan indicates osteoclastic activity.

Hot uptake of bone scan seen with:

→ Osteoblastic metastasis/ prostatic metastasis

→ Paget's disease

→ Fibrous dysplasia

→ Osteoarthritis

→ Osteomyelitis (3 phase bone scan)

Cold uptake of bone scan is seen in:

→ Multiple myeloma (not preferred for bone scan)

→ Focal cortical defects

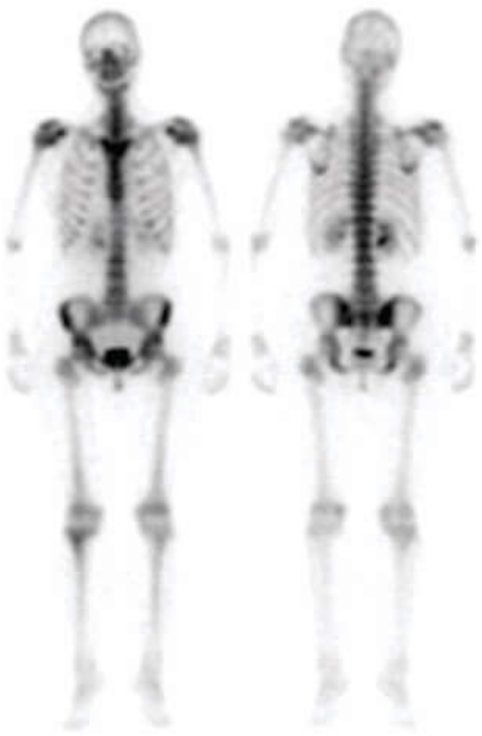
Normal bone scan:

→ Axial skeleton shows normal uptake in bone scan.

→ IOC for spinal metastasis is MRI.

→ Normal Bone image shows uptake of tracer in axial skeleton, bilateral shoulder, sacral region and kidneys

Normal Bone Scan



Tc-99m MDP

- Tracer uptake greatest in axial skeleton
- Background activity of soft tissue
- Kidneys routinely visualized
- Skull can appear uneven (variations in calvarial thickness)
- Sites of persistently increased symmetric uptake are- Acromial and Coracoid processes of the scapulae, Medial ends of the clavicles, Junction of the body and manubrium of the sternum and the sacral alae

Super scan:

→ *It resembles normal bone scan but kidney is not visualized.*

→ **It is seen with:**

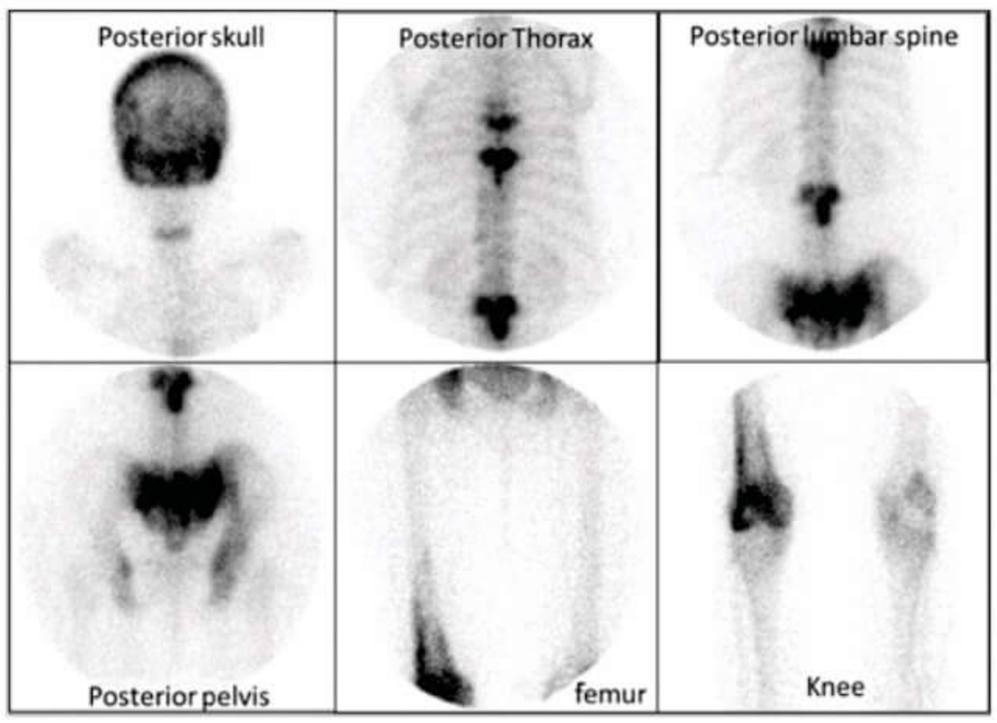
- *Renal failure*
- *Diffuse metastatic bone disease*
- *Diffuse metabolic bone disease like hyperparathyroidism*

Paget's disease:

→ *Bone scan shows increased uptake of isotope in calvarium and vertebral body.*

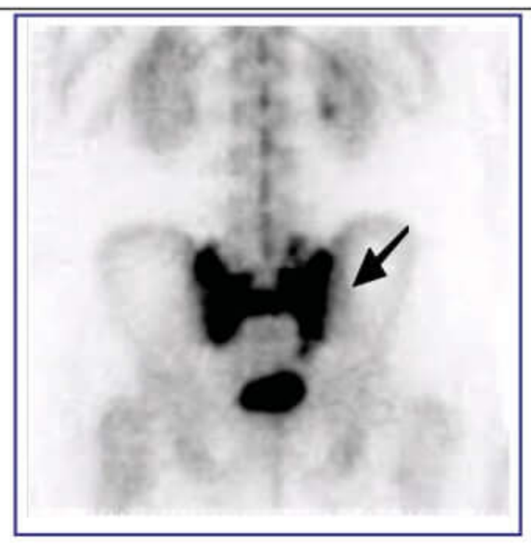
→ *Because of increased osteoblastic activity in cotton wool skull (feature of Paget's) – increased uptake in calvarium.*

→ *Because of increased osteoblastic activity in vertebra and in its posterior elements – shows hot uptake giving "mickey mouse sign" on bone scan.*



Sacral insufficiency fracture/ osteoporotic fracture of sacrum:

→ "H sign / Honda sign"



Technetium 99m Sulphur colloid scan:

→ Taken up by reticuloendothelial cells

→ used for

- Phagocytes study
- Evaluate splenic disease
- Detect occult abscess

→ It shows hot uptake in focal nodular hyperplasia (because it has increased number of Kupffer's cells)

Note:

1. Stellate scar in kidney Oncocytoma
2. Stellate scar in pancreas Serous cystadenoma
3. Stellate scar in liver

Fibrolamellar variant of HCC → (has increased hepatocyte) → No hot uptake

Focal nodular hyperplasia → (has increased hepatocyte and Kupffer cells) → hot uptake

On Sulphur colloid scan

NUCLEAR MEDICINE –II

Renal imaging using scintigraphy

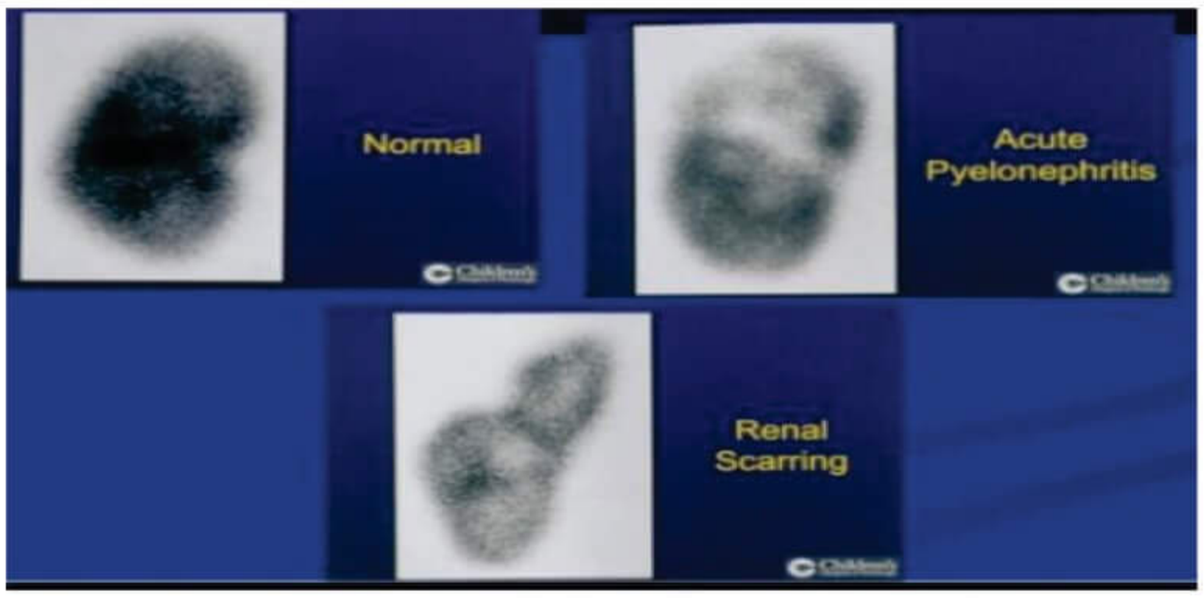
1. Morphological / anatomical / static imaging

→ Done with Tc^{99m}DMSA Scan

→ Also used for evaluating cortical scars

→ **Used for:**

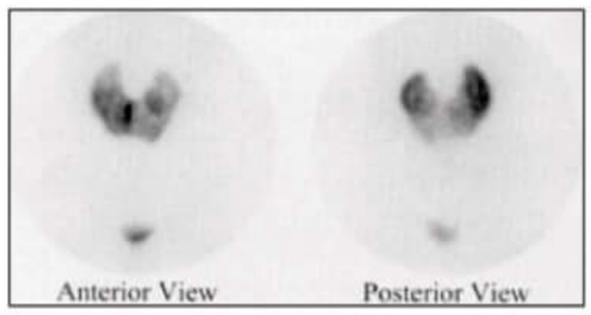
- Cortical function
- Corticomedullary differentiation
- Cortical scars evaluation
- Functional masses of kidney evaluation



DMSA gets reabsorbed and gets conc. In Cortex

DMSA Scan

- Horse-shoe kidney



Functional / Dynamic Renography

→ Done with Tc^{99m} DTPA / Tc^{99m} MAG3

→ **Tc^{99m} DTPA** – evaluate G.F.R

→ **Tc^{99m} MAG3** – used to evaluate

- Renal function
- Renal perfusion
- Renal plasma flow

Captopril – DTPA scan:

→ Used for screening of renovascular hypotension

→ But, gold std for renal artery stenosis is Renal angiography

Gallium – 67 scans:

→ This binds to lymphocytes

→ Used for lymph node scintigraphy

→ Used to locate occult abscess

Example: → In sarcoidosis

- Because of presence of B/L hilar lymph node and Right paratracheal lymph node → gives "Lambda sign" in thorax on gallium scan
- **In face** – uptake is seen in B/L parotid in nasopharynx & also, in B/L orbits → gives "Panda sign" on gallium scan

Indium -III labelled WBC scan:

→ Used for locating occult abscess

V/Q scan / ventilation – perfusion scan:

→ IOC for PTE - CT-angiography (i.e. MDCT with contrast)

→ But, IOC for - PTE in pregnancy
- PTE in iodine allergy

} V/Q Scan

→ For ventilation study - Xe, Kr used

→ For perfusion study - Tc^{99m} Labelled MAA used (macroaggregates of albumin)
- Tc^{99m} Labelled RBC

Somatostatin receptor scintigraphy / Octreotide scintigraphy:

→ Done in patients with neuroendocrine tumors like

- Carcinoid tumors
- Gastrinoma
- VIPoma
- Glucagonoma

Note: Insulinoma is somatostatin receptor negative

Points to remember

→ **Parathyroid adenoma** - Tc^{99m} Sestamibi scan used (previously thallium subtraction study is done)

→ **Pancreatic carcinoma** - Selenium-methionine scan used

Different types of radioactive Iodine:

→Normal iodine is I^{127}

Radioisotope	$t_{1/2}$	Uses
I^{131}	8 days	Used for radio ablation; systemic radiotherapy for well differentiated thyroid metastasis; emits β & γ-ray killing of Ca cells is done by β rays
I^{125}	60 days	Brachytherapy for prostate tumor, Radio immunoassay
I^{124}	4 days	It is a positron emitter used in PET scan
I^{123}	13 hrs.	RAIU studies / scintigraphy; functional scan (Pertechnate scan can be used)

Hyperthyroidism with ↓ed RAIU

→ Subacute thyroiditis / Dequevirian thyroiditis

→ Thyrotoxicosis factitia (exogenous thyroid hormone - Hamburger's thyroiditis)

→ Struma ovarii

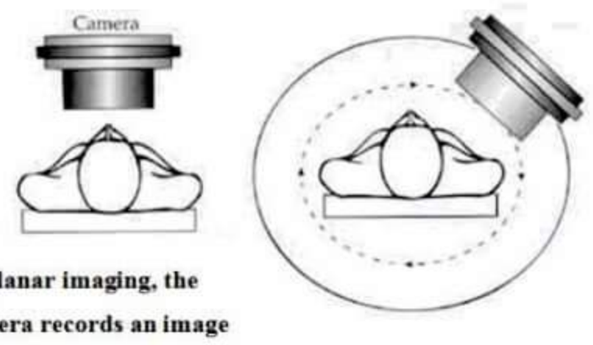
SPECT imaging:

→ It has a 360° revolving gamma camera giving 3D images

→ Tc^{99m} radioisotope is used ($t_{1/2}$ = 6 hrs.)

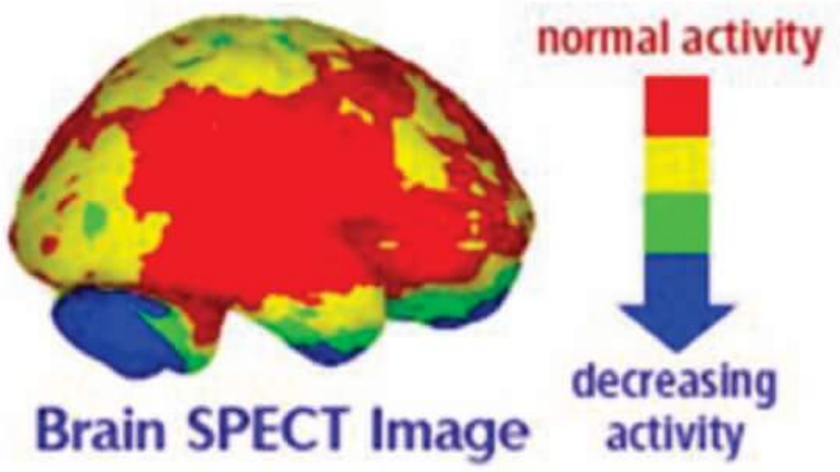
→ **Tc^{99m} – HMPAO:**

- Lipophilic / lipid soluble
- Crosses blood brain barrier
- Cerebral perfusion is evaluated



In planar imaging, the camera records an image from one perspective.

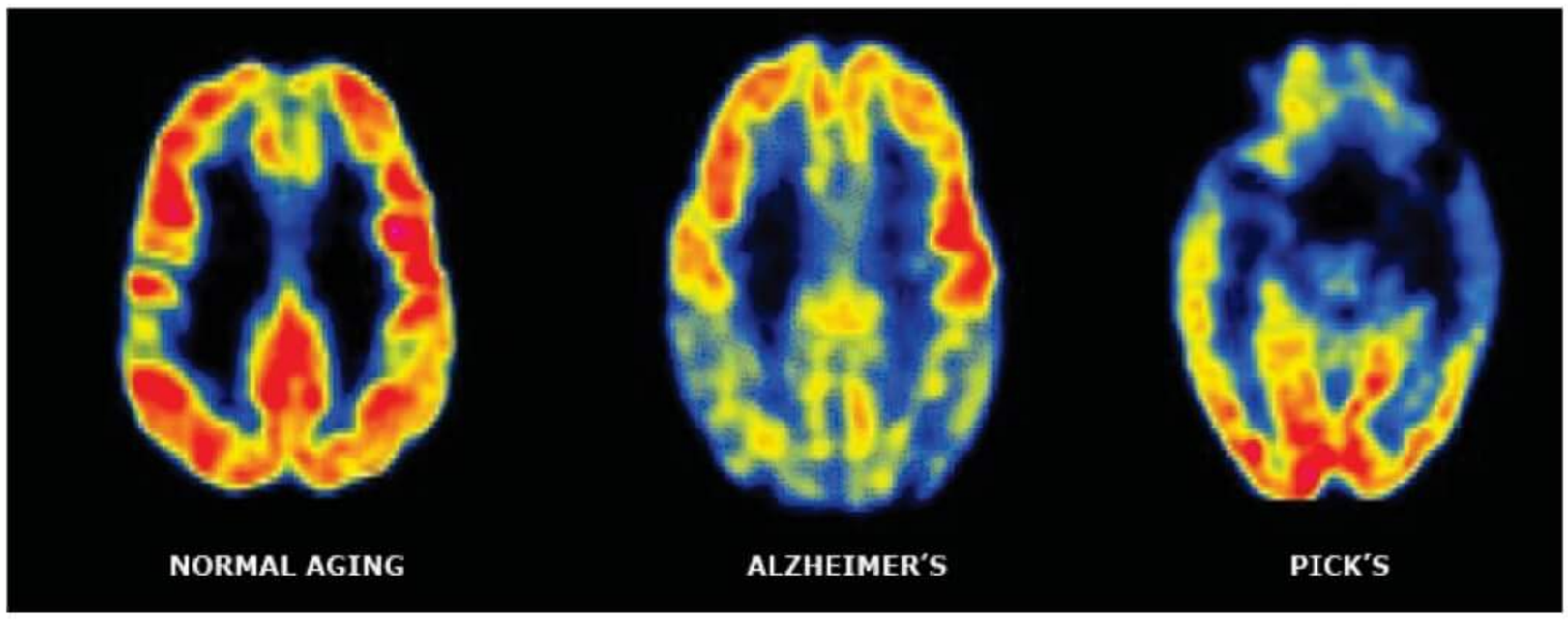
In SPECT imaging, the camera rotates around the patient, recording multiple images that are then reconstructed into a 3-D data set by the computer.



Note:

-Decreased cerebral perfusion in Parieto temporal region → Alzheimer's ds.

-Decreased cerebral perfusion in Fronto temporal region → Pick's ds.



PET scan:

→ 18-FDG is used ($t_{1/2}$ =110 mins)

→ **Warburg effect:** is aerobic glycolysis occurring in tumor cells

→ Because of this effect, 18 FDG selectively enters into tumor cells

Note:

→ Blood glucose should be normal before 18 FDG – PET

18 FDG negative tumors

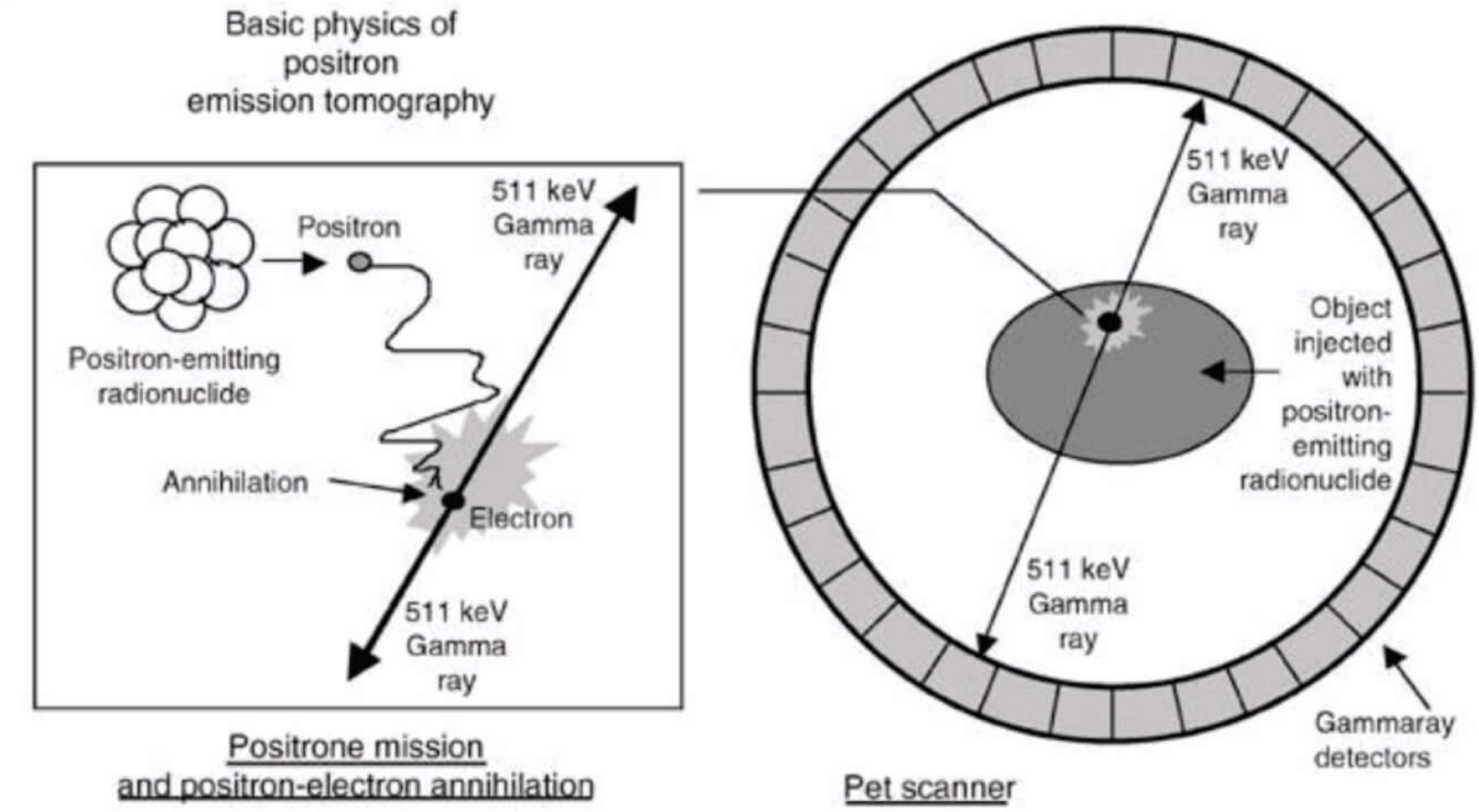
→ Tumors with low mitotic & low metabolic activity

- Typical carcinoids
- Bronchoalveolar Ca
- Mucinous Ca

Based on Warburg effect

Scar ↓ 18-FDG PET (-)	Vs	Residual / Recurrence of tumor ↓ 18-FDG PET (+)
Radiation necrosis ↓ 18-FDG PET (-)	Vs	Residual / Recurrence of tumor ↓ 18-FDG PET (+)

Basic physics of PET:



Positrone mission and positron-electron annihilation

Pet scanner

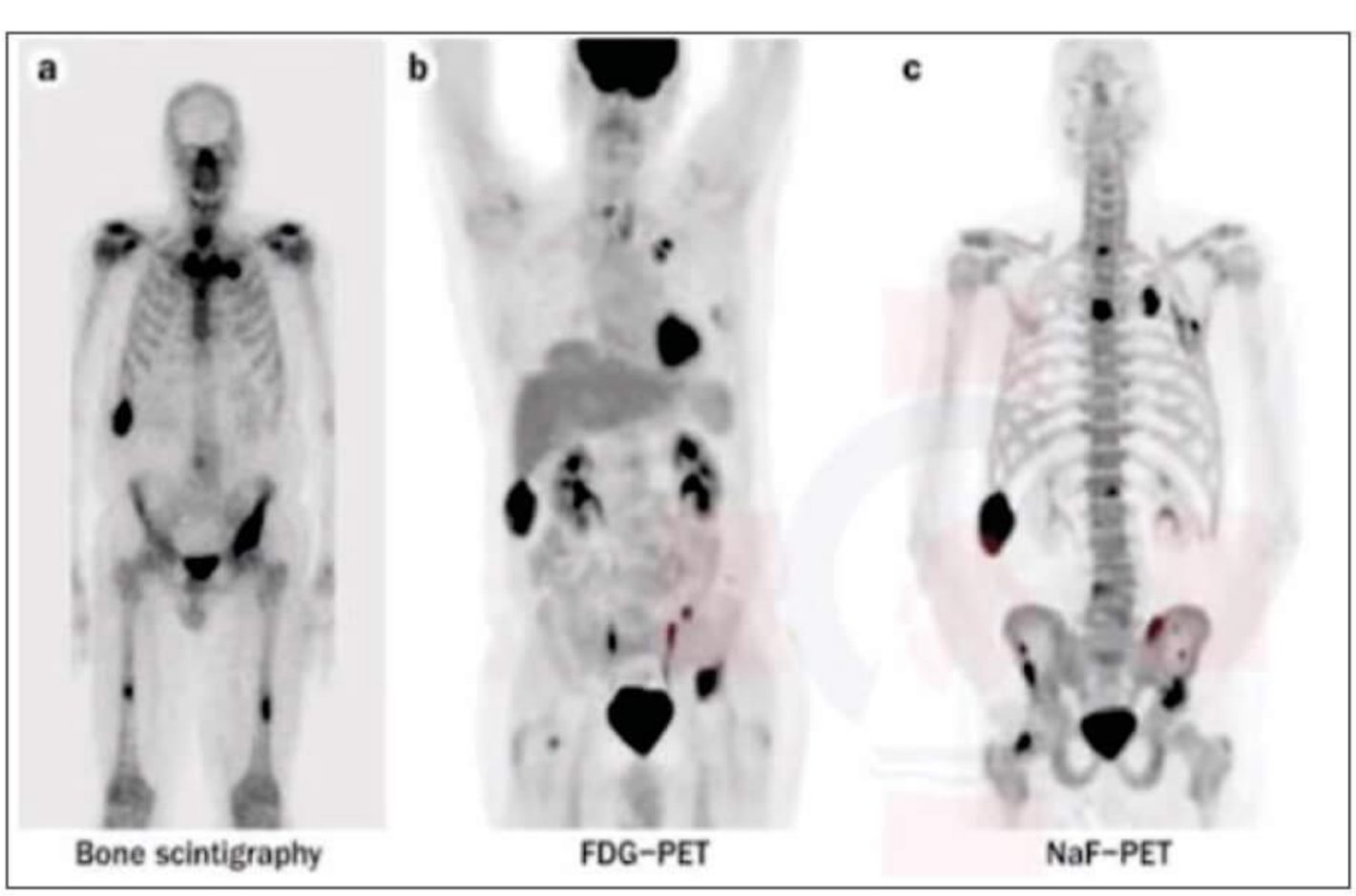
Points to remember:

→ Gold std. in evaluation of solitary pulmonary nodules – CT guided biopsy

→ 2nd preferred IOC (non-invasive) – PET scan

→ **For skeletal metastasis**

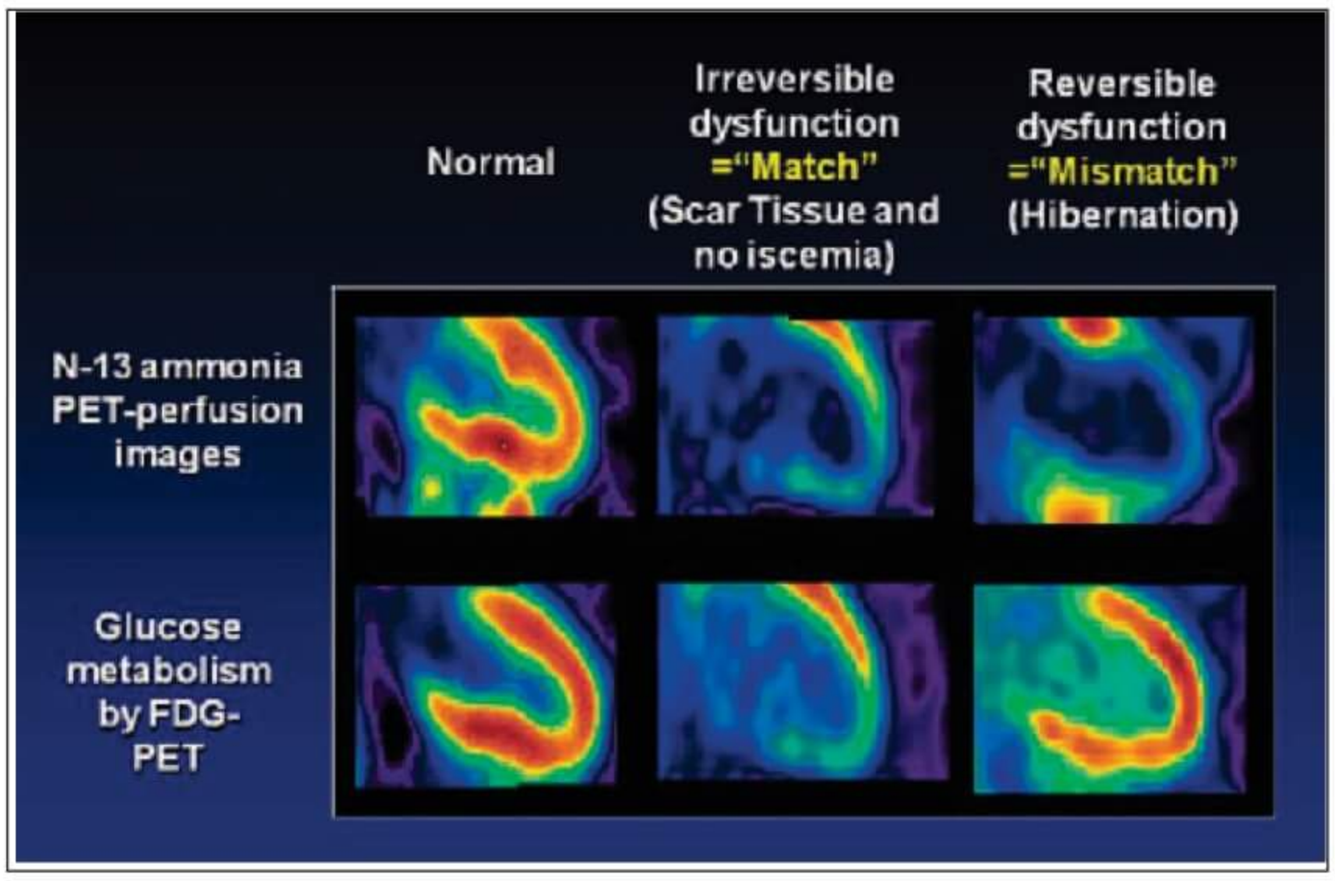
NaF-PET > 18 FDG PET > whole body MRI > Bone scintigraphy



PET scanning in heart:

→ **N-13 ammonia PET** = very sensitive for myocardial perfusion

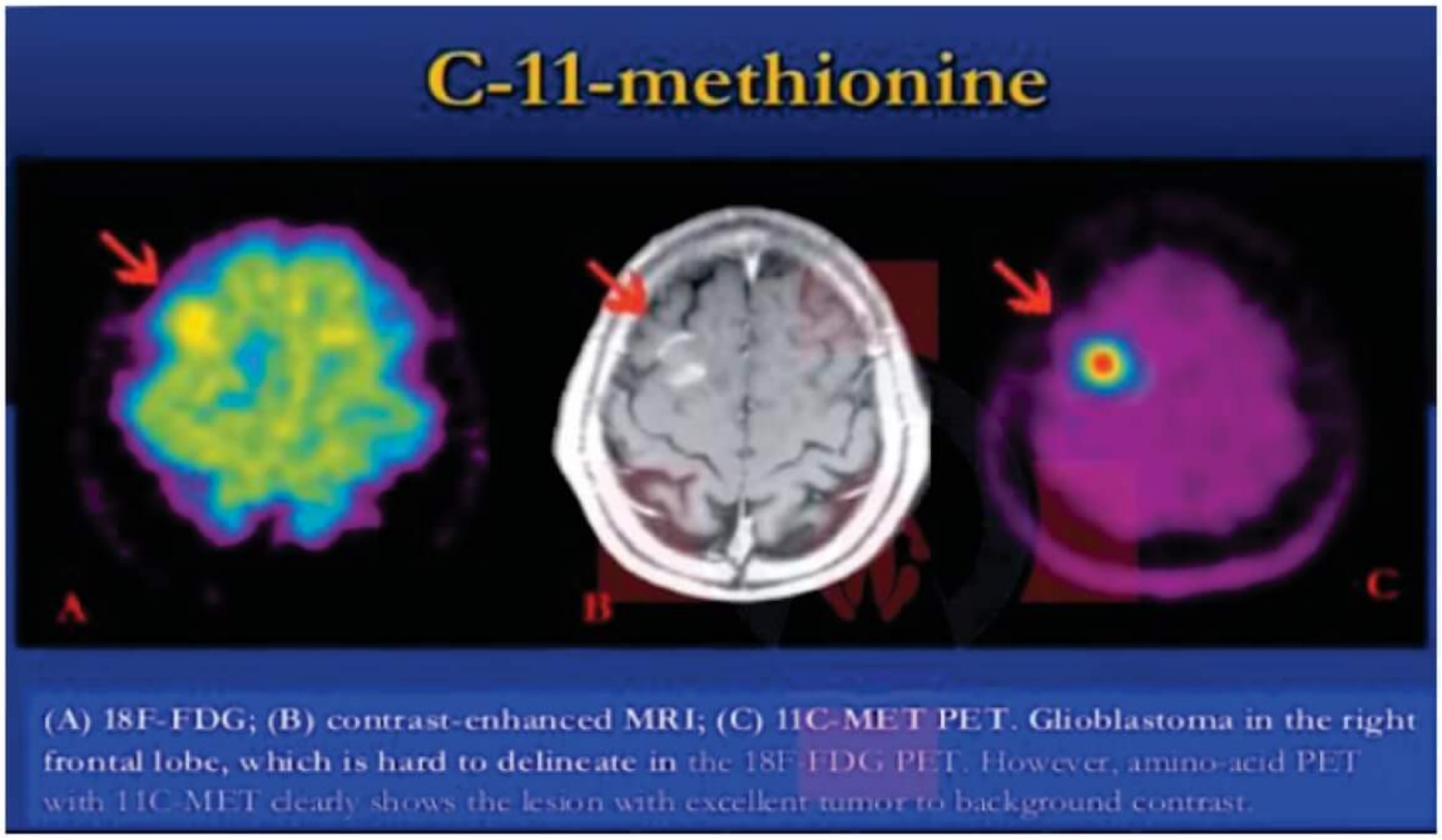
→ **18 FDG-PET** = Myocardial viability



- If **N-13 ammonia PET (-) & 18 FDG PET (-)** → Suggestive of scar tissue
- If **N-13 ammonia PET (-) & 18 FDG PET (+)** → Hibernating myocardium

Note:

→ C-11 methionine PET is better than 18 FDG PET – for brain tumors



(A) 18F-FDG; (B) contrast-enhanced MRI; (C) 11C-MET PET. Glioblastoma in the right frontal lobe, which is hard to delineate in the 18F-FDG PET. However, amino-acid PET with 11C-MET clearly shows the lesion with excellent tumor to background contrast.

Points to remember:

1. Light bulb appearance on MRI abdomen → **Pheochromocytoma**
2. Light bulb appearance on MRI liver (T_2W) → **Hemangioma**
3. Light bulb appearance on MRI brain (DW-MRI) → **Acute infarct**
4. Light bulb appearance on shoulder radiograph → **Posterior dislocation**

Light bulb appearance on MRI abdomen

Points to remember:

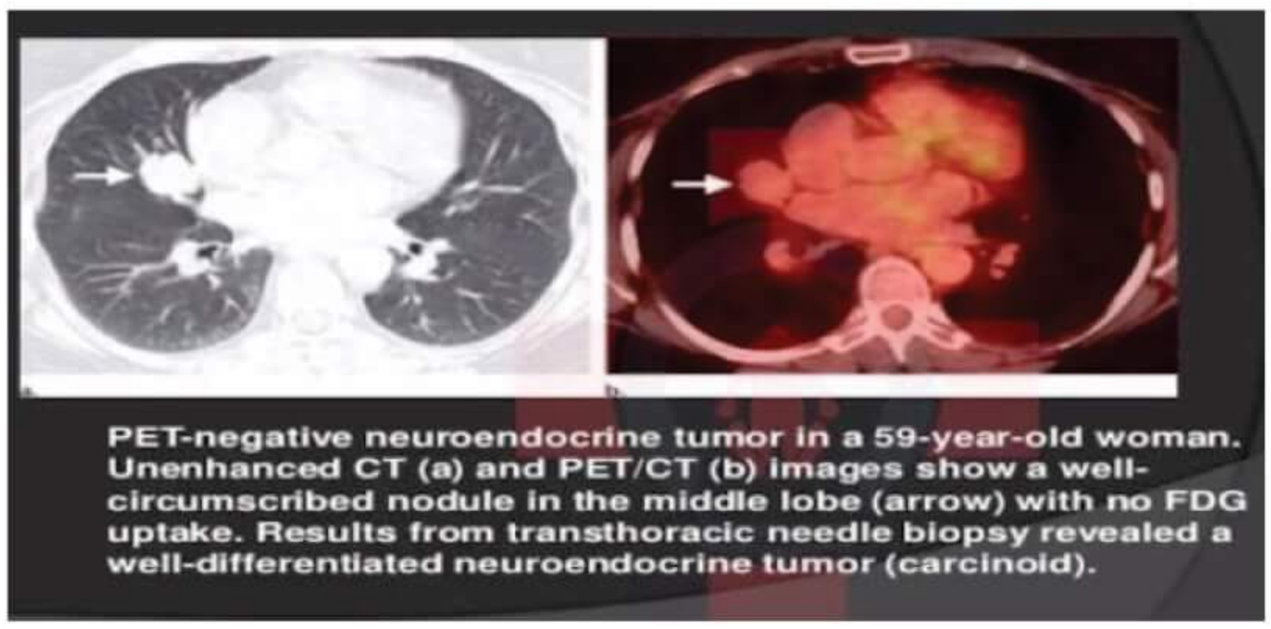
→ IOC for Adrenal Pheochromocytoma - **MRI**

→ For extra abdominal Pheochromocytoma - **DOPA PET > MIBG > MRI**

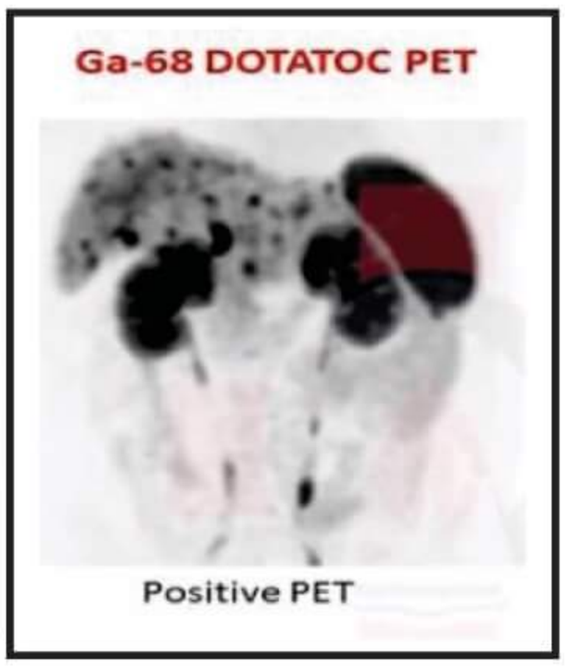
Points to remember:

→ Ga-68 DOTATOC PET / DOTATATE PET = carcinoid tumor

(Somatostatin receptor SPECT can also be done)



PET-negative neuroendocrine tumor in a 59-year-old woman. Unenhanced CT (a) and PET/CT (b) images show a well-circumscribed nodule in the middle lobe (arrow) with no FDG uptake. Results from transthoracic needle biopsy revealed a well-differentiated neuroendocrine tumor (carcinoid).



→ PSMA-PET (Prostate specific membrane antigen) = Prostate cancer

→ NaF PET = Skeletal metastasis

→ C11 methionine PET = Brain tumor

→ DOPA PET = Extra abdominal Pheochromocytoma

RADIOTHERAPY (Part 1)

Mechanism of action of Radiotherapy

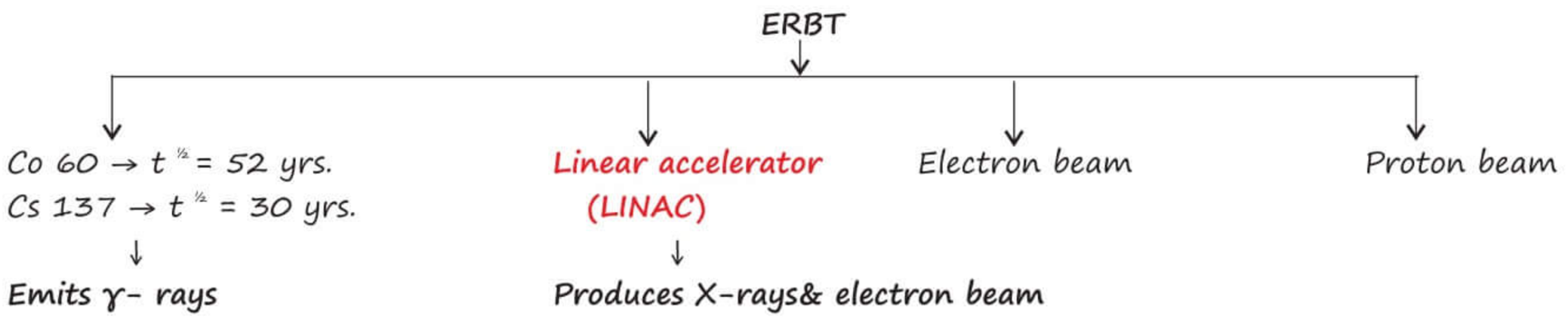
→ **By causing**

- Ionization of molecules (removal of electron)
- Free radical generation
- Ds DNA damage more than ss DNA damage

Types of Radiotherapy

Teletherapy	Brachytherapy	Systemic Radiotherapy
• AKA External BeamRadiotherapy (EBRT) • MC method of Radiotherapy	It can be – Interstitial brachytherapy (as in Prostate Ca) – Intracavitary brachytherapy (as in cervical Ca) – Moldbrachytherapy (as in epithelial cancers or Penile Ca)	• Oral/Injectable form of radioisotope is used • E.g. – I^{131}

Teletherapy



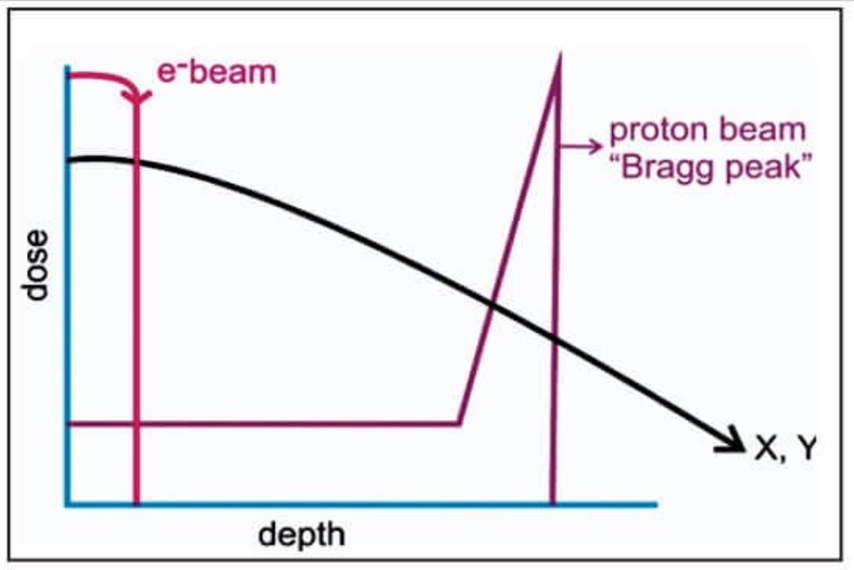
→ Most commonly used rays in Radiotherapy/Teletherapy =X-rays

→ Types of X-rays

Orthovoltage X-rays	Super Voltage X-rays	Megavoltage X rays
• Have energy up to 500 KV	• Have energy of 500-1000 KV	• Have energy > 1 MV • Preferred over orthovoltage because of skin sparing effects

→ **Electron beams (superficial pathologies)**

- Deposits most of its radiation dose in superficial tissues
- Used for Mycosis fungoidis – Total skin electron beam irradiation is done
- Also done for Tumors of eyelids & lips
- It is the most common method preferred for Intraoperative RT



→ **Proton beams**

- Deposits most of its radiation dose deep inside the tissues
- Produces Bragg peak
- Preferred for Deep seated brain tumor

Inverse Square Law

→ Intensity of radiation is inversely proportional to the square of distance

$$\text{Intensity } \alpha \quad \frac{1}{\text{Distance}^2}$$

→ MC side effect of RT – Skin erythema

Intensity Modulated Radiotherapy (IMRT)

→ In this, the intensity is modulated to reach only the tumor site sparing the adjacent normal tissue

→ It is best suited for Prostate cancer

Stereotactic Radiotherapy

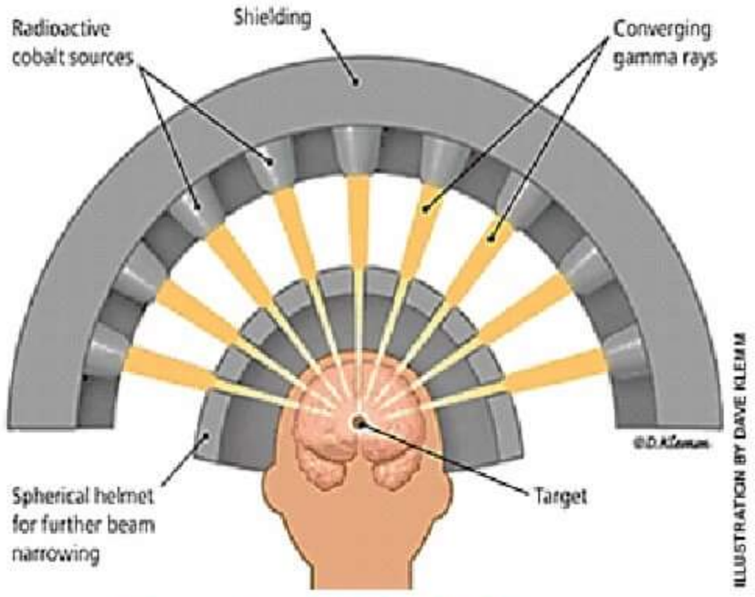
→ In SRT – large dose of radiation is deposited on the tumor in single fraction with high precision

→ It is done by using

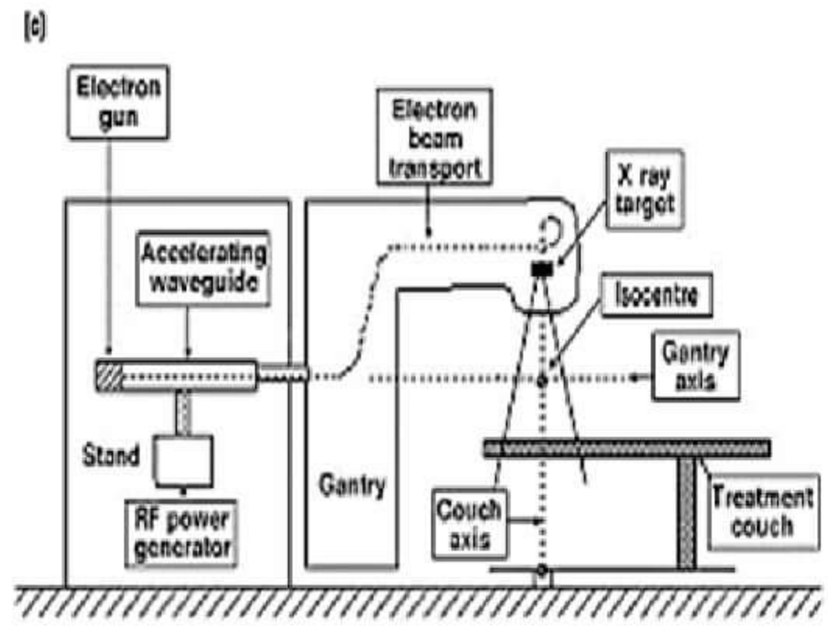
- **Gamma Knife**
  - Uses Co_{60}(emits γ-rays)
  - Uses Leksell frame
- **Cyber Knife**
  - Uses LINAC (emits X rays)
  - Robotic manipulator is used (No Leksell frame)

→ **Uses of stereotactic RT**

- Used in the treatment of
  - Solitary brain metastasis
  - Trigeminal neuralgias
  - AV malformation
  - Meningiomas
  - Schwannomas
  - Pituitary adenoma

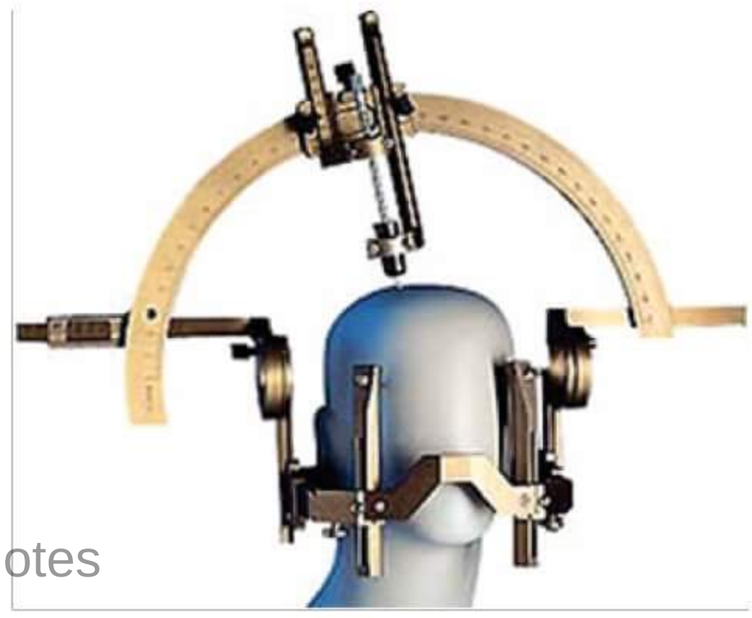


Stereotactic Radiotherapy



LINAC

Cyber Knife robotic system



Leksell frame

Brachytherapy

Permanent Implants	Temporary Implants
• Radio-isotopes with short $t^{1/2}$ are used	• Radio-isotopes with long $t^{1/2}$ are used
• Isotopes used are – Gold – Iodine 125 (t ½- 60 days) – Palladium – Cesium 131 – Yttrium	• Isotopes used are – Radium 226(t ½ = 1622yrs) – Cobalt 60 – Cesium 137

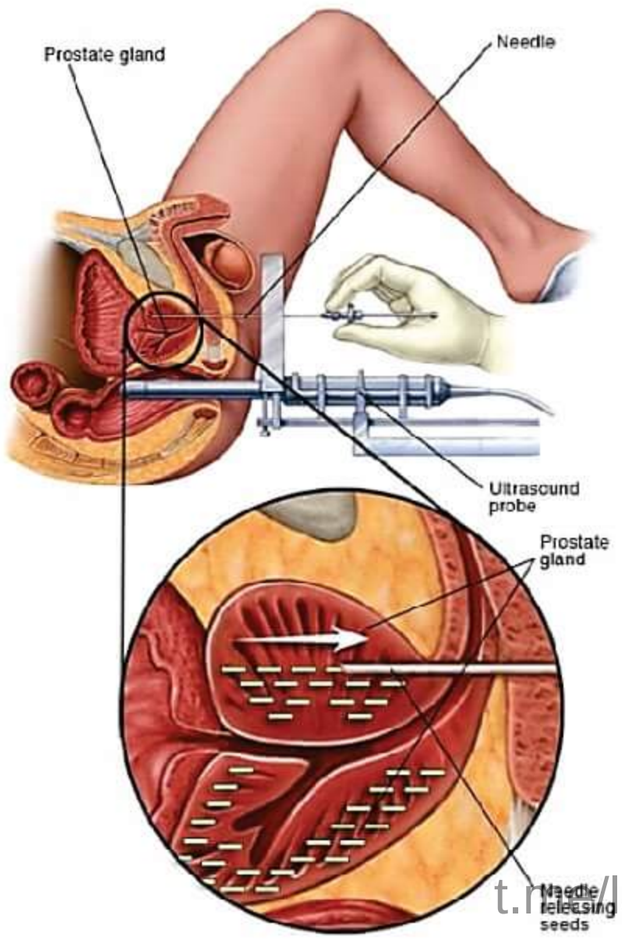
RADIOTHERAPY- PART 2

Remote After loading

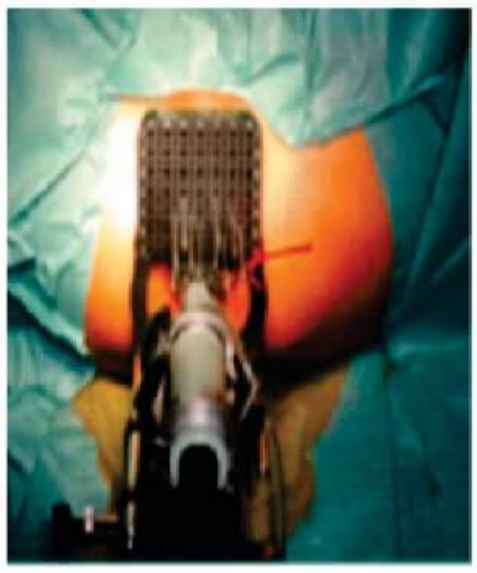
→ It is a technique used to avoid radiation damage to the surgeon and normal tissues of the patient from radiation while inserting radioisotope in the tumor site

→ In this technique empty pellets/catheters are inserted first and are then filled with radioisotopes from reservoir by robotic means

→ This technique is used in **Brachytherapy**



Brachytherapy of Prostate



Remote After loading Technique

Mold Brachytherapy

→ Radioisotopes are kept in contact with epithetical surfaces

Mold Brachytherapy

Systemic Radiotherapy

→ Radioisotopes given orally or injected

I^{131}	Beta And Gamma Emitter	Thyroid Metastasis
P^{32}	Beta emitter	**Polycythemia Vera**
Strontium	Beta emitters	**Bone metastasis**
Samarium	Beta and Gamma Emitter	Bone metastasis

→ **Iodine - 131**

- t ½ = 8 days
- Used in Systematic Radiotherapy for Thyroid metastasis
- Beta & gamma emitter
- Killing of cancer cells is by Beta rays
- Most carcinogenic Radioisotope

Pure Beta - emitters

→ Yttrium
→ Phosphorus
→ Strontium

Radio sensitizers Vs Radio protectors

Radio sensitizers	Radio protectors
• Hyperbaric oxygen (Hypoxic tumors → radio resistant)	• Amifostine - Does not cross BBB
• Metronidazole • Misonidazole	• Pentoxiphylline
• Cisplatin	• IL-1
• 5FU, gemcitabine	• GM-CSF
• Hydroxyurea	

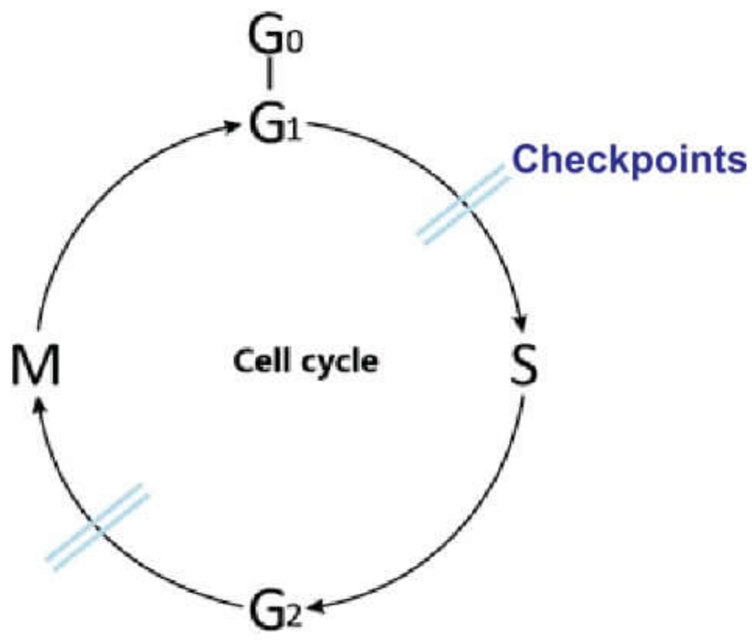
Law of Bergonie

→ This law states that

- Undifferentiated cells (cells with high mitotic activity) are – Radiosensitive
- Quiescent well differentiated cells are –Radioresistant

Radiosensitive	Radioresistant
• Nephroblastoma (AKA Wilm's tumor) • Medulloblastoma • Pinealoblastoma • Ewing's sarcoma • Lymphoma • Myeloma • Seminoma / Dysgerminoma	• Nervous tissue • Stratified squamous epithelial cells of vagina

Cell cycle



→ The checkpoints of cell cycle are controlled by –p53 gene
→ Three proteins work in coordination with p53 gene
- **p21** – Arrest cell cycle
- **GADD 45** – DNA repair gene
- **BAX** – Apoptotic gene

→ When Radiotherapy is given it causes extensive DNA damage that can't be repaired by **GADD 45**and undergoes apoptosis by activation of **BAX gene**
→ If a tumor is associated with **p53 mutation (Li Fraumeni syndrome)** – it becomes Radioresistant

→ Radiotherapy at G1 Phase causes – Chromosomal damage
→ Radiotherapy at G2 Phase – Chromatid damage

→ Most radiosensitive phase of cell cycle – G_2M phase > M phase
→ Most radio resistant phase – Late S phase

→ Most radio sensitive tissue – Bone marrow/Gonads
→ Most radio resistant tissue – Nervous tissue

→ Most radio resistant organ – Vagina

→ Most radio sensitive Blood cell – Lymphocyte
→Most radio resistant blood cell – Platelet

Craniospinal irradiation

→ It is done in
- Medulloblastoma – **Prophylactic Craniospinal irradiation** is done because of its drop metastases
- Pinealoblastoma
- Non-Hodgkin's lymphoma
- ALL
- Small cell Ca

→MC hormone deficient after Craniospinal irradiation – GH Deficiency

Important points to know

→ MC thyroid cancer that develops after head and neck radiation - Papillary Carcinoma of Thyroid

→ **Papillary Ca of Thyroid has**

- Psammoma bodies
- Orphan Annie nuclei
- Associated with Thyroglossal duct

→ Thyroid cancer that develops in a case of long-standing goiter – Follicular carcinoma of Thyroid

→ **Follicular carcinoma of Thyroid has**

- Hematogenous spread
- Hurtle cells
- FNAC cannot be used to differentiate Benign follicular adenoma from Follicular carcinoma of Thyroid

→ Dose of RT that is deposited in treatment of bone metastasis - 8 Gy in single fraction (has longer period of pain relief)

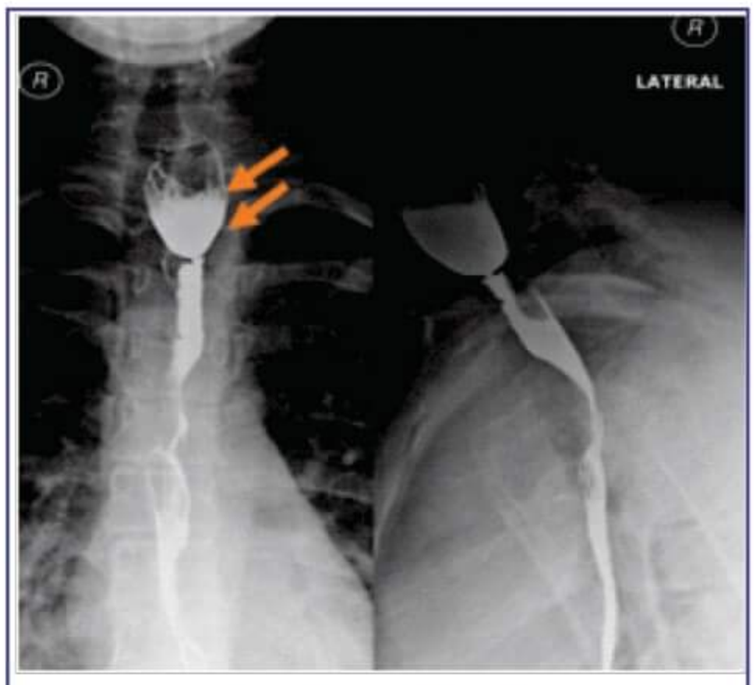
GASTRO INTESTINAL RADIOLOGY –I

Esophageal webs:

→ Seen associated with **Patterson Kelly Syndrome / Plummer-Vinson Syndrome**

→ Webs are present in upper part of esophagus

→ Shows proximal pooling of barium on barium swallow



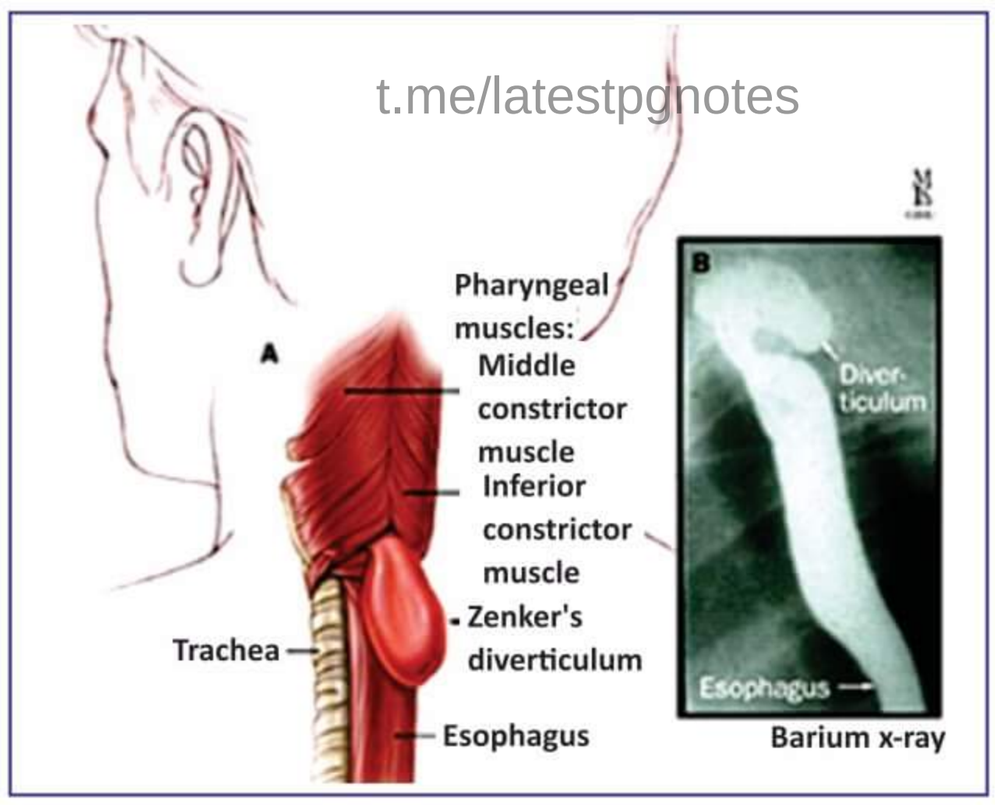
Esophageal webs

Zenker's diverticulum

→ False diverticulum– since only mucosa is out pouching

→ It is a posterior midline out pouching

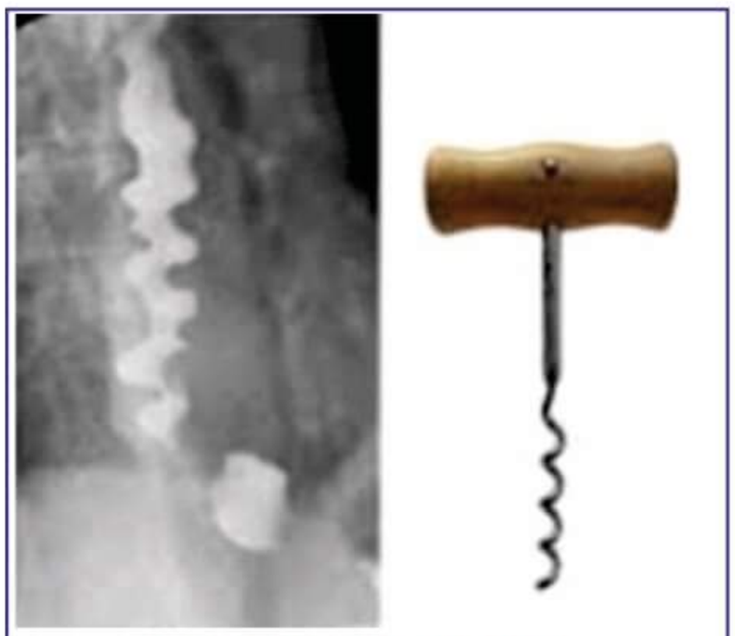
→ IOC is Barium swallow



Barium x-ray

Diffuse esophageal spasm:

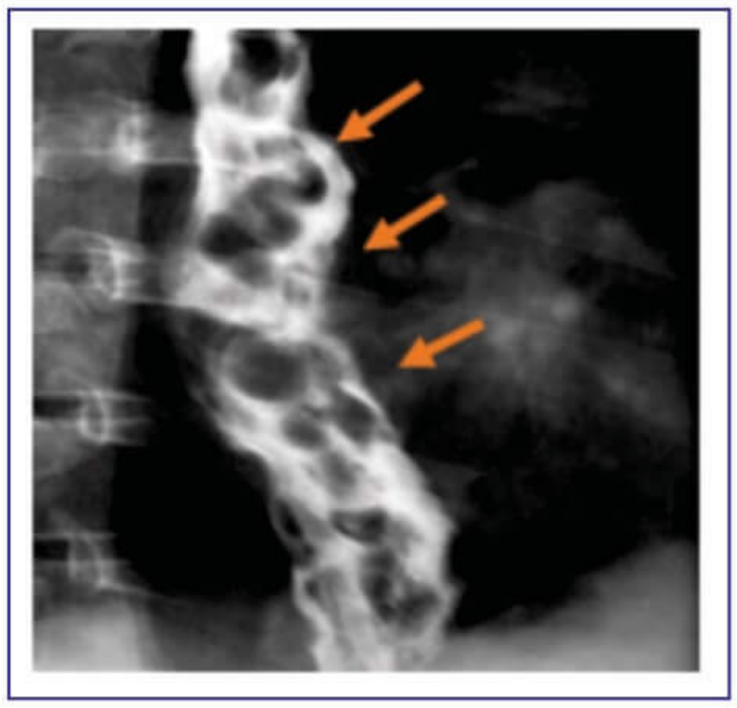
→ Gives **cork screw appearance** of esophagus on barium swallow



Cork screw esophagus

Esophageal varices:

→ Gives **serpentine / worm like filling defects** on barium swallow

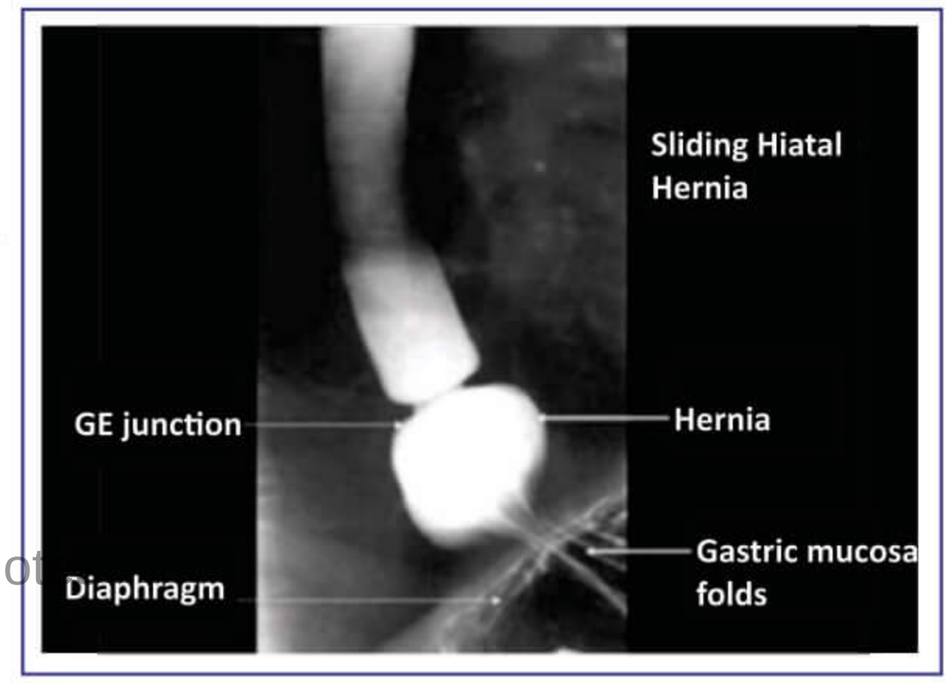


Hiatus hernia

→ AKA sliding hernia

→ Herniation of a part of stomach into thorax through diaphragmatic opening is known as hiatus hernia

→ IOC is barium swallow

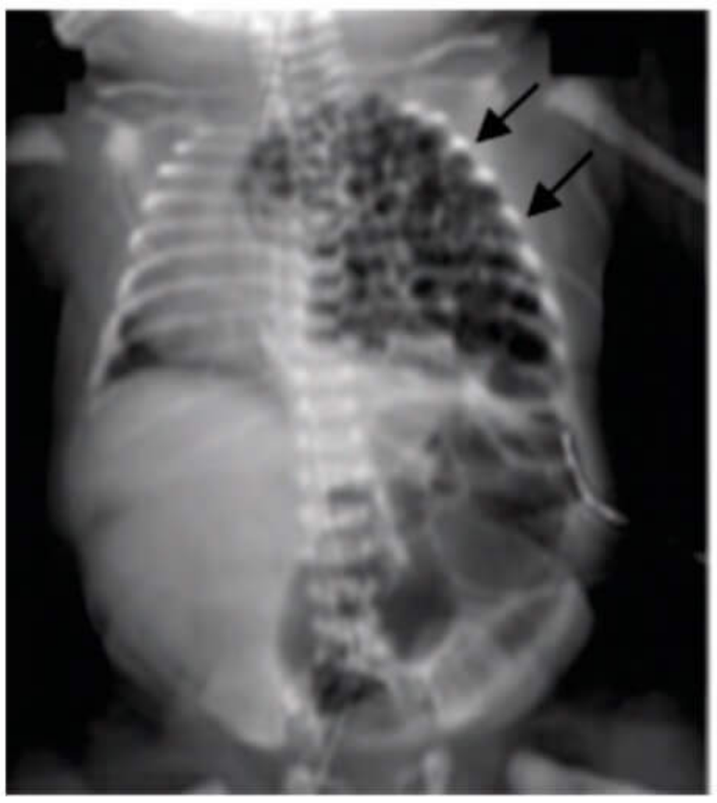


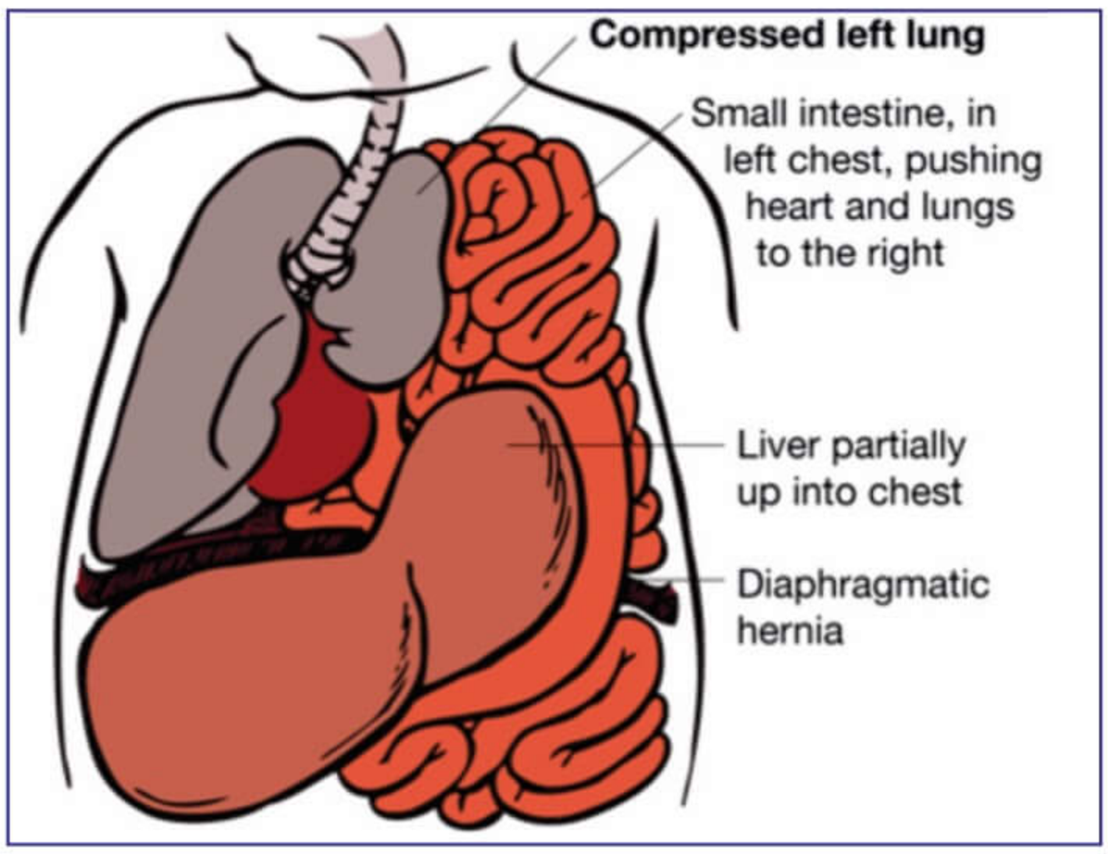
Congenital Diaphragmatic hernia:

→ It is a defect in pleuroperitoneal membrane

→ 2 types:

1. **Bochdaleck hernia (M/C)** – Left posterolateral defect
2. **Morgagni hernia** – Right anteromedial defect

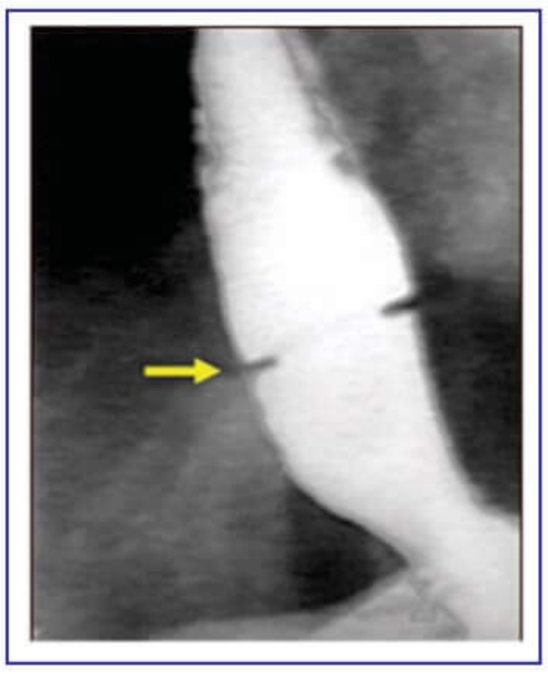




→ **In a chest radiograph** – multiple dilated bubble loops can be seen

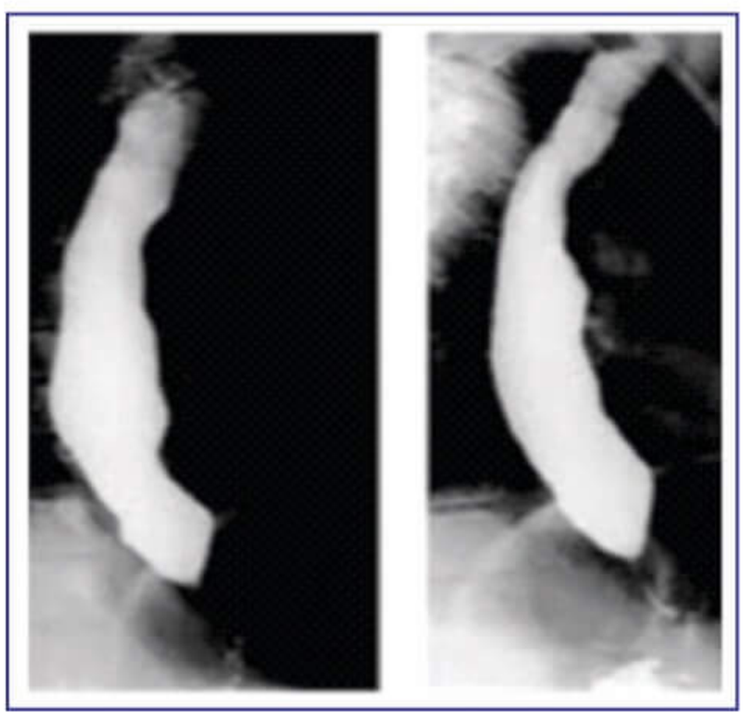
Schatzki's Ring:

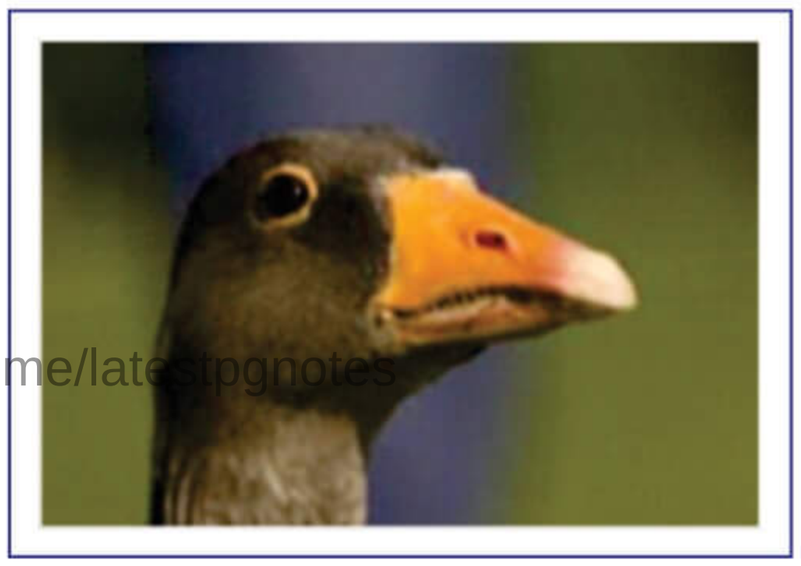
→ Mucosal ring in lower end of esophagus



Achalasia Cardia:

→ Barium swallow shows bird beak or rat tail appearance





Note: Rat tail appearance with shouldering is seen in esophageal Ca

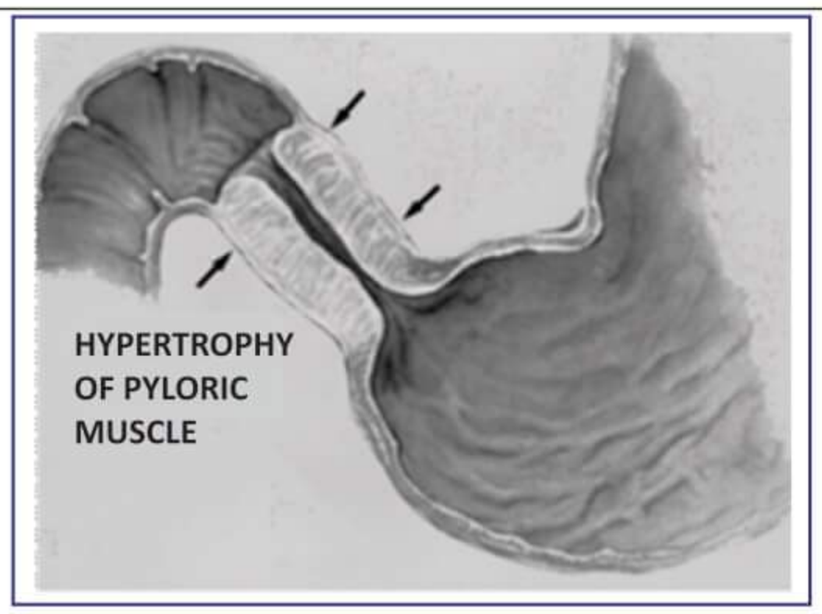
Scleroderma:

→ Shows dilated aperistaltic patulous appearance of esophagus on barium swallow

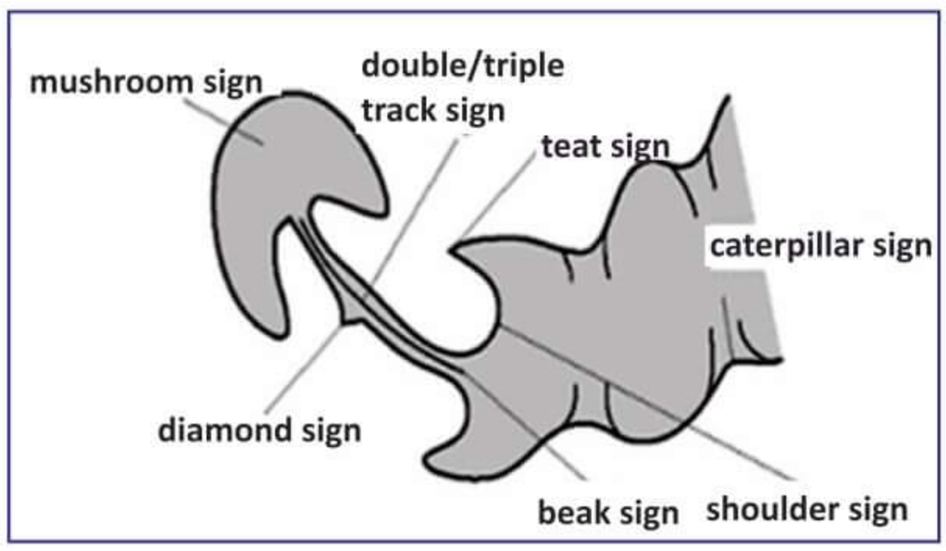
→ Has soft tissue calcinosis in hand

Congenital hypertrophic pyloric stenosis:

→ MC in 1st born male child
→ Presents with non-bilious vomiting, at 3-12 weeks of age
→ Classical feature is metabolic alkalosis with paradoxical aciduria
→ IOC is USG
→ In USG
- Target sign
- Cervix sign → Indentation of muscle mass on fluid filled antrum
- Antral nipple sign → Redundant pyloric canal mucosa protruding into gastric antrum

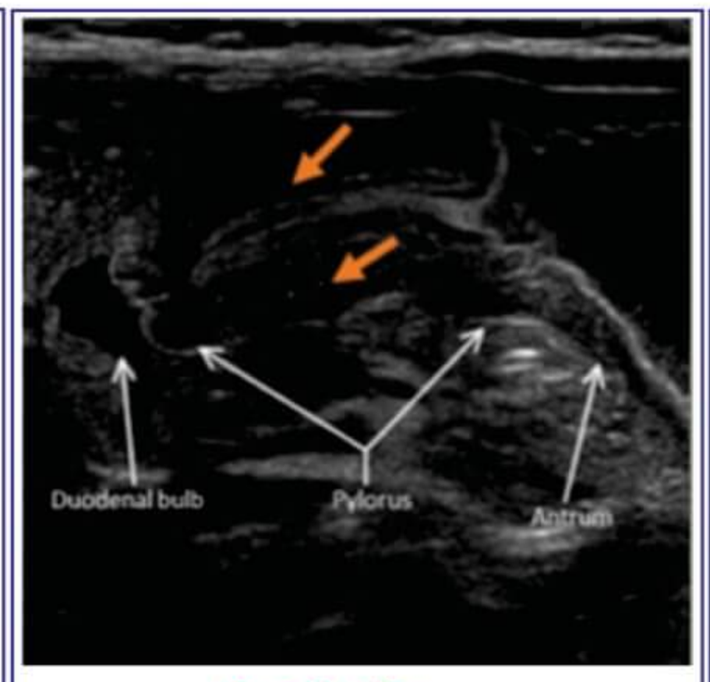


→ Has Pyloric Ms. wall thickness > 3 mm
Pyloric length > 16mm
→ On barium study
- String sign
- Diamond / twinning sign
- Mushroom sign
- Double track sign
- Caterpillar sign- because of gastric hyperperistalsis



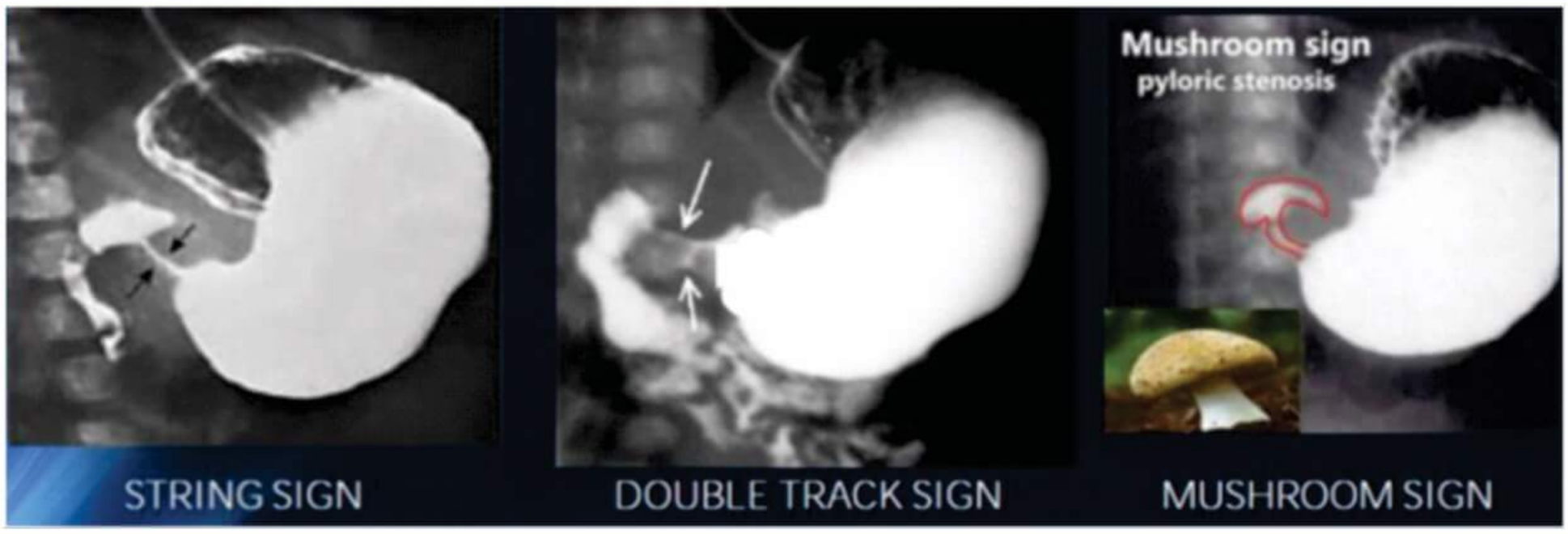
→ **In CHPS** = because of continuous vomiting & gastric hyperperistalsis there will be ↓sed gastric residue.


Target sign



Cervix sign

Antral nipple sign



Note:

In abdominal X-ray

→ Single bubble appearance = CHPS

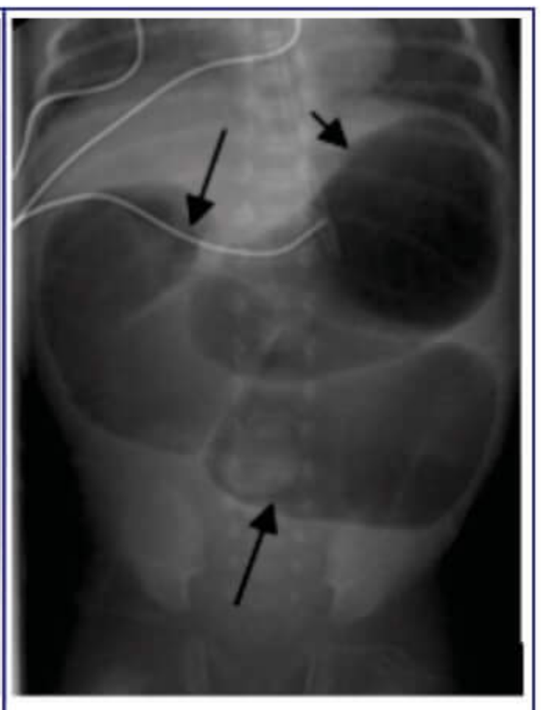
→ Double bubble appearance = Duodenal atresia

→ Triple bubble appearance = Jejunal atresia

→ Multiple air fluid levels = Ileal atresia

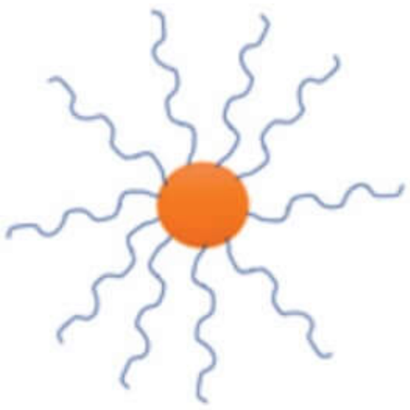
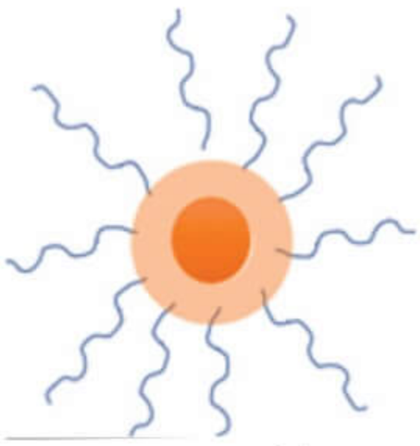
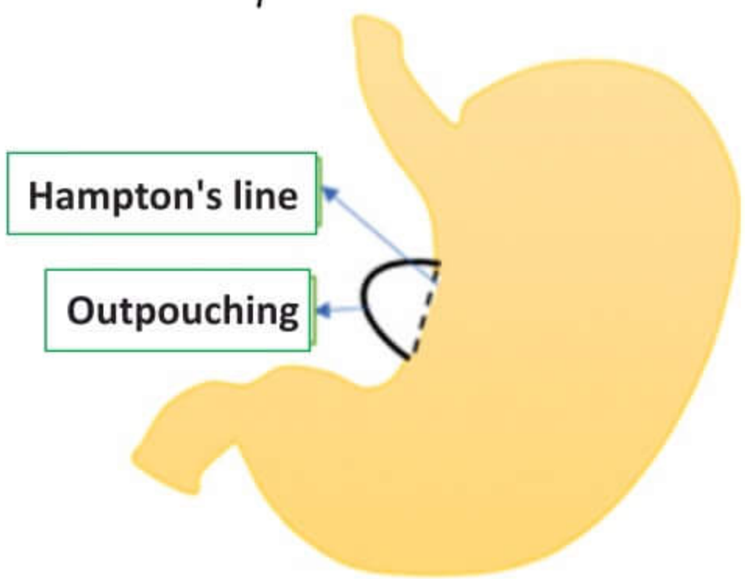
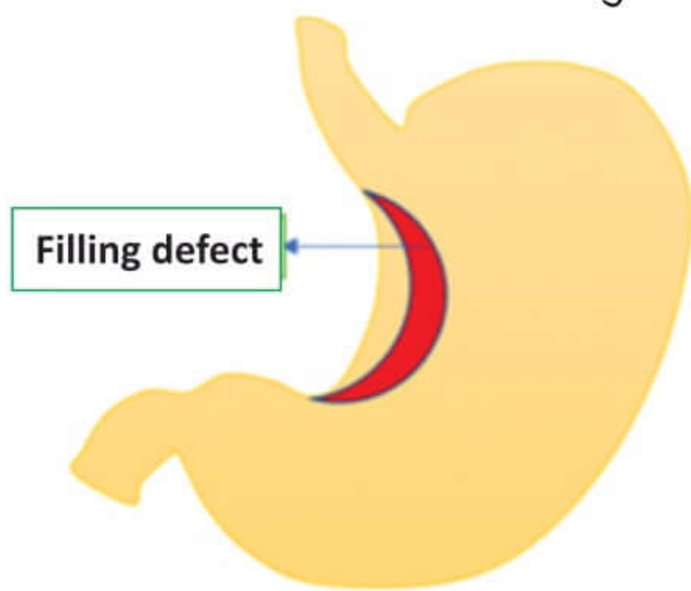
CHPS

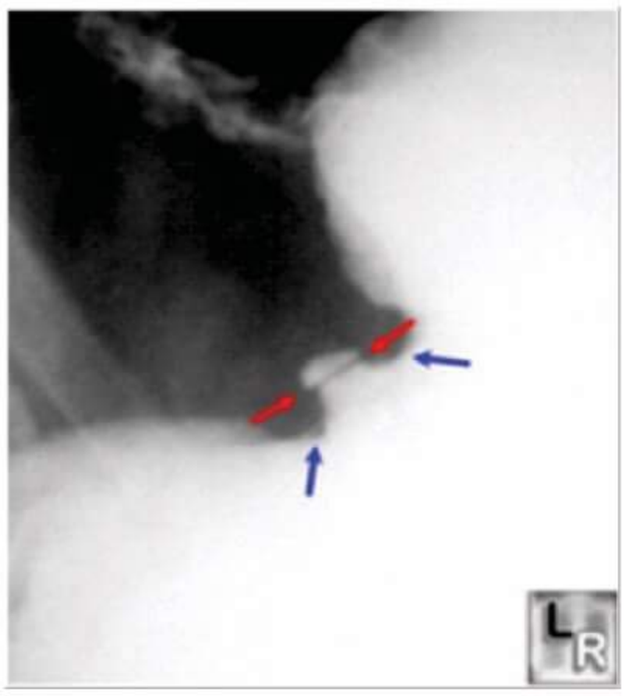
Duodenal atresia



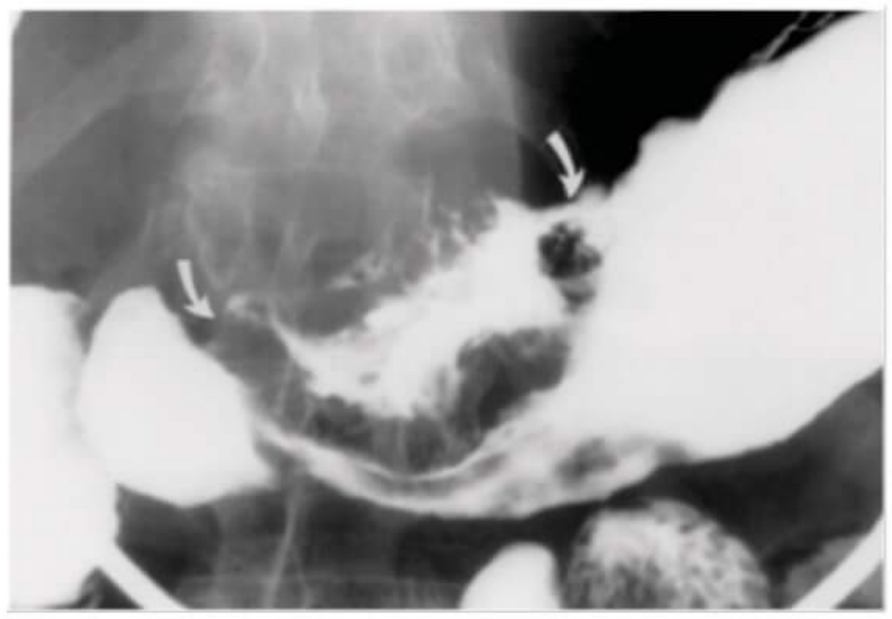
Jejunal atresia

GASTRIC ULCERS

Benign	Malignant
	
* Mucosal rugae extend up to ulcer base	* Has aggressive infiltrated mass around ulcer * Rugae stops & don't reach ulcer base
On Barium meal: → Shows Hampton line ulcer collar	**On barium meal:** → shows carmen meniscus sign
	



Hampton's Line



Carmen meniscus sign

Pneumoperitoneum:

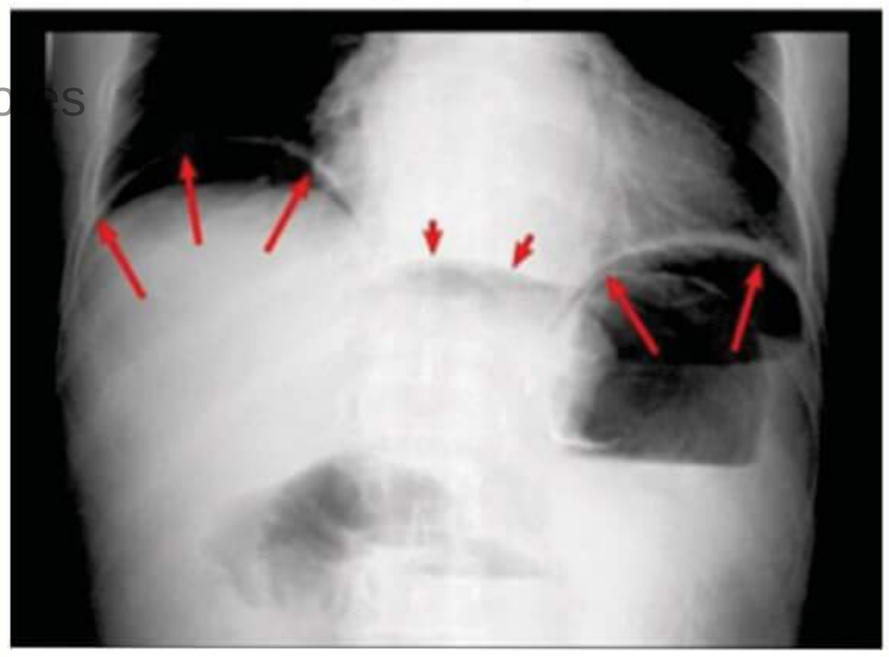
→ IOC is CT-scan (shows air anterior to liver)

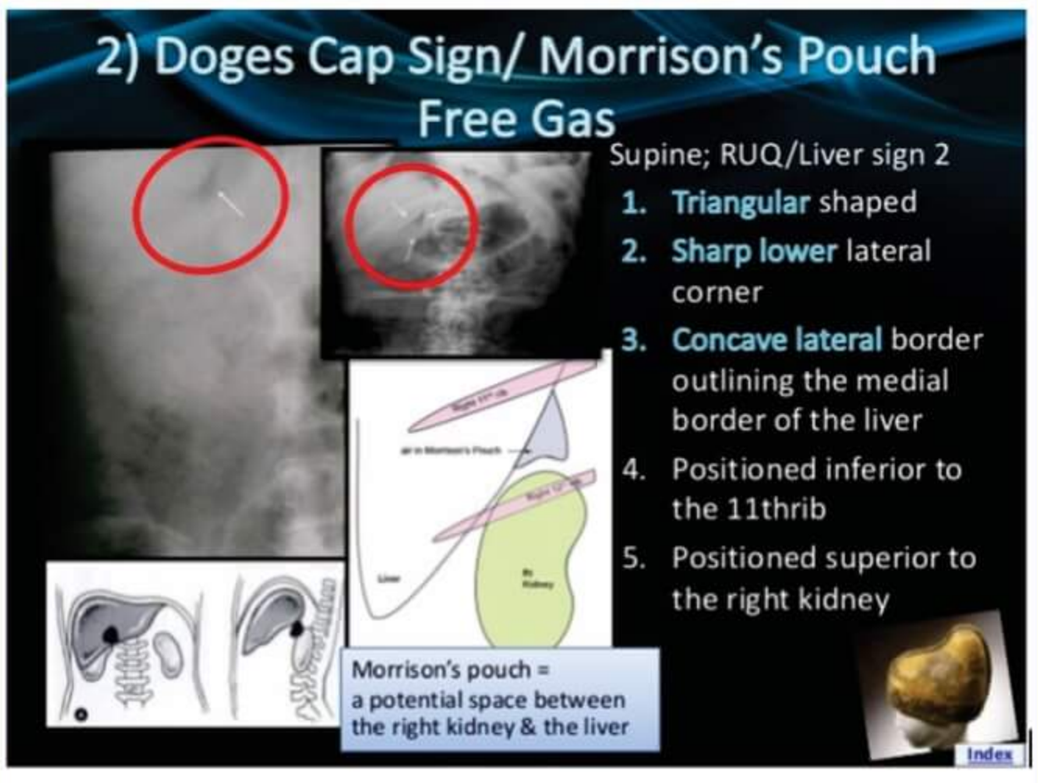
→ Best x-ray view – Chest x-ray erect

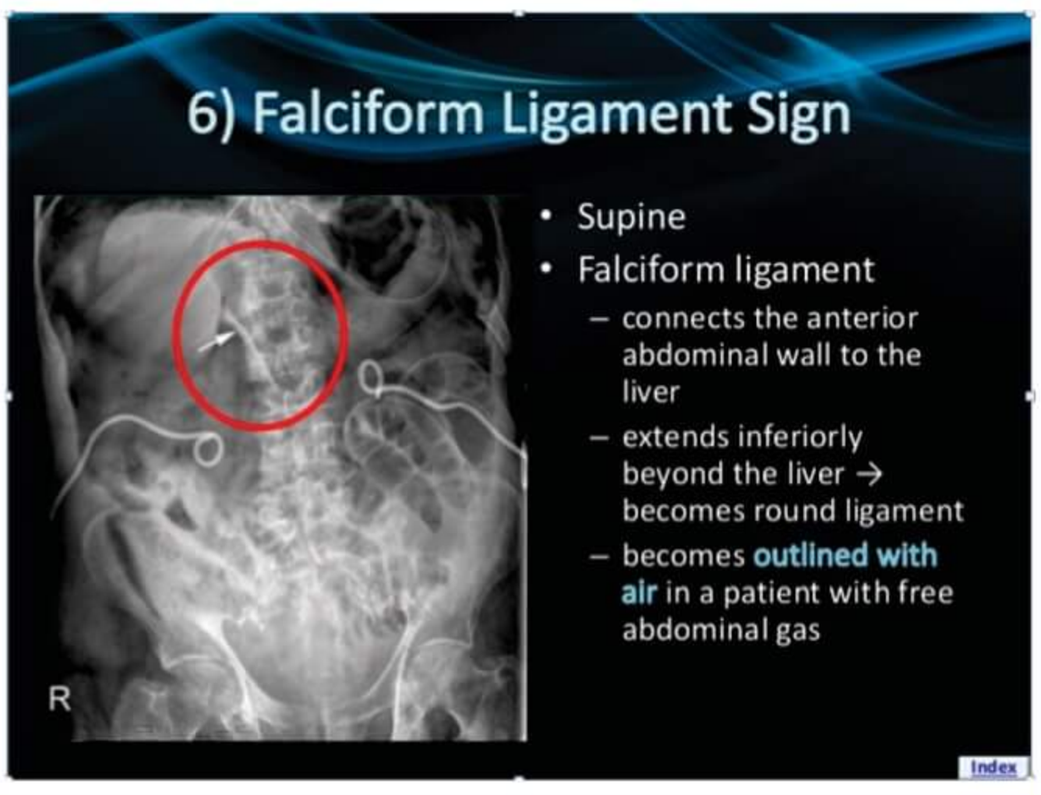
On radiography:

1. Cupola sign: air under central tendon of diaphragm
2. Doges cap sign: free air in Morrison's pouch
3. Falciform ligament sign:
   - Because of free air in abdomen all ligaments stand
   - out clearly
   - Falciform ligament sign / ligament teres sign /
   - lateral umbilical ligament / inverted V sign /
   - median umbilical ligaments / urachus sign
4. Football sign:
5. Rigler's sign: air on either side of bowel wall
6. Tell-e-tale triangle sign: Triangular air lucency

Cupola sign







7) The Football Sign

- massively air-filled peritoneum

L

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4) Rigler's Sign

R

- Supine
- Bowel wall **outlined by intraluminal & extraluminal air** (extraluminal = free peritoneal gas)
- **Both sides** of bowel wall can be seen (red arrows)

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12) The Triangle Sign

- small triangles of free gas positioned between the large bowel and the flank

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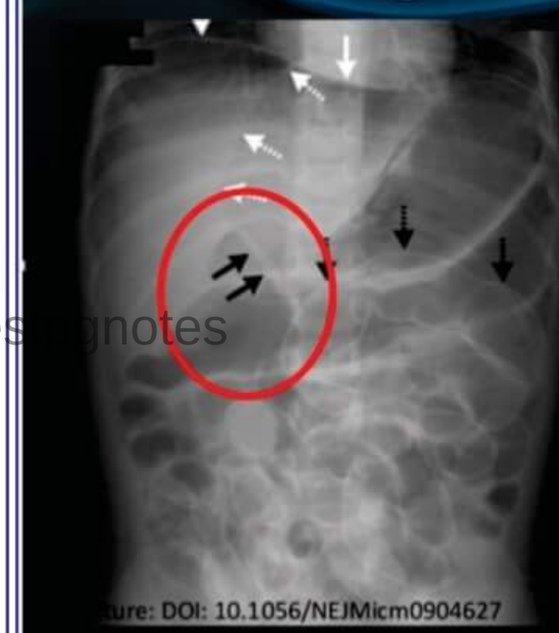
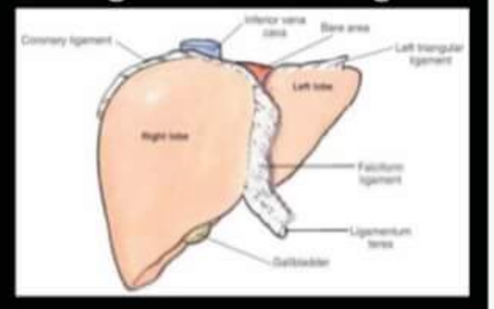
Others: Ligamentum Teres Sign



- Extraluminal air in the fissure for the Ligamentum Teres
- Linear density running along the inferior edge of



ture: DOI: 10.1056/NEJMicm0904627

Emerg Med J 2011;28:728 doi:10.1136/emj.2010.098699

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Others: The "Inverted V" Sign

- Supine
- Free air outlining the **lateral umbilical ligaments**, coursing inferiorly and laterally from the umbilicus
  - Infants: umbilical arteries
  - Adults: inferior epigastric vessels

http://dx.doi.org/10.1148/radiology.151.1.6230689

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Others: Urachus Sign

- Air contrasted urachus
- Vertical line between bladder and umbilicus
- Outline of medial umbilical ligament

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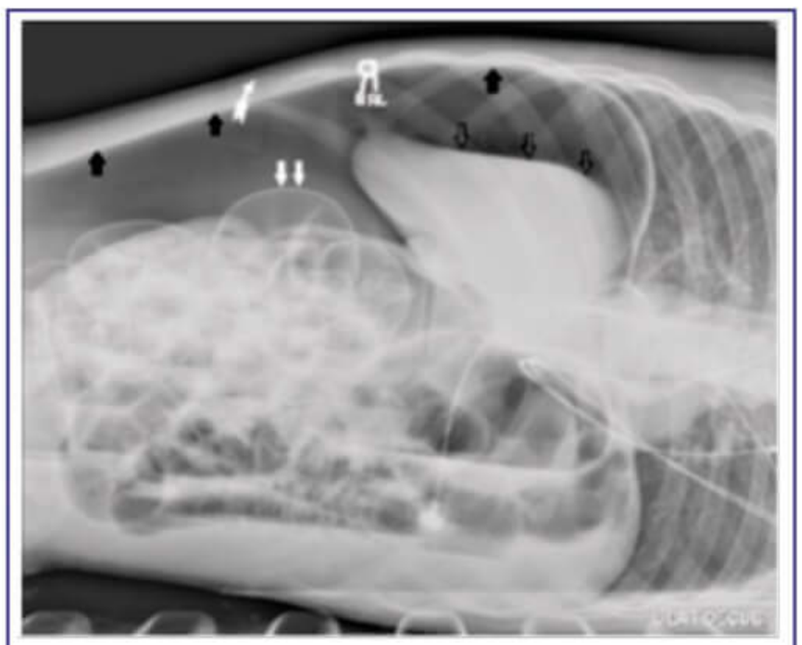
→ 2nd best x-ray view for pneumoperitoneum = left lateral decubitus



Pneumoperitoneum -left lateral decubitus view

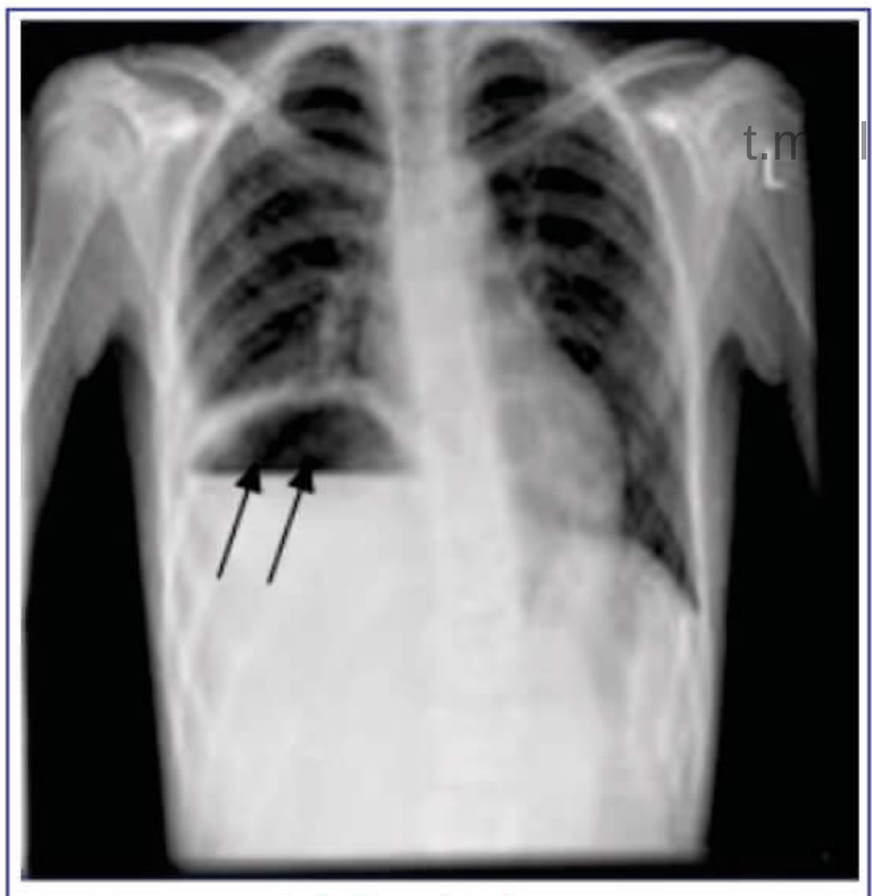
Pseudo pneumoperitoneum:

→ Chilaiditi sign: A normal variant → a part of bowel interposed between right dome of diaphragm & liver

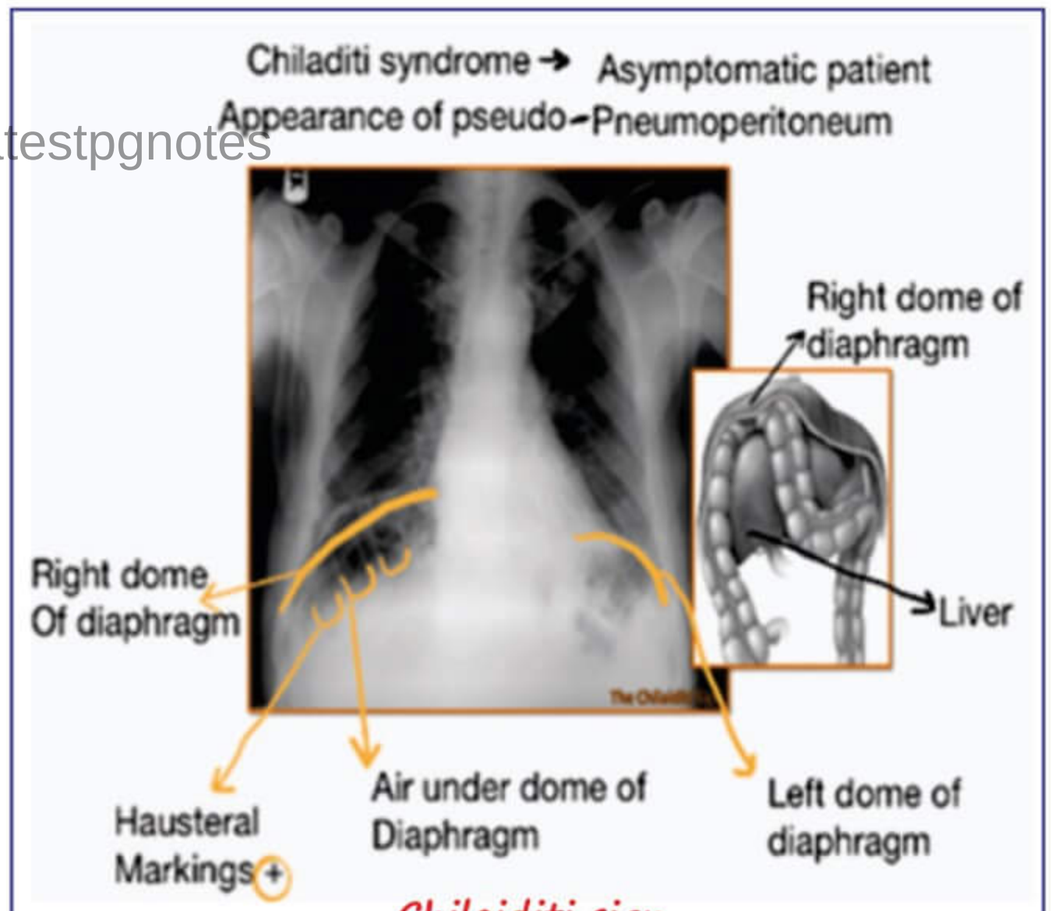
→ Subphrenic abscess

→ Subpulmonic pneumothorax

→ Basal atelectasis



Subphrenic abscess



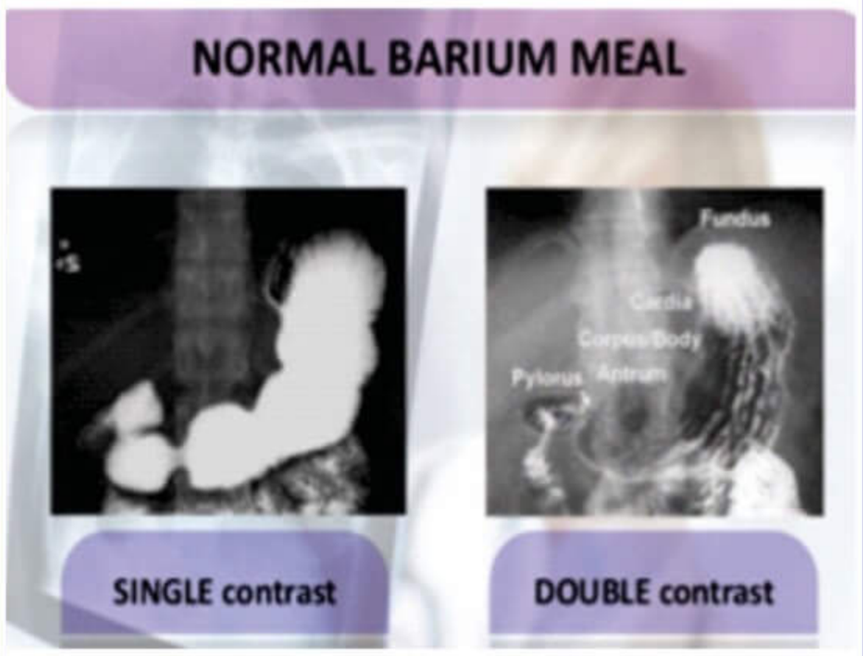
Chilaiditi sign

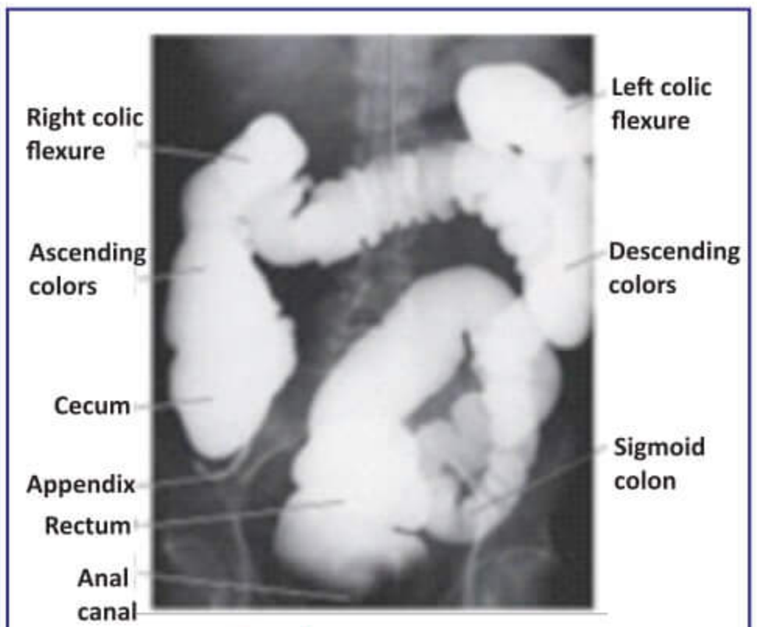
GASTRO INTESTINAL RADIOLOGY – II

Barium Study:

→ Barium swallow – Oesophagus
→ Barium meal – Stomach & duodenum
→ Barium meal follow through – Small intestine
→ Barium enema – Large intestine

Barium Meal





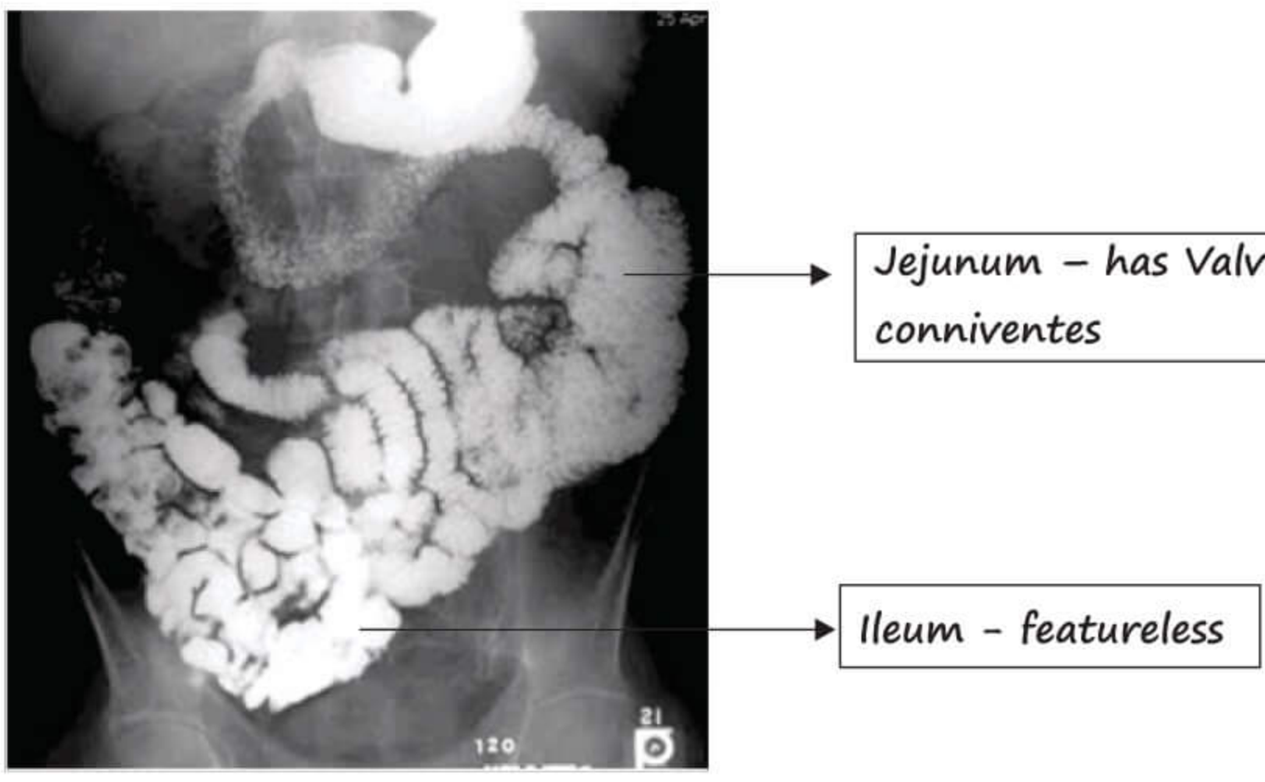
Barium enema

→ **Barium meal – 2 types**

1. Single contrast – only barium given
2. Double contrast – barium & air given (better)

→ **On Barium meal follow through**

- Jejunum – has Valvulae conniventes
- Ileum – featureless



Barium meal follow through

Enteroclysis

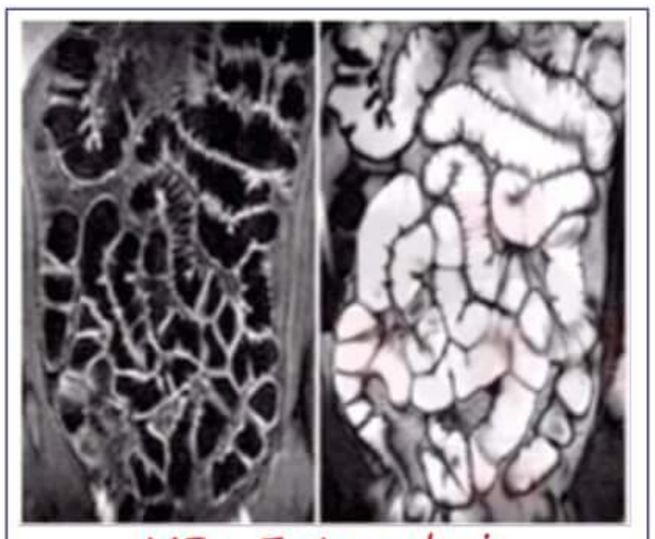
→ Through NJ tube, barium is given directly to stomach &X-ray taken

→ If CT used **CT- enteroclysis**

→ Double contrast is used ($BaSo_4$ & Methylcellulose)

→ If MRI used and fluid in bowel provides the MR signal- **MR-enteroclysis**

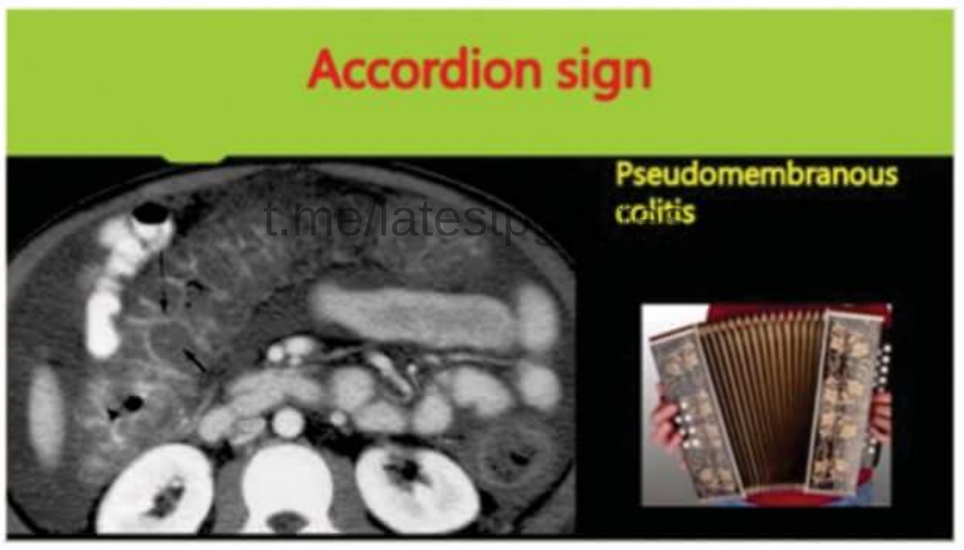
CT-Enteroclysis



MR- Enteroclysis

Pseudomembranous colitis

→ **Accordion sign** – Thick edematous mucosal wall seen in Pseudomembranous colitis and other nonspecific colitis, ischemic colitis



Ascariasis:

Multiple linear lucencies

Medusa head appearance on USG

Shark mouth ileocecal valve:

→ Normal appearance of ileocecal valve in colonoscopy

Shark mouth appearance

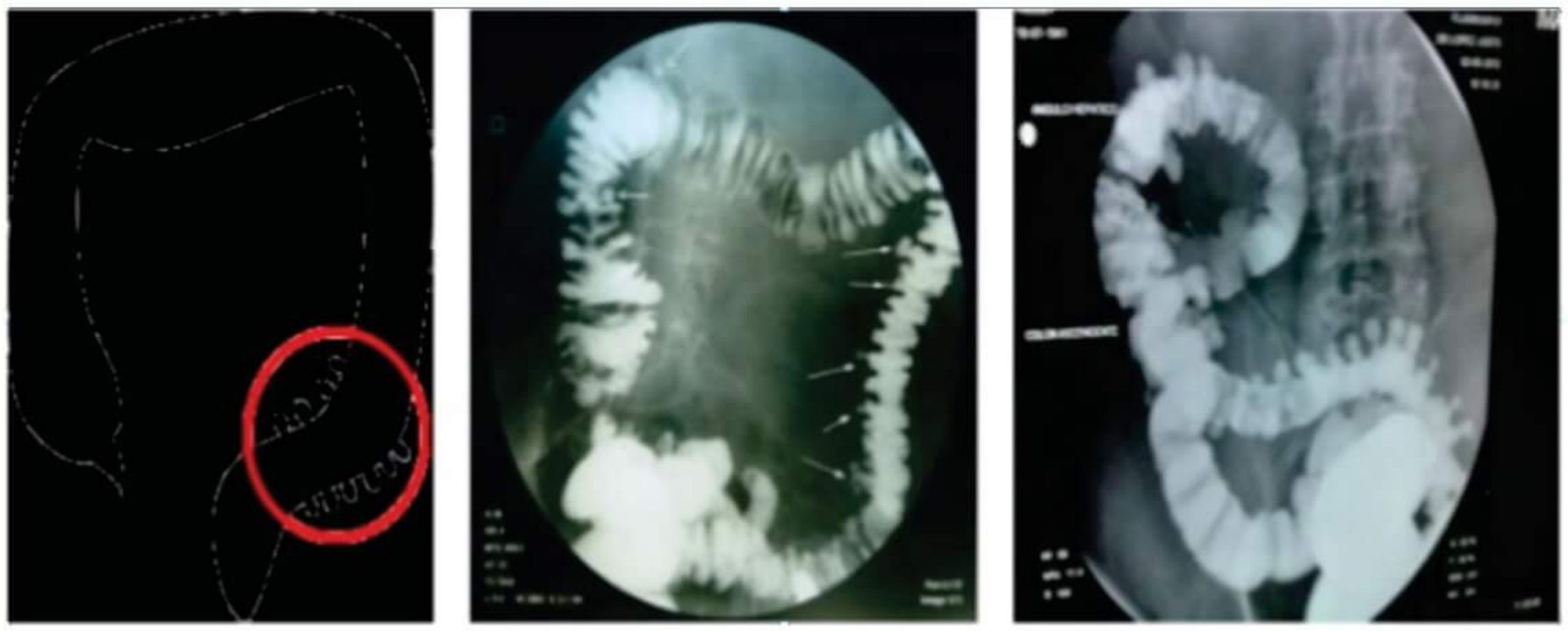
Diverticulosis:

→ Has multiple outpouching on mesenteric side

→ M/C site is sigmoid colon

→ IOC for diverticulosis is **barium enema (Saw tooth appearance)**

→ IOC for diverticulitis is **CECT**



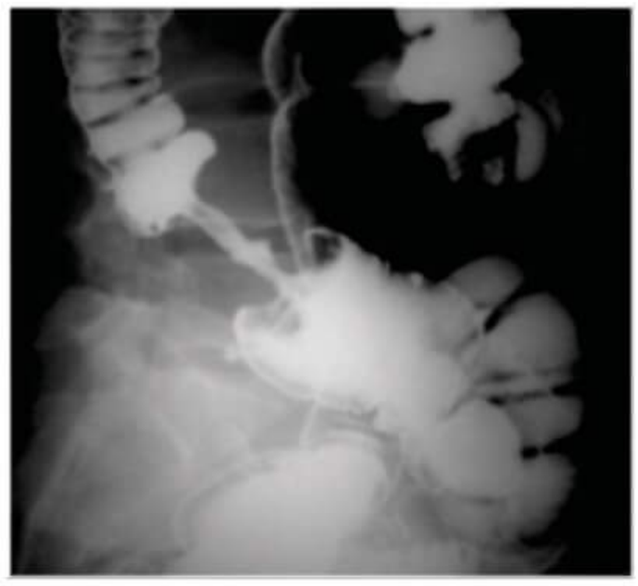
Saw tooth appearance

NOTE:

→ Pseudo sacculation in Crohn's disease & Meckel's diverticulum occurs in anti-mesenteric side

→ Barium is C/I in suspected bowel perforation - causes peritonitis

Colon Cancer



Apple core lesion

Sigmoid volvulus:

- In X-ray coffee → bean sign
- In barium enema → Bird beak / bird of prey sign
- No Haustrations

(X-ray) coffee bean sign

Bird beak / bird of prey sign

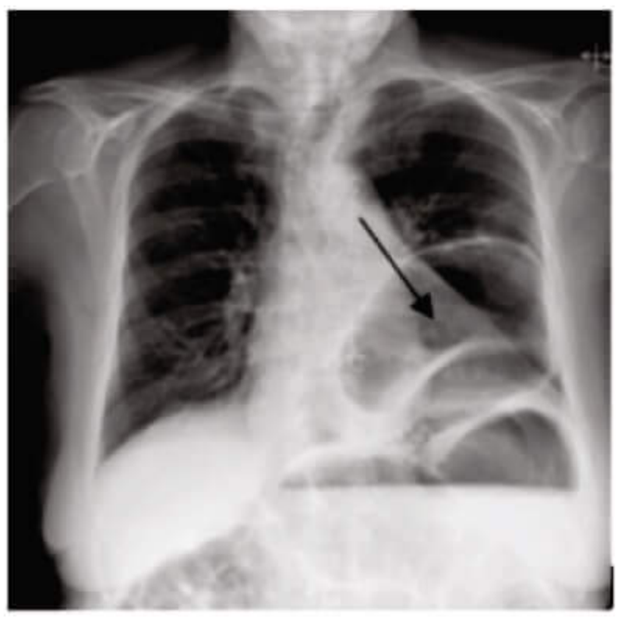
Cecal volvulus:

- In X-ray coffee bean sign
- Haustrations can be seen

X-ray → coffee bean sign

Gastric volvulus:

- In X-ray → coffee bean sign (located in epigastric area)

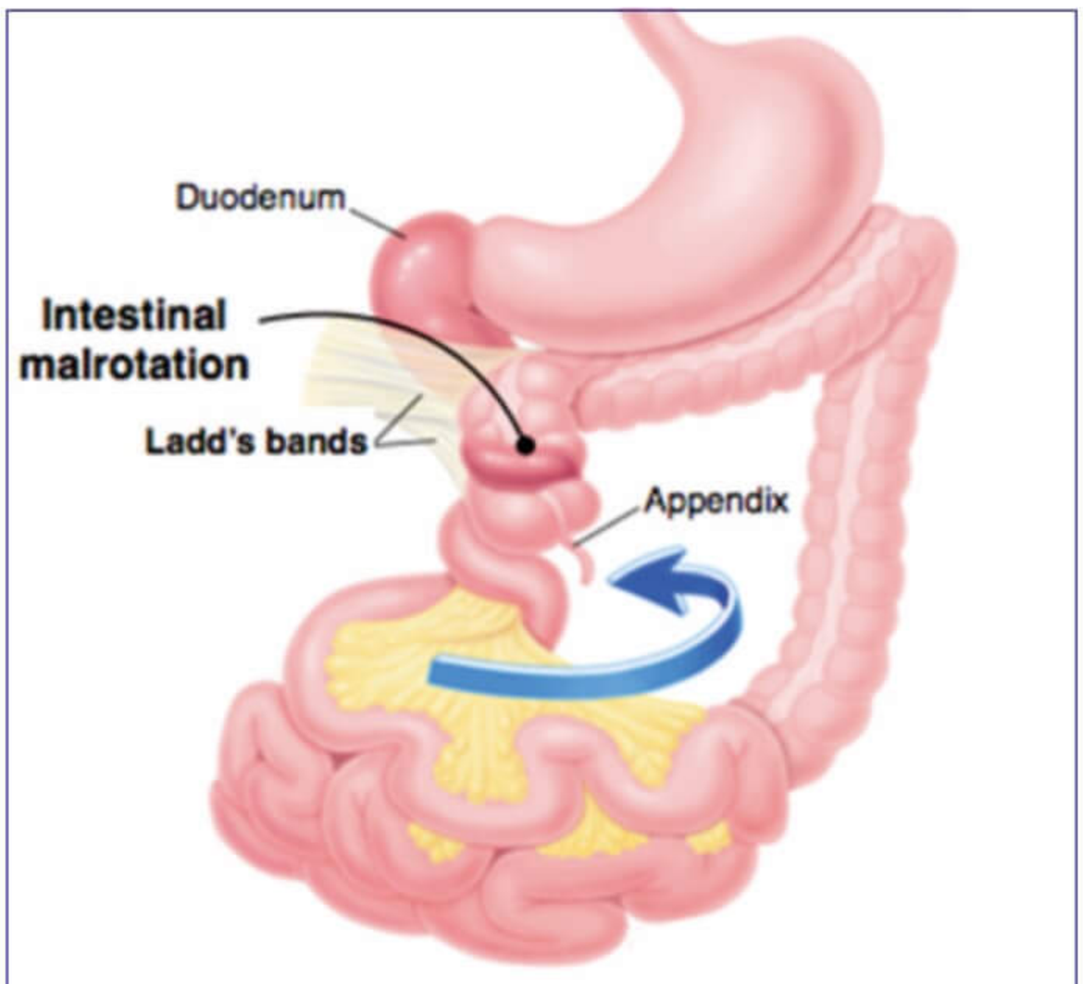


X-ray → coffee bean sign

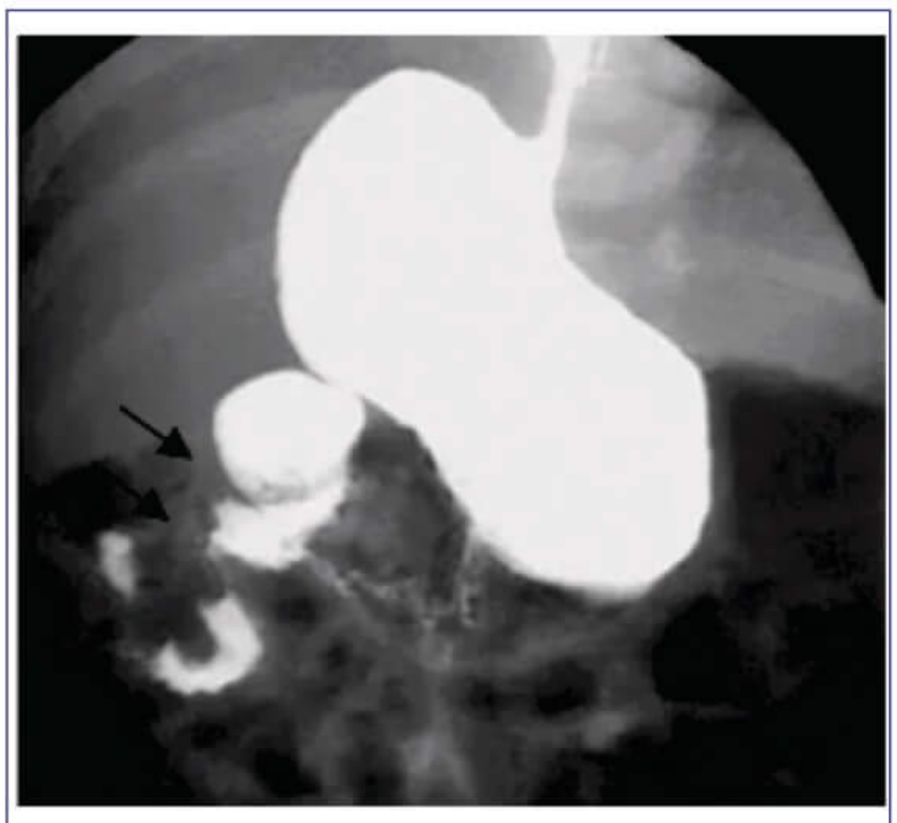
Midget volvulus:

- Corkscrew appearance of small intestinal loops (all small intestine loops are present on right side) on barium study– **Corkscrew sign**
- On USG or CT- shows **whirlpool sign**

Clinical	Ass. Congenital defects	Management
• bilious vomiting (rarely non-bilious) • Hemodynamic instability • Abdominal distention	• Congenital diaphragmatic hernia • Congenital heart disease • Omphalocele	Surgical (LADD procedure)



Intestinal malrotation with midgut volvulus



Corkscrew sign

Whirlpool sign on USG

Whirlpool sign on CT

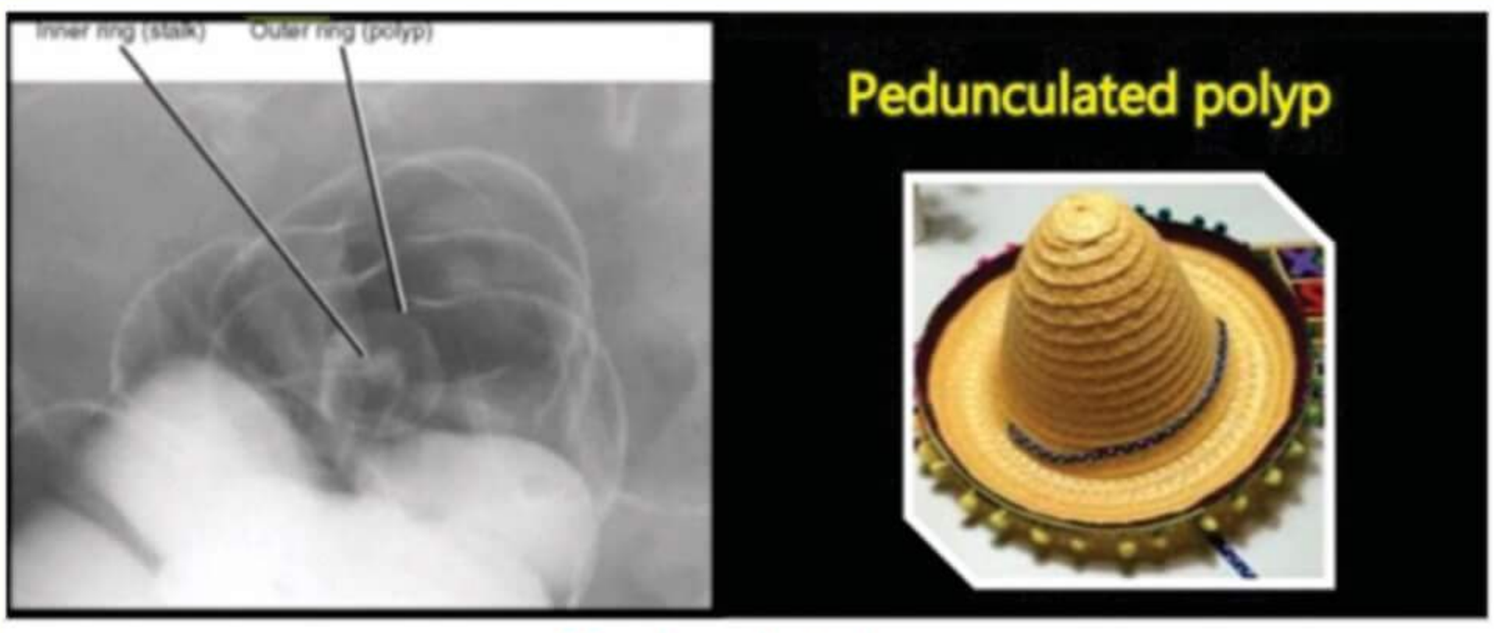
Sessile colonic polyp:

→ Bowler hat sign – Cup shaped filling defect seen in air contrast barium enema that represents polyp if it points toward lumen

Bowler hat sign

Pedunculated polyp:

→ Mexican hat sign – has an inner ring of outer ring.

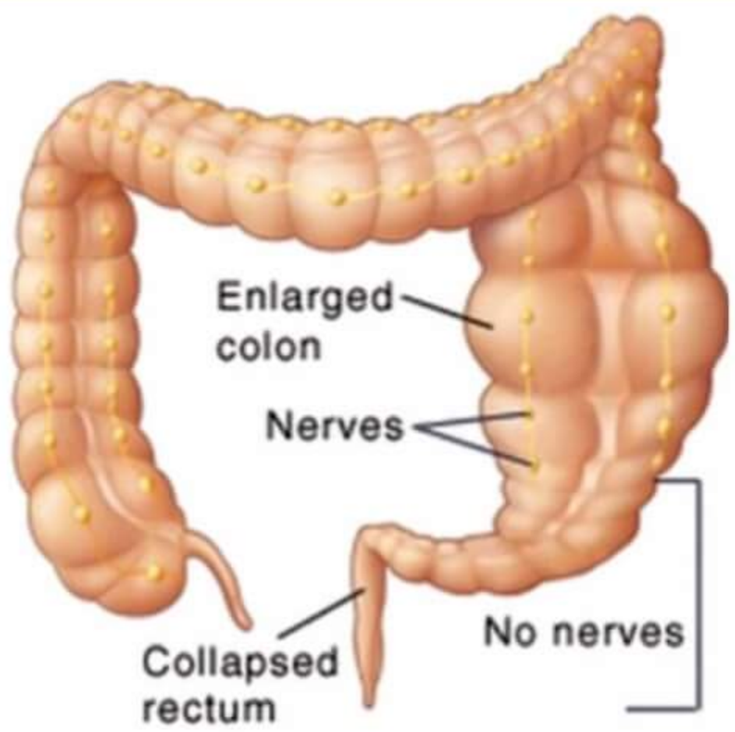


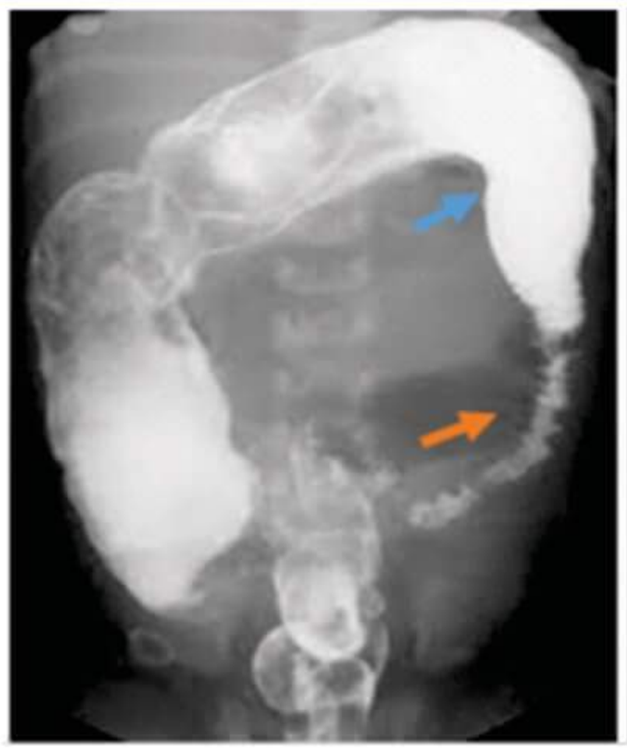
Mexican hat sign

Hirschsprung disease:

→ Failure of migration of ganglions to distal part of colon

→ AKA colonic aganglionosis





Distended port is normal

Constricted part is abnormal

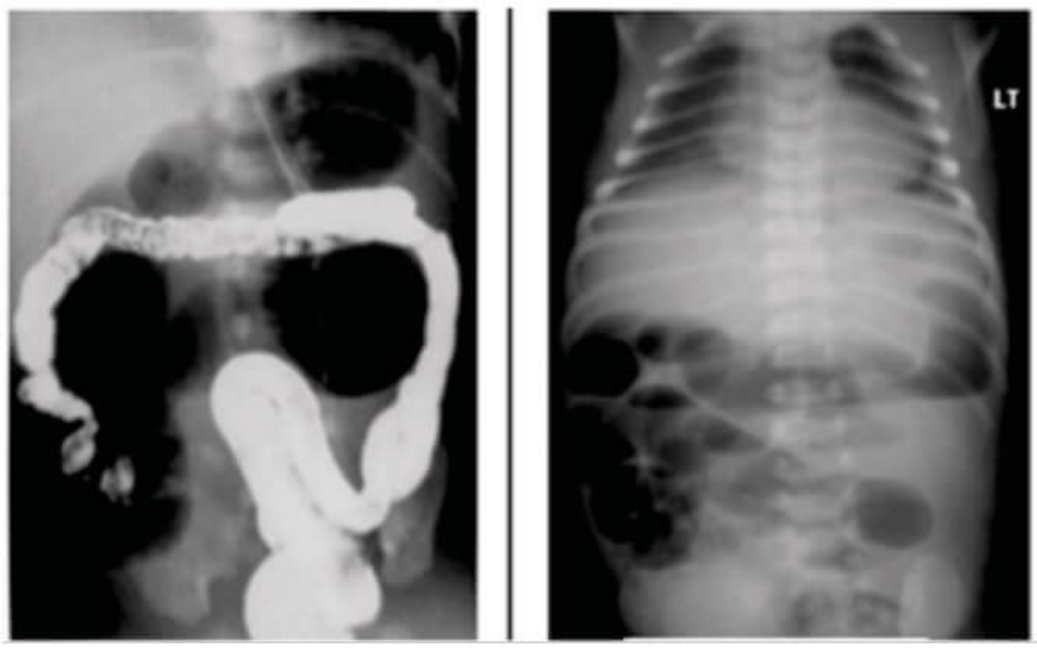
Small bowel Vs large bowel obstruction:

SBO	LBO
→ Dlated central bowel loop	→ Dilated peripheral bowel loop
→ Diameter of distension-35 cm	→ Diameter of distension >5 cm
 * Has step ladder pattern * Has string of beads sign * In jejunal obstruction - Valvulae conniventes plica circularis 	 * Solid feces sign * Haustral folds

Ileal atresia:

→ **On barium enema**

- Microcolon
- Apple peel appearance
- Multiple air fluid levels



Microcolon Multiple air fluid levels

Meconium ileus:

→ Soap bubble appearance in RIF on abdominal X-ray

Soap bubble appearance (X-ray)

Note:

→ Soap bubble appearance around knee - **GCT / Osteoclastoma**

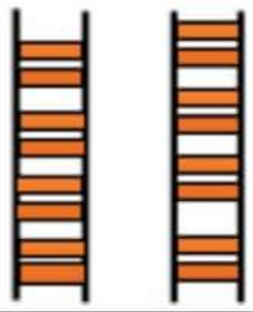
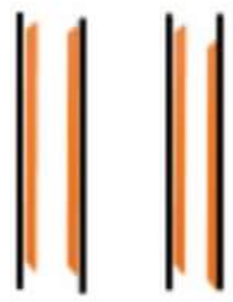
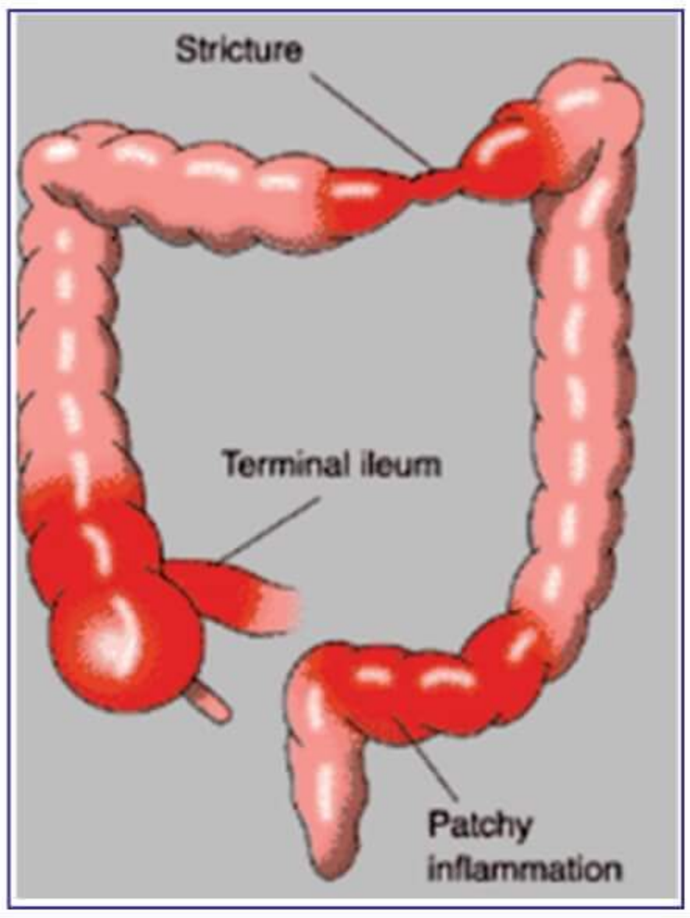
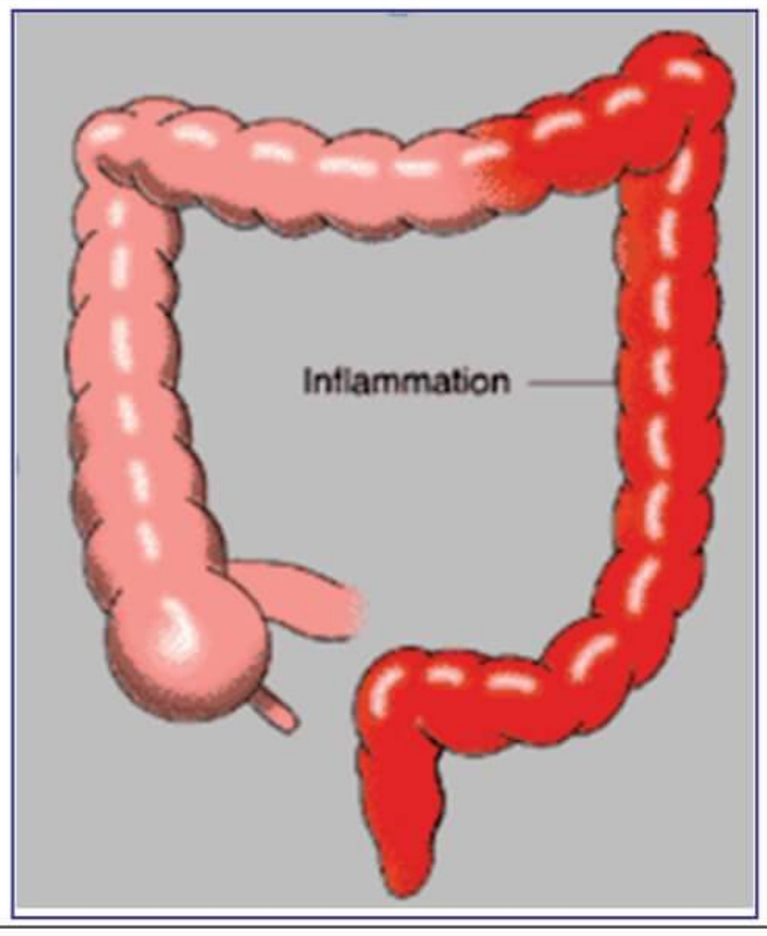
→ Soap bubble appearance of mandible - **Adamantinoma**

→ Soap bubble appearance on MRI brain - **Cryptococcus**

→ Soap bubble appearance on Antenatal scan-**Multicystic dysplastic kidney**

Inflammatorybowel Disease:

Inflammatory bowel Disease

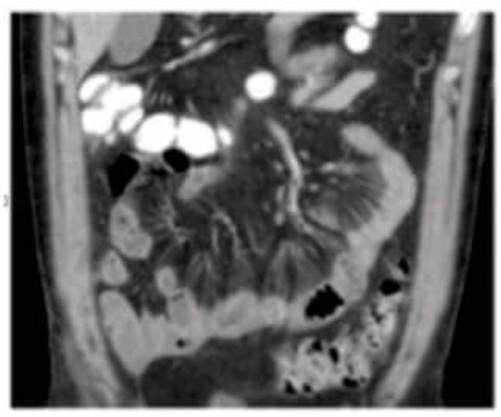
Crohn's disease	**Ulcerative colitis**
→Terminal ileitis	→Rectum
→ Skip areas 	→ Continuous → Backwash ileitis 
→ has transmural involvement	→ has superficial involvement
→ **Signs seen** * Target sign / halo sign * Comb sign * Rose thorning sign * Creeping fat sign * String sign of Kantor	→ **Signs seen** * Mucosal granularity * Lead pipe appearance * Collar button sign * Loss of haustration
→ **Earliest finding:** * Aphthous ulcer – gives cobblestone appearance in bowel Note: Cobblestone appearance in oesophagus- Candida	→ **Earliest finding** * Mucosal granularity
→ Has Pseudo sacculation → Has rectal sparing /fibrosis/strictures/ gut shortening	→ Has Pseudo polyps & crypt abscesses
	

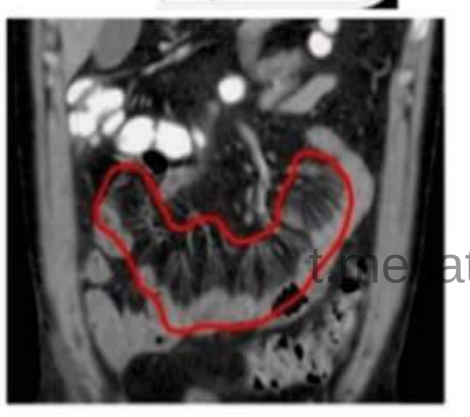
Aphthoid ulcers
(target sign)

- **Pathology:** mucosal ulcers with surrounding translucent mound of edema.

Cobblestone appearance: due to deep fissuring ulcers around inflammed mucosa

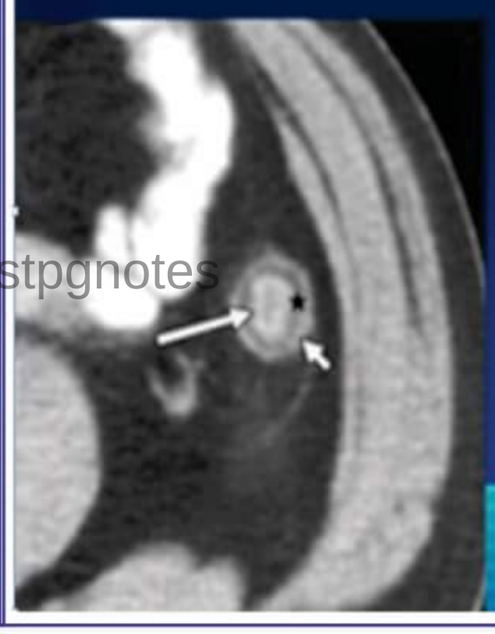
Comb sign





- Comb sign on contrast CT or MRI : Increased number of visible vessels on the mesenteric side of the affected segments of small bowel, which give the appearance of the teeth of a comb
- Found in Crohn's disease or lupus enteritis.

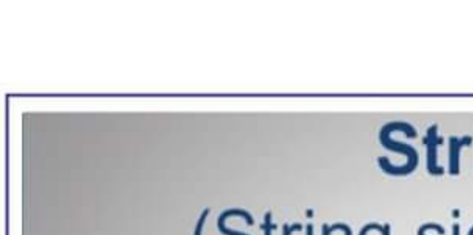
The Fat Halo Sign



- The **fat halo sign** is seen on CT scans of the abdomen and appears as a thickened bowel wall demonstrating three layers: an inner and an outer layer of soft-tissue attenuation, between which lies a third layer of fatty attenuation.

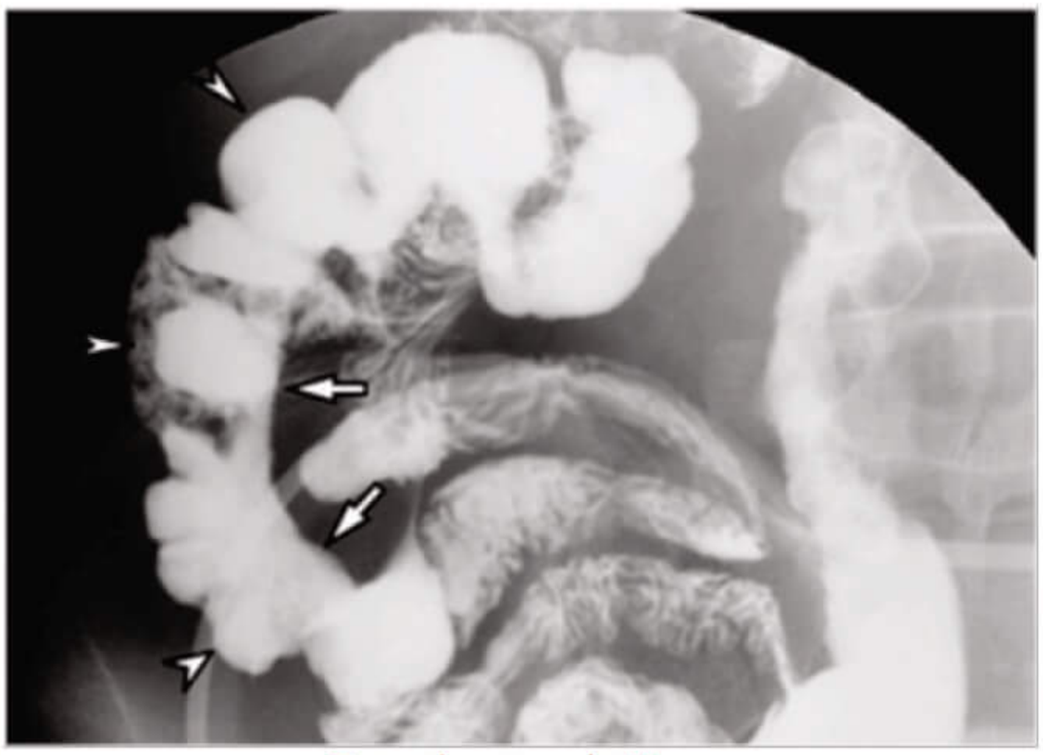
Stricture
(String sign of Kantor)

Pathology: edema &/or fibrosis with ulcerated mucosa (resembling frayed string).



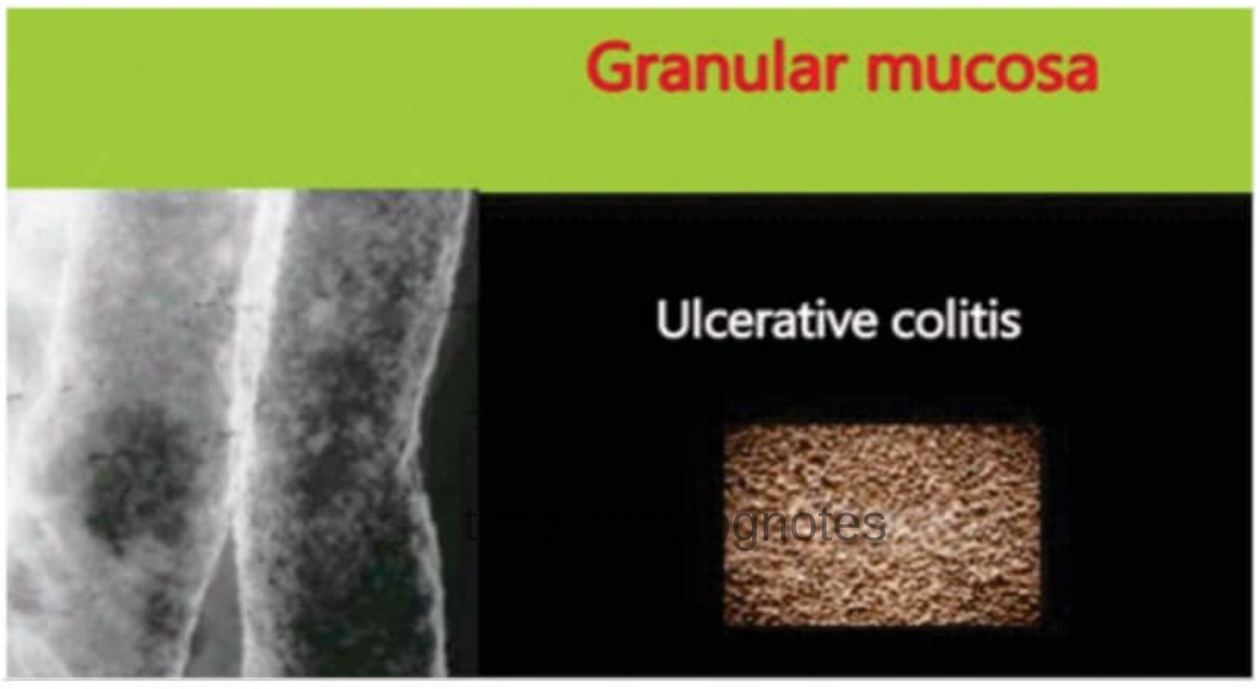
Fissure ulcers
(Rose thorn appearance)

Pathology: transmural ulcers



Pseudosacculations

Lead pipe appearance of colon



Ischemic Colitis:

→ Thumb print appearance on abdominal radiograph because of edematous mucosa due to ischemia.

→ **M/C site** – Splenic flexure (Watershed area of colon)

Thumb print appearance (x-ray)

Ileocecal TB:

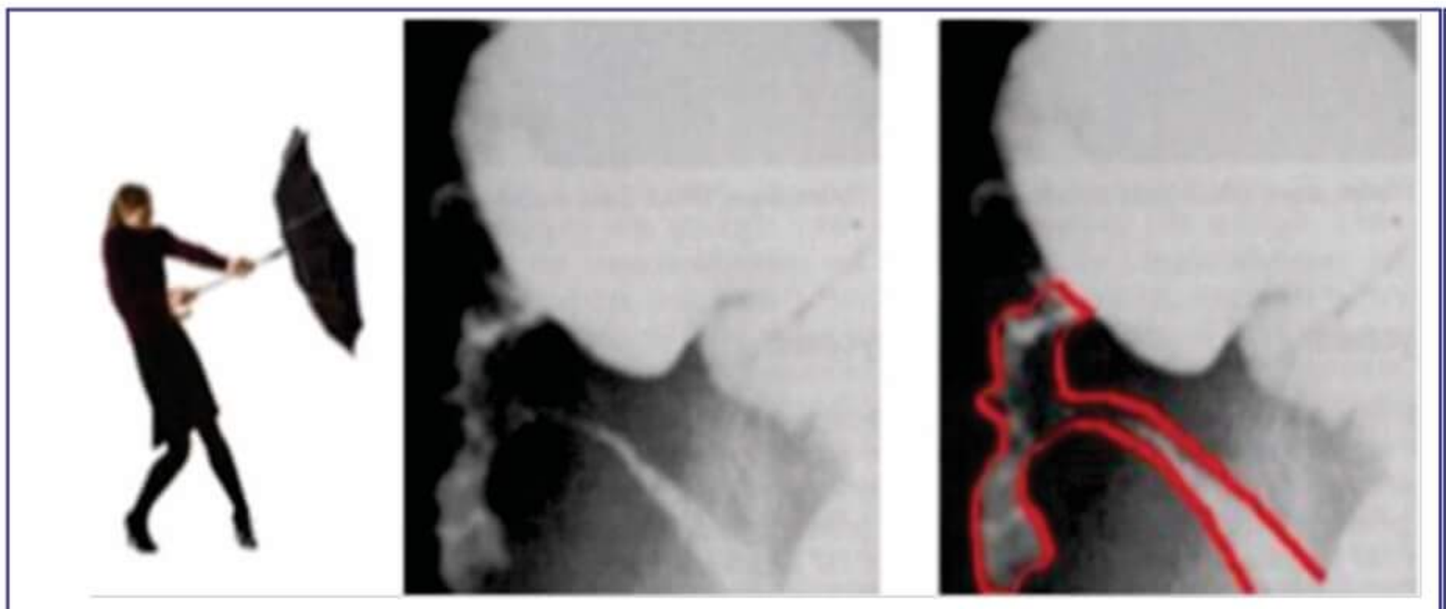
→ has obtuse ileocecal angle & pulled up cecum

→ Thickened ileocecal valve -Fleischer sign / inverted umbrella sign

→ Retracted,fibrosed cecum -Goose neck deformity

→ On Barium enema, pooling of barium in normal part & hyperperistalsis of barium in affected part is seen – Sterling sign

→ Has transverse ulcers -leads to purse string or napkin ring stenosis (note: Typhoid-has longitudinal ulcers)



Fleischer sign / inverted umbrella sign

Goose neck deformity

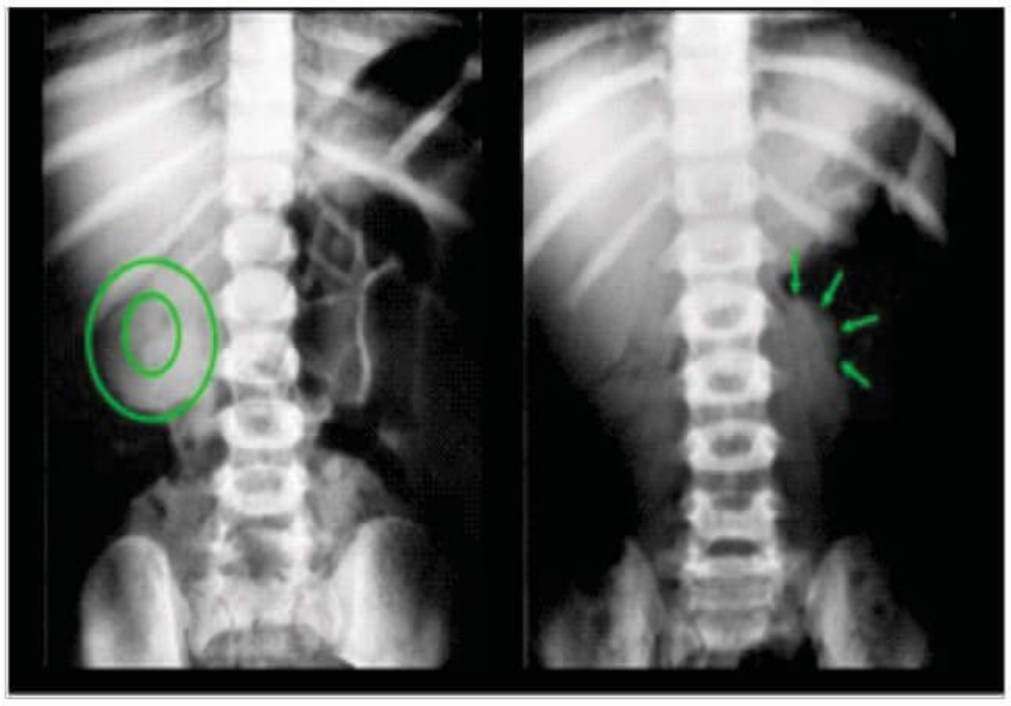
Sterling sign

Intussusception:

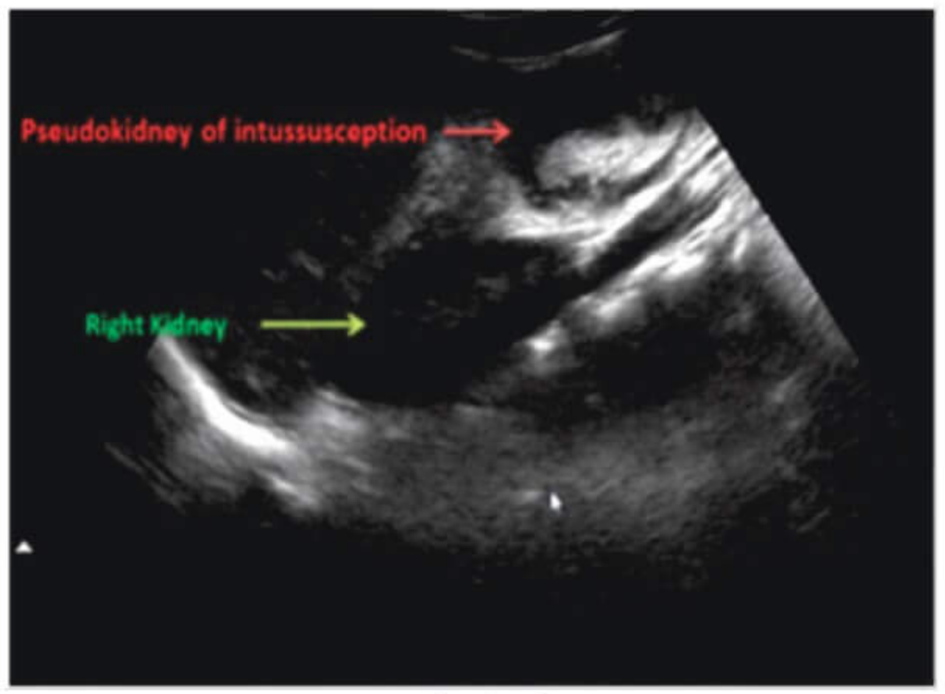
→ On a plain radiograph
- Meniscus sign

→ On USG
- Target sign / doughnut sign
- Pseudo kidney

→ On Barium
- Claw sign / pincer sign
- Coiled spring appearance

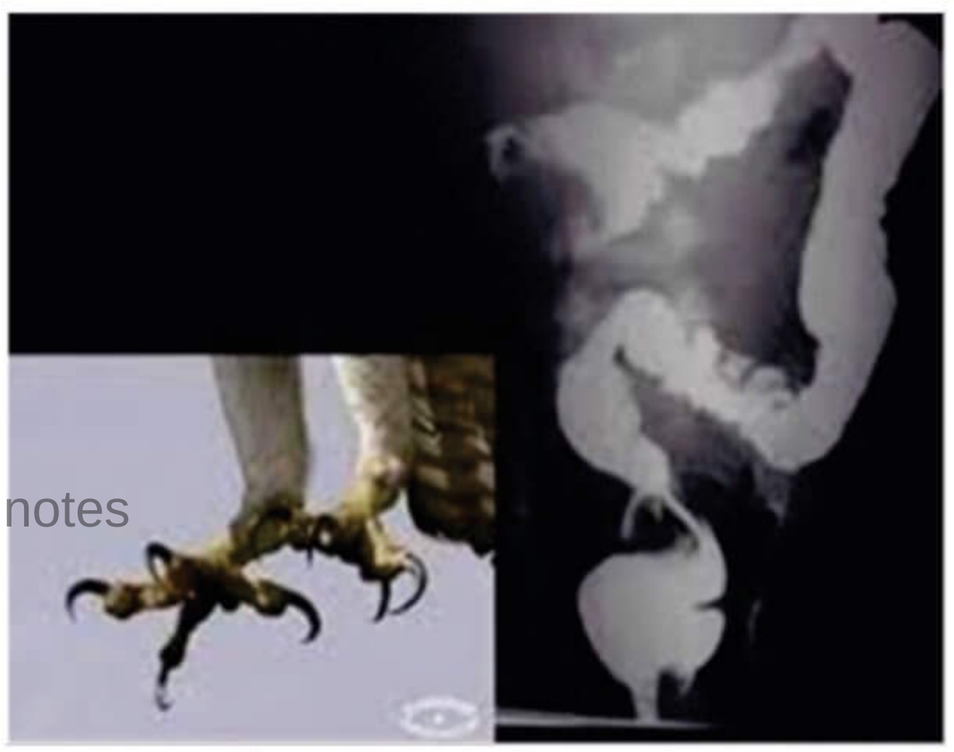


Target sign Meniscus sign

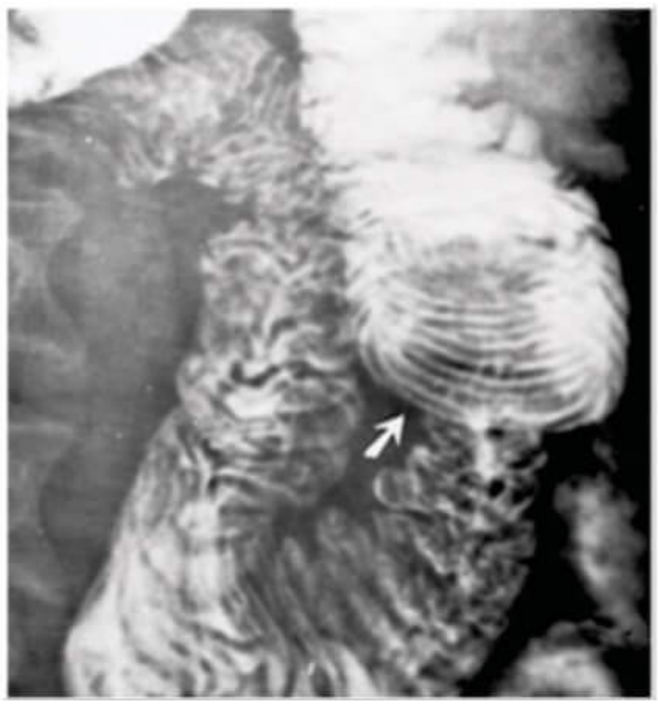


Pseudo kidney

Target sign / doughnut sign



Claw sign / pincer sign



Coiled spring appearance

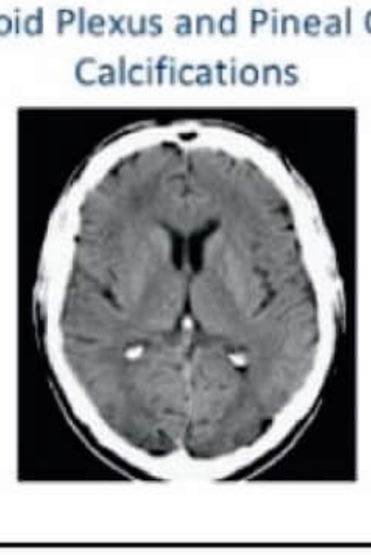
SUMMARY:

Radiological Features	Disease
• Bird's beak appearance	→ Oesophageal achalasia
• Cock screw appearance	→ Diffuse oesophageal spasm
• Seagull /Mercedes Benz /Crow feet sign	→ Radiolucent gall stone with gas
• Medusa head colonies on CT	→ Round worm
• Pincer sign, claw sign, coiled spring appearance	→ Intussusception
• Whirl pool sign on USG	→ Midgut volvulus
• Coffee bean sign, bent tyre tube sign	→ Sigmoid volvulus
• Shark mouth appearance	→ Ileocecal valve
• Lead pipe appearance	→ Ulcerative colitis
• String of Kantor, bulls' eye or target lesion	→ Crohn's disease
• Thumb printing sign	→ Ischemic colitis
• Saw tooth appearance	→ Diverticula of colon (sigmoid)
• Apple core lesion, napkins sign	→ Ca-colon
• Claw appearance	→ Intussusception

NEURORADIOLOGY PART -1

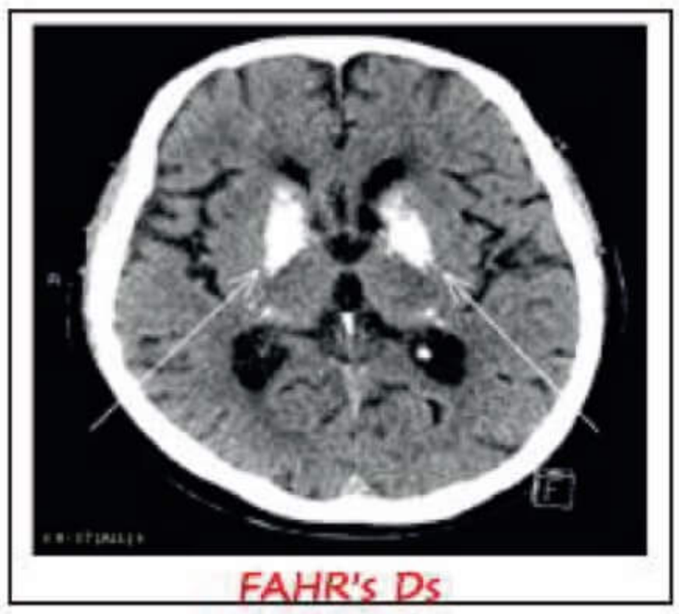
Normal sites of calcification in brain

→ Pineal gland (present posterior to third ventricle)
→ Choroid plexus (Present in occipital horns of lateral ventricle)
→ Folds of dura (like falx cerebri, tentorium cerebelli)
→ Lens


Choroid Plexus and Pineal Gland Calcifications

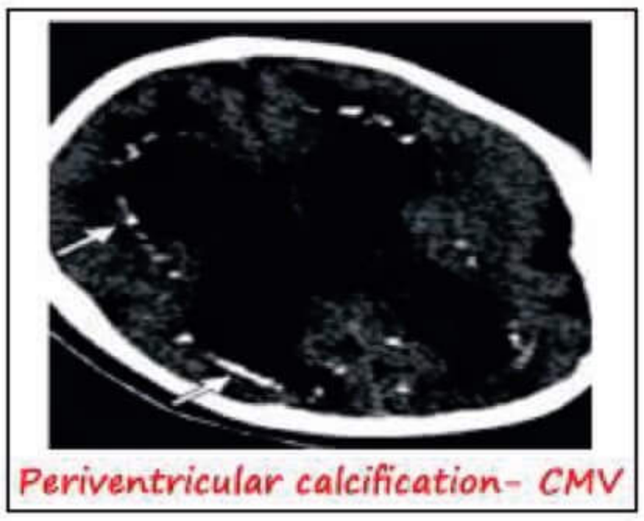
Basal ganglia calcification

→ Hypoparathyroidism
→ Pseudohypoparathyroidism
→ Hypoxia
→ Hypothyroidism
→ Hyperparathyroidism
→ CO poisoning
→ Lead poisoning
→ TORCH infection
→ FAHR disease (B/L symmetrical basal ganglia calcification)

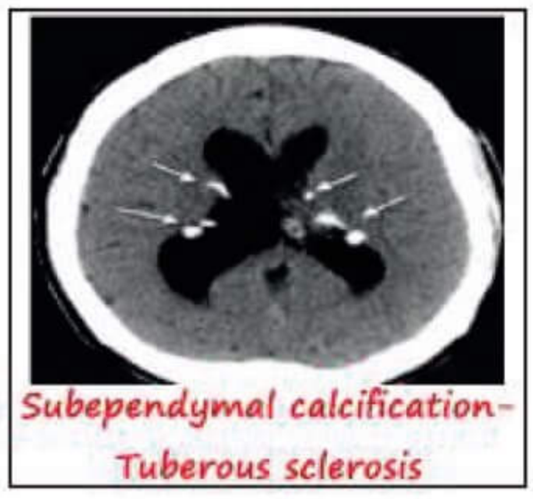

FAHR's Ds

Basal ganglia calcifications are NOT seen in Wilson disease.

→ Periventricular calcification is classic feature of CMV


Periventricular calcification- CMV

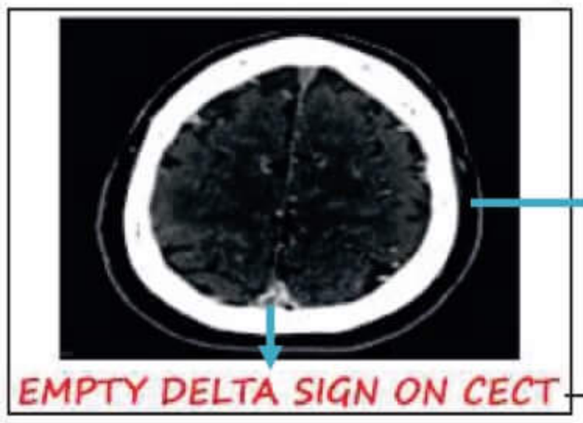
→ Subependymal calcification – tuberous sclerosis


Subependymal calcification- Tuberous sclerosis

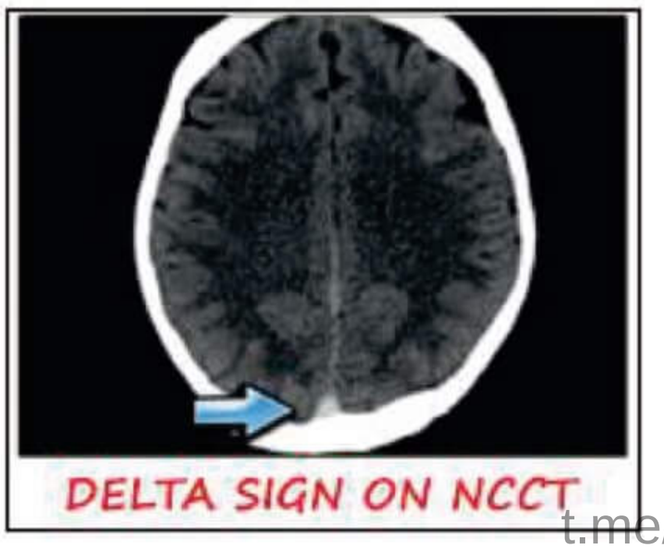
Superior sagittal sinus thrombosis

→ Empty delta sign

- Hypodensity within the hyperdense posterior falx
- Feature of superior sagittal sinus thrombosis seen on CECT.

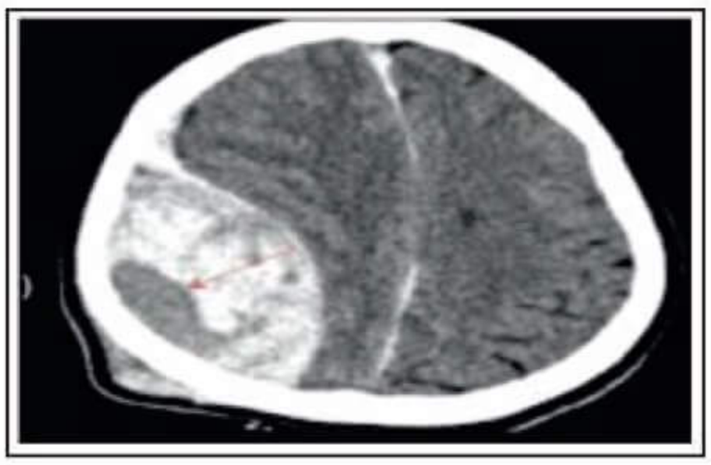


→ Delta sign

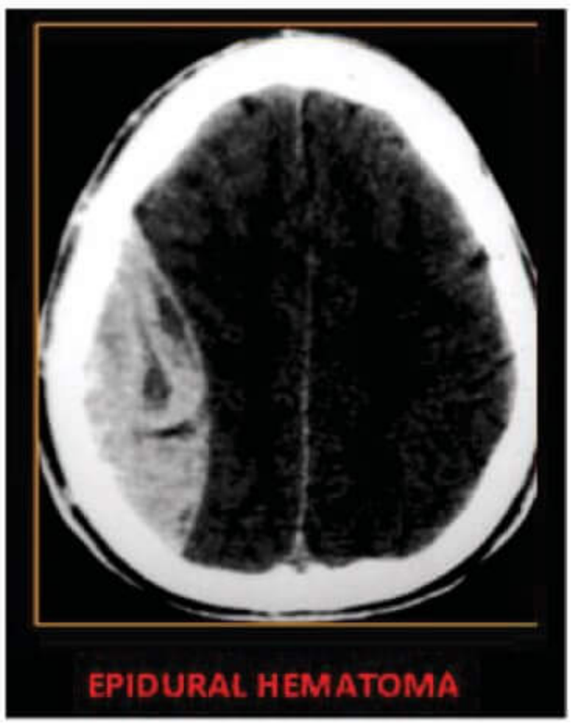


Swirl sign

- Hypodensity within the hyperdense epidural hematoma
- Indicates active extravasation (bleeding) of unclotted blood.

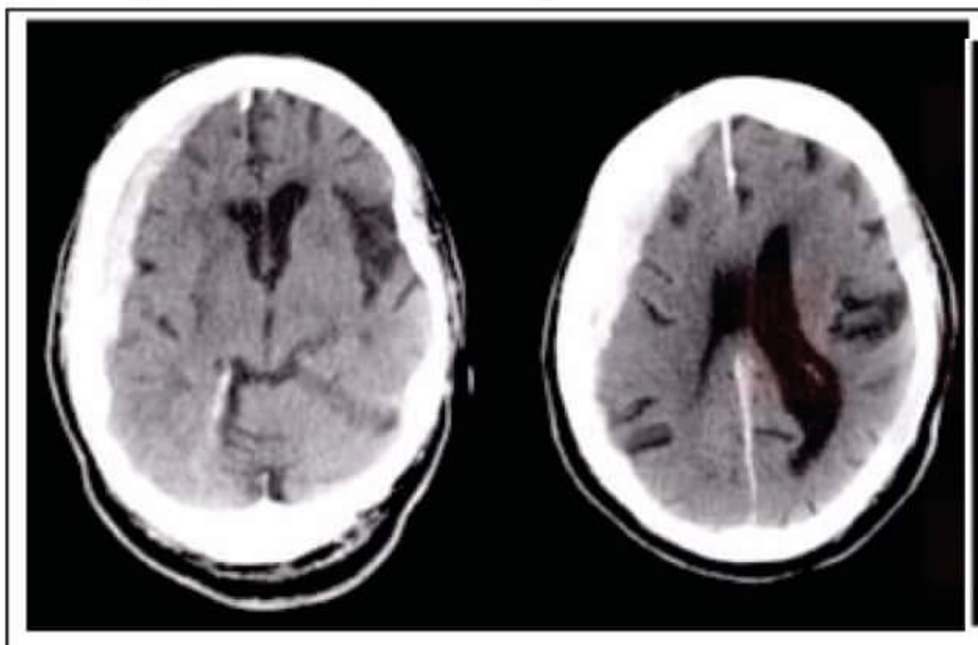


EDH (Epidural hematoma)

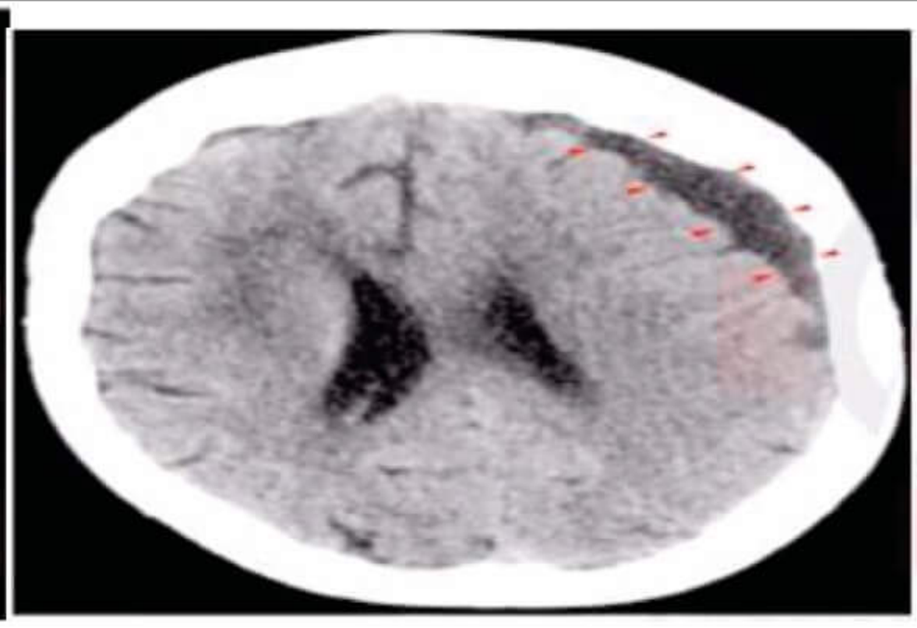


- AKA Extradural hematoma
- Biconvex / lentiform / lemon shaped appearance seen
- Limited by suture lines so does not cross sutures
- Due to rupture of middle meningeal artery
- Happens due to fracture of Pterion (H shaped suture)
- Causes midbrain hemorrhages or Duret hemorrhages
- Causes uncal herniation
- Causes third nerve palsy
- Has lucid interval

SDH (Subdural hematoma)



Acute SDH (Hyperdense on CT)

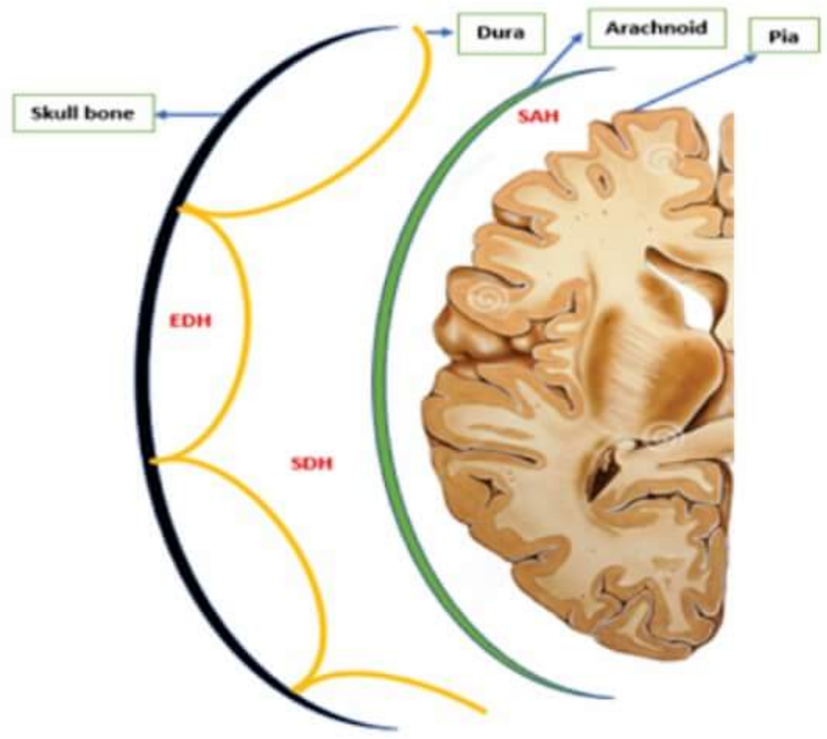


Chronic SDH (Hypodense on CT)

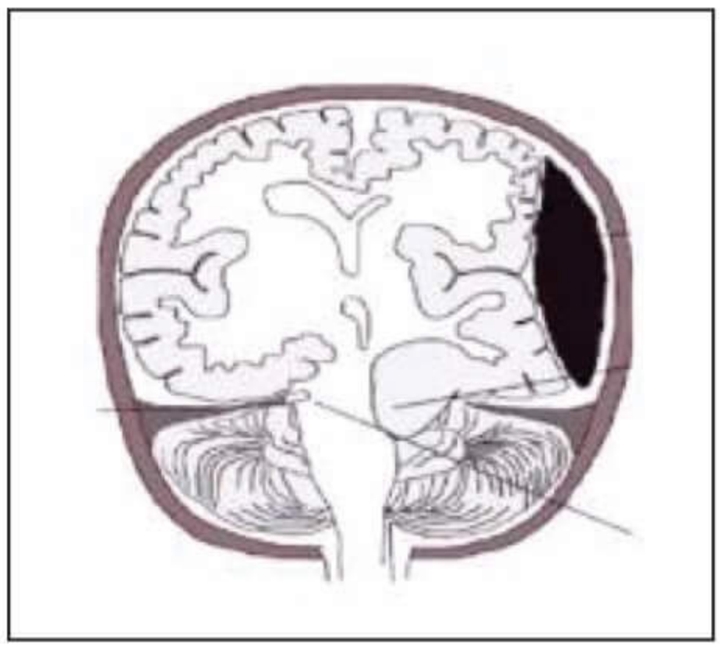
- Concavo-convex or Crescentic or banana shaped
- Crosses suture lines
- Happens due to rupture of Bridging veins
- Seen with
    - Chronic old trauma

- Cortical atrophy
- Alzheimer's disease
- Punch drunk syndrome (Professional boxer)
- Battered baby syndrome (BBS also has metaphyseal corner fracture)

SAH (Subarachnoid hemorrhage)



- Shows Hyperdensity in:
  - sulcal spaces
  - sylvian fissures
  - basal cisterns
  - anterior interhemispheric fissure
- IOC for acute SAH (<48 hrs) – NCCT
- IOC for chronic SAH (>48 hrs)–MRI
- Most common cause of SAH –Trauma
- Most common cause of spontaneous SAH – Rupture of Berry aneurysm
- IOC to know cause of SAH – 4 vessel angiography
  - 2 Vertebral arteries
  - 2 Internal Carotid arteries
- In case of acute settings, to know site of aneurysm – CT Angiography
- In chronic setting / stable patient to know site of aneurysm – MR Angiography
- Gold standard for the imaging of intracranial aneurysms and vascular malformations – Digital subtraction catheter angiography (DSA)



Kernohan Notch Phenomenon

↓

False Localizing sign

=> Head Trauma / Mass / EDH → uncal herniation

↓

Compresses midbrain

(crus cerebri on contralateral side gets compressed under tentorium

Cerebelli)

↓

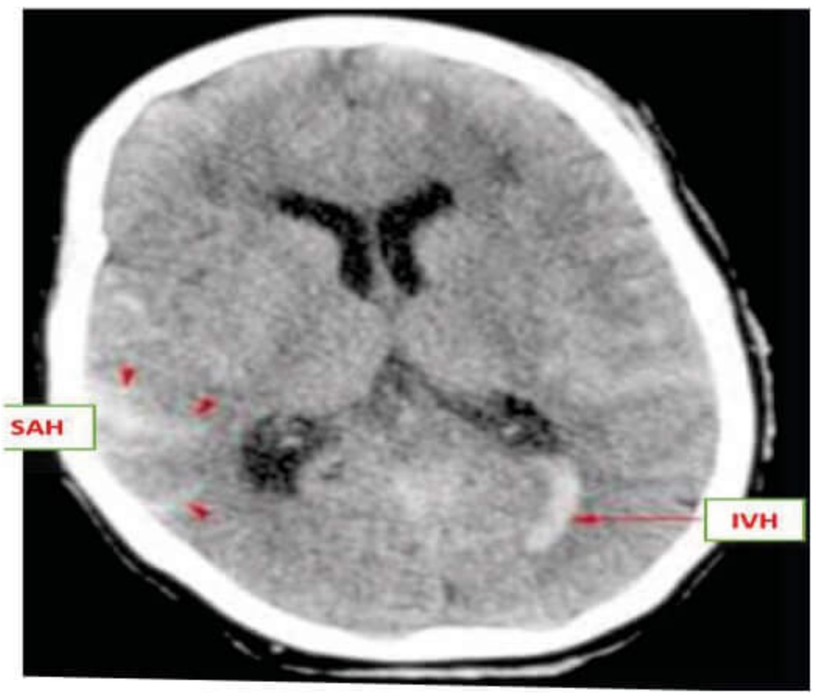
Known as kernohan Notch

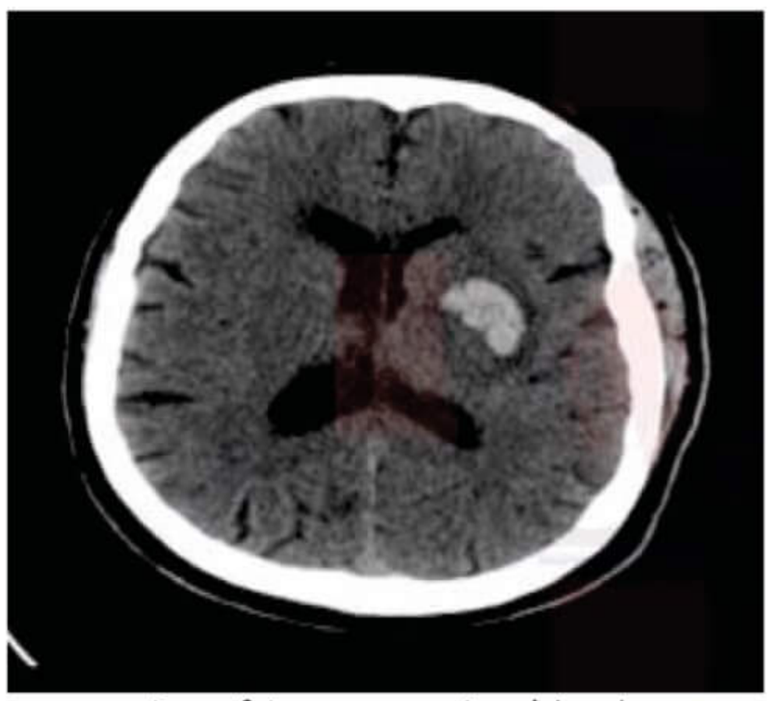
↓

Paralysis occurs ipsilateral to the side of lesion

Intraventricular bleed- occipital horn of Lateral ventricle

Intraparenchymal bleed- Left putamen





Most common site of hypertensive bleed – Putamen

- Young patient with RTA, unconscious (poor GCS)

  ↓

  NCCT – normal / petechial hemorrhages

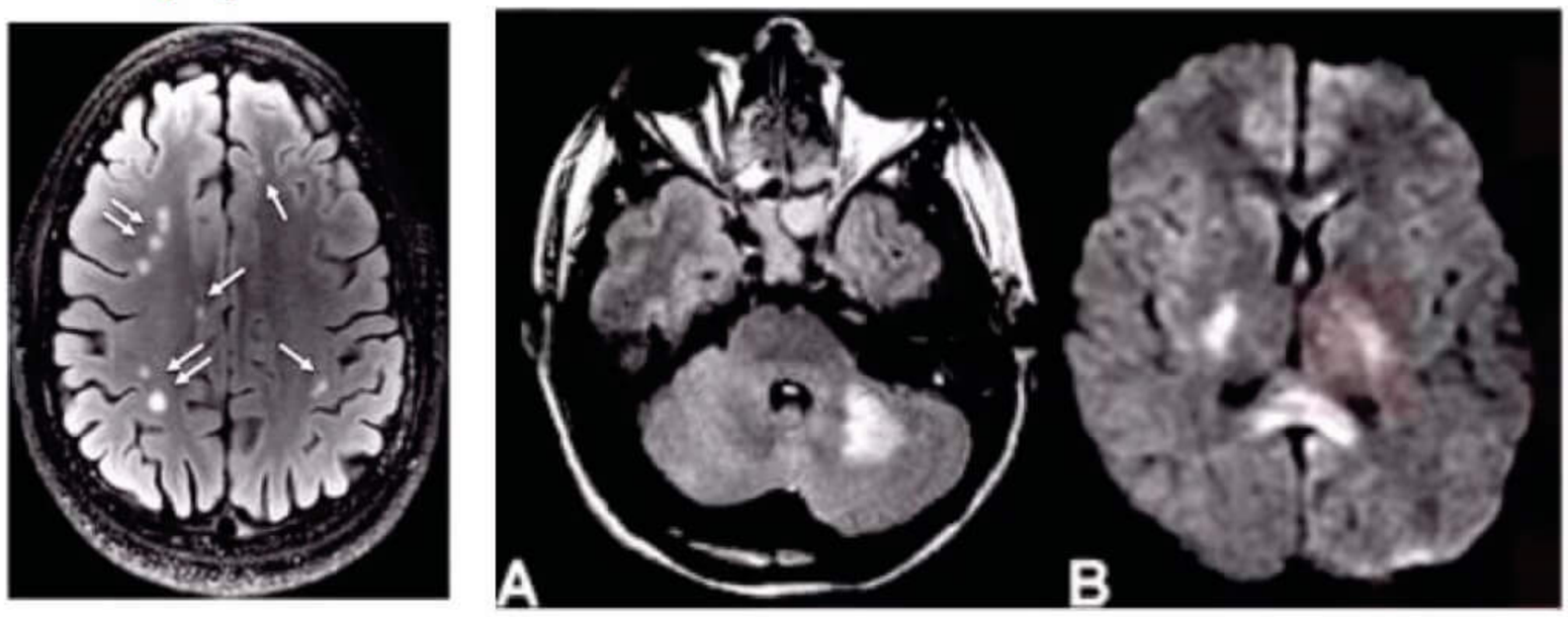
  ↓

  Suspect **diffuse axonal injury**

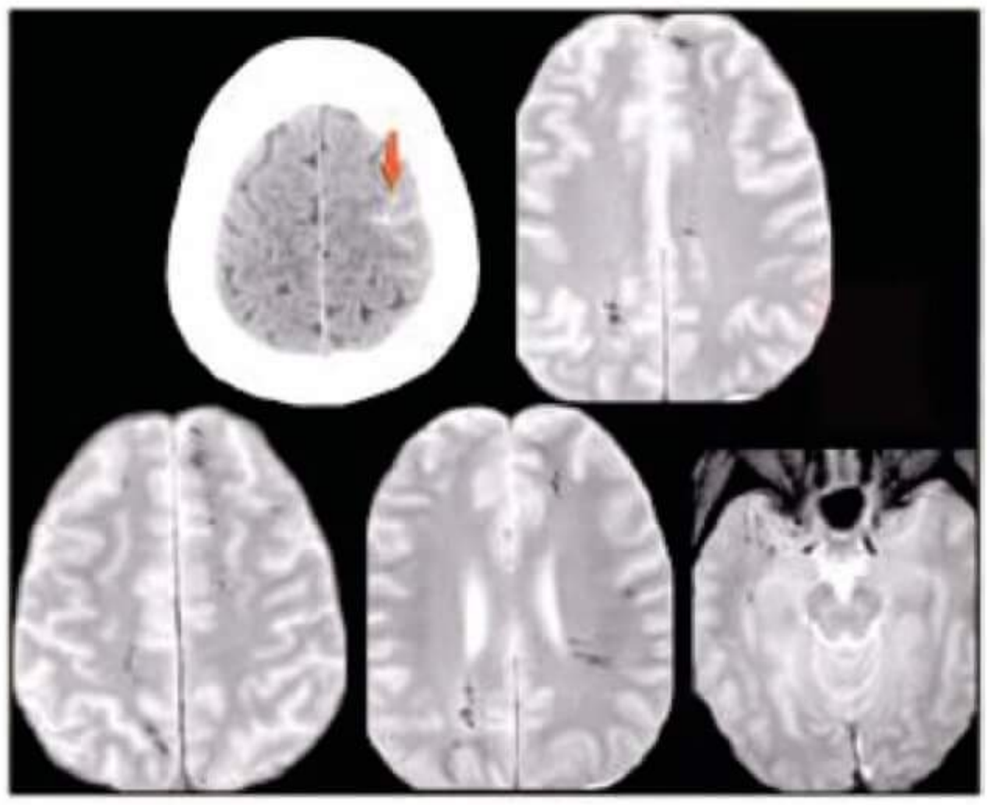
  ↓

  IOC – MRI (hyperintensities in white matter of brain can be viewed)

Diffuse axonal injury



⇨ To evaluate petechial hemorrhages, sequence of MRI preferred –Susceptibility weighted imaging (SWI)/ Gradient Echo imaging



SWI

MOUNT FUJI sign

- Feature of Tension pneumocephalus
- IOC – CT scan

Mount Fuji sign

SCIWORA (Spinal cord injuries without radiographic abnormalities)

→ Occurs exclusively in CHILDREN < 8 years with quadriplegia after accidental fall

→ Involves Upper cervical spinal cord

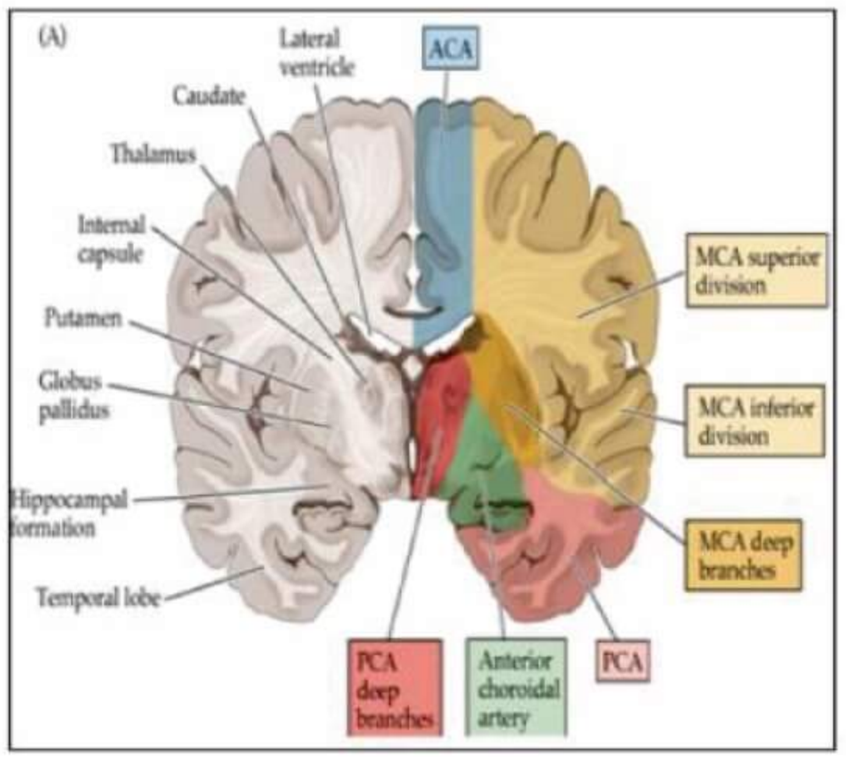
→ IOC – MRI (to look for injury at the upper cervical spinal cord)

Arterial supply of brain

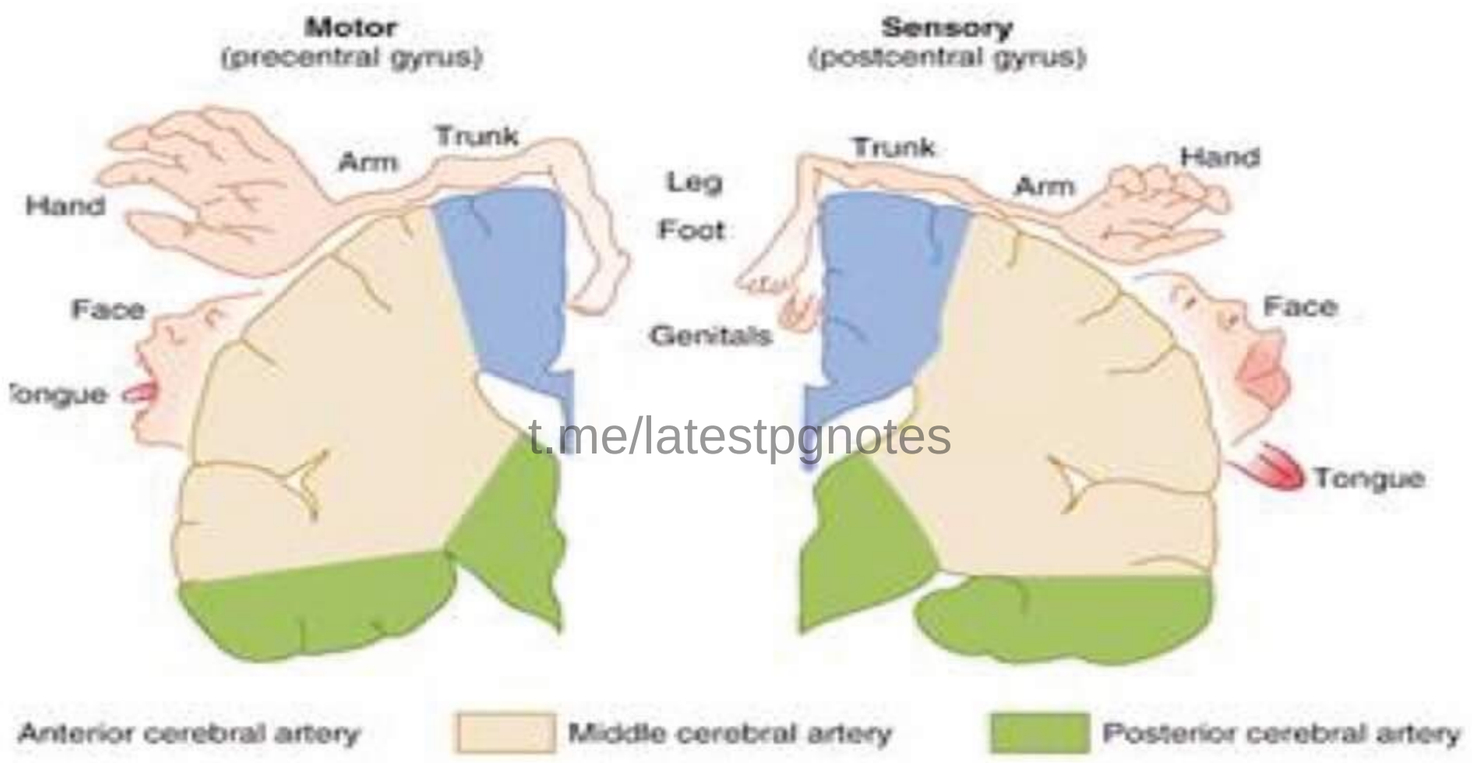
→ **Medial and superior surface** of brain is supplied by Anterior cerebral artery

→ **Superolateral surface** of the brain is supplied by Middle cerebral artery

→ **Occipital lobe and inferior part of temporal lobe** is supplied by Posterior cerebral artery.



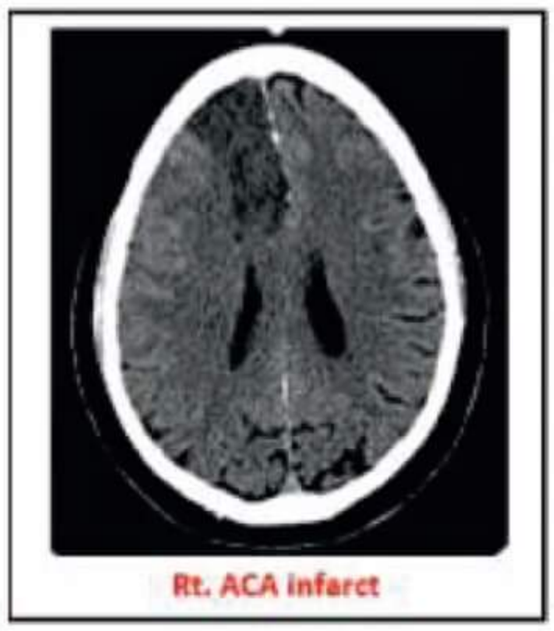
HOMONCULUS



→ For anterior cerebral artery infarction – Paraplegia is the main symptom

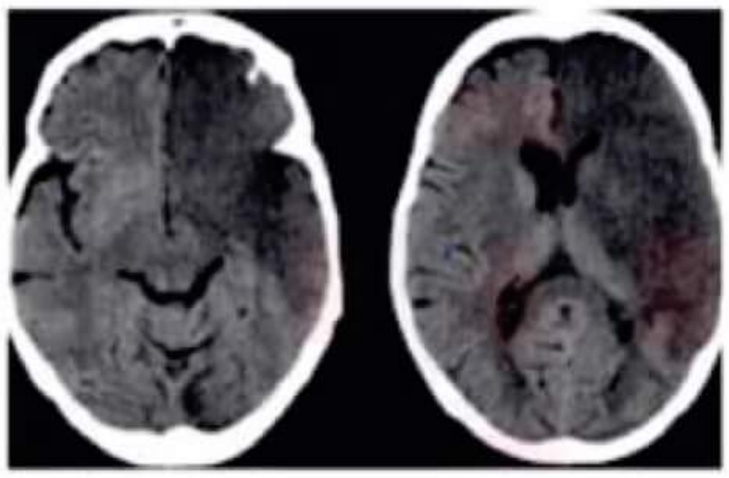
→ Middle cerebral artery infarction – Hemiplegia is the main symptom

→ Posterior cerebral artery infarction – Visual symptom is the main symptom

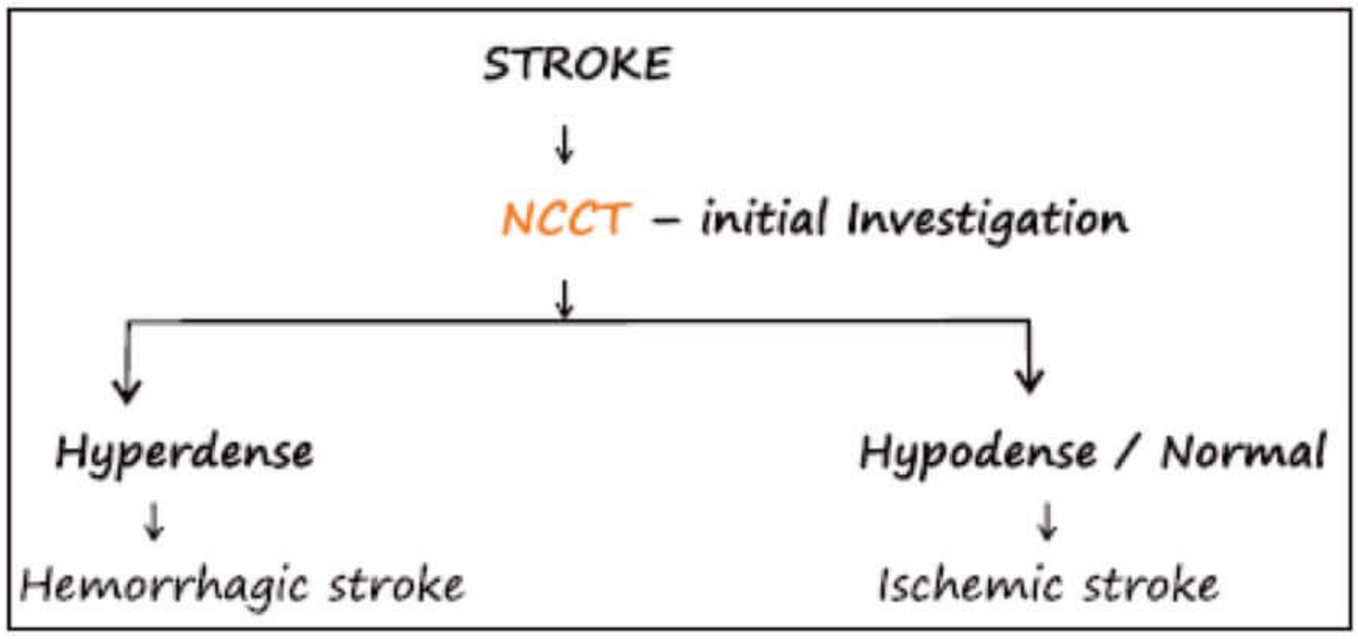

Rt. ACA infarct


Rt. MCA INFARCT

ACA + MCA Infarct



Stroke /CVA



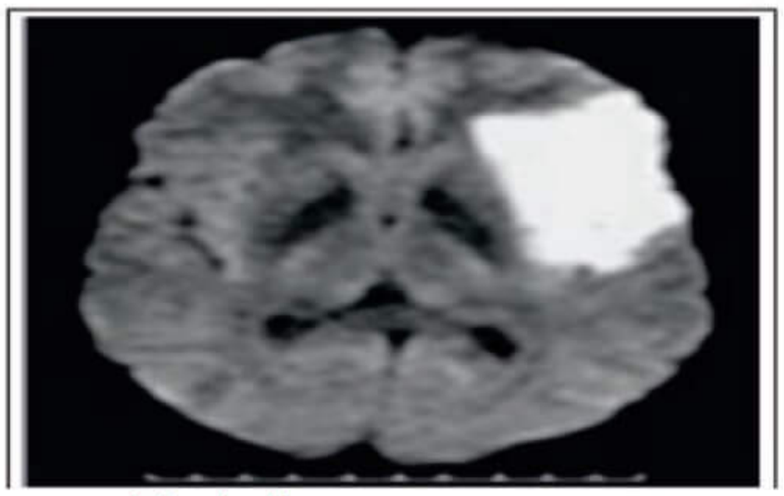
→ IOC for acute infarct / Ischemic stroke → **Diffusion weighted MRI** (CT scan can be normal in acute infarcts)

→ IOC for stroke – **Non contrast CT scan**

NEURORADIOLOGY PART -2

Acute infarct/Ischemic stroke

→ Light bulb appearance on DW – MRI brain is suggestive of Acute infarct/ischemic stroke



Light bulb appearance on DW

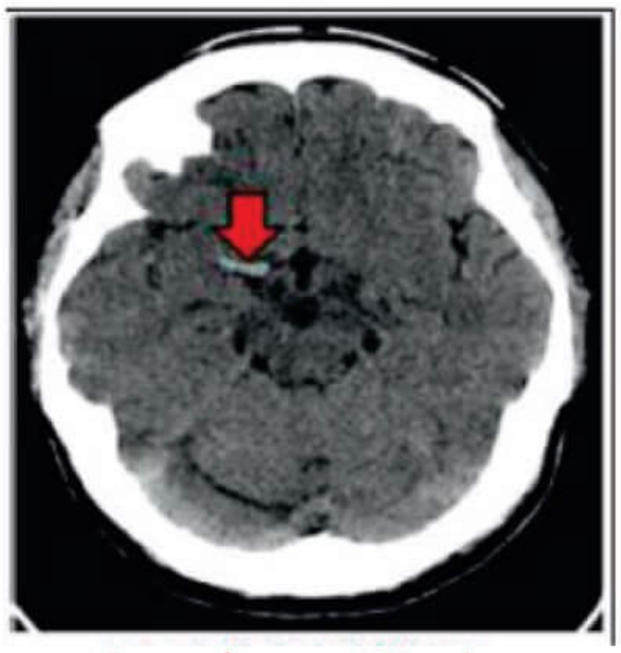
Signs of acute infract on NCCT scan

→ Hyperdense MCA sign

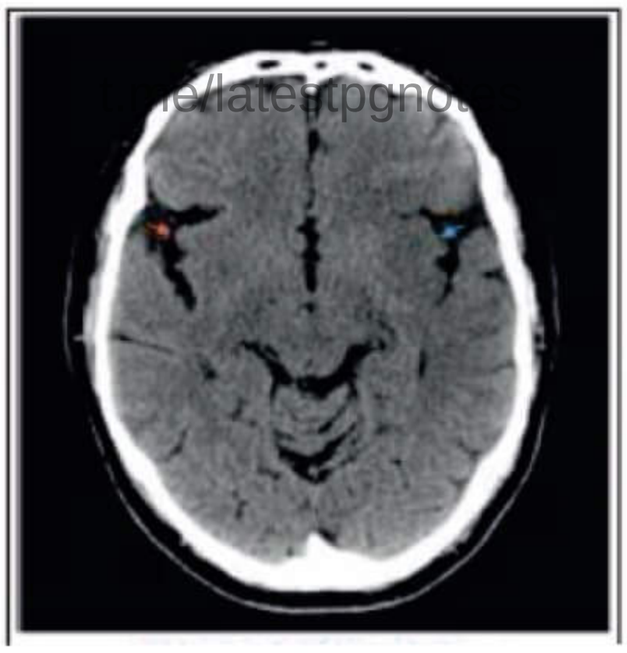
→ **Sylvian dot sign**

→ Obscuration of lentiform nucleus

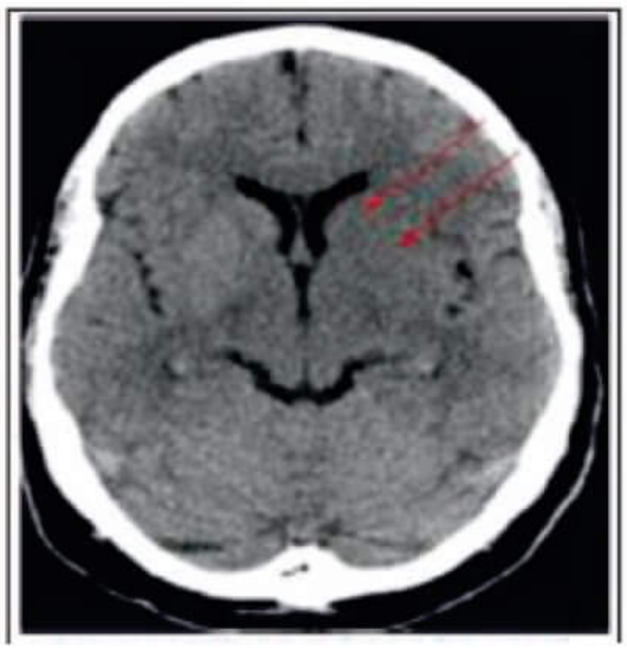
→ **Insular ribbon sign**



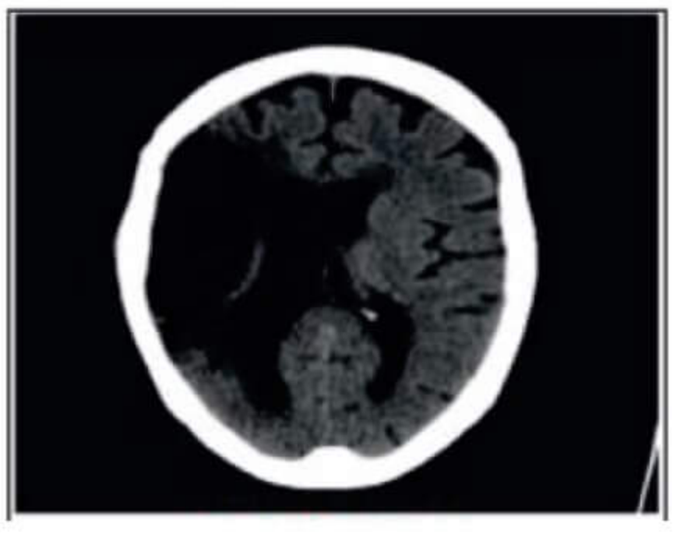
Hyperdense MCA sign



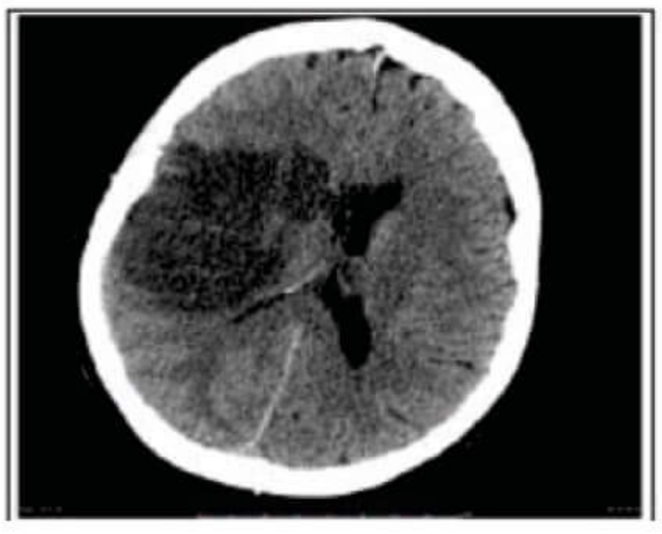
Insular ribbon sign



Obscuration of lentiform nucleus



Chronic infarct



Acute infarct

Radiological findings of demyelinating disorders

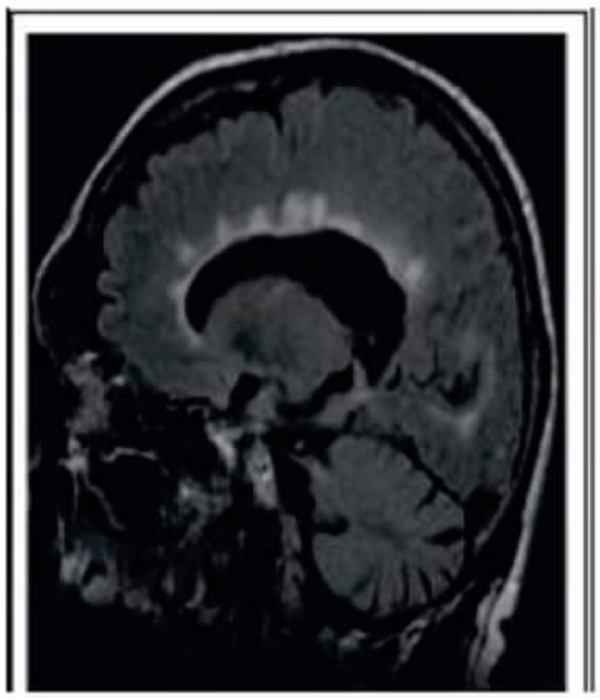
Multiple sclerosis (Autoimmune)

→ Autoimmune destruction of myelin formed

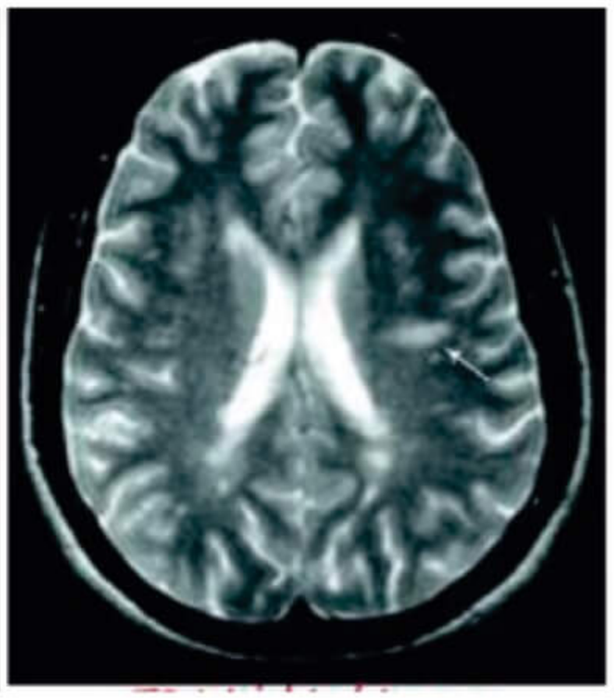
→ Periventricular white matter hyperintensities perpendicular to ventricles – DAWSON Fingers

→ Involvement of Calloso-septal interface

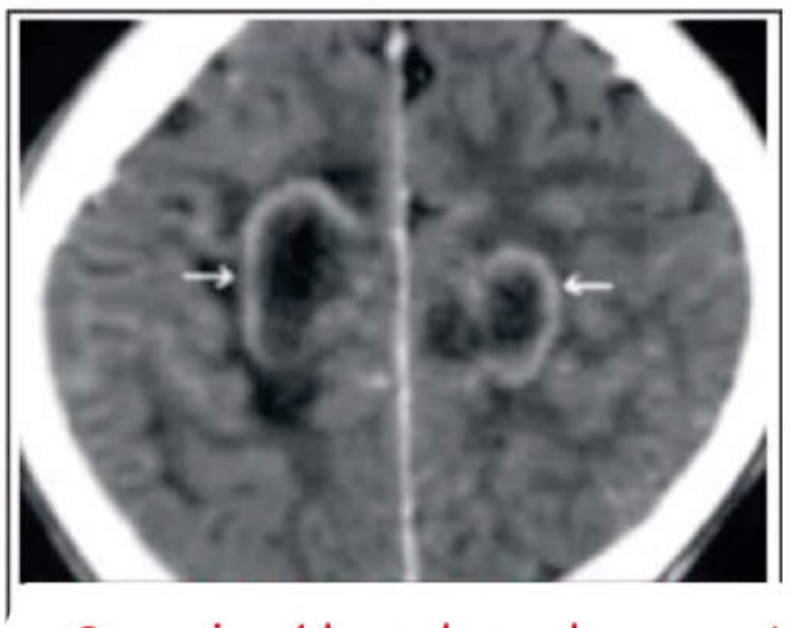
→ Open ring / horseshoe enhancement is suggestive of demyelination.



DAWSON Fingers



T2 weighted image of DAWSON fingers

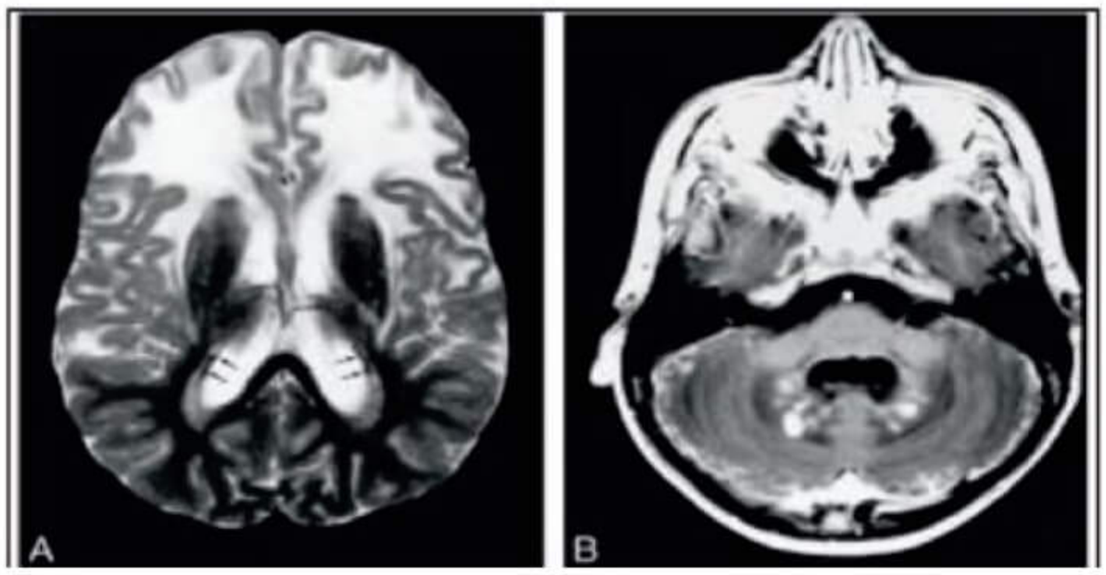


Open ring / horseshoe enhancement

Radiological findings of Demyelinating disorders / white matter leukodystrophy

→ Alexander disease

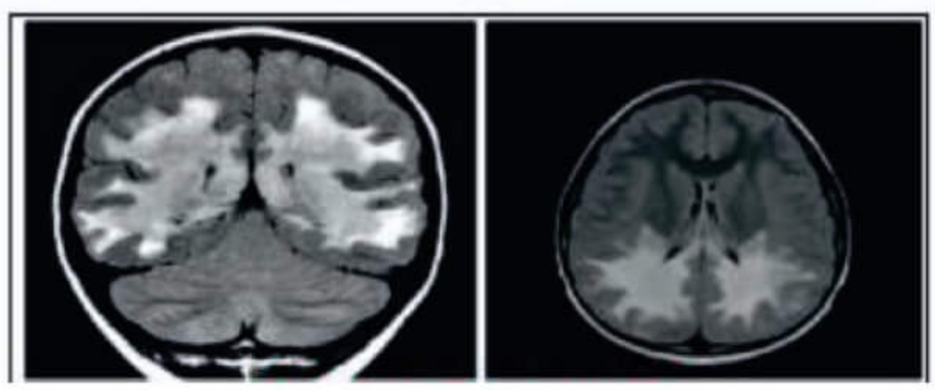
- White matter dystrophy of Bilateral frontal lobes
- Associated with Megalencephaly (Large skull)



Alexander disease

→ Adrenoleukodystrophy

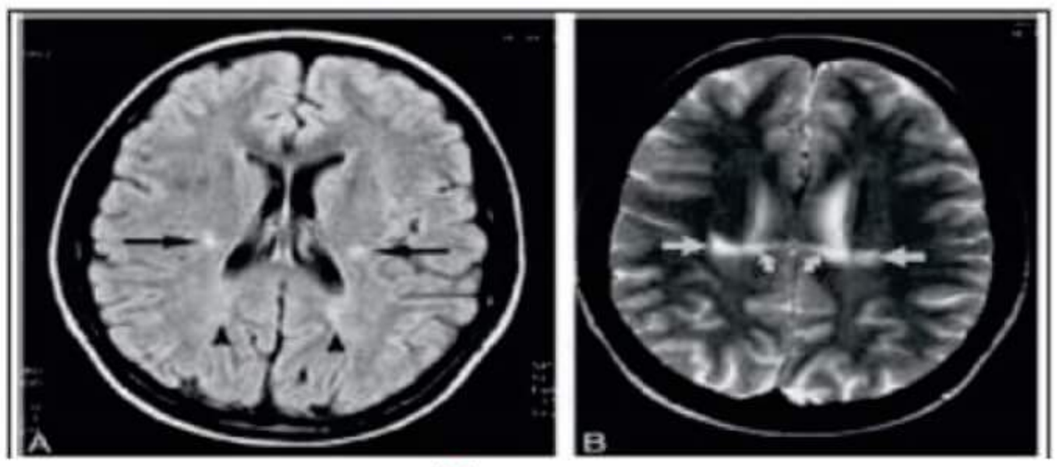
- White matter of Bilateral occipital lobes is involved.



Adrenoleukodystrophy

→ Krabbes Disease / Globoid cell leukodystrophy

- Involvement of B/L thalami



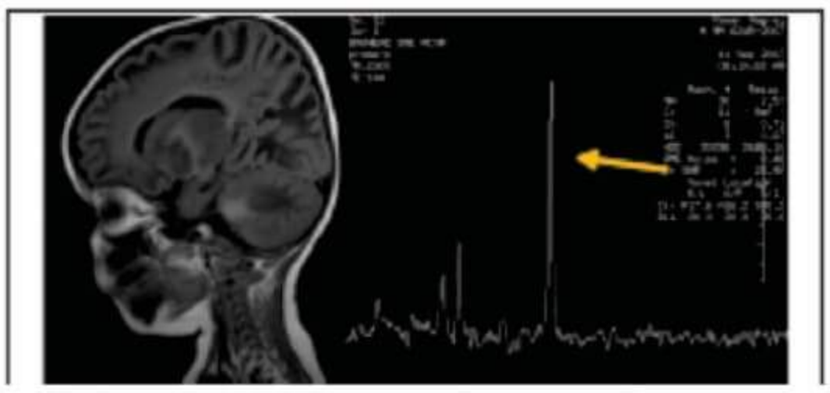
Krabbes Disease

→ Metachromatic Leukodystrophy

- Deficiency of Aryl sulfatase
- Deep white matter disease with sparing of subcortical 'U' fibers
- Lamellated / Tigroid / Leopard skin Appearance on MRI

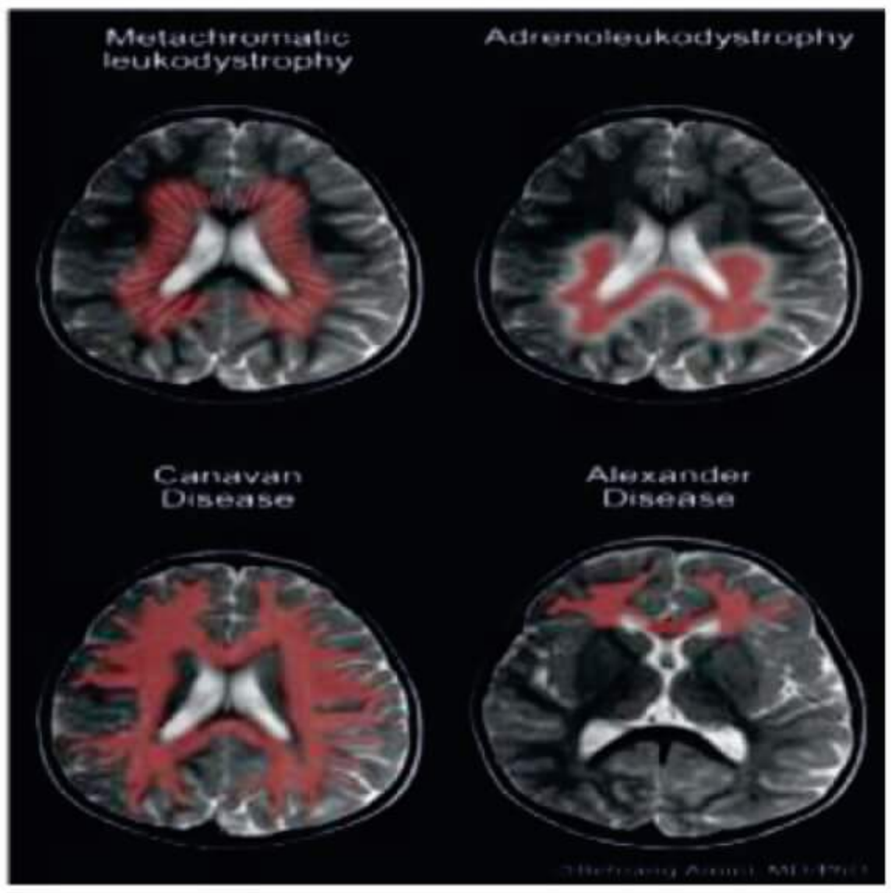
→ CANAVANS disease

- Diffuse white matter involvement
- N – acetyl / aspartate peak / NAA peak on MR – spectroscopy @ 2 ppm
- Patient has Megalencephaly



NAA peak on MR – spectroscopy @ 2 ppm
CANAVANS disease

Summary



Ring Enhancing lesions

→ Ring enhancing lesions In AIDS patient – Toxoplasmosis (Eccentric Target Sign)

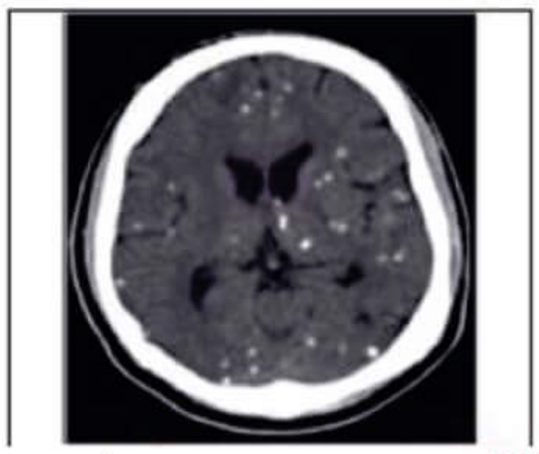
→ Ring enhancing lesions that are Multiple, conglomerate (fused) with lipid lactate peak on MRS – Tuberculoma

→ Ring enhancing lesions that shows Diffusion Restriction - Cerebral abscess

→ Ring enhancing lesions at Grey white matter Junction – Metastasis

→ Ring enhancing lesions that shows **Escobar staging** – Neurocysticercosis

- **Vesicular stage** → Parasite is alive, Minimal edema
- **Colloidal stage** → colloidal cyst disintegrates and perilesional edema is maximum
- **Granular stage** → thick walled cyst and edema decreases
- **Calcific nodular stage** → dense calcifications gives Starry sky appearance on NCCT and No Edema



Starry sky appearance on NCCT

→ Rice grain calcification – Cysticercosis

Rice grain calcification

Starry sky appearance

→ On NCCT Brain – Neurocysticercosis (Calcific nodular stage)

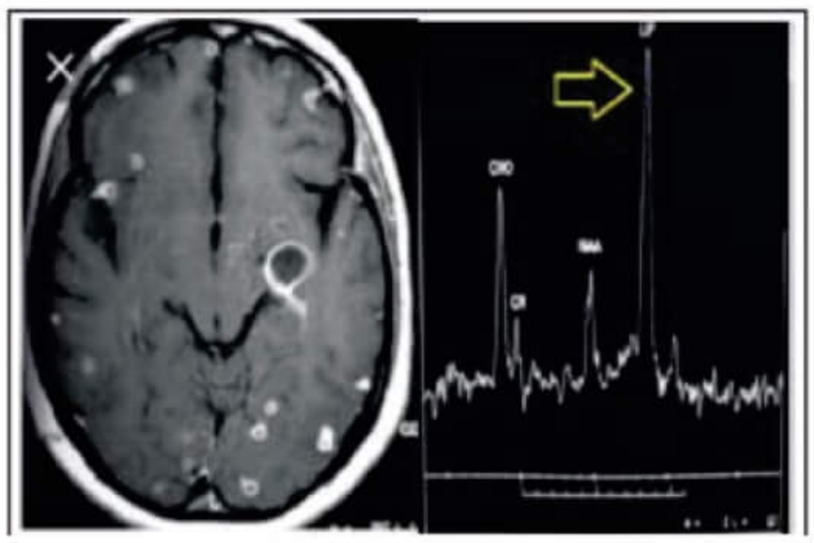
→ On histopathology – Burkitt's lymphoma

→ On USG liver – Acute hepatitis

→ On immunofluorescence – PSGN

Tuberculoma

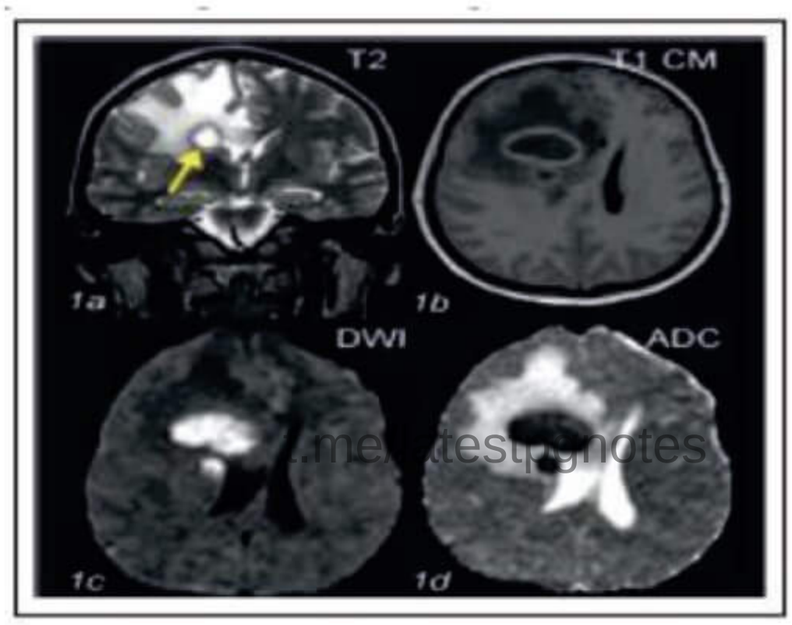
→ Multiple ring enhancing lesions that show a Lipid lactate peak (LLP) on MR Spectroscopy at 1 ppm



MR Spectroscopy

Cerebral Abscess

→ Ring enhancing lesion showing Diffusion Restriction (DWI)



Encephalitis

→ **HSV encephalitis**

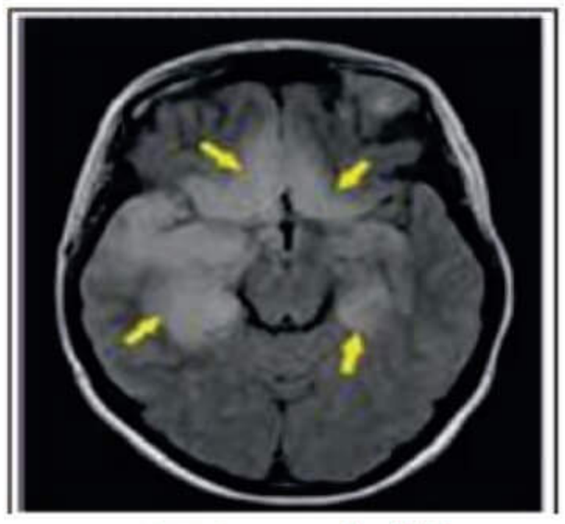
- Involvement of temporal lobe (MC)
- Involvement of Basi frontal lobes

→ **VZV encephalitis**

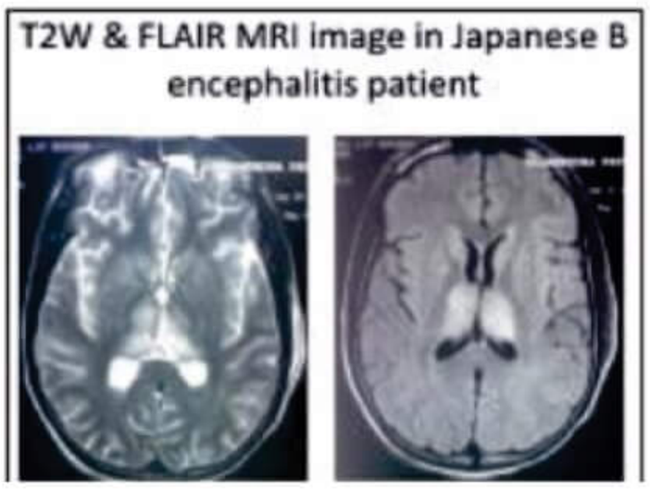
- Involvement of Cerebellum

→ **Japanese encephalitis**

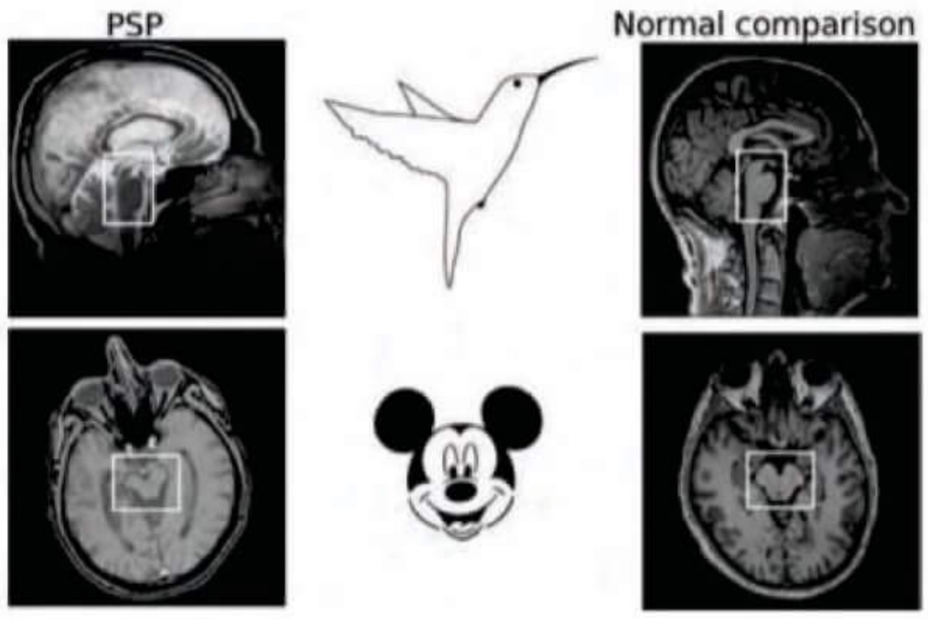
- Involvement of B/L thalami



HSV encephalitis

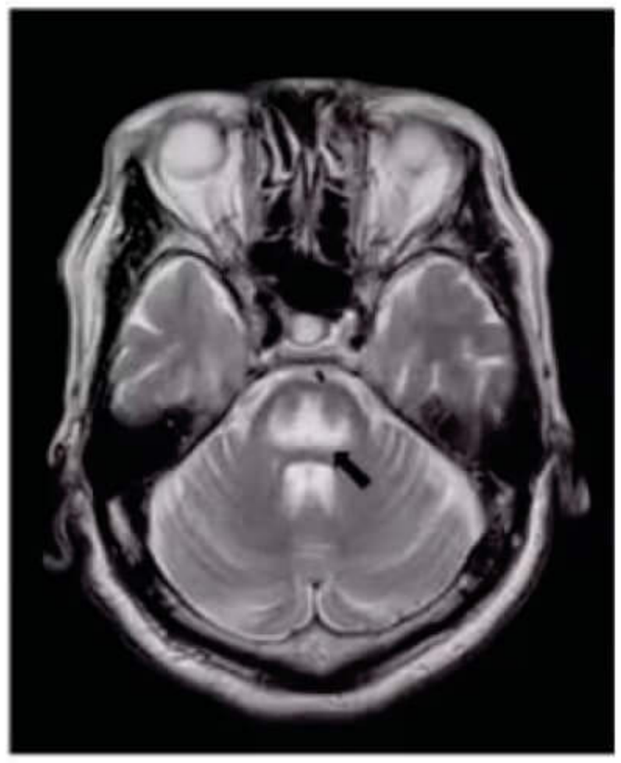


Supra nuclear palsy



→ Shows
- Humming bird sign (midbrain atrophy) – on sagittal MRI
- Micky Mouse Sign (midbrain atrophy) – on axial MRI

Panda sign

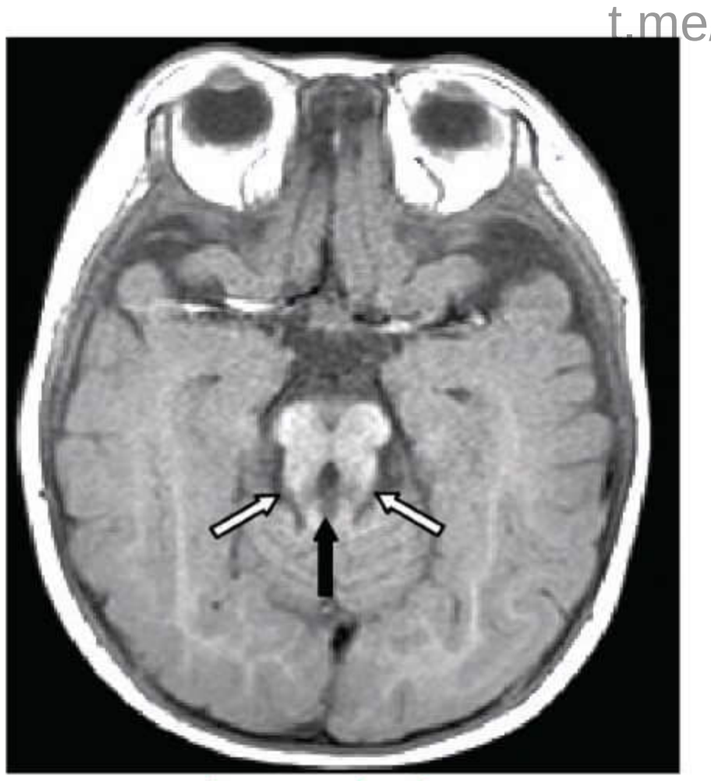


→ Feature of Wilson disease (due to deposition of copper)

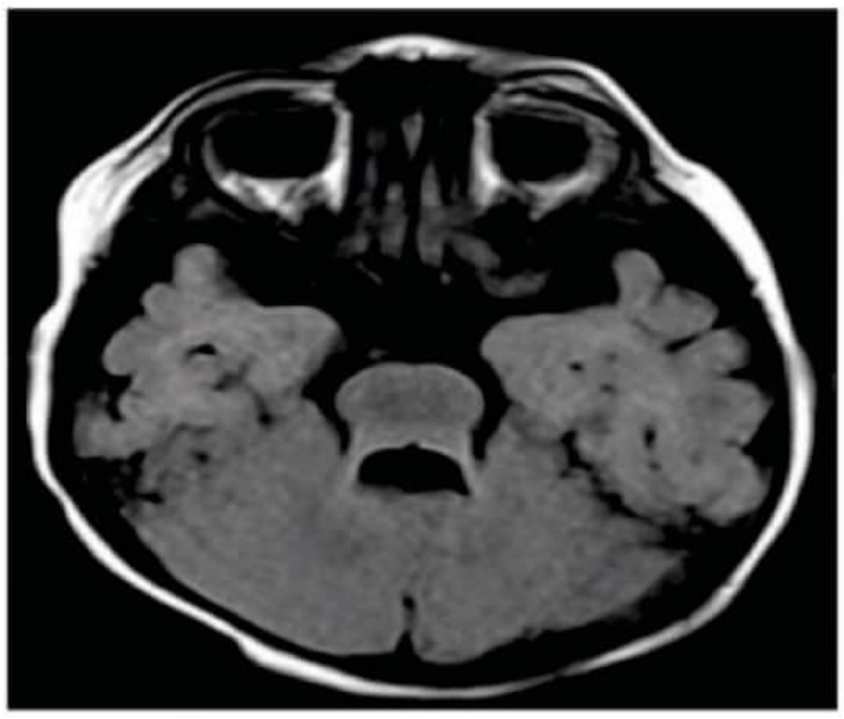
Joubert syndrome

→ Molar tooth sign (due to elongated Cerebellum Peduncles

→ Bat wing appearance (dilation of 4th Ventricle)



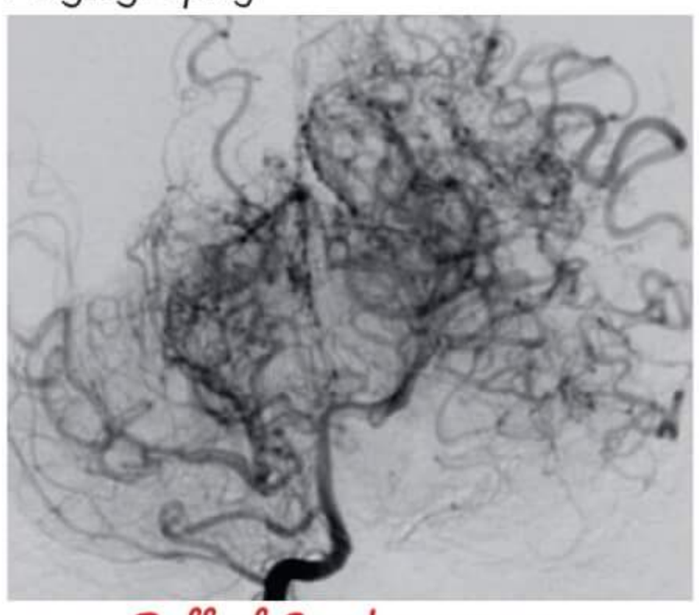
Molar tooth sign



Bat wing appearance

Moya Moya Disease

→ Chronic vasospasm of supraglenoid part of ICA – gives **Puff of Smoke appearance** on Angiography



Puff of Smoke appearance

Vein of Galen Malformation

→ Characterised by Triad of

- Midline cystic swelling
- Hydrocephalus
- CHF

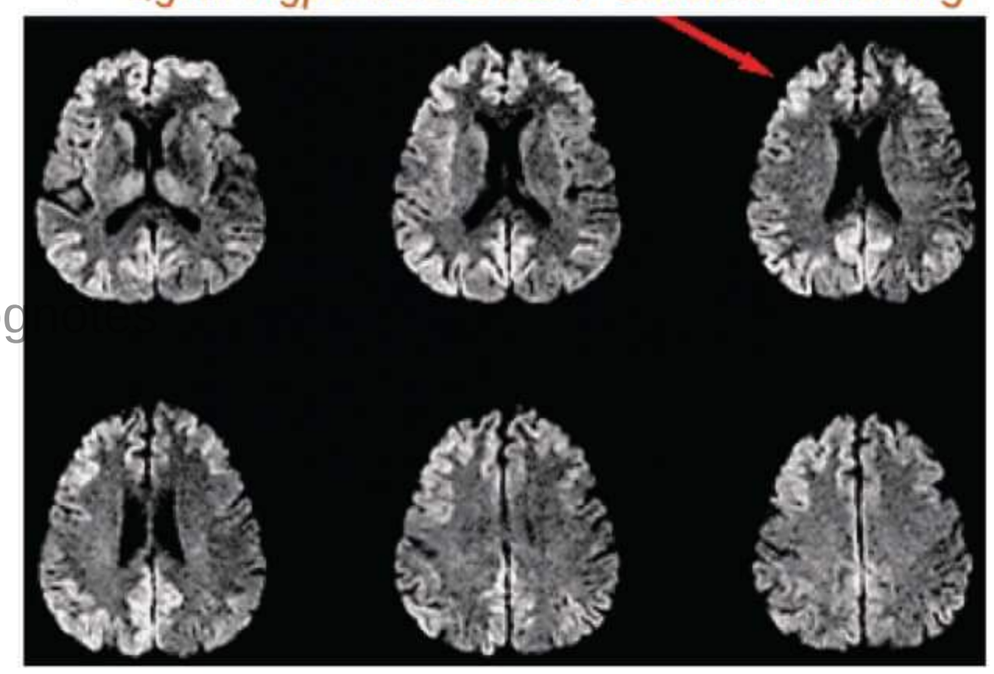
Multiple system atrophy (Type C)

→ **Hot Cross Bun sign** (Cruciate Cross like Hyperintensities)

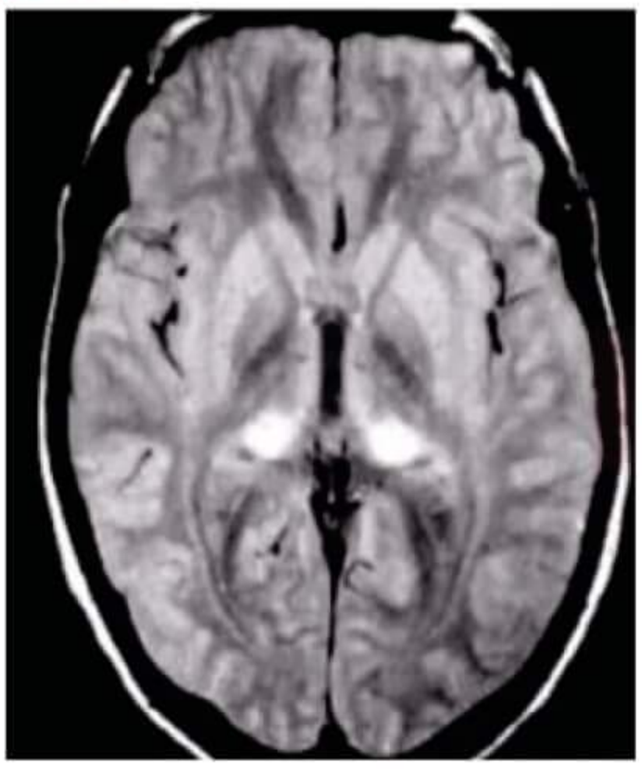
Hot Cross Bun sign

CJD (Spongiform leuco encephalitis)

→ **Gyral Hyperintensities / Cortical ribboning**

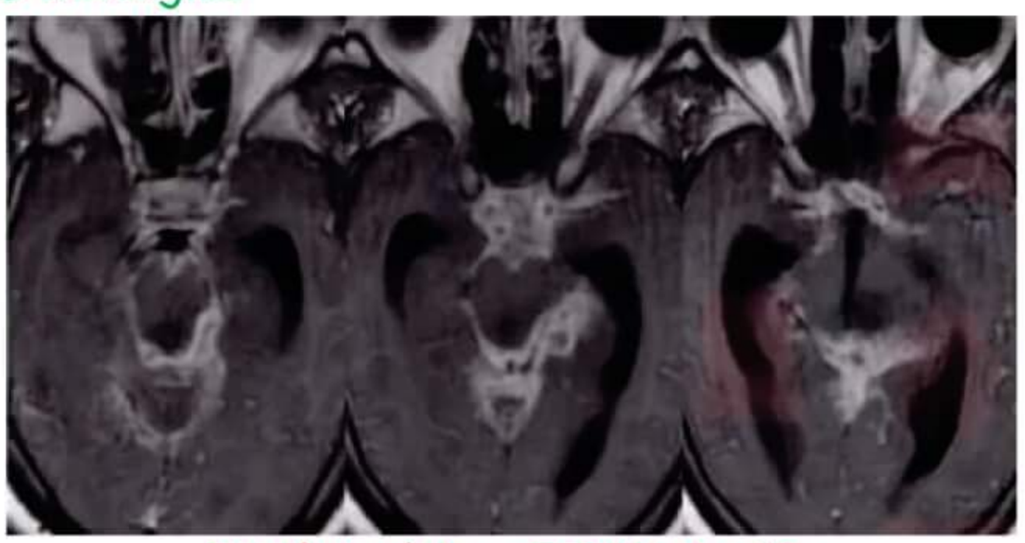


Variant CJD



→ Shows **Hockey Stick Sign** on CT

TB meningitis

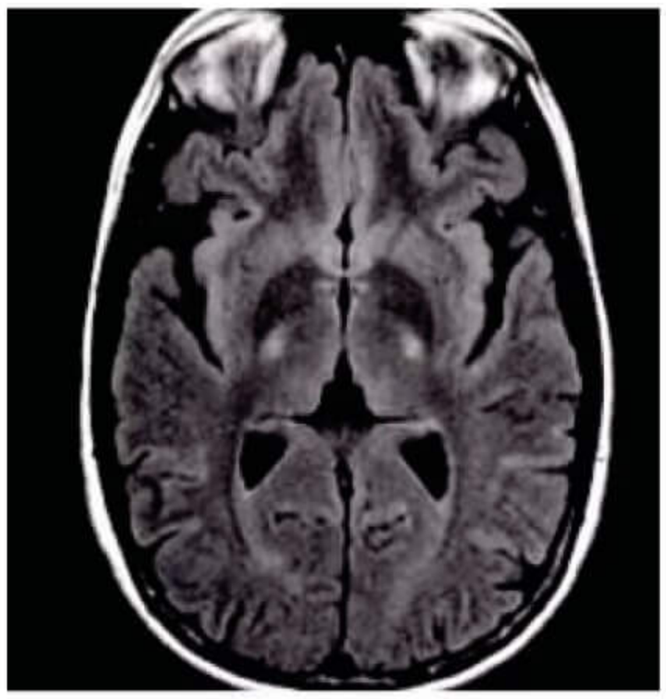


Basal exudate – TB Meningitis

→ Characterised by

- Basal exudates
- Hydrocephalus
- Infarcts

AML (Amyotrophic Lateral sclerosis)



→ *Hyperintensities in corticospinal tracts* (Posterior limb of Internal capsule)

NEURORADIOLOGY -PART 3

Brain tumor

→ MC brain tumor – Secondaries/metastasis
→ MC primary brain tumor – Meningioma
→ MC intraparenchymal brain tumor – Glioma
→ MC calcifying brain tumor – Craniopharyngioma
→ MC intraparenchymal calcifying brain tumor → Oligodendroglioma

Oligodendroglioma

→ Commonly in Frontal lobe
→ Chicken wire calcification
→ Fried egg appearance

Most brain tumors are hypodense on CT except:

→ Medulloblastoma
→ CNS lymphoma
→ Meningioma
} hyperdense on CT
→ Pineal Germinoma

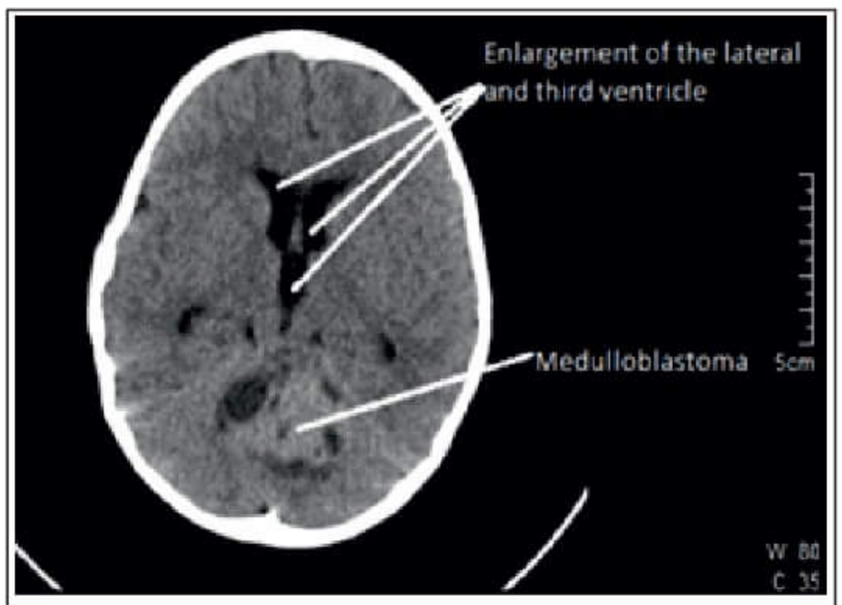
Note: IOC for brain tumors → CE-MRI (contrast enhanced MRI)

→ Brain tumor spread by CSF: MeC-EGG
- Me-Medulloblastoma
- C-CNS lymphoma
- E-Ependymoma
- G-Glioblastoma multiforme
- G-Germinoma

→ Calcifying brain tumors;"Ca2+ COME"
- C-Craniopharyngioma (MC)
- A-Astrocytoma, aneurysm (2'A's)
- C-Choroid Plexus papilloma
- O-Oligodendroglioma (MC intraparenchymal calcifying)
- M-Meningioma
- E-Ependymoma

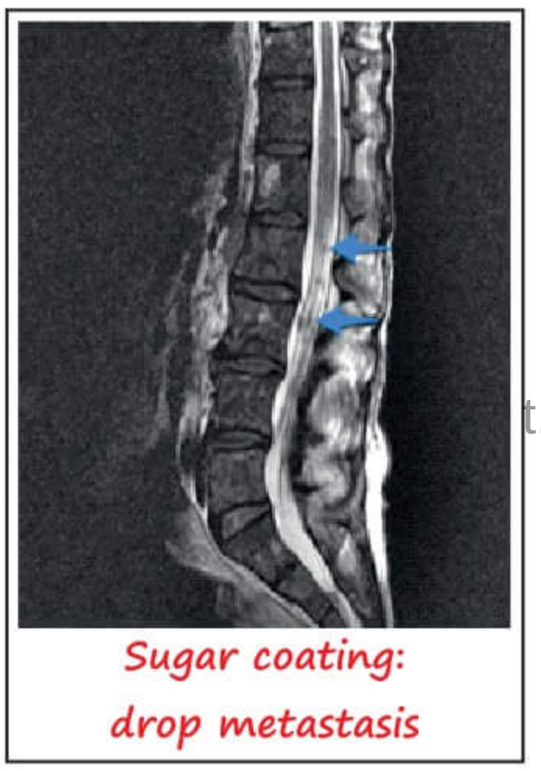
Medulloblastoma (PNET)

→ Highly malignant undifferentiated tumor
→ 15-20% pediatric brain tumor
→ Occurs at 4-11-year age group peaks at 5 years
→ M > F (2-4 times)
→ **Location**- from roof of 4th ventricle & cerebellar vermis
→ 1/3 have subarachnoid metastasis and drop metastasis to spine
→ Hyperdense on CT
→ On MRI-**diffusion restriction**

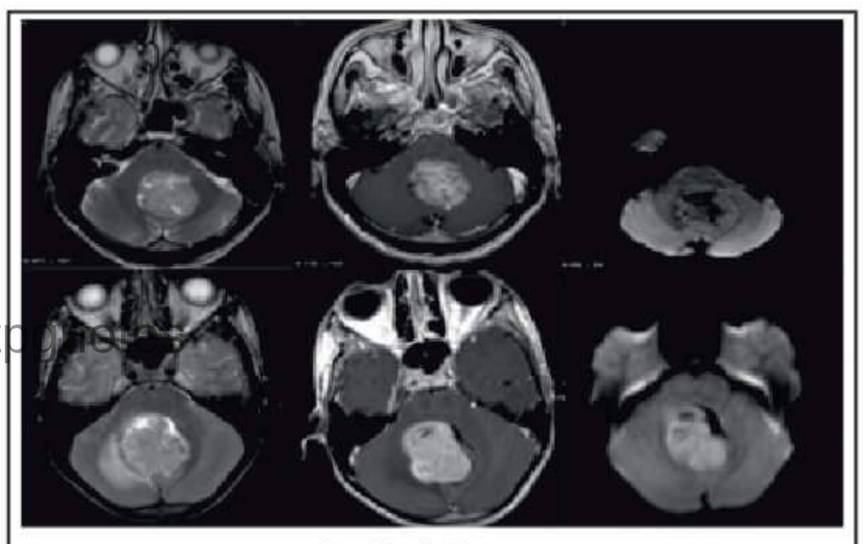


Medulloblastoma

Ependymoma	Medulloblastoma
→ Floor of 4th ventricle	→ Roof of 4th ventricle & Cerebellar vermis
→ Hypodense on CT	→ Hyperdense on CT
→ NO diffusion restriction	→ Diffusion restriction
→ ↑ ADC	→ ↓ ADC
→ Foraminal spread	→ CSF spread, drop metastasis with Sugar coating
	→ Prophylactic cranio spiral Irradiation



Sugar coating:
drop metastasis



medulloblastoma

Ependymoma:

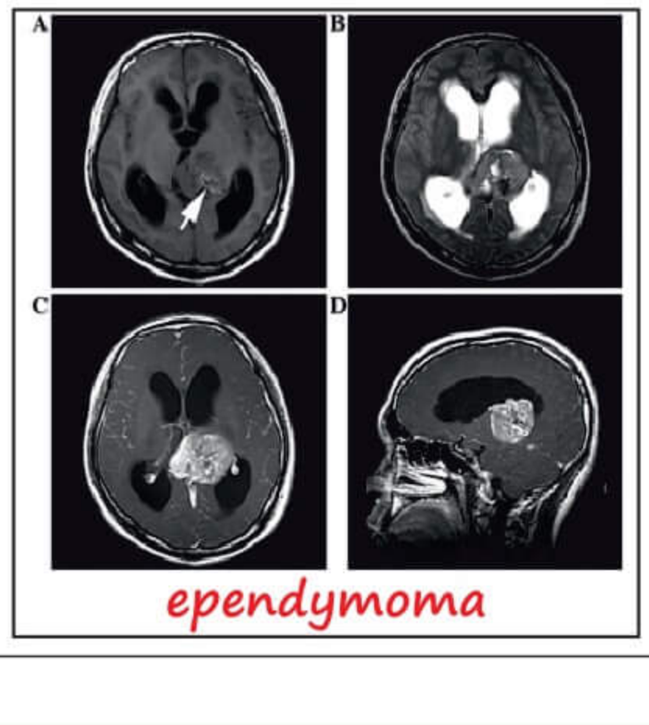
→ 10% primary brain tumors of children

→ 70 % are infratentorial and 30% are supratentorial

→ M > F

→ **Location**- arise from ependymal cell of floor of 4th ventricle and foramen of Luschka and less commonly from roof.

→ Plastic tumor that conforms to ventricle and extrudes through foramen of Luschka

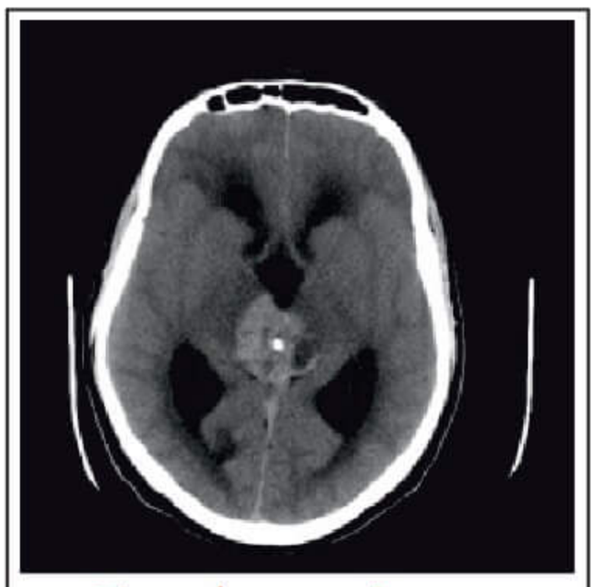


ependymoma

Pineal Germinoma

→ Lesion posterior to 3rd ventricle

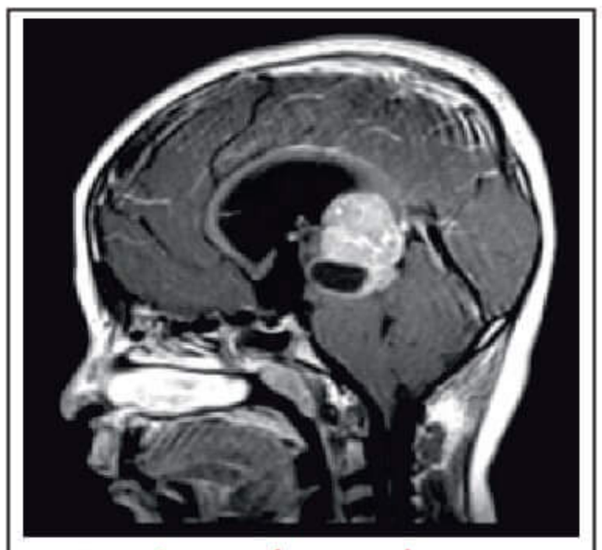
→ They are hyperdense lesions.



Pineal germinoma

PARINAUD Syndrome

→ Pineal gland tumor compressing superior colliculus causing upward gaze palsy



Parinaud syndrome

Craniopharyngioma	Pituitary Adenoma
→ Solid cystic lesions	→ Solid
→ Suprasellar lesion with sellar extension	→ Seller mass with suprasellar extension
→ Machine oil proteinaceous content	→ Figure of 8 / snowman appearance
→ **On CT**- Calcificationis seen	→ No calcification
→ Hyperintense on T1	→ Hypointense on T1

Craniopharyngioma

→ can be Adamantinomatous / papillary

Adamantinomatous	papillary
• More common in children • Commonly undergoes calcification	• More common in adults • No calcification

Glioblastoma Multiforme:

→ Thick wall Enhancing lesion with some areas of necrosis

→ Can cross the midline and invading the corpus callosum which gives a **Butterfly shaped lesion**

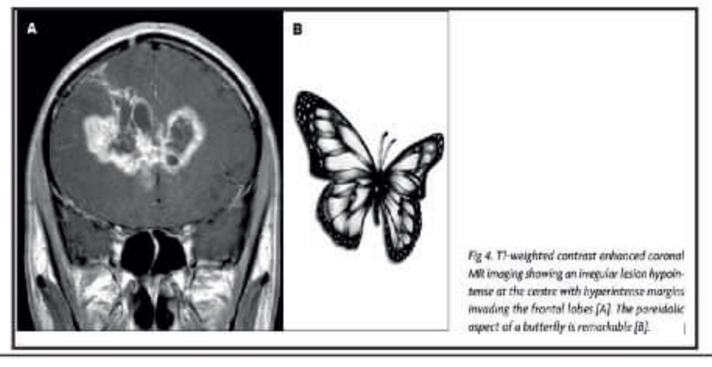
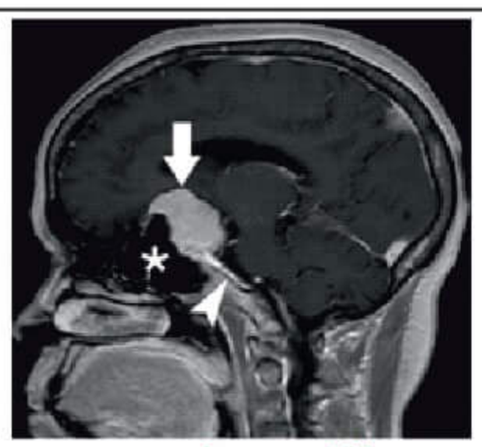


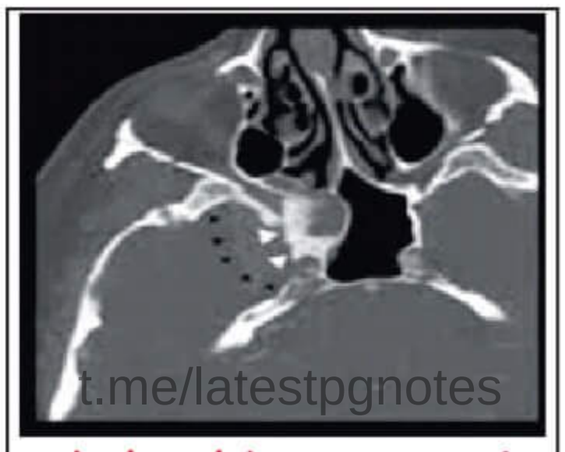
Fig 4. T1-weighted contrast enhanced coronal MR imaging showing an irregular lesion hypointense at the centre with hyperintense margins invading the frontal lobes [A]. The parasagittal aspect of a butterfly is remarkable [B].

Meningioma

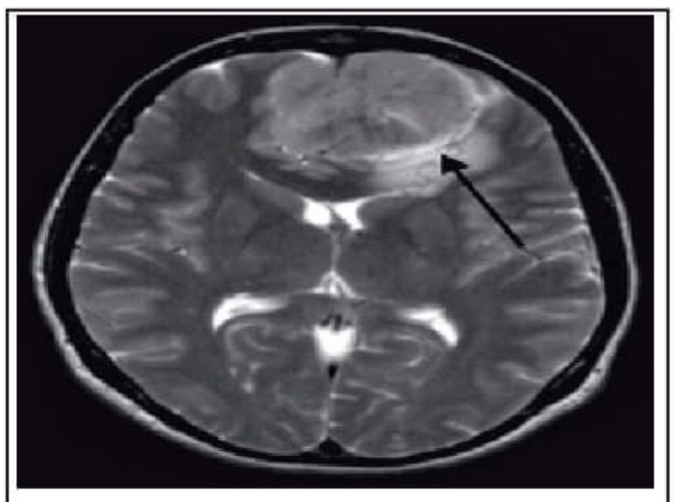
- → **MC primary brain tumor**
- → Broad base towards Dura
- → Dural Tail sign
- → Commonly calcify
- → Sunray / Spoke Wheel vasculature
  - It produces Intense contrast enhancement
  - "Early to come & late to go" → Mother in Law sign(Early enhancement & delayed washout)
- → Hyperdense on CT
- → calcification
- → Skeletal hyperostosis
- → Pneumosinusdilatans – **adjacent sinuses are dilated**
- → **On MRI** → isointense / Hypointense on T_2
- → **On MRS** →Alanine Peak @ 1.4 ppm
- → Extra axial, intradural
- → Intradural extramedullary
- → Produces**CSF cleft**

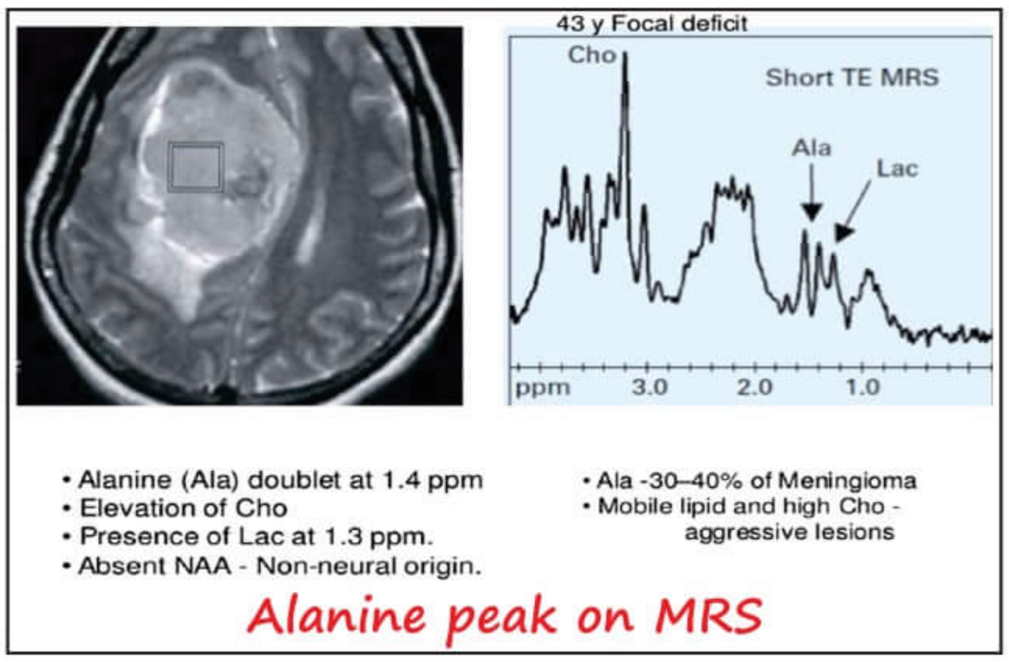
meningioma


Pneumosinus dilatans



Skeletal hyperostosis


CSF cleft

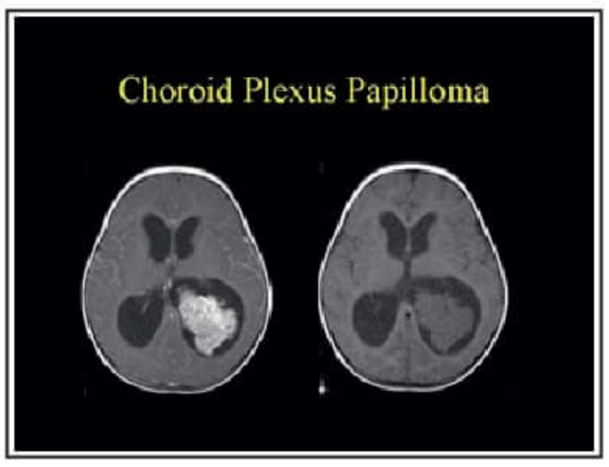


- Alanine (Ala) doublet at 1.4 ppm
- Elevation of Cho
- Presence of Lac at 1.3 ppm.
- Absent NAA - Non-neural origin.
- Ala -30–40% of Meningioma
- Mobile lipid and high Cho - aggressive lesions

Alanine peak on MRS

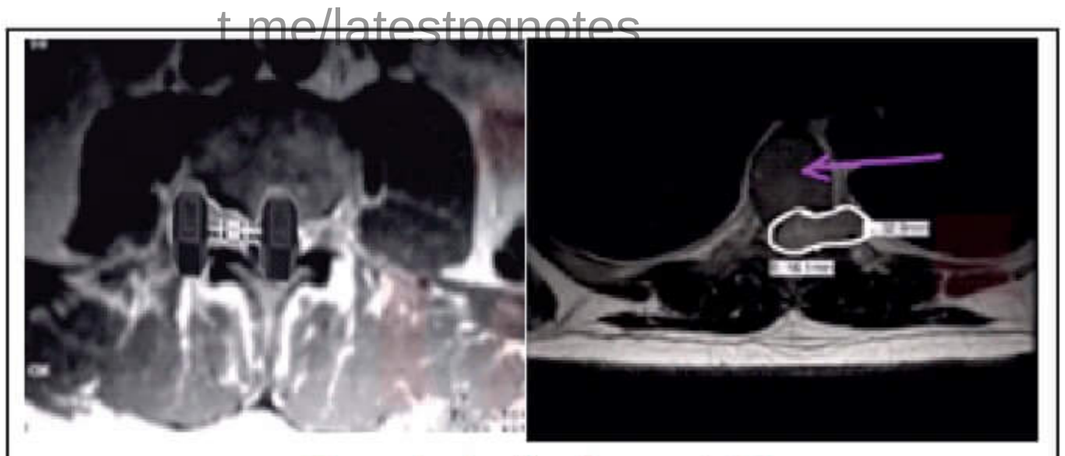
Choroid plexus papilloma

- → CSF producing
- → Normal location of choroid plexus is occipital horns of lateral ventricle
- → **Causes both Upstream and downstream hydrocephalus**



NEURO RADIOLOGY PART 4

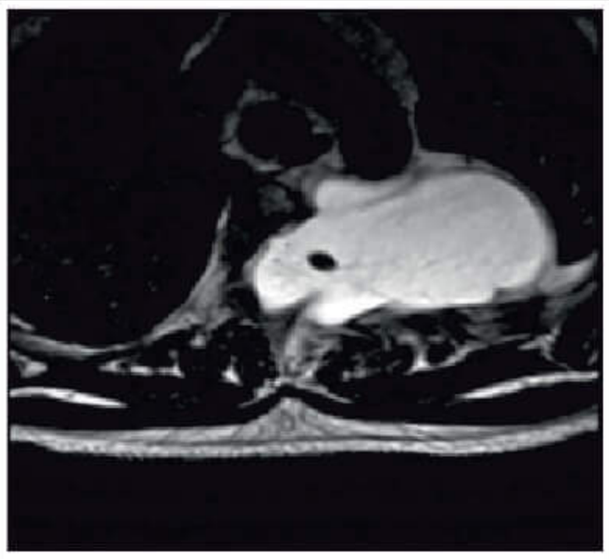
NF1	NF 2
→ Defect in chromosome- 17 → protein involved in NF1 is **Neurofibromin**	→ Defect in chromosome- 22 → Protein involved in NF2 **is Merlin**
→ **NF1 are Peripheral lesions** • Lisch Nodules • Iris Hamartomas • Optic nerve gliomas • Plexiform neurofibromas	→ **NF2 are Central lesions** Mnemonics 'MISME' • Multiple inherited • Schwannoma • Meningioma • Ependymoma
→ **Musculoskeletal defects** • ribbon ribs • Sphenoid dysplasia of greater wing of Sphenoid • Bare orbit sign-absent innominate line • Pseudoarthrosis of tibia • Scoliosis • Lateral meningocele	



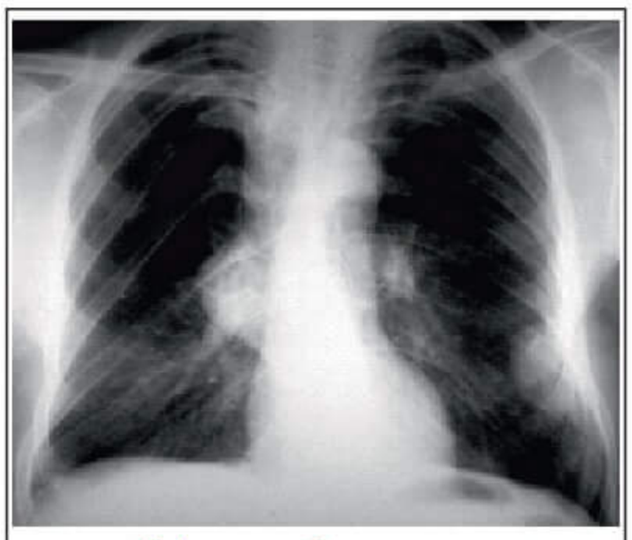
Dumb bell sign -NF

Scoliosis – NF1

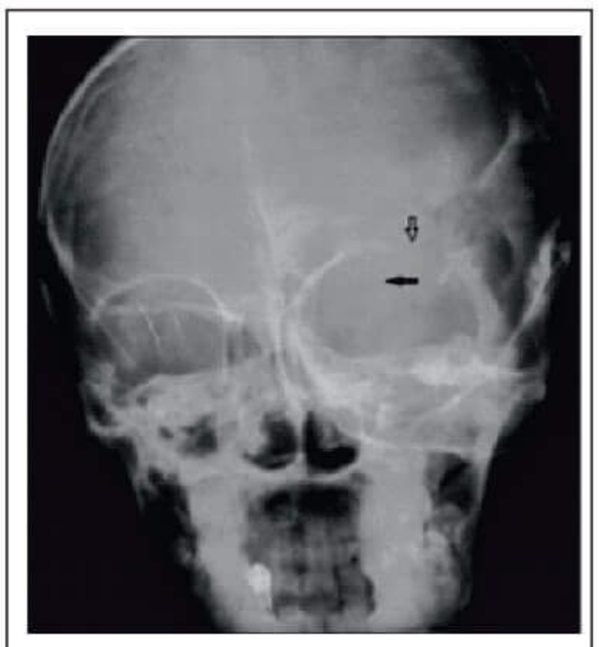
Pseudoarthrosis of tibia -NF1



Lateral meningocele



Ribbon ribs – NF1

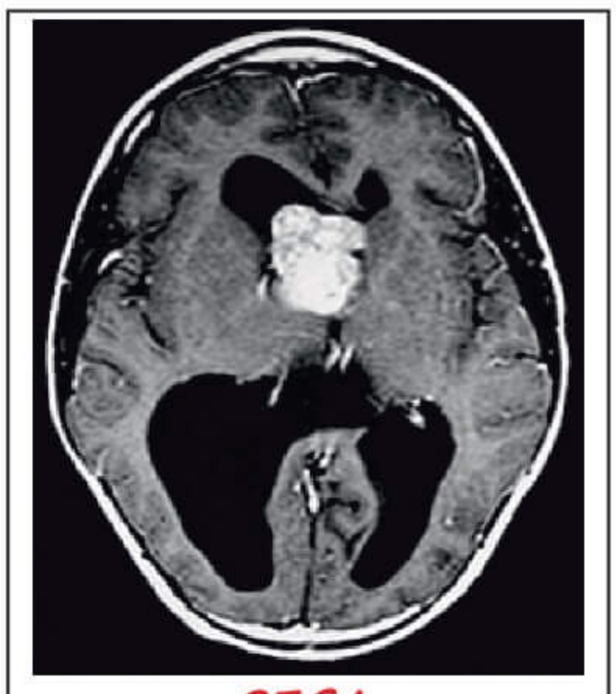


Bare orbit sign –NF1

Tuberous sclerosis:

- → Subependymal calcific nodules showing candle drippling like calcifications
- → **Ash leaf macule (MC)**
- → Adenoma sebacium (Angiofibroma)
- → Bilateral angiomyolipoma in kidney
- → Shagreen patch
- → Subependymal calcificnodules
- → Cortical tubers
- → SEGA
  - subependymal Giant cell astrocytoma
  - SEGA more commonly located on **'Foramen of Monro'**

Tuberous sclerosis



SEGA

Findings of tuberous sclerosis

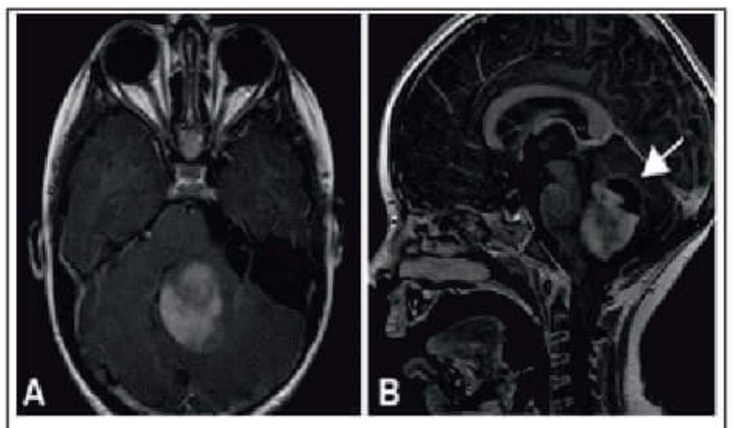
→ VOGTS TRIAD: (EPI LO IA)
- EPI-Epilepsy
- LO-Low IQ
- IA-Adenoma sebacium

→ Cardiac Rhabdomyoma

→ In the Lungs – cystic dilatation of lymphatic vessels, common in Female called as lymphangioleiomyomatosis (LAM)

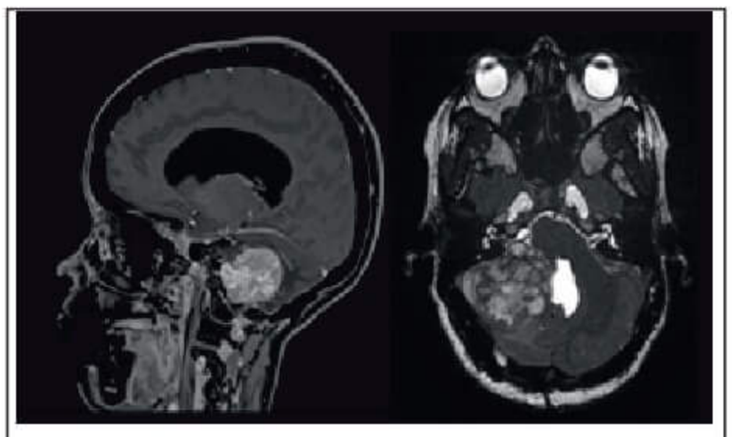
Cystic lesion with enhancing neural nodule involving cerebellar hemisphere

Child → Pilocytic astrocytoma



Pilocytic astrocytoma

adult → Hemangioblastoma



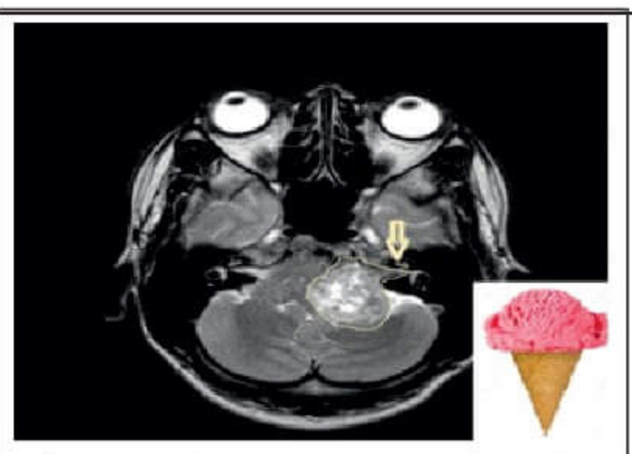
hemangioblastoma

Von-Hippel Lindau Syndrome (VHL)

→ More than 1 cystic lesions
→ Ch 3 defect
→ B/L clear cell RCC
→ Cerebellar **hemangioblastomas**
→ Retinal hemangioblastomas
→ ↑ risk of **pheochromocytomas**
→ ↑ risk of islet cell tumors
→ ↑ risk of endolymphatic sac tumors

Acoustic Neuroma / Vestibular Schwannoma

→ Ice cream cone appearance
→ M/C cerebellopontine angle tumor
→ NF_2 – B/L acoustic neuromas



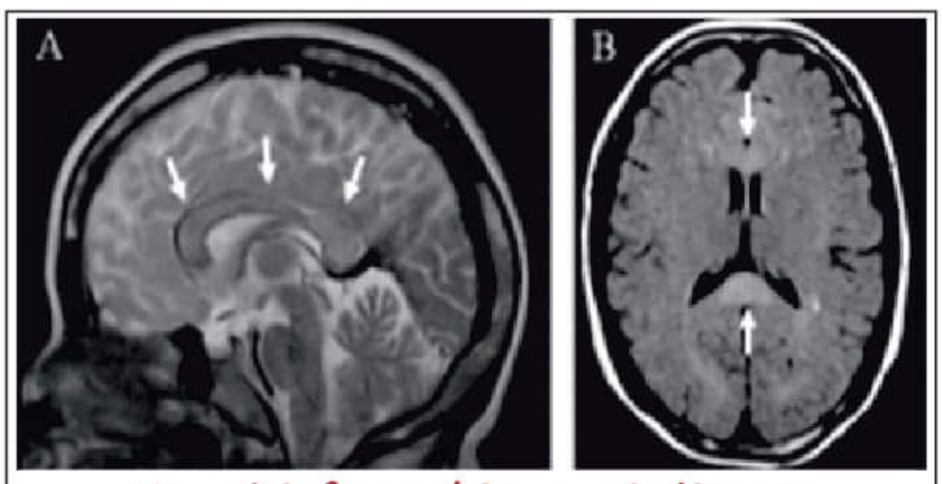
Ice cream cone appearance

Imaging signs associated with Corpus callosum

→ Lipoma of corpus callosum- Bracket calcification
→ Agenesis of corpus callosum- Racing car sign/moose head appearance /Viking helmet sign
→ Necrosis of corpus callosum- MarchiafavaBignami disease

Bracket calcification - lipoma

Racing car sign- agenesis

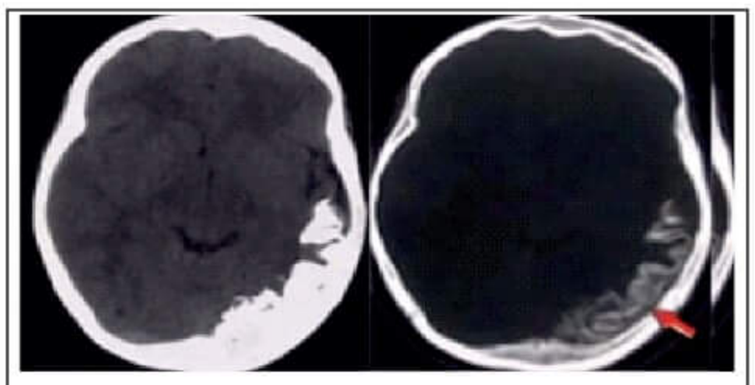


Marchiafava-bignami disease

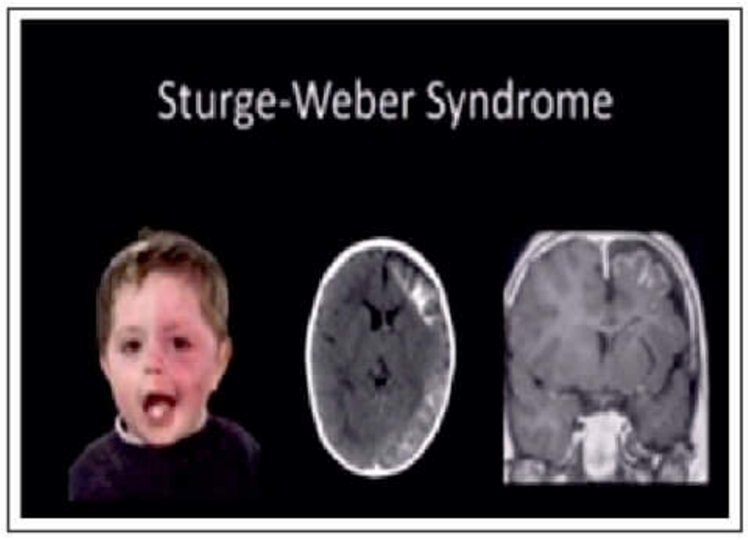
STURGE – WEBER SYNDROME

→ aka **Trigemino encephalic vascular malformation**

- In face – port wine stain
- In leptomeningeal area – tram track appearance
- Ipsilateral hemi atrophy of the brain
- seizure (contralateral to the port wine stain)



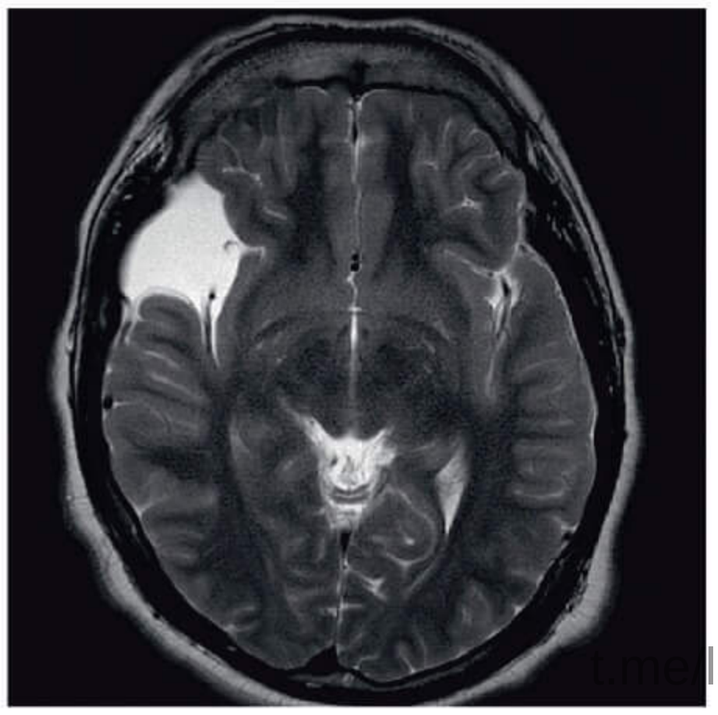
Tram track appearance



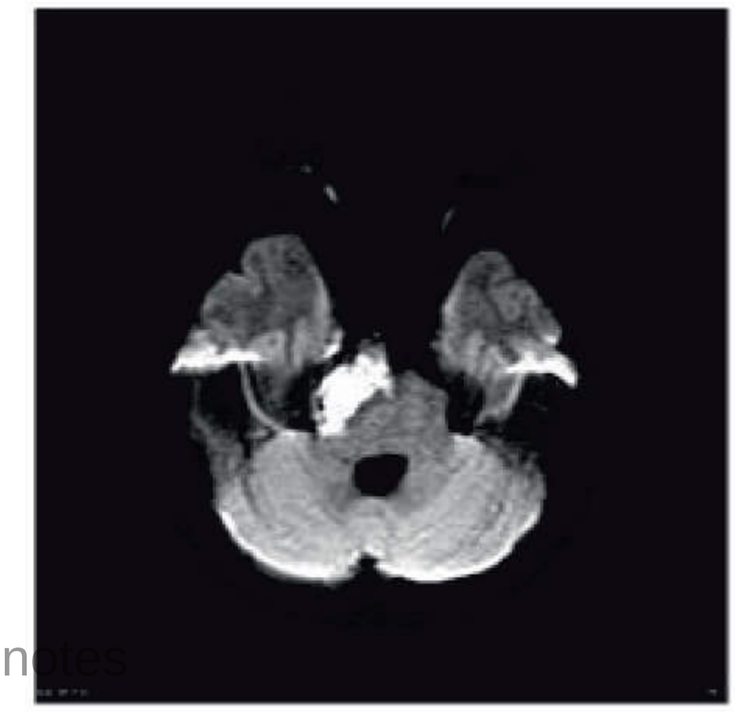
Arachnoid cyst

→ Cystic lesion at the level of **sylvian fissure**(Not communicating with lateral ventricle)

ARACHROID CYST	Epidermoid CYST
→ Common at the region of Sylvian fissure	→ Common at the CP angle
→ CSF containing cyst	→ Keratin containing cyst
→ suppressed by FLAIR	→ Not completely on suppressed by FLAIR
→ No diffusion restriction	→ diffusion restriction
→ HIGH ADC value	→ Low ADC value
→ Dark on DWI	→ Bright on DWI



Arachnoid cyst



Epidermoid cyst

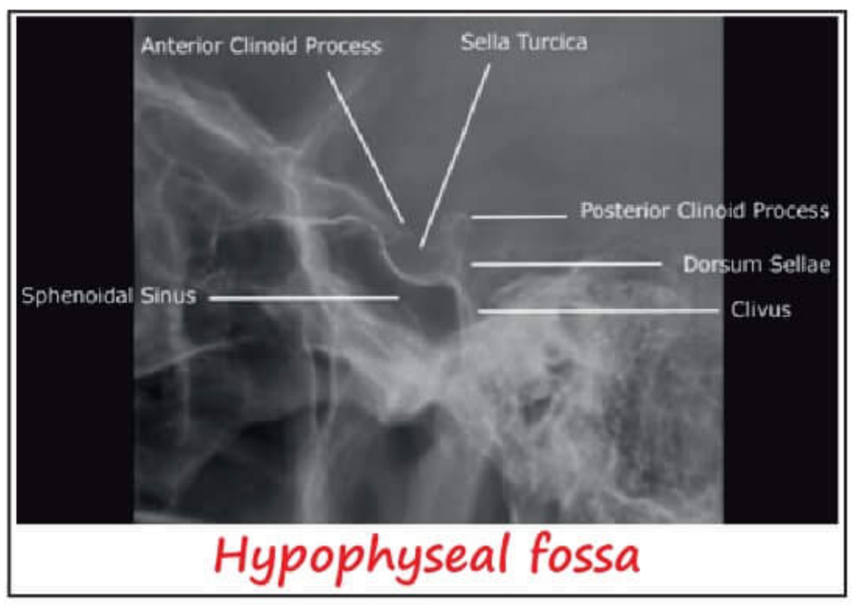
Signs of ↑ ICT

→ Earliest radiological sign of ↑ ICT in child - sutural diastases

→ Over a period of time there will be multiple indentation over the skull bones producing Silver beaten / copper beaten skull

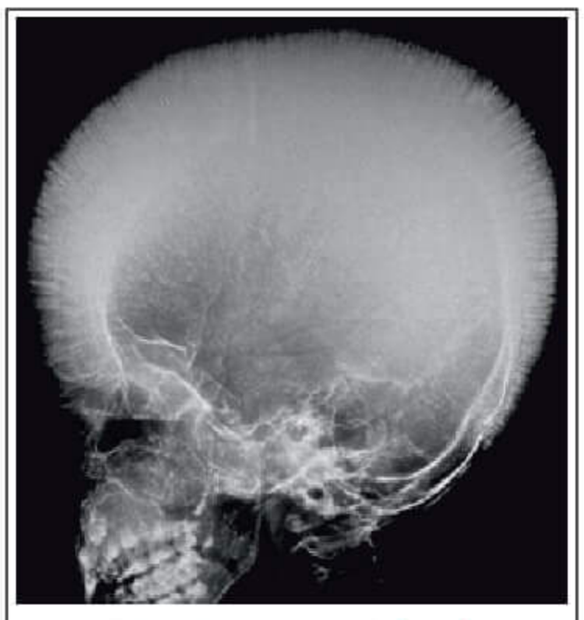
→ Earliest radiological sign of ↑ ICT in adult - erosion of dorsum Sella

→ Crew cut / hair on end appearance occurring in cases of thalassemia's and sever hemolytic anemia



Hypophyseal fossa

Silver / copper beaten skull

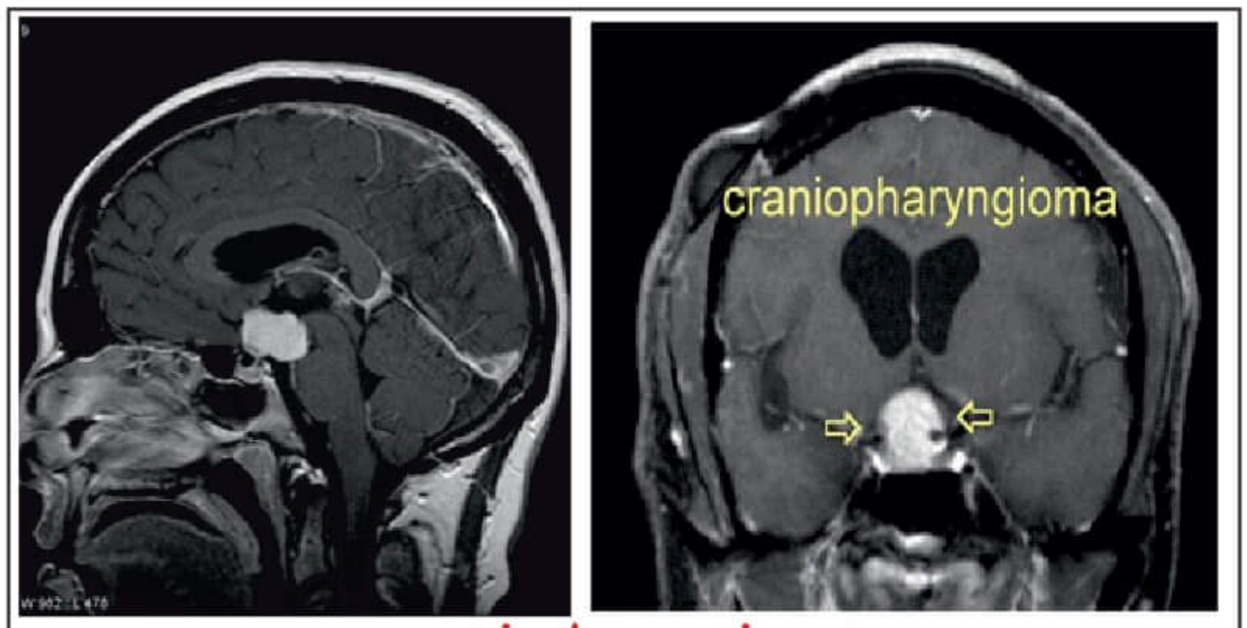


Crew cut / hair on end appearance

craniopharyngioma

→ Lesion in the Sella showing calcification

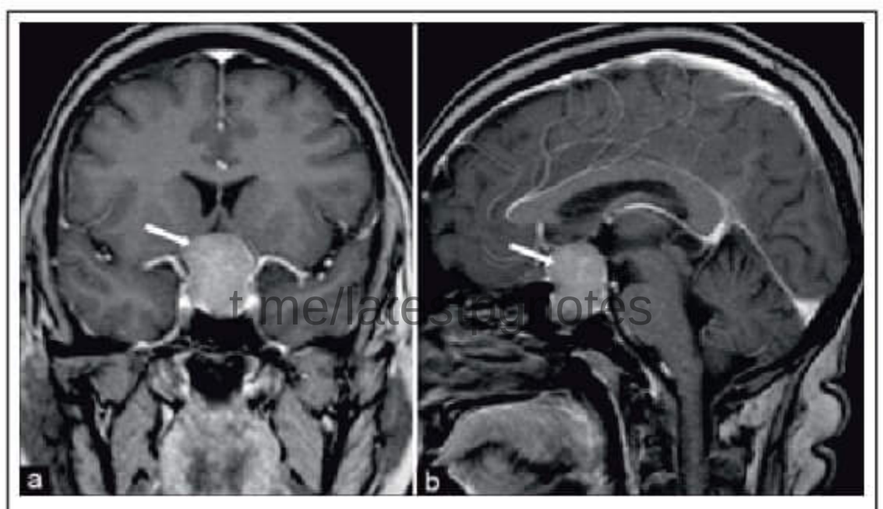
→ Most common calcifying brain tumor



craniopharyngioma

Pituitary macroadenoma

→ Lesion at the level of the Sella, which is solid and having classic figure of 8 or snowman appearance



Pituitary macroadenoma

Halloverden Spatz disease

→ EYE OF TIGER Appearance

→ Aka '**PKAND**':**Pantothenate kinase associated neuro degeneration**

→ Iron deposition around the Globus pallidus, Giving hypointensesignal around the Globus pallidus

→ Central hyperintensity is due to gliosis

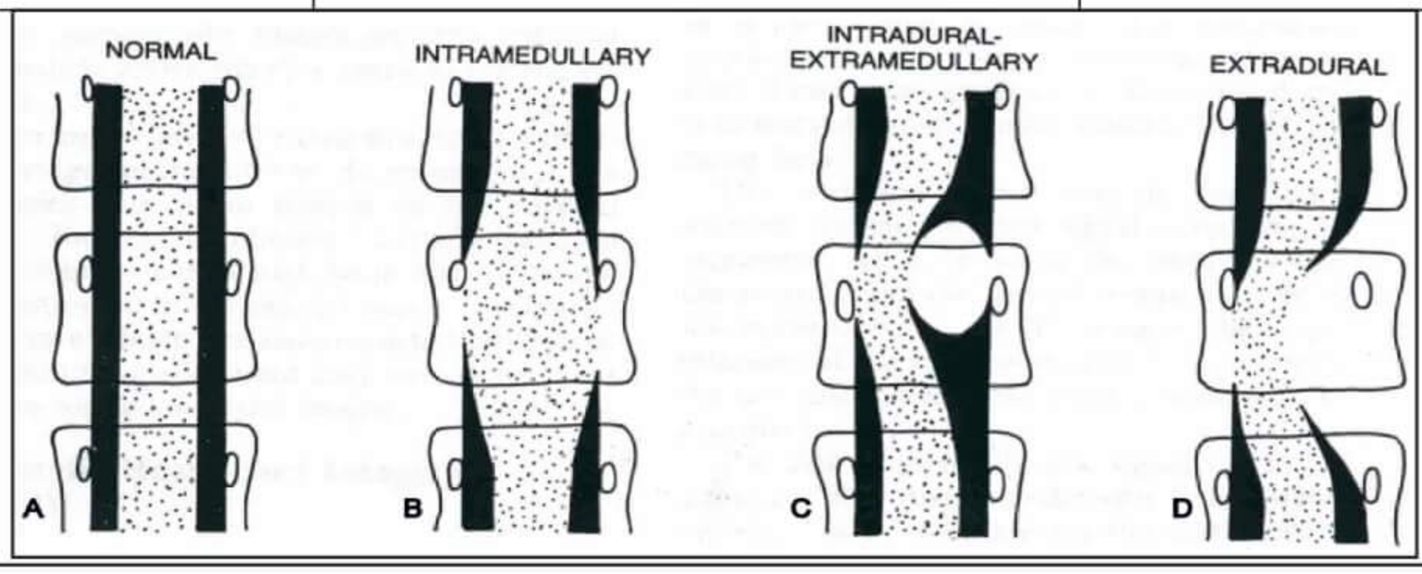
Halloverden Spatz disease

NEURORADIOLOGY – Part 5

Myelography

→ inject contrast into subarachnoid space to evaluate lesions in and around spinal cord

Intramedullary	Intradural Extramedullary	Extradural
• Tapered appearance Called as "Trouser leg" appearance.	• Meniscus sign	• Feathery appearance

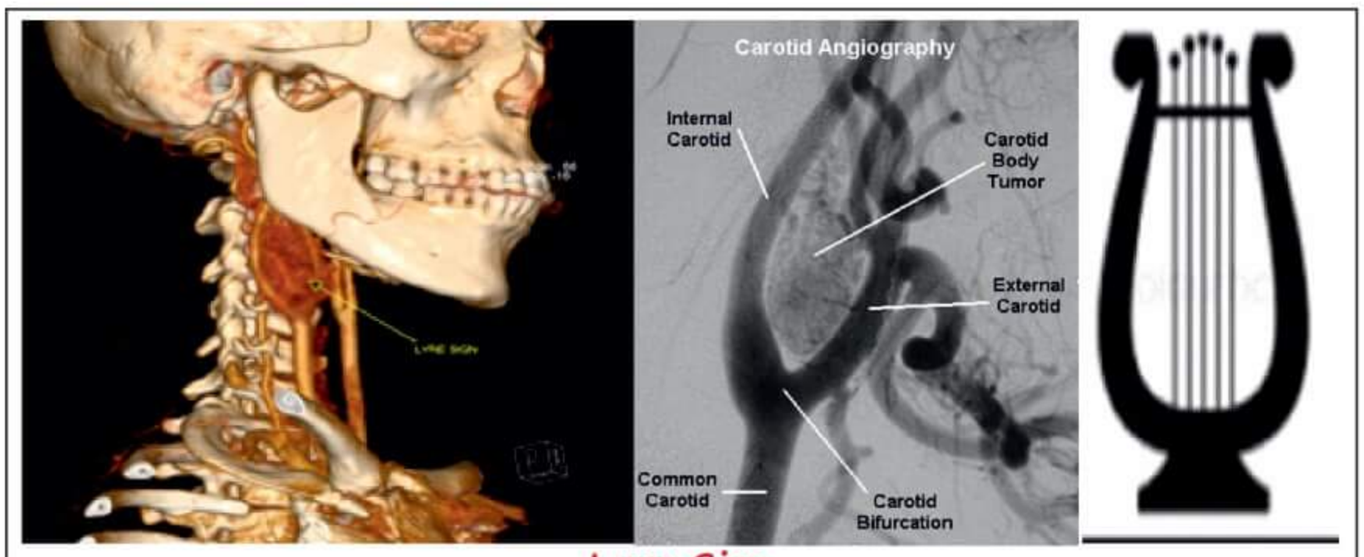


CAROTID BODY TUMOR

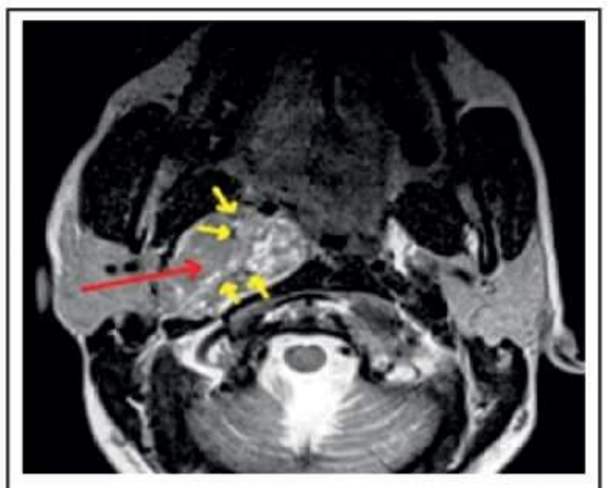
→ **On CT Scan** – Enhancing vascular lesion showing splaying of external and Internal Carotid Arteries

→ **Lyre Sign** is seen with carotid body tumours (Splaying of external carotid artery and internal carotid artery by a carotid tumor)

→ **On MRI** – These carotid body tumor / paraganglioma show **salt and pepper appearance**



Lyre Sign



Salt and Pepper Appearance

ANENCEPHALY

→ Acrania (absent cranial vault)and loosely arranged brain parenchyma on antenatal scan suggests Anencephaly.

→ Earliest congenital abnormality detected as early as 10^{th} week.

→ **FROG EYE appearance** (loosely arranged brain parenchyma with orbits and absent cranial vault)

ANENCEPHALY

CHIARI MALFORMATION

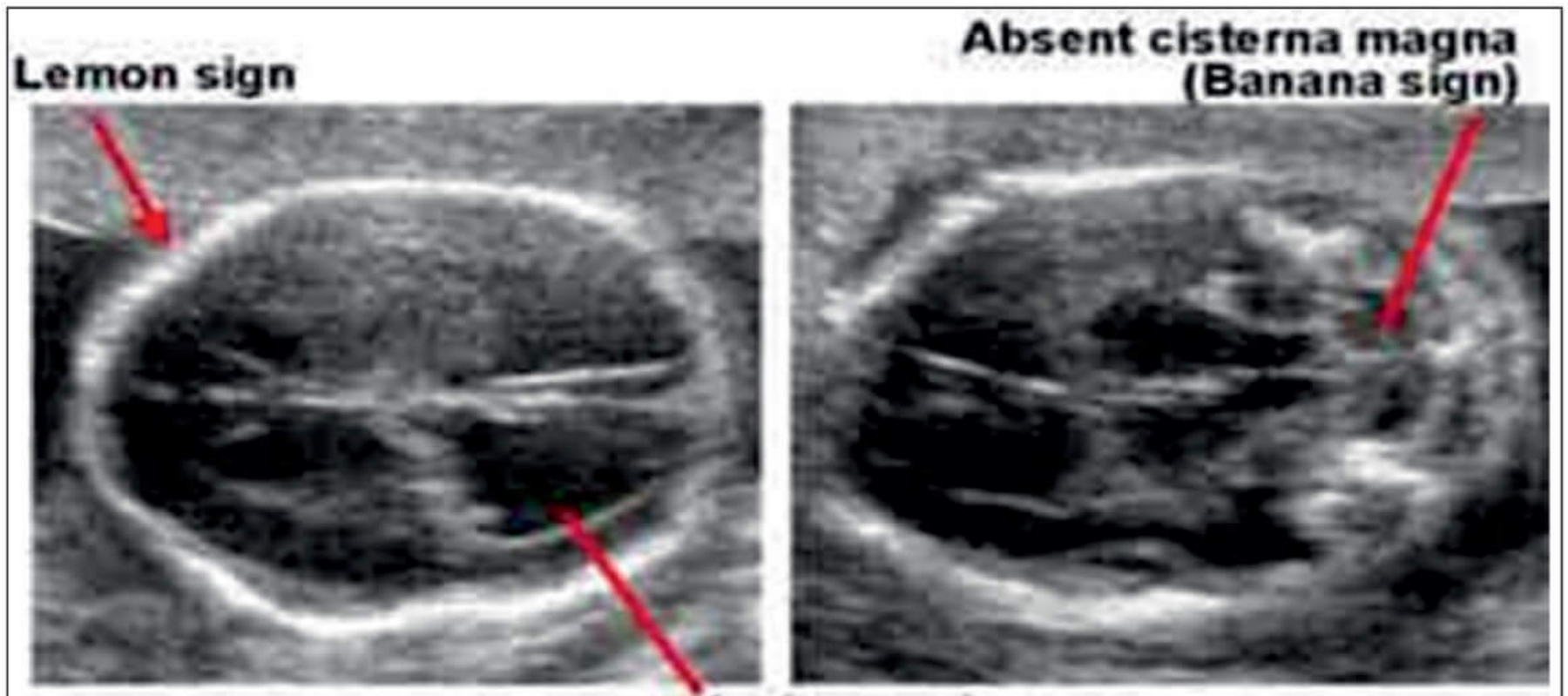
→ BANANA SIGN- Wrapping of cerebellum around brainstem (due to herniation of vermis)

→ LEMON SIGN- Anterior bossing of frontal bone (due to hydrocephalus)

→ Banana and Lemon Sign are features of Chiari Malformation and also"**Spina Bifida**"

→ **Reasons for spina Bifida to have Lemon sign and Banana sign**

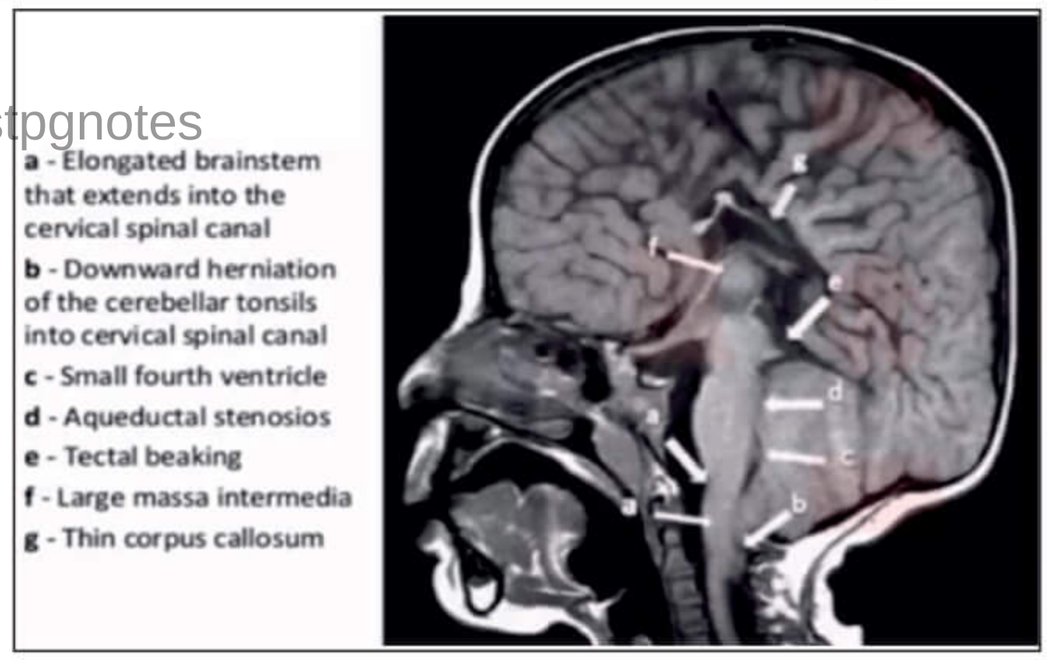
- 100 % cases of lumbar myelomeningocele haveassociation with Chiari malformation



CHIARI MALFORMATION

→ **Features of Chiari Malformation**

- Tectal Beaking
- Vertically placed 4th ventricle
- Lacunar skull



DANDY WALKER MALFORMATION

→ Agenesis of cerebellar vermis which causes the fourth ventricle to communicate with cisterna magna is a feature of Dandy walker malformation.

- Mega cisternamagna
- Large posterior fossa in Dandy Walker
- (Small posterior fossa in Chiari malformation)

Mega CisternaMagna

→ **Spinal metastasis**- Involvement of vertebral body and sparring of disc spaces.

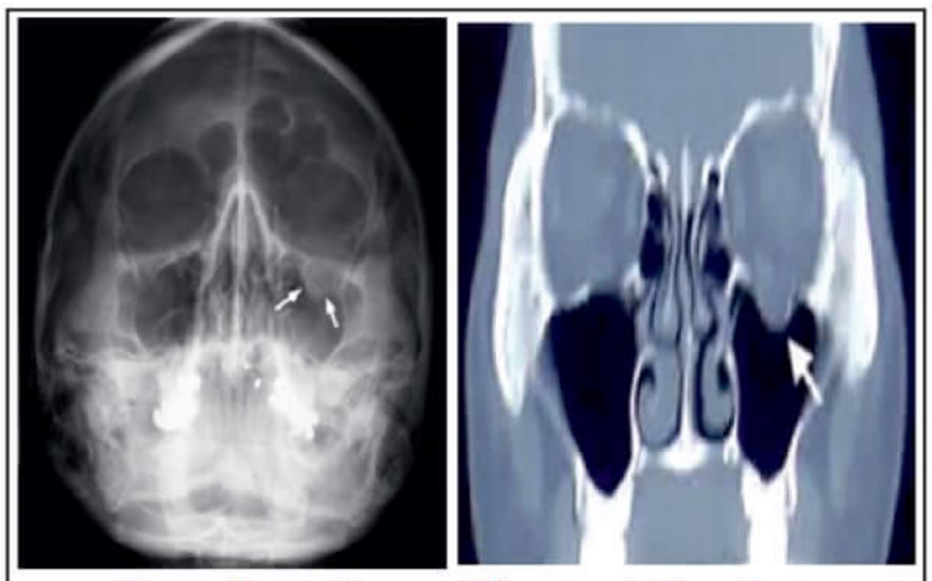
→ **Pott's spine** – Paradiscal in nature (Involvement of disc and adjacent end plates)

Blow out fracture

→ Aka tear drop fracture

→ Contents of orbit hanging out into the maxillary sinus.

→ Best view for orbital floor visualization- WATER's view



Tear drop Sign – Blow out Fracture

NEURAL TUBE MIGRATION DISORDERS

→ Agyria

- Absence of gyrations in the brain
- Aka Lissencephaly
- Figure of 8 appearance (brain looks smooth and soft)

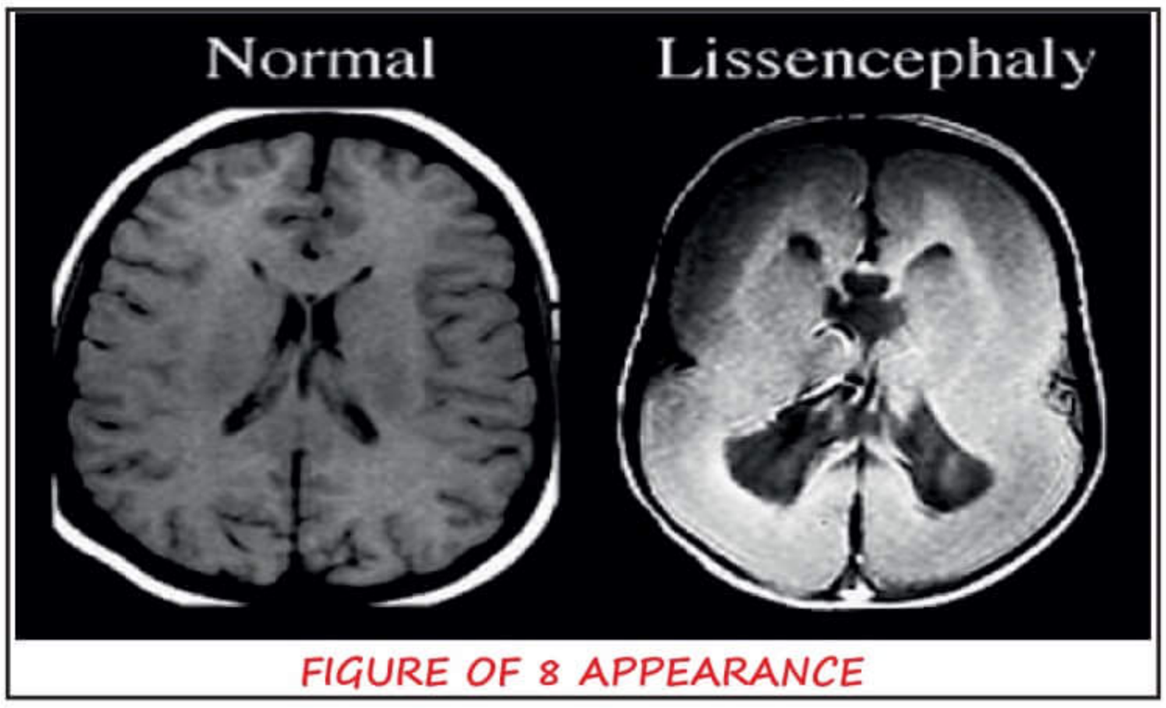
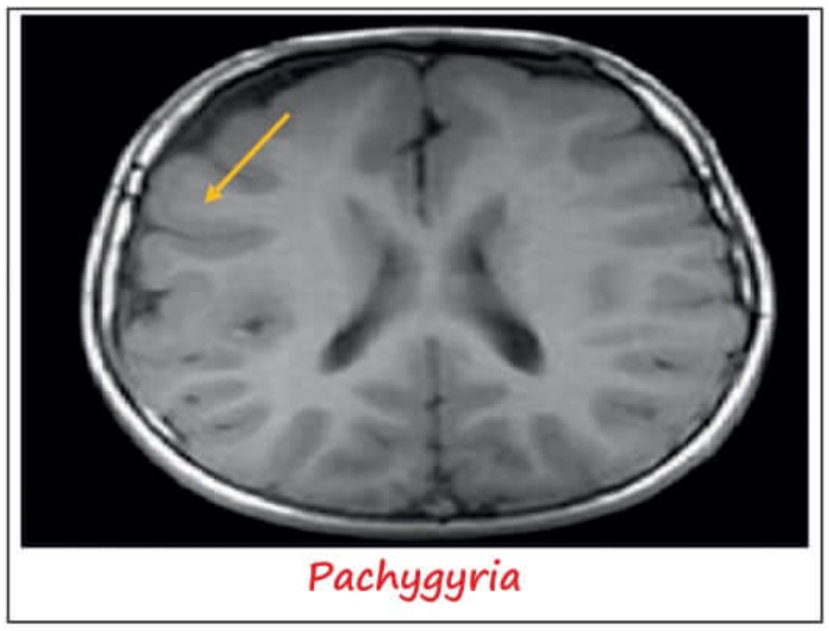


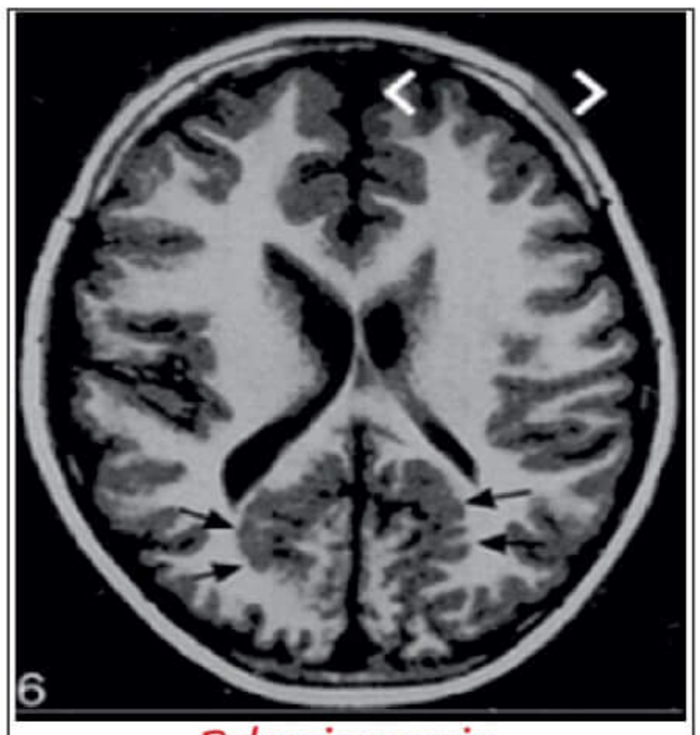
FIGURE OF 8 APPEARANCE

→ **Pachygyria**- Thick and few gyri



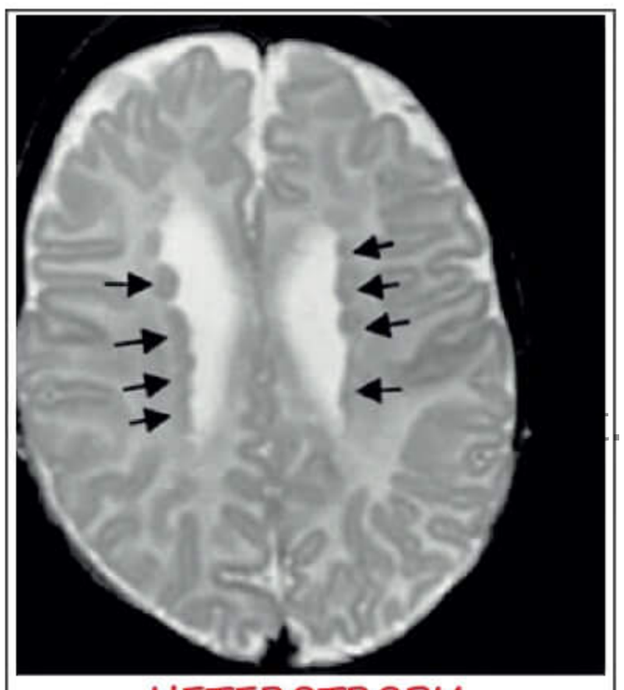
Pachygyria

→ **Polymicrogyria** – Thin, small and multiple gyri



Polymicrogyria

→ **Heterotopia** – Heterotopic tissue of grey matter present within white matter of brain



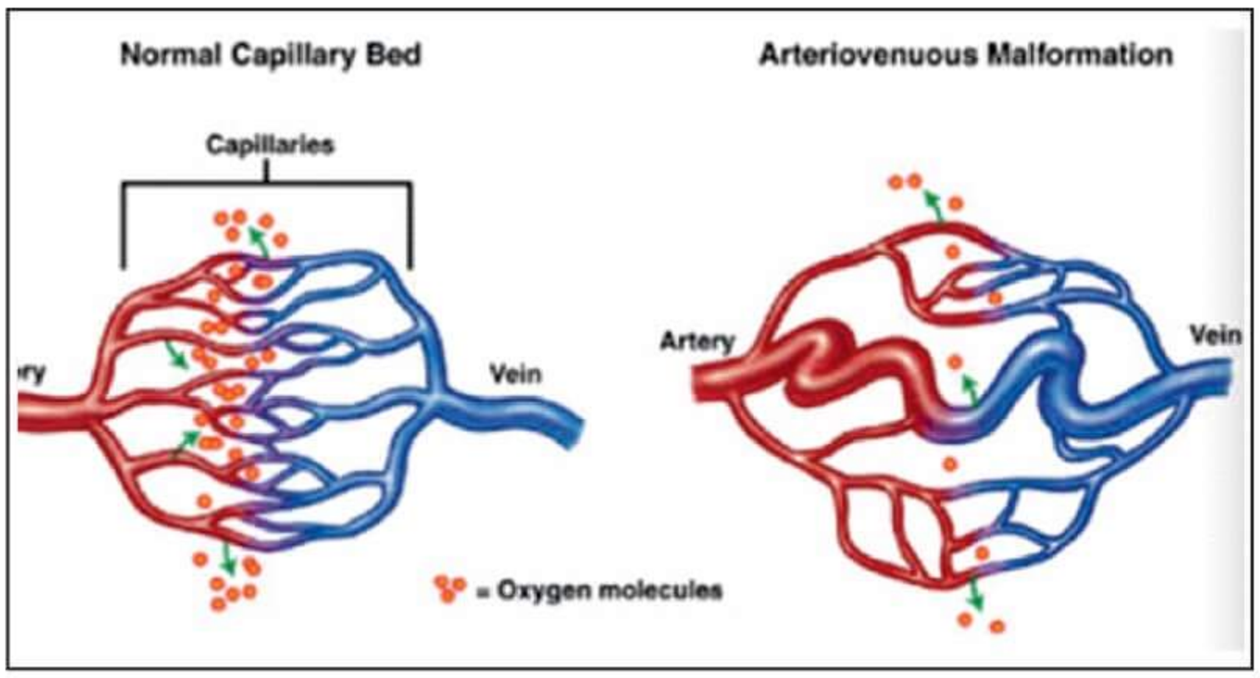
HETEROTROPIA

→ Holoprosencephaly

- Single lateral ventricle giving BOOMERANG ventricle or Pancake appearance
- PATAU syndrome has Holoprosencephaly (midlinedefect)

Holoprosencephaly

AV MALFORMATION

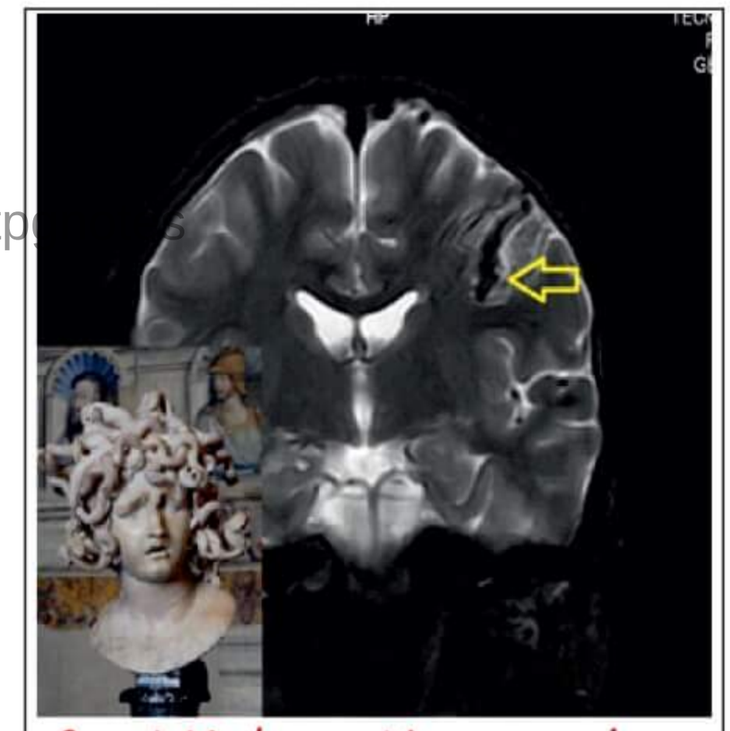


→ **True AV malformation**
- Has **Central nidus**
- Has definite **Feeding artery**

→ **Cavernous angioma** -Popcorn appearance on MRI brain

→ **Venous malformation (Venous Angioma)**-Caput medusa / spoke wheel appearance

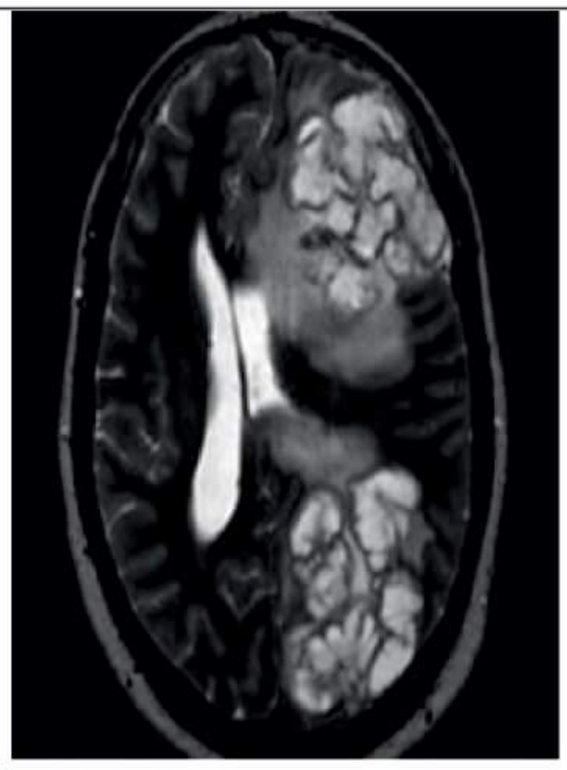
POPCORN Appearance- Cavernous Angioma



Caput Medusa - Venous angioma

Soap Bubble appearance on

→ **MRI**
- **Brain** → Cryptococcus neoformans
- **On/around knee** → Giant cell tumor or osteoclastoma
- **Of mandible** → Adamantinoma
- **Of abdominal radiograph** → Meconium ileus
- **Of antenatal scan** → Multicystic dysplastic kidney



Soap Bubble Appearance-Cryptococcus

Retinoblastoma

→ Intraorbital calcification

→ B/L Retinoblastoma + Pineal gland tumor- Trilateral retinoblastoma

→ B/L Retinoblastoma + Pineal gland tumor (Trilateral retinoblastoma) + Suprasellar mass- Quadrilateral retinoblastoma

→ 2nd MC cancer in retinoblastoma- osteosarcoma

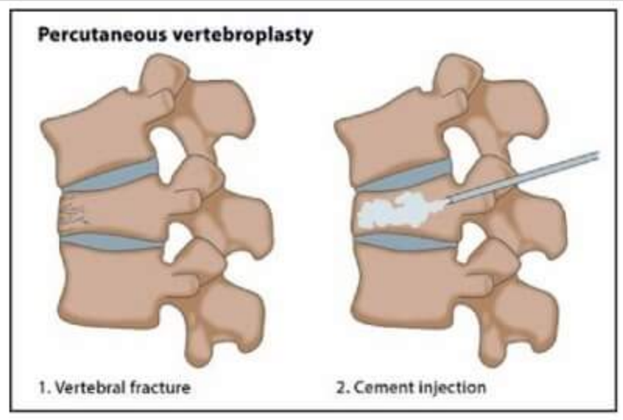
→ Mutation of RB gene on chromosome 13.

Retinoblastoma

Percutaneous Vertebroplasty

→ Done to relieve pain by injecting cement in posterior eminence of vertebral body in osteoporotic fractures.

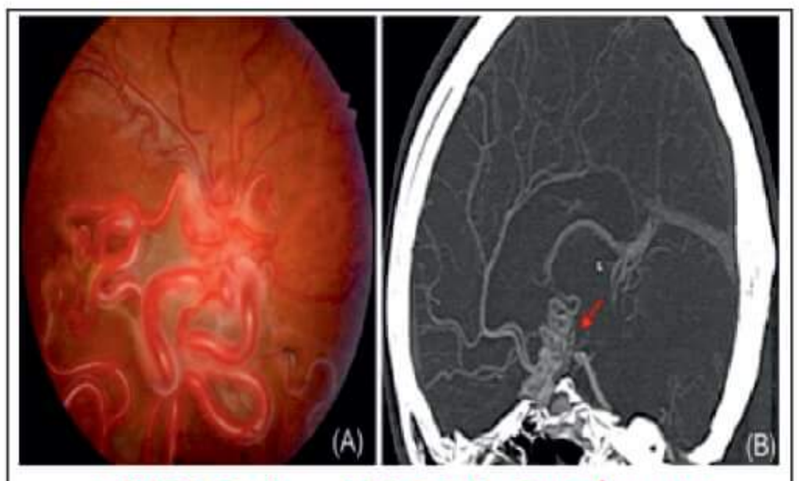
→ Cement used- PMMA, polymethylmethacrylate



Mesencephalo – oculo -facial angiomatosis also called as

→ Aka WYBURN – MASON syndrome / Retinocephalic vascular malformation

- Pulsatile Exophthalmos
- Seizure
- PORT WINE STAIN



WYBURN – MASON Syndrome

Pulsatile exophthalmos

→ Also seen in **Caroticocavernous fistule**

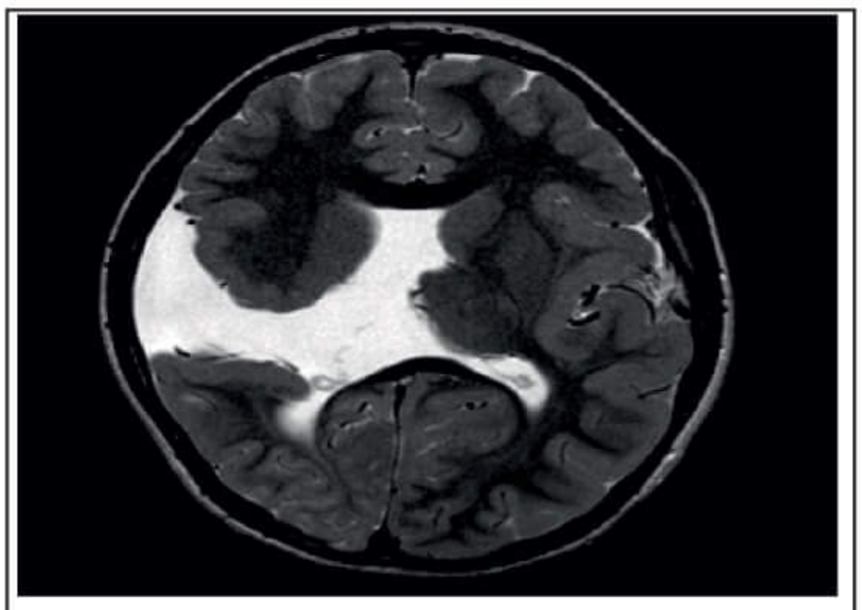
→ In caroticocavernous fistula, after basal skull fracture - Communication between carotid artery, internal cranial artery and the adjacent cavernous sinus

↓

back flow of blood from internal carotid into ophthalmic veins causing pulsatile exophthalmos along with prominent superior ophthalmic vein

SCHIZENCEPHALY

→ Cystic lesion **at silvian fissures** communicating with lateral ventricles



SCHIZENCEPHALY- T2 weighted image

Cystic lesion at sylvian fissure communicating with lateral ventricle – Schizencephaly

Cystic lesion at sylvian fissure not communicating with the lateral ventricle – Arachnoid

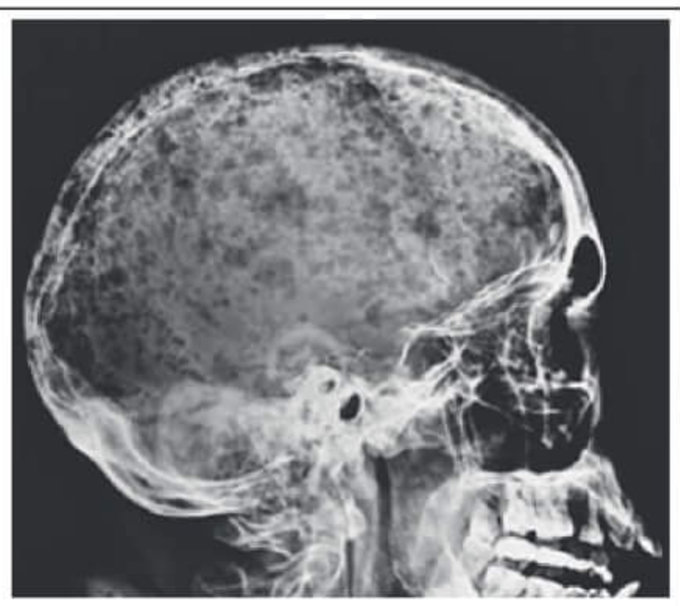
Growing Skull Fractures

→ Entrapment of leptomeninges after skull fracture forming – LEPTOMENENGIAL CYST

NOTE

- Tram track calcifications → Sturge Weber
- Starry sky on NCCT Brain → Neurocysticercosis
- Diffuse nodular Calcification→ Toxoplasmosis
- Bracket calcification → Lipoma of corpus calcium
- Cotton wool skull → Paget's disease
- Salt and pepper skull → hyperparathyroidism
- Lacunar skull → Chiari Malformation
- Pepper pot skull → Hyperparathyroidism
- Raindrop skull → Multiple myeloma
- Geographical skull → Eosinophilic granuloma

Pepper pot skull
Hyperparathyroidism



Raindrop skull → Multiple myeloma

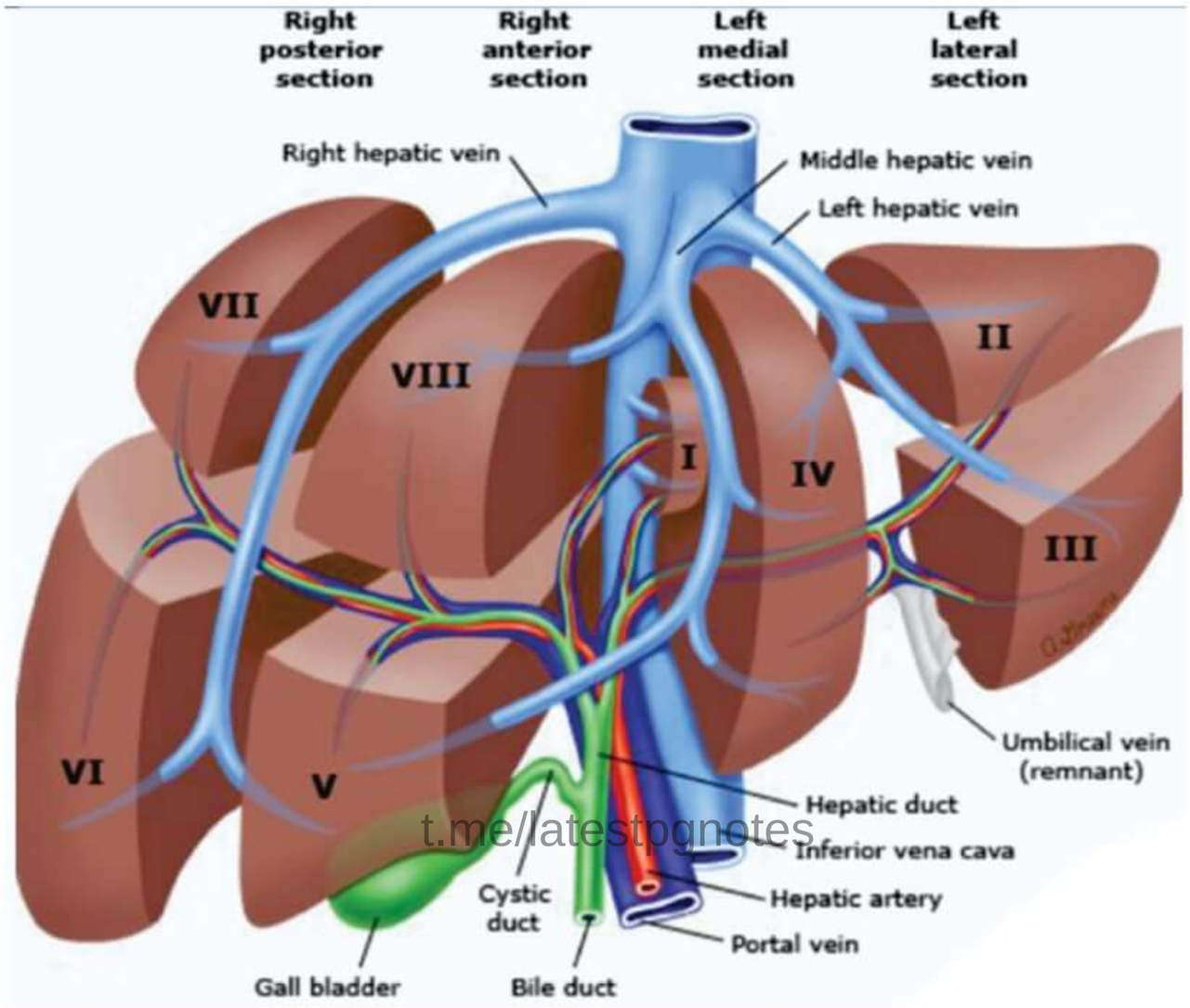
Geographical skull → Eosinophilic granuloma

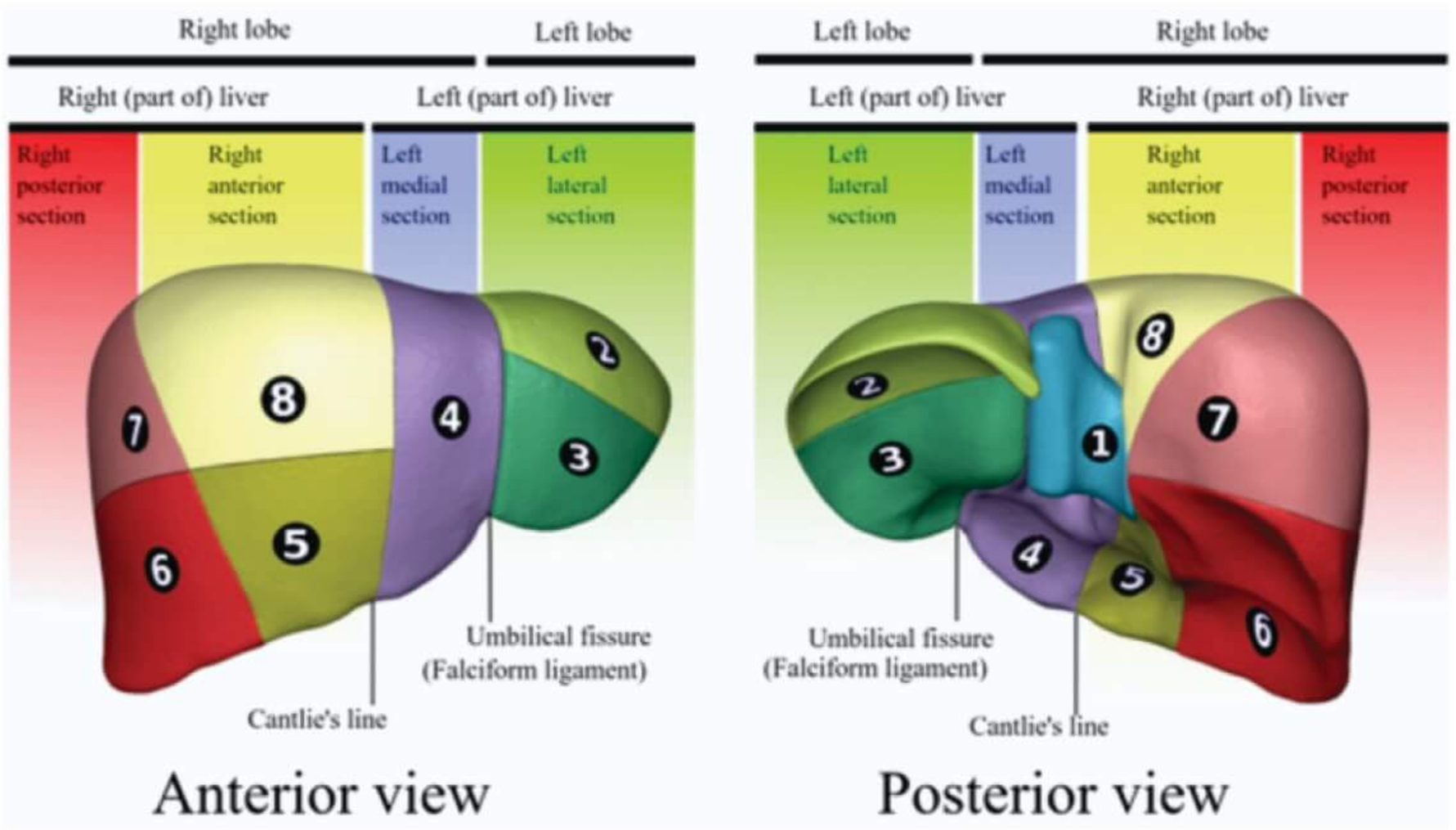
HEPATOBILIARY RADIOLOGY

Couinaud segments of liver:

→ has 8 segments (I- VIII)

- **Middle hepatic vein** – divides liver into right & left halves
- **Right hepatic vein** – divides right lobe into Anterior &Posterior halves
- **Left hepatic vein** - divides left lobe into medial & lateral halves
- **Portal vein** - runs transversely dividing liver into 8 segments



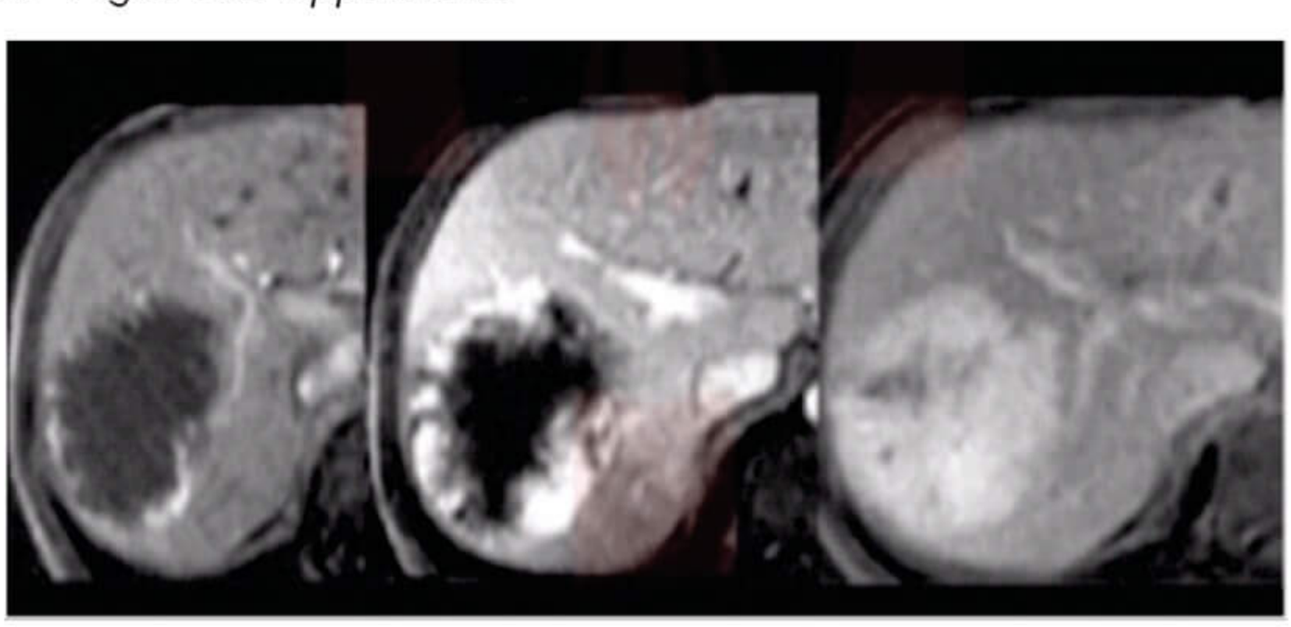


Note:

- MHV, PV &Cantlie line lie in the same plane
- Falciform ligament& LHV lie in the same plane

Haemangioma

- M/C benign lesion of the liver
- **Radiological finding:**
  - → On USG → hyperechoic area
  - → On CECT →Delayed centripetal enhancement after initial peripheral nodular enhancement
  - → On T_2W-MRI →light bulb appearance



Haemangioma showing Delayed centripetal enhancement after initial peripheral nodular enhancement

Few important Enhancement patterns

Hemangioma → Delayed centripetal enhancement

HCC → derives major blood supply from Hepatic artery

HCC → Has early arterial enhancement with rapid washout

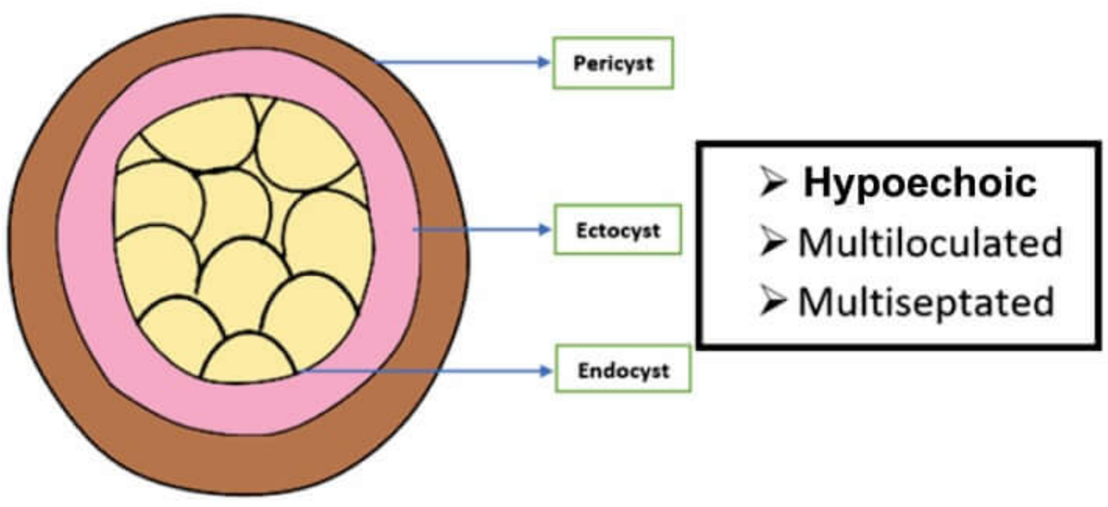
Meningioma → Early enhancement, delayed washout

→ "Mother in law" sign

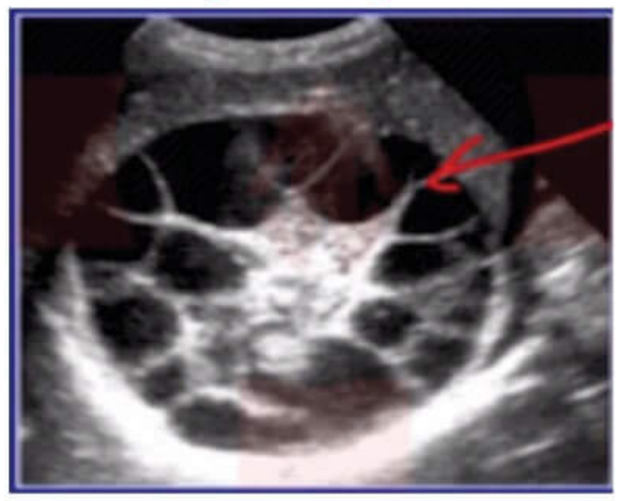
Light bulb appearance

→ On MRI Liver	– Hemangioma
→ On MRI Abdomen	– Pheochromocytoma
→ On DW-MRI Brain	– Acute infarct
→ On Shoulder Radiograph	– Posterior dislocation of shoulder

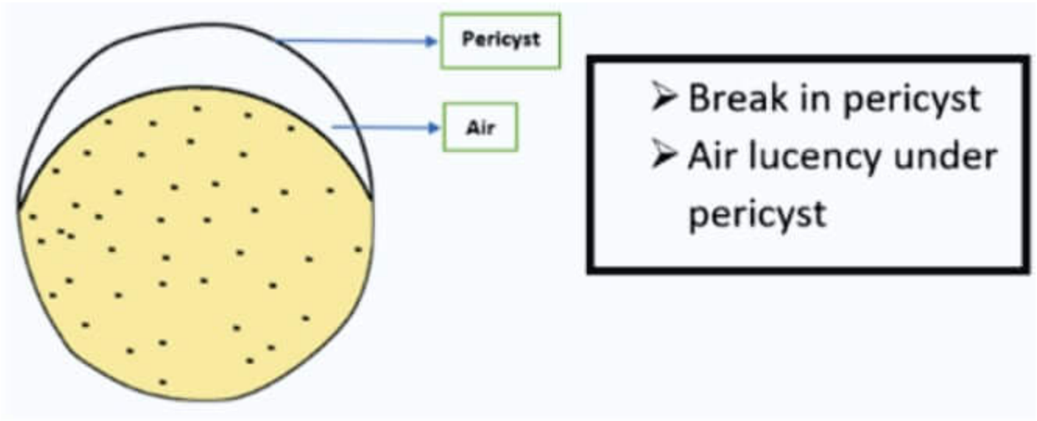
Radiological findings of hydatid cyst



Hydatid Cyst

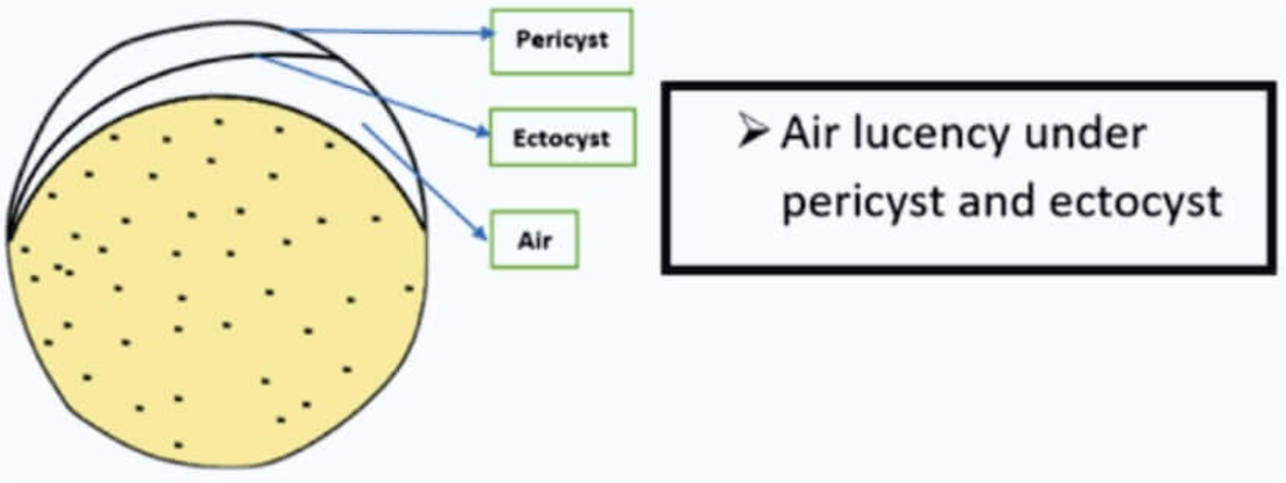


Honey comb appeareance
Or Rossette appearence



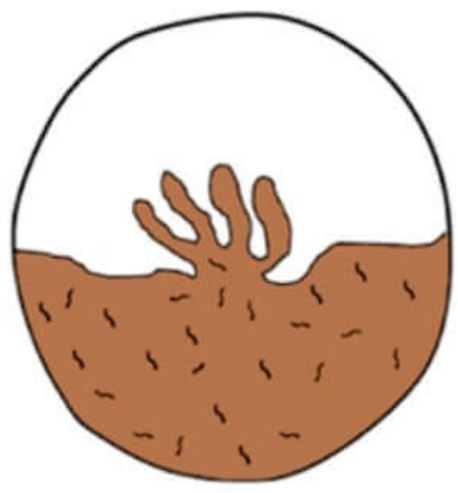
- Break in pericyst
- Air lucency under pericyst

Meniscus sign



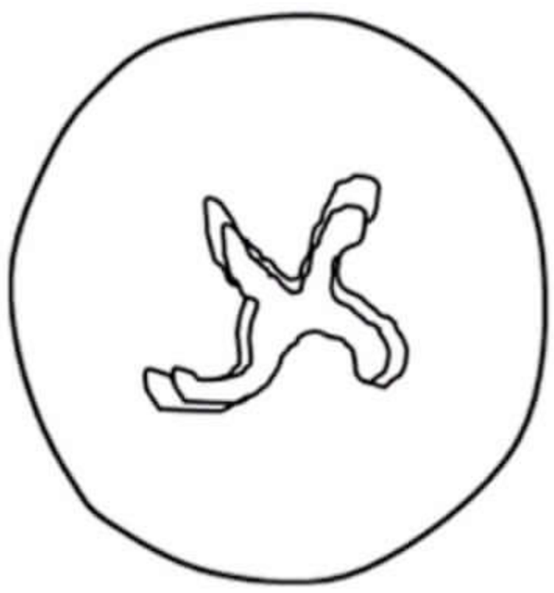
- Air lucency under pericyst and ectocyst

Cumbo sign



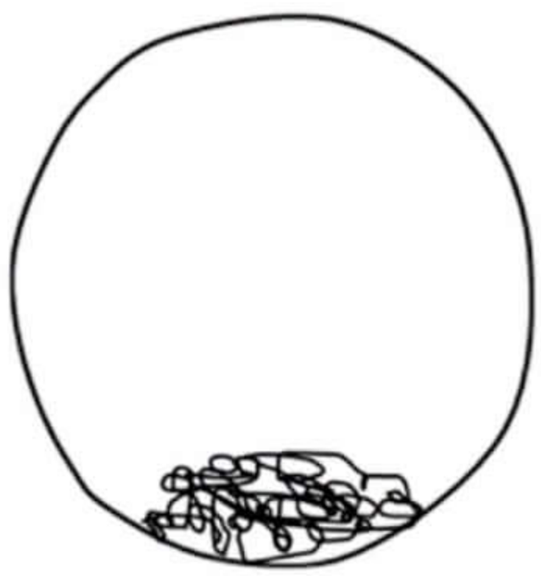
- Membrane floating over cyst fluid

Water lily sign/ Camalote sign/ floating membrane sign



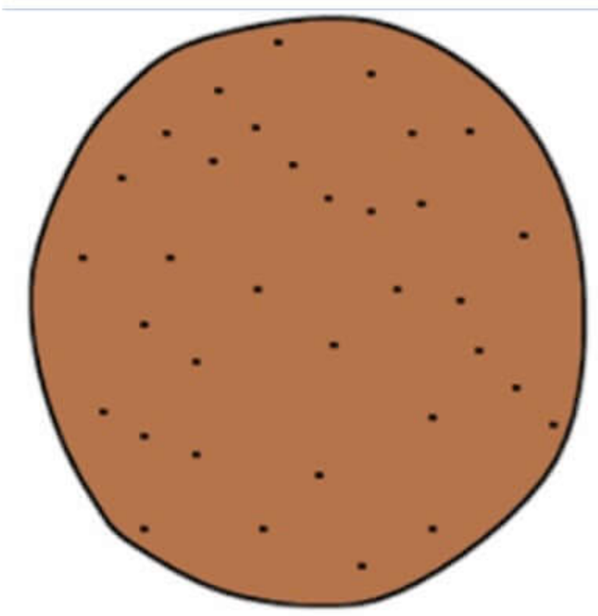
Serpent sign

- Fluid lost and only membrane floating



Sunrise/ Sunset sign

- **Membrane settle down**



Hydatid Sand sign

- Cystic area with Protoscolex of echinococcus

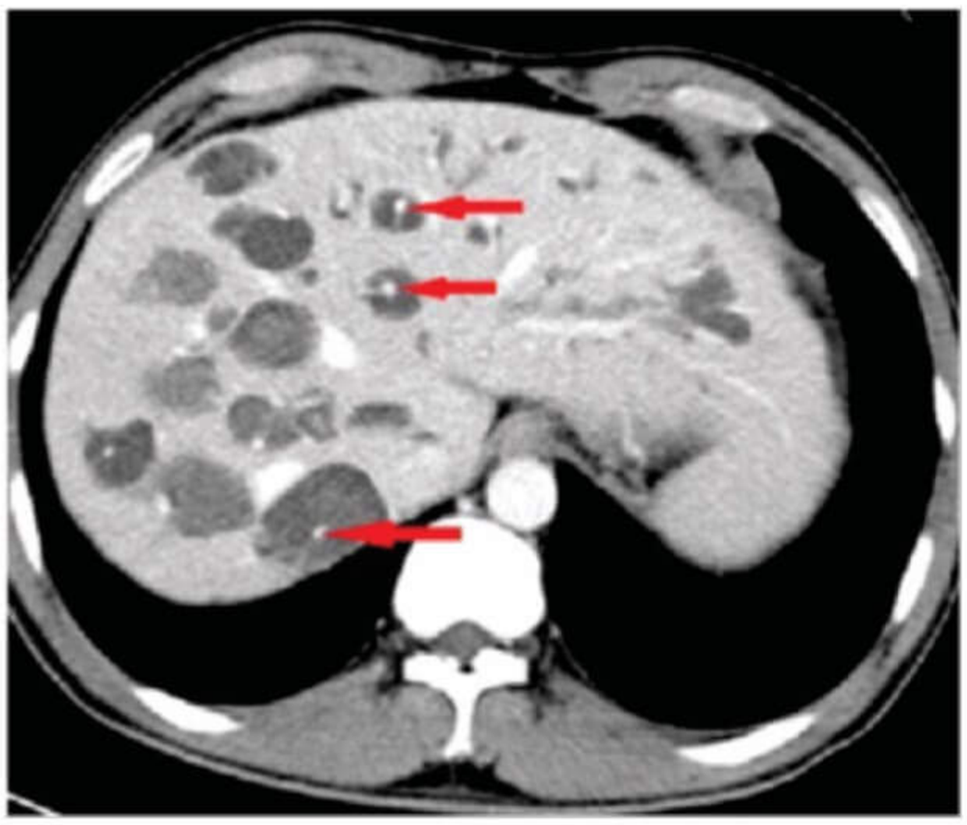
Signs of Hydatid Cyst

- Honey comb appeareance Or Rossette appearence
- Meniscus sign
- Cumbo sign
- Water lily sign/ Camalote sign/ floating membrane sign
- Serpent sign
- Sunrise/ Sunset sign
- Hydatid Sand sign

Carolis disease:

→ It is a type V choledochal cyst – Intrahepatic biliary dilatation

→ "Shows central dot sign"

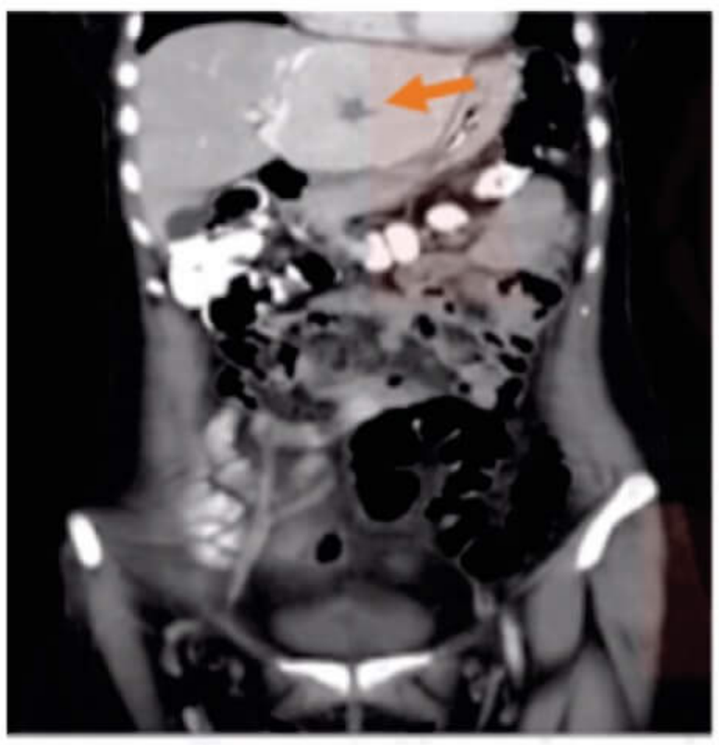


Focal nodular hyperplasia

→ Has increased number of hepatocytes, bile ducts & Kupffer cells

→ On imaging, shows **Stellate scar appearance**

→ On Tc ^{99m}-sulphur colloid shows hot uptake (because of increased Kupffer cells)



Stellate scar appearance

Hot Uptake on Tc ^{99m}-sulphur colloid/ FNH

Acute hepatitis:

→ Edematous hepatocytes along with fibrous strands around portal vein gives **Starry sky appearance on USG**

NOTE:

Starry sky appearance

- On NCCT brain -calcific nodular stage of NCC
- On histopathology – Burkitt's' lymphoma
- On immune florescence – PSGN
- On USG liver – Acute hepatitis

Starry sky appearance on USG- acute hepatitis

Biliary atresia:

→ "**Triangular cord sign** "is seen

→ Has empty GB fossa / Ghost gall bladder

Distal CBD obstruction: shows "Double Barrel appearance" on USG due to dilated CBD

Acute cholecystitis:

→ IOC is Ultrasound

→ Most accurate is HIDA scan

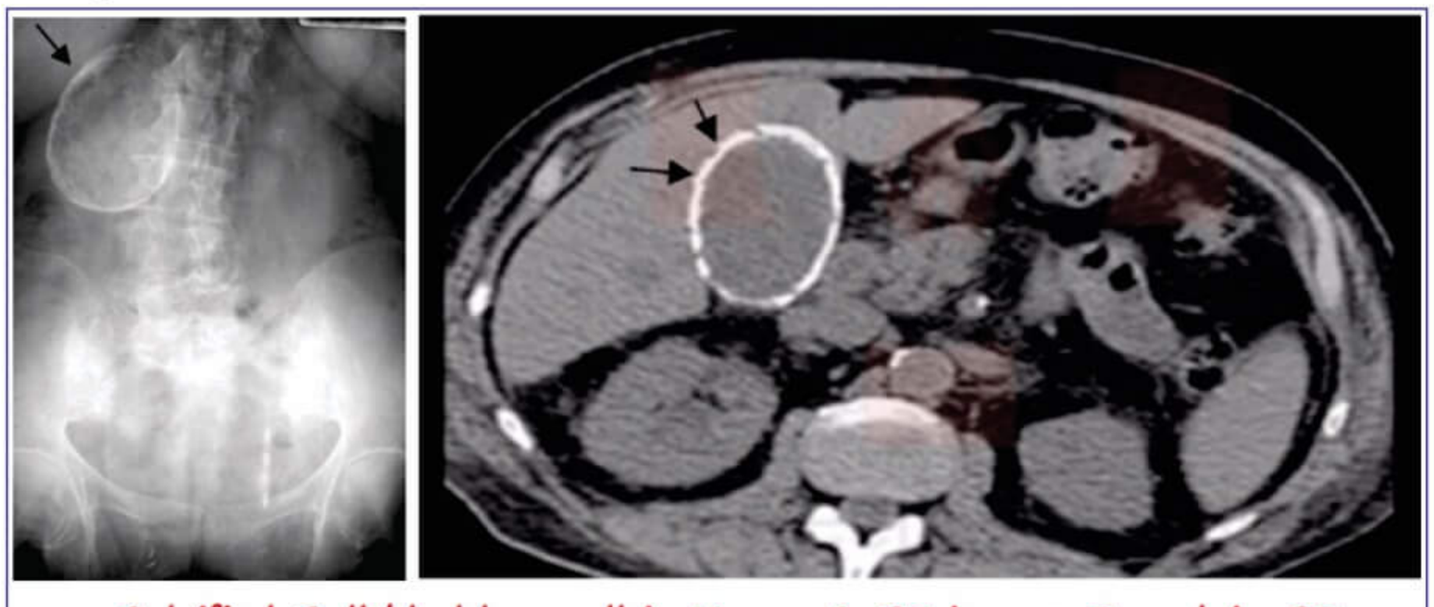
USG findings:

- GB wall thickening
- Luminal distension
- Posterior sonographic murphy sign
- Peri cholic fluid

Porcelain GB:

→ It is a pre malignant condition

→ Characterized by calcification of wall of GB

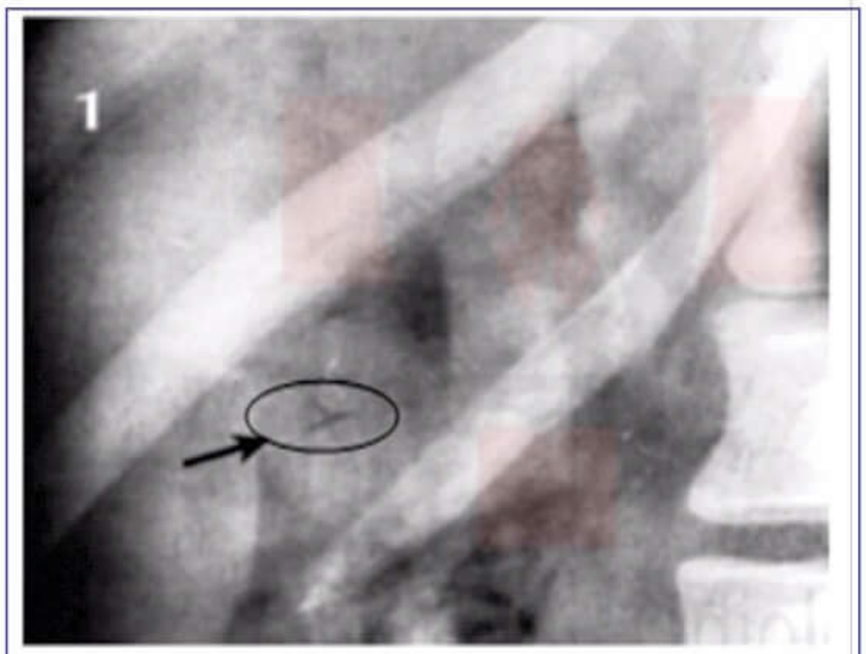


Calcified Gall bladder wall in X-ray & CT image-Porcelain GB

Mercedes Benz sign:

→ Seen when air is trapped within GB calculi

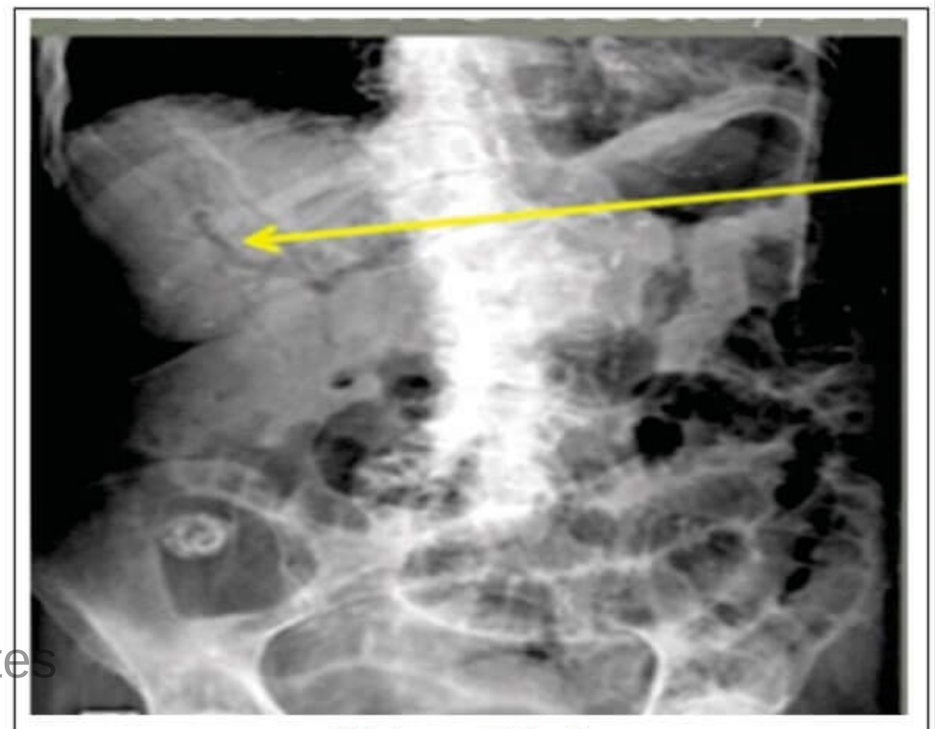
→ Also known as - **Seagull / Crow feet sign**



Mercedes Benz / Seagull / Crow feet sign

Riglers Triad: Seen in Gallstone Ileus

- Pneumobilia (air in biliary tree)
- Small bowel obstraction
- Impacted ectopic gallstone



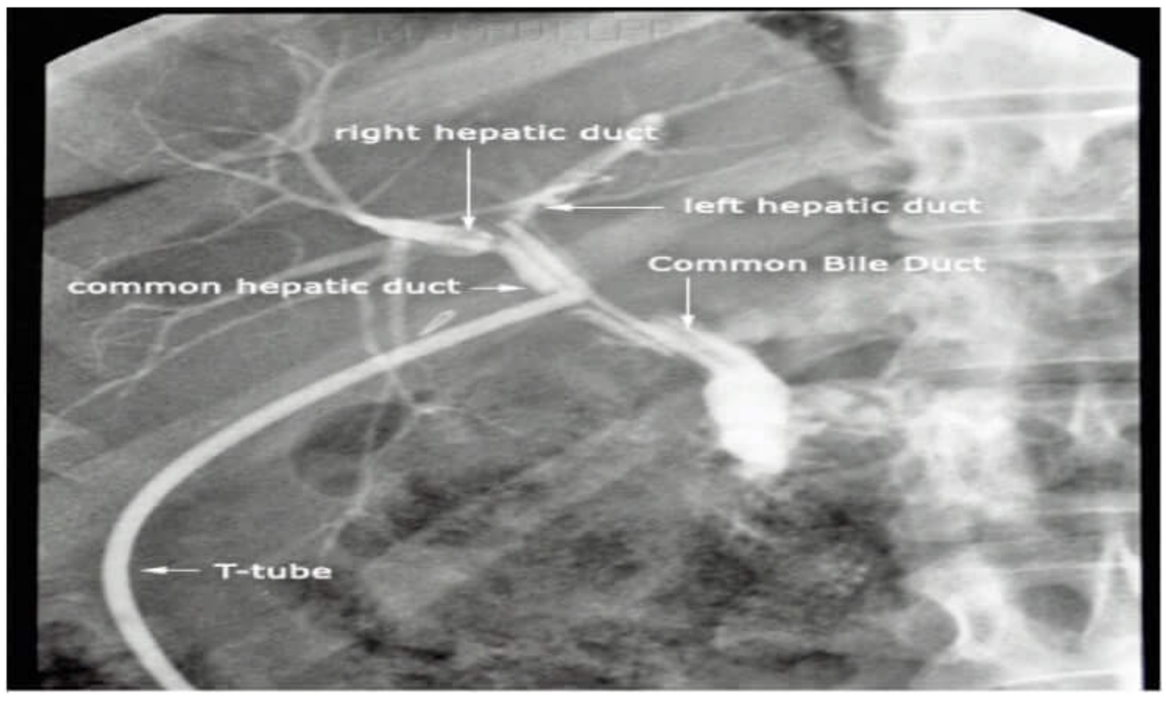
Riglers Triad

Note:

→ PTC – done for upper CBD obstruction

→ ERCP – Done for lower CBD obstruction

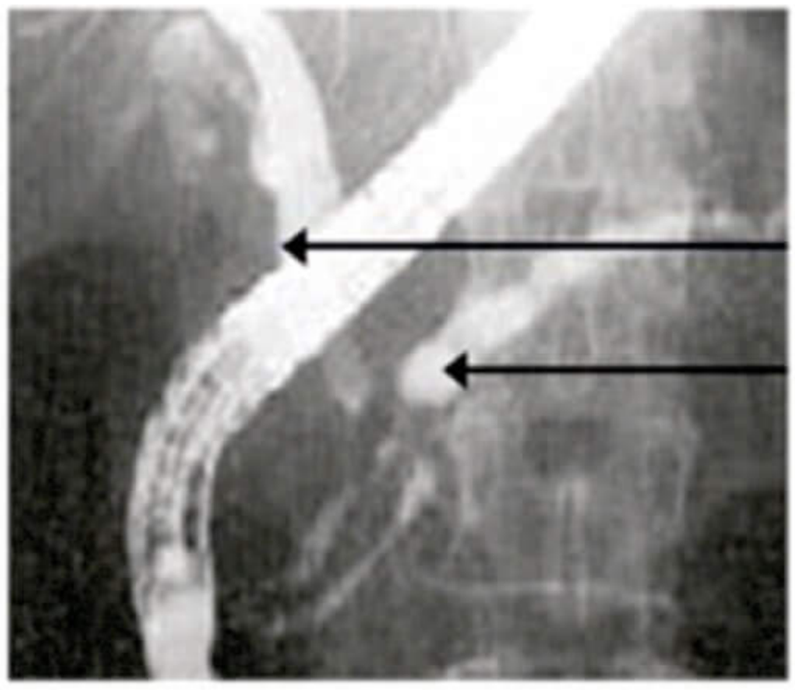
Identify the Investigation shown below



T-tube cholangiogram

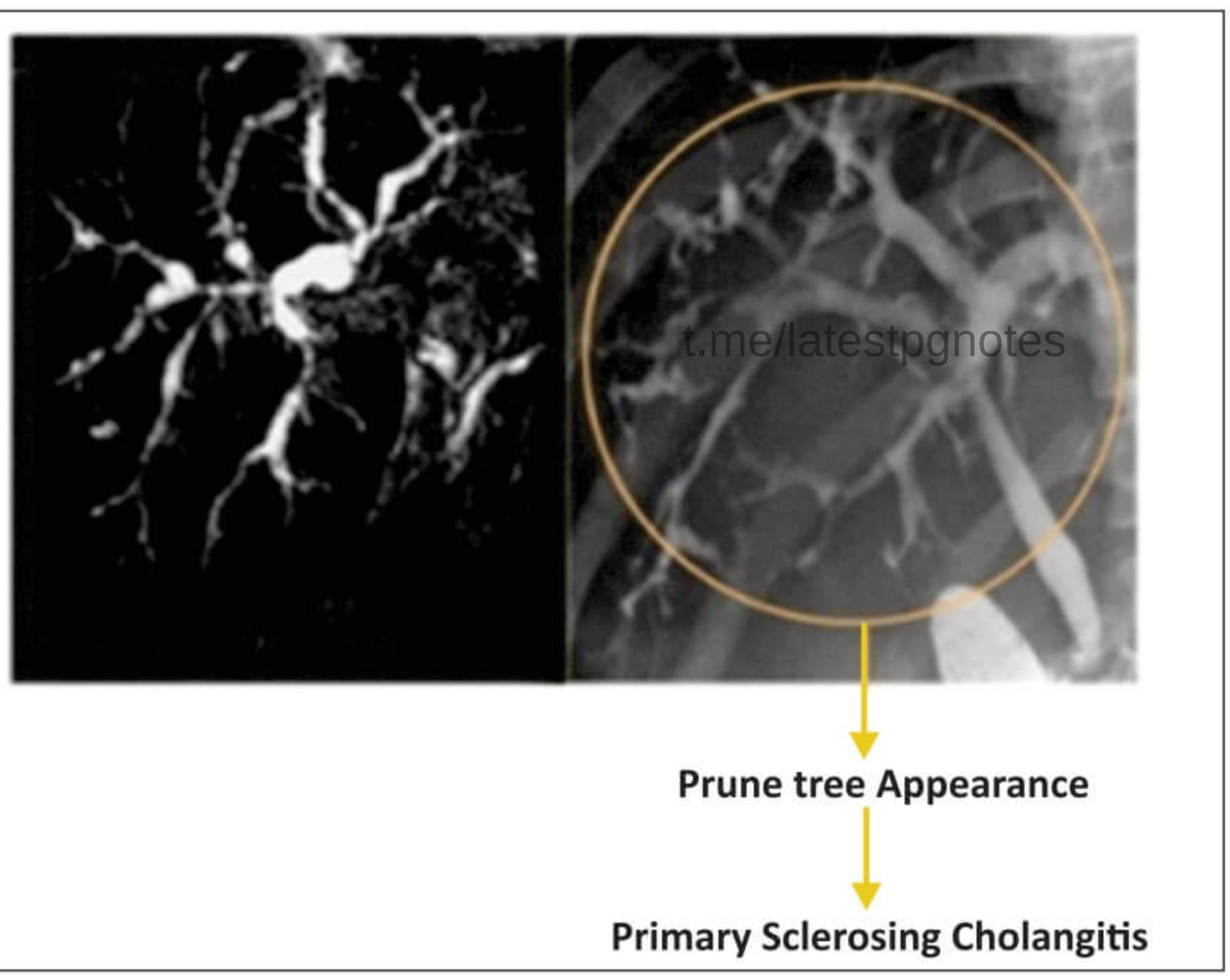
Double duct sign:

→ Seen on ERCP → Indicates Periampullary Ca



Important points to remember:

→ Prune tree appearance on ERCP / MRCP – Primary sclerosing cholangitis



Note:

→ Prune tree appearance on CXR – Pulmonary arterial hypertension

PANCREATIC RADIOLOGY

Acute Pancreatitis:

→ Imaging IOC – CECT

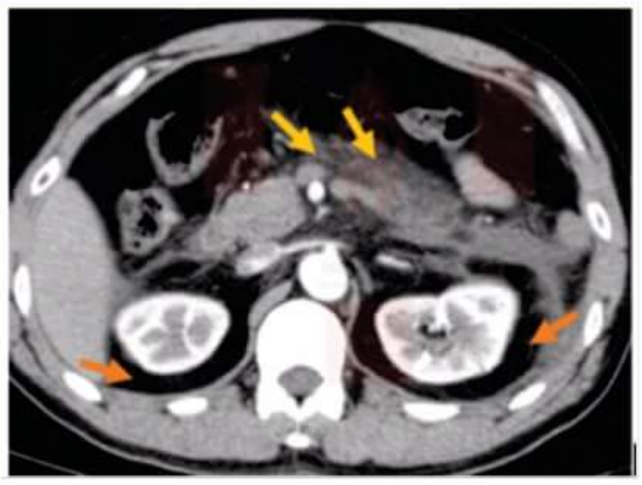
→ **Radiological signs:**

- **Gasless abdomen:** Because of repeated vomiting
- **Colon cut off sign:** Due to colonic spasm of transverse colon
- **Sentinel Loop sign:** Due to adjacent small bowel loop ileus
- **Renal halo sign:** On CT, perinephric fluid collection along with existing Perirenal fat gives a renal halo

Gasless abdomen

Colon cut off sign

Sentinel Loop sign



Renal halo sign

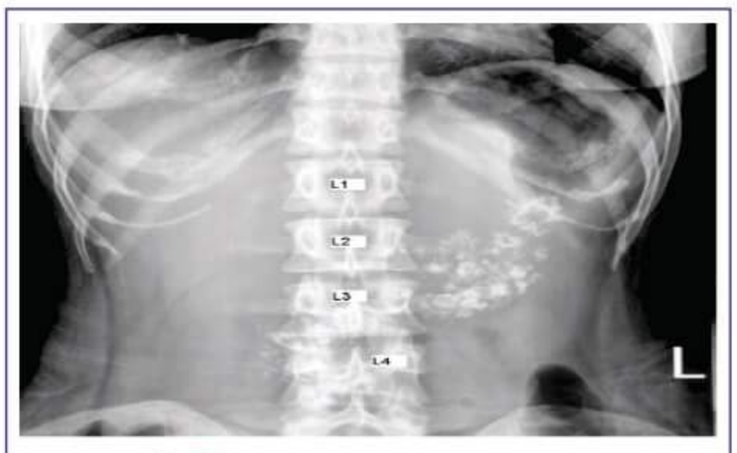
Chronic pancreatitis:

→ Has calcifications

→ On MRCP / ERCP

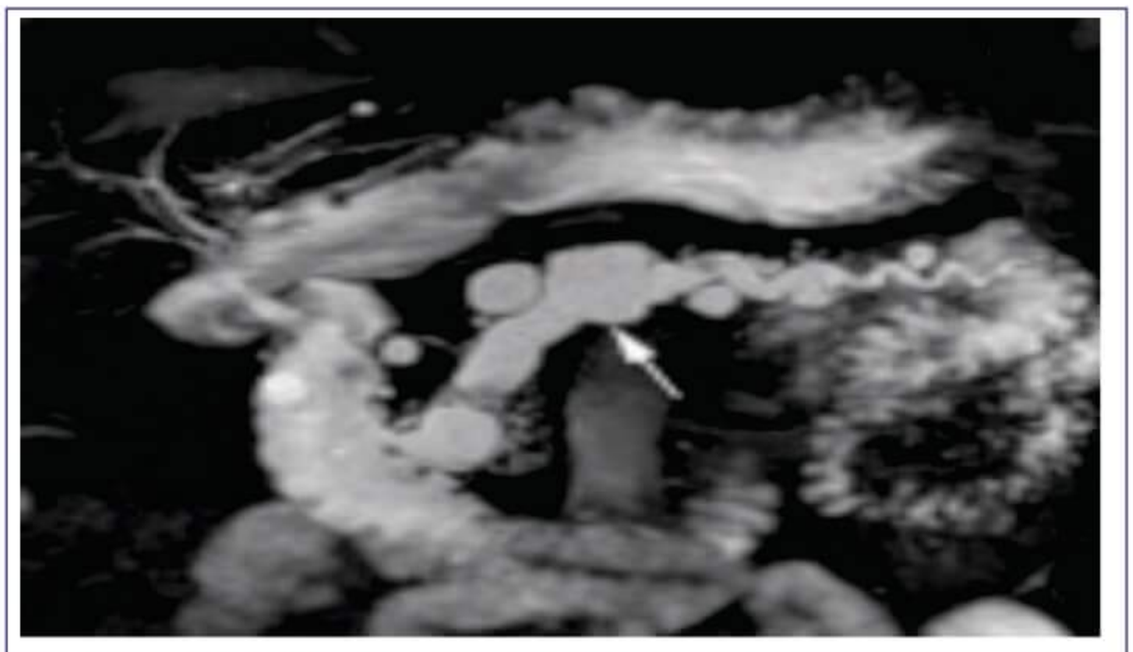
- Beaded / tortures appearance of pancreatic duct
- String of Pearls / string of beads appearance
- Chain of lake appearance

→ On Barium – Reverse 3 sign of frostberg
(also seen in Ca Head of pancreas)



Calcifications in Pancreas

Calcifications in Pancreas



String of Pearls / string of beads appearance on MRCP

Ca head of pancreas:

→ Widening of C-shaped loop of duodenum
→ Mucosal irregularity/ Rose thorning of 2nd part duodenum on medial wall
Reverse 3 sign of frostberg

Reverse 3 sign of frostberg

Serous cystadenomas of pancreas shows

→ sunburst appearance of pancreas due to radiating fibres

• Fetal skull like calcification of bladder	→ Schistosomiasis – Risk factor for SCC of Bladder
• Christmas tree app. of bladder	→ Neurogenic bladder
• Thimble bladder	→ TB Bladder
• Pear shaped / tear shaped	→ Extrinsic compression of bladder (by pelvic hematoma / Pelvic L.N)

fetal skull like calcification of bladder

Christmas tree app. of bladder

Pear shaped / tear shaped bladder

Renal TB:

→ IOC – CECT

→ In kidney:

- Earliest → Moth eaten calyces (on IVP)
- Putty kidney / Cement kidney

→ **In ureter:**

- Tortuous / beaded appearance / cork screw appearance of ureter
- Kerr's kink
- On cystoscopy- golf hole ureteral orifice

→ **In bladder:**

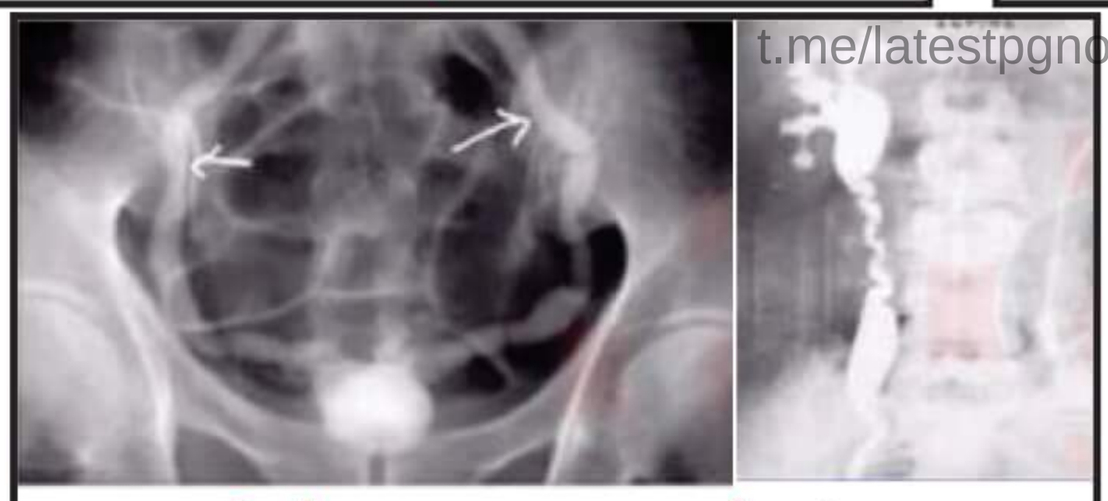
- Thimble bladder

Note:

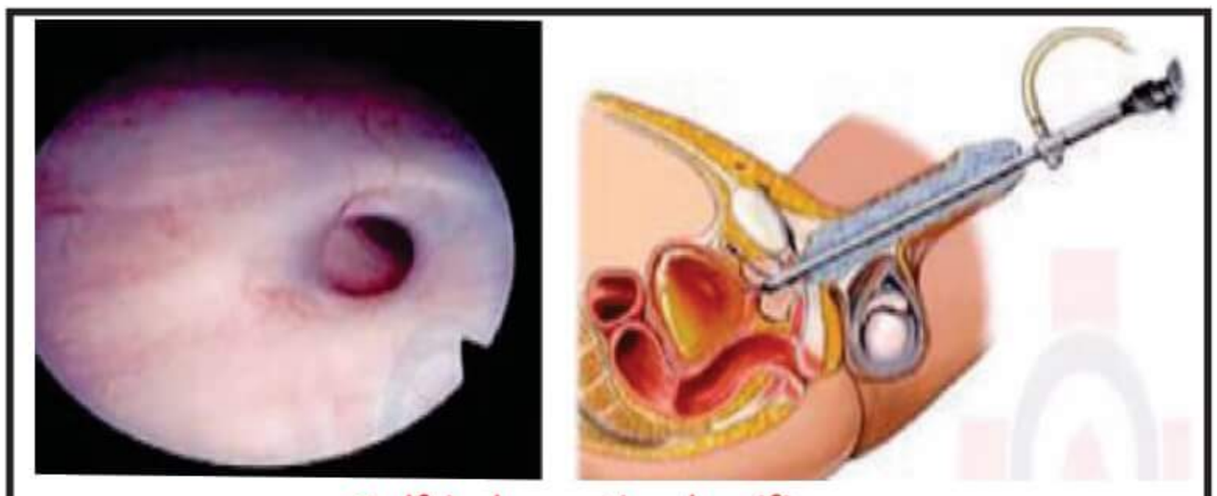
- IOC for renal TB = CT UROGRAPHY/CT-IVP/CECT
- IOC for early renal TB = CT-IVP/IVP

Moth eaten calyces on IVP

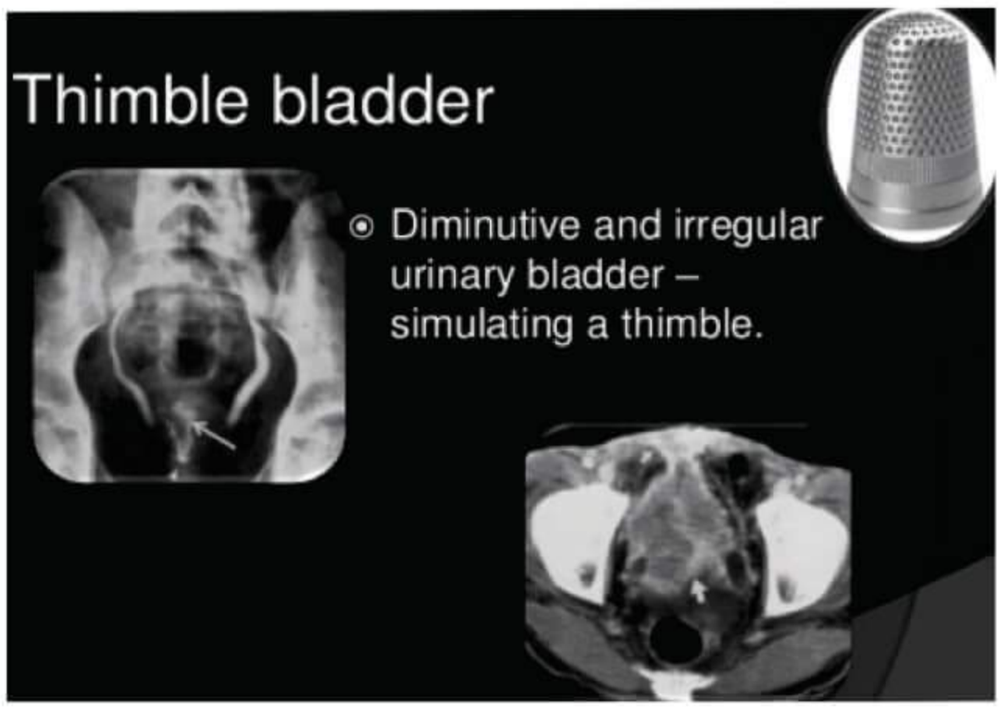
Putty kidney / Cement Kidney



Cork screw appearance of ureter

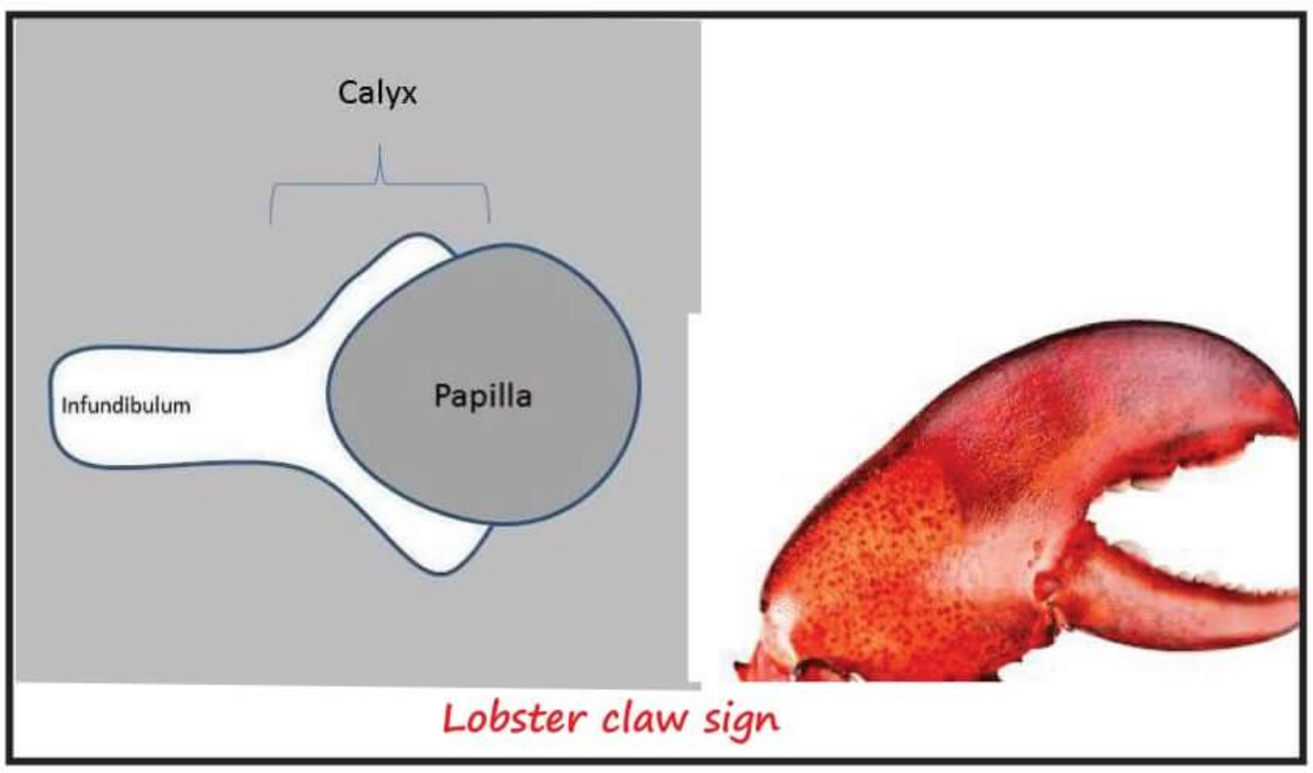


Golf hole urethral orifice



Radiologic findings in renal papillary necrosis


Egg in cup appearance

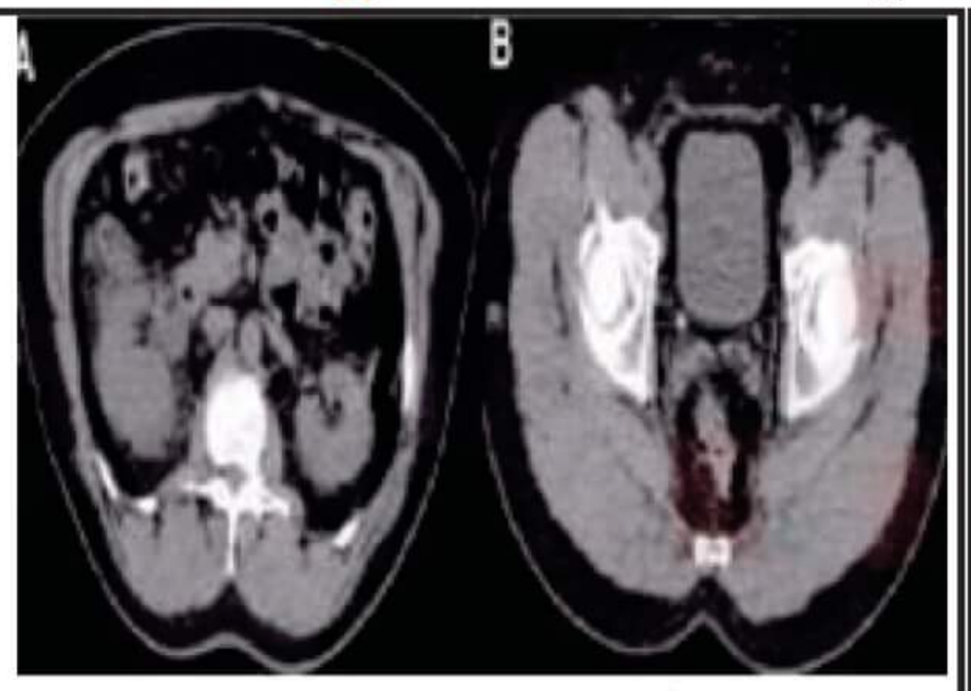


Lobster claw sign

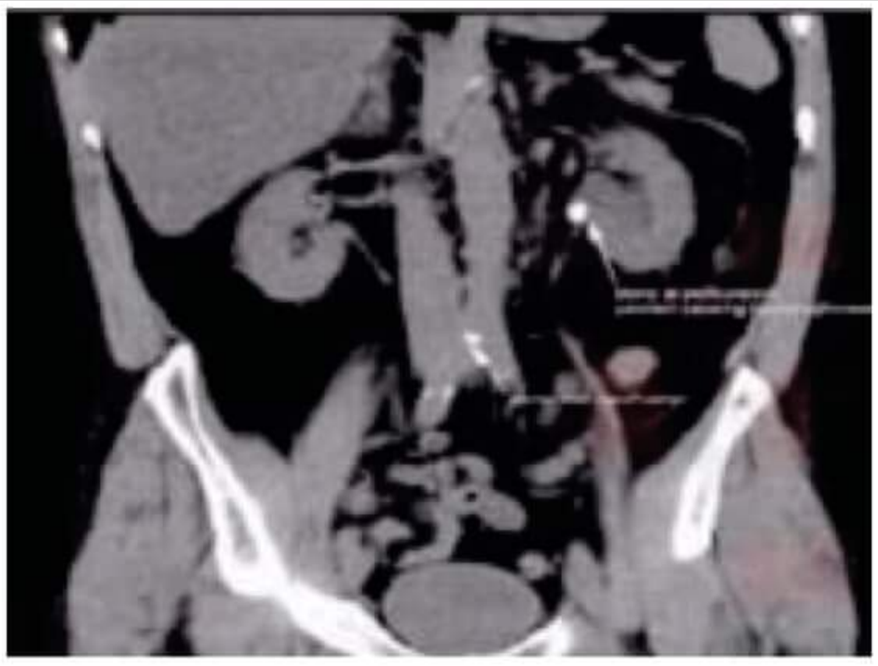

Ring sign

Important points to remember:

- IOC for ureteric calculi → NCCT
- Dual energy CT → Characterize the type of kidney stone



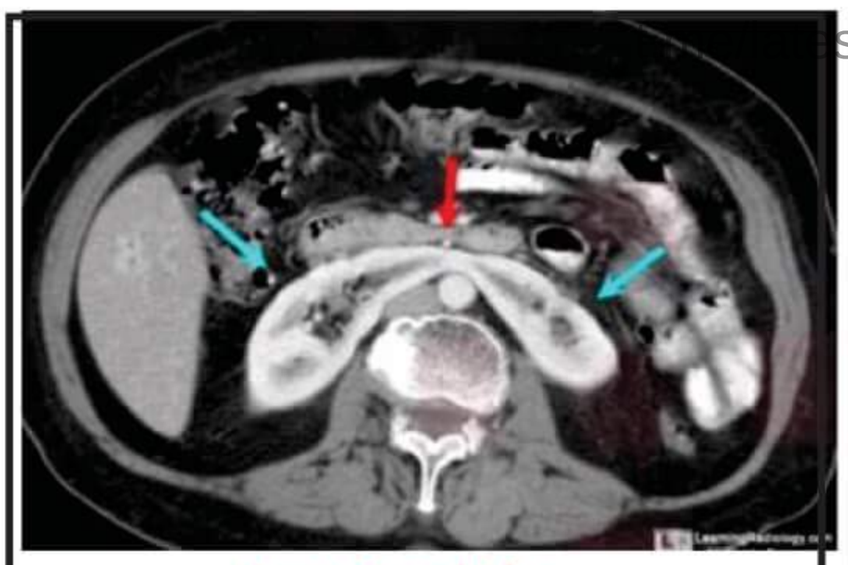
A) CT@ kidney level – Right kidney is bulky and hazy
B) CT @ Bladder level – Distal right ureteric calculi



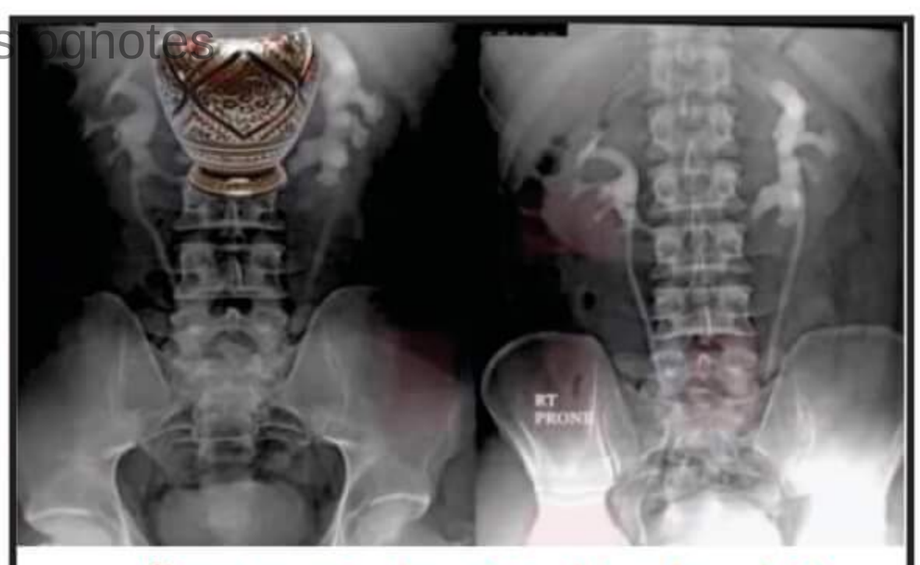
Coronal CT showing Left pelvi-ureteric junction calculi

Horse shoe kidney:

- Upward ascent of kidney is prevented by IMA(inferior mesenteric artery)
- Fusion of inferior pole of both kidneys, the inferior calyces are medially oriented.
- Gives "shaking hand sign & flower vase sign "on IVP



Horse shoe kidney



flower vase sign / shaking hand sign

Retroperitoneal fibrosis:

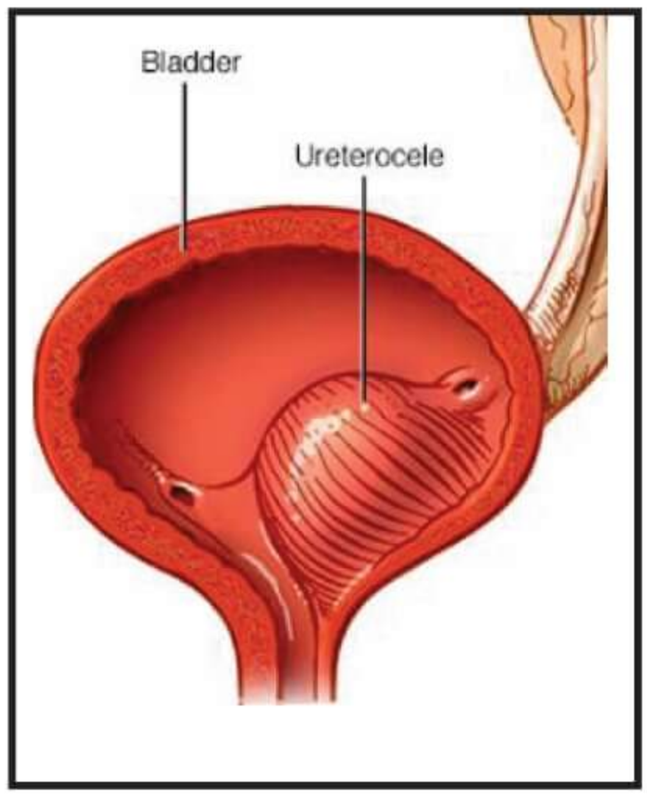
- Inferior calyces are laterally oriented
- Due to fibrosis ureters are pulled medially in lumbar area giving "Maiden waist deformity"

Maiden waist deformity

Ureterocele:

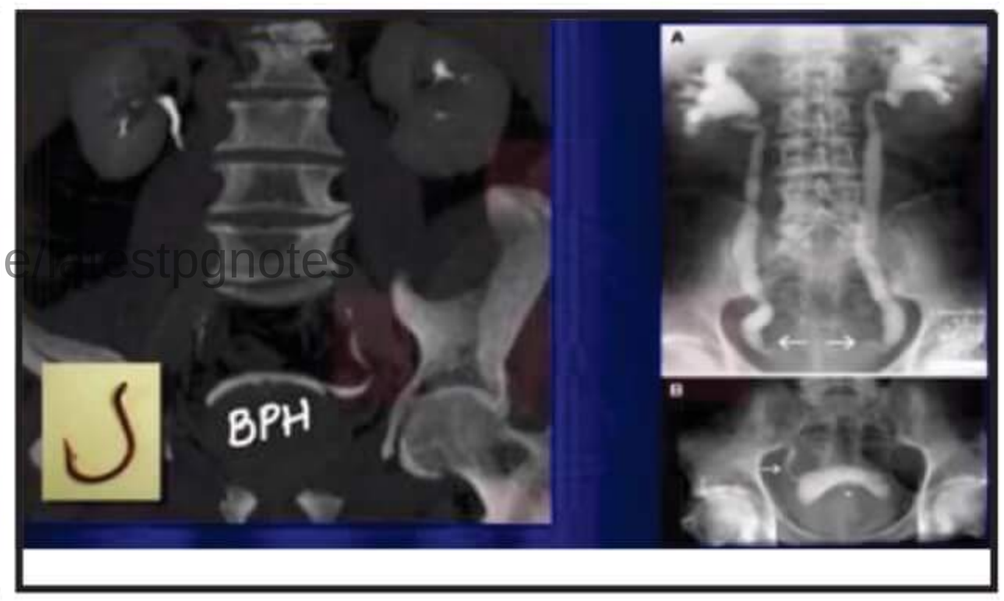
- Intra-luminal obstruction in bladder wall
- Gives "Adder head" or "Cobra head" app. on IVP

Adder head" or "Cobra head sign



Benign prostatic hyperplasia:

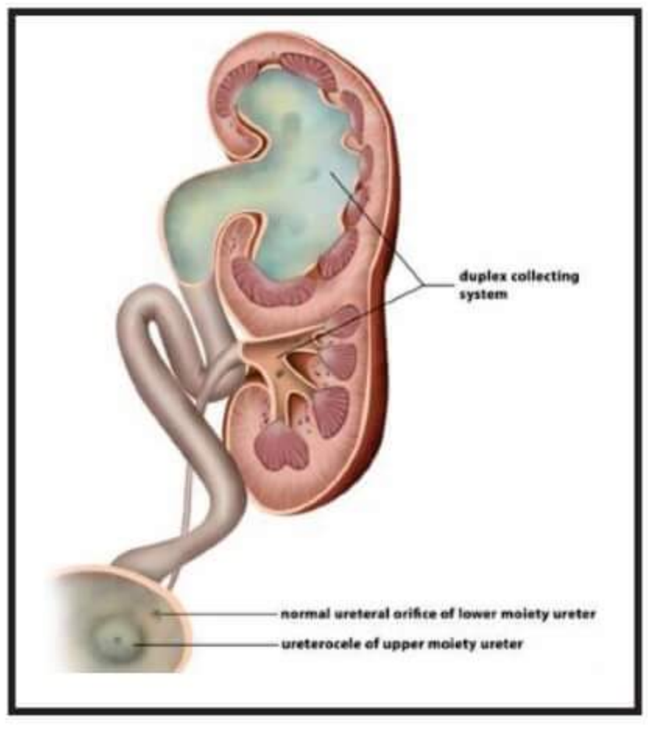
- Fish hook appearance at distal ureter



Dropping lily sign:

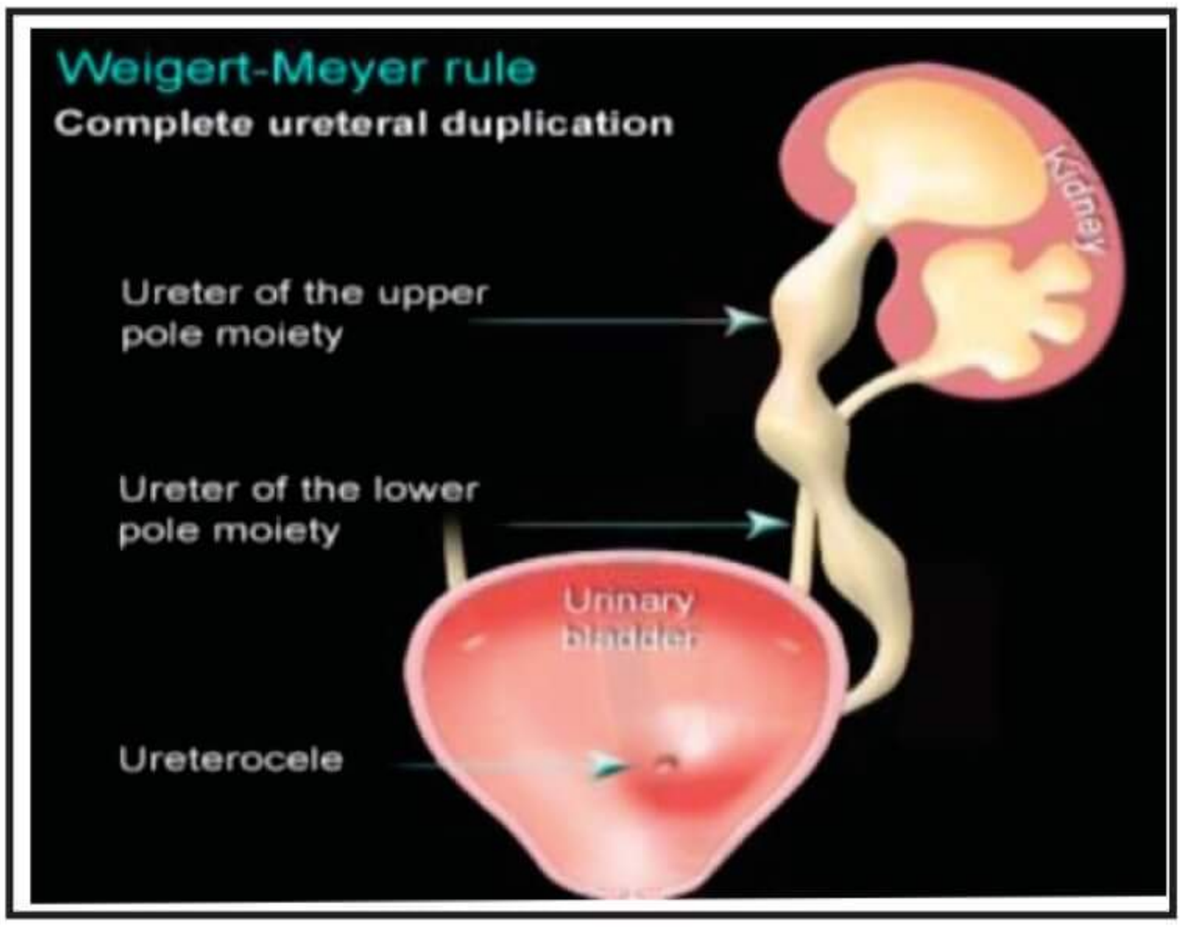
- Seen with
  - → duplex kidney with non-functional upper moiety
  - → RCC/ Hypernephroma / Grawitz tumor

Dropping lily sign



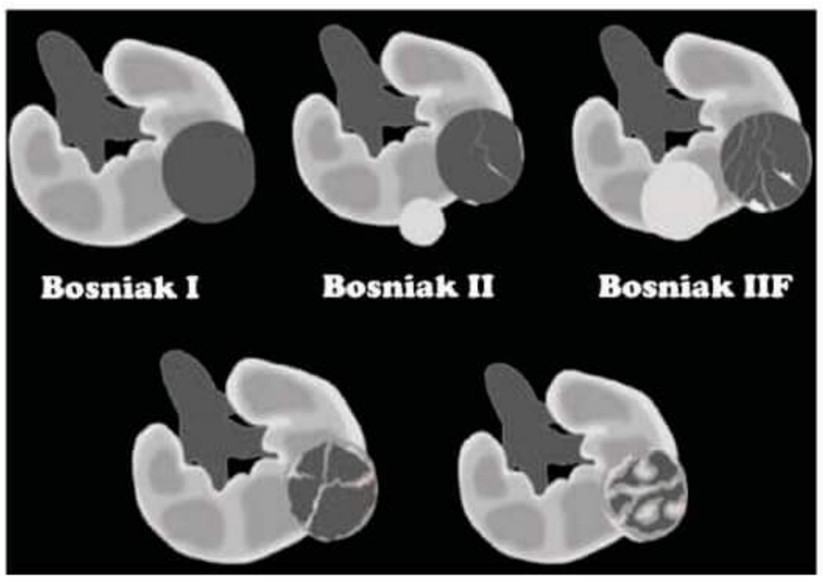
Weigert – Meyer Rule of duplex kidney

- Ureter of superior / upper pole moiety inserts inferomedial on the bladder & is more prone to obstruction, especially ureterocele
- Inferior/ lower pole ureter inserts superolateral on the bladder & is more prone to reflux



Bosniak classification:

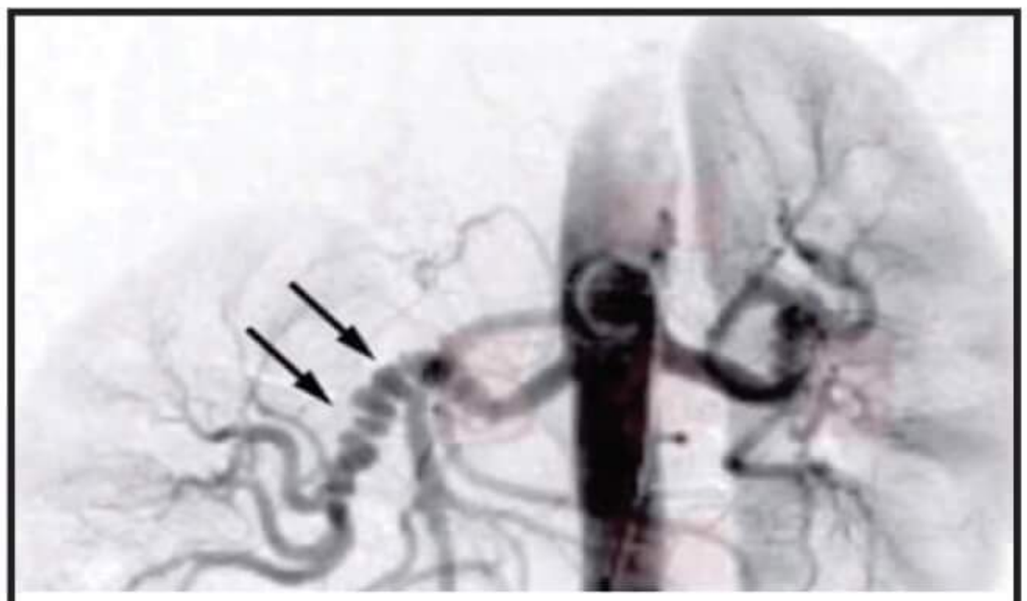
- Used for Renal Cysts



Class	Description	Features
1	Simple cyst	Anechoic, imperceptible wall, round
2	Minimally complex	Single thin septation, thin calcification
2F	Minimally complex- (need follow up)	Thin septation, thick calcification, hyper dense on CT
3	Indeterminate	Thick or multiple septation, mural nodule
4	Clearly malignant	Solid mass with cystic spaces

Fibromuscular dysplasia:

- On angiography – Beaded / Tortuous / Pile of plate app. of renal artery is seen
- M/C artery involved – Renal artery
- 2nd M/C artery involved – ICA



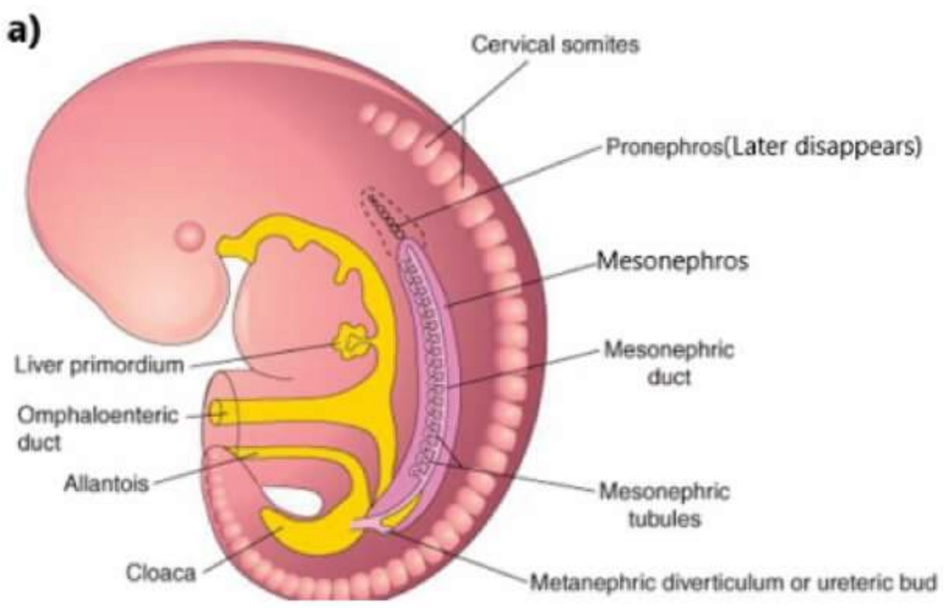
Pile of plate app. of renal artery on Angiography

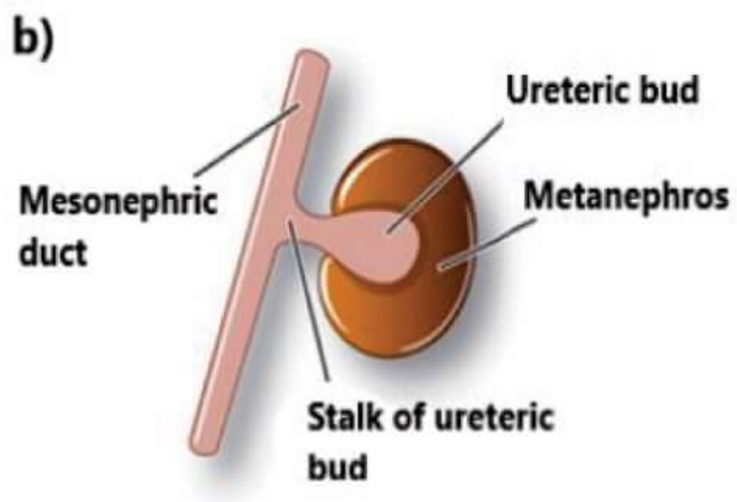
Multicystic Dysplastic kidney

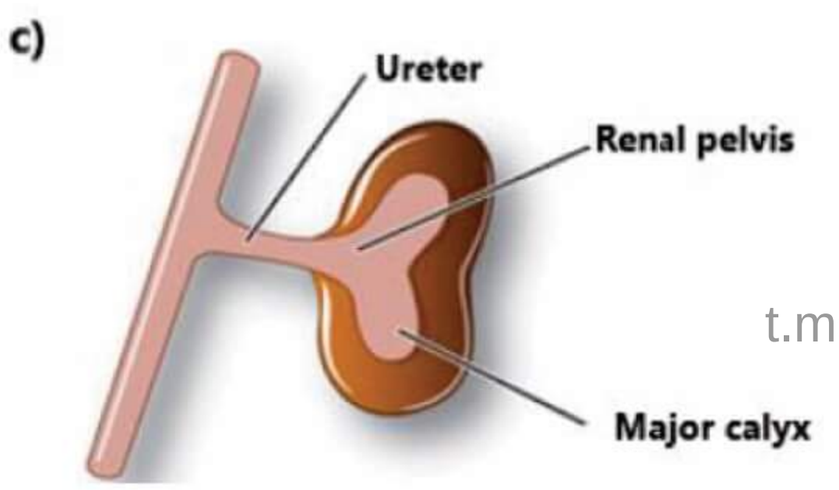
→ MC Cystic kidney disease

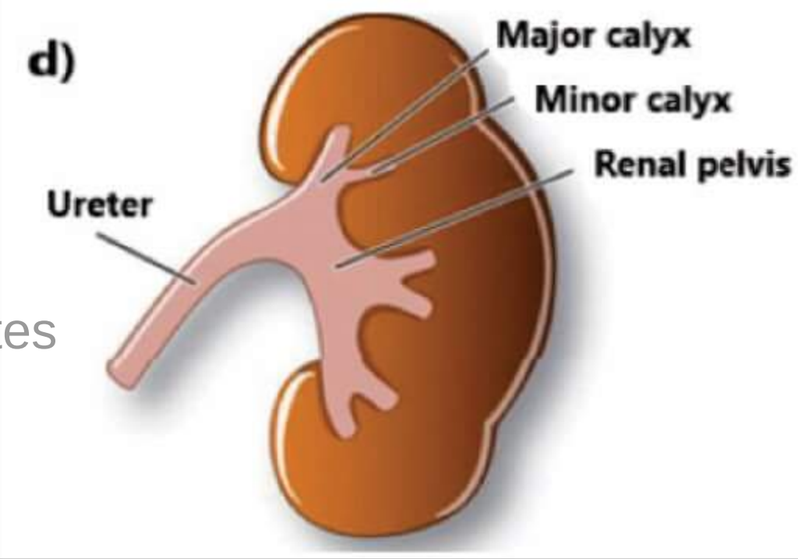
→ Mostly unilateral

Embryology of kidney development

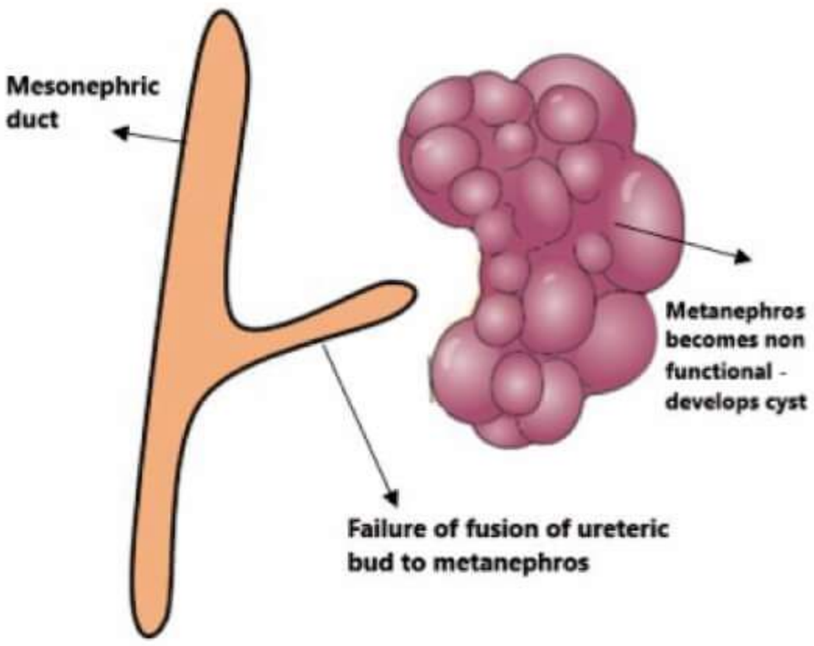






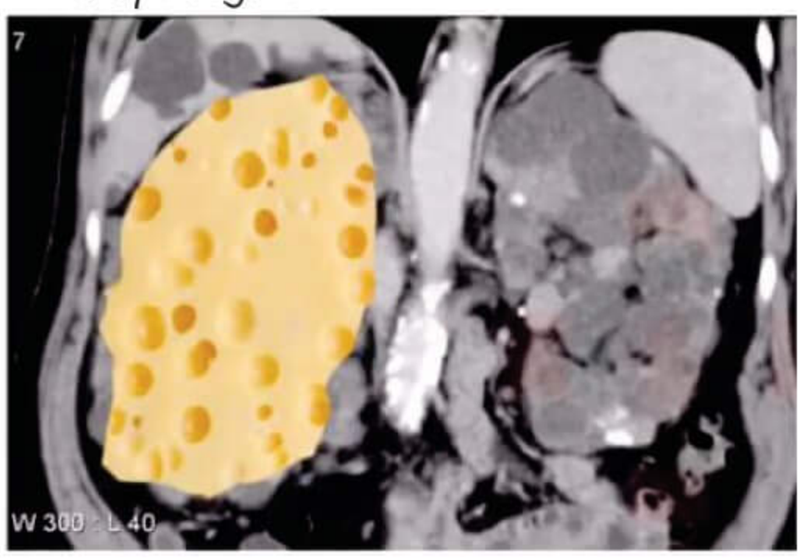


Multicystic Dysplastic kidney



→ Shows **Soap bubble appearance** on Antenatal scan

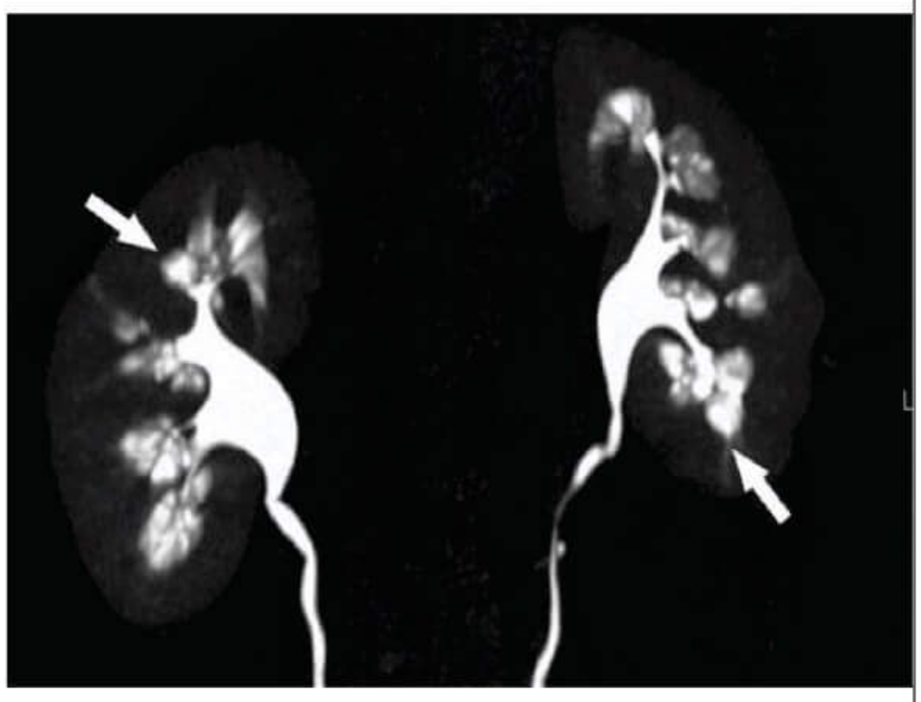
Difference between ADPKD & ARPKD

	ADPKD (Adult)	ARPKD (Child)
Defective protein	→ Polycystin	→ Fibrocystin
Unilateral/Bilateral	→ Bilateral	→ Bilateral
Hepatic cyst	→ Present	→ Present
Hepatic fibrosis	→ Present	→ More common
Radiological features	→ Swiss cheese appearance on Nephrogram  → Spider leg appearance on Pyelogram 	→ Shows Striated Nephrogram 

Medullary sponge kidney

→ On IVP, Contrast opacified collecting ducts gives Bouquet of flowers appearance

→ Pathophysiology

In Medullary sponge kidney → Cystic dilatation of CD	
Urinary stasis in the cystic spaces ↓ Medullary nephrocalcinosis	On IVP, Contrast deposition in cystic spaces ↓ Bouquet of flowers appearance
	

Note

→ Cortical Nephrocalcinosis – Seen in Alport's syndrome

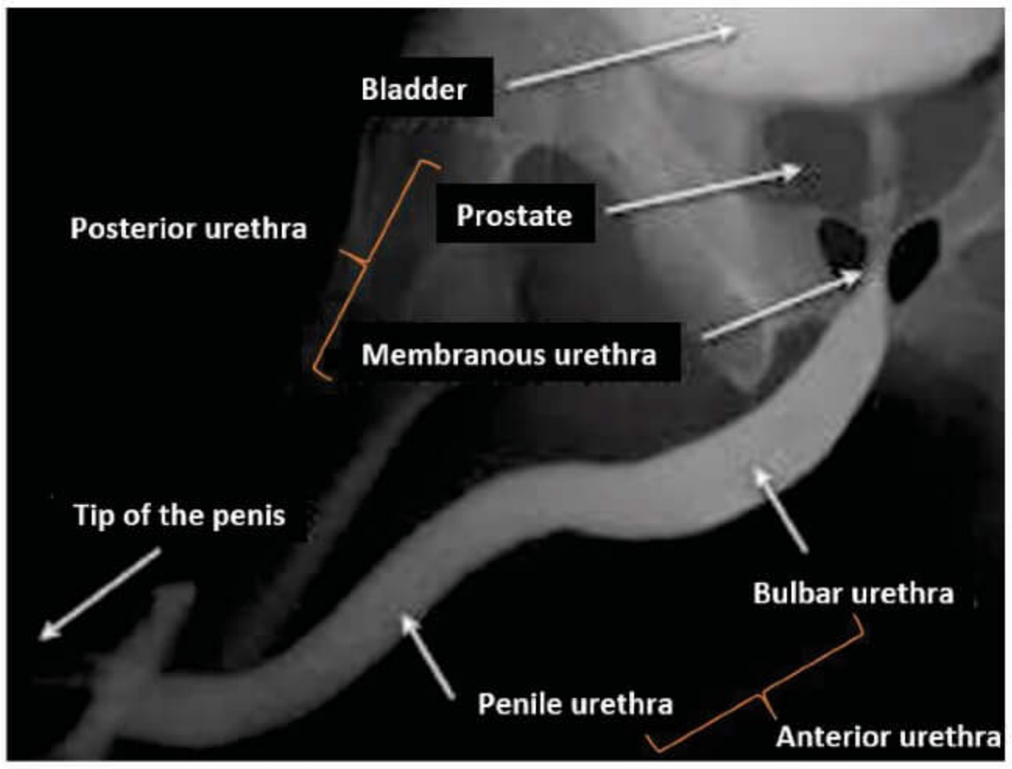
Cortical Nephrocalcinosis

Points to know

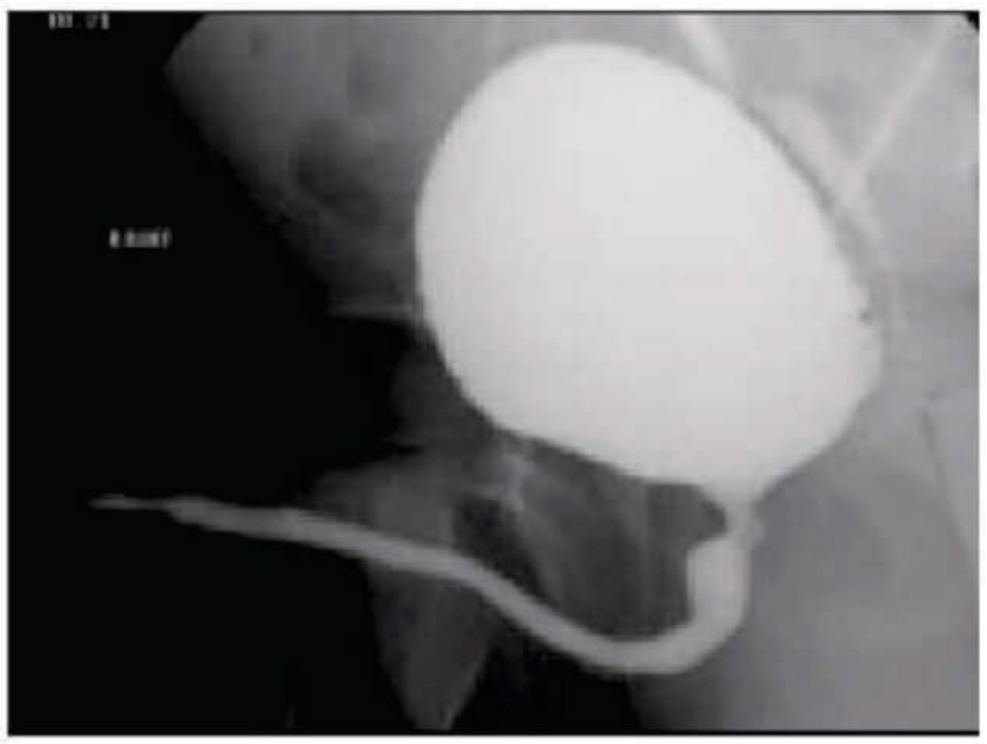
→ Best to evaluate Posterior urethra – **MCU (Micturating Cystourethrogram)**

- IOC for Posterior urethral valve – MCU
- IOC for Vesicouretric reflux - MCU

→ Best to evaluate Anterior urethra – **RGU (Retrograde Urethrogram)**

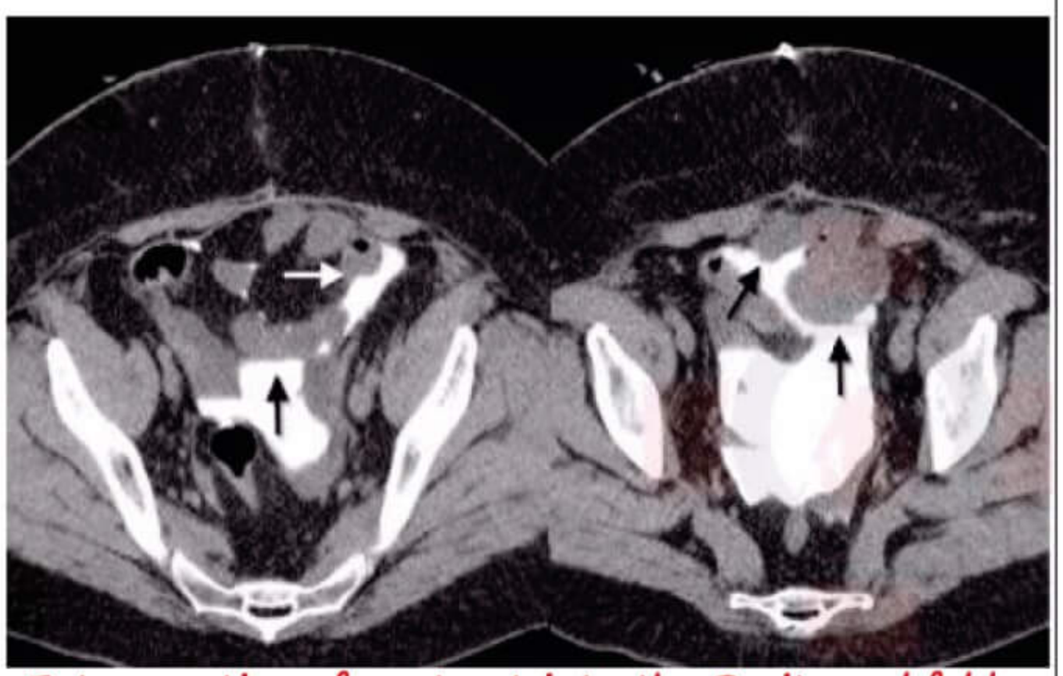
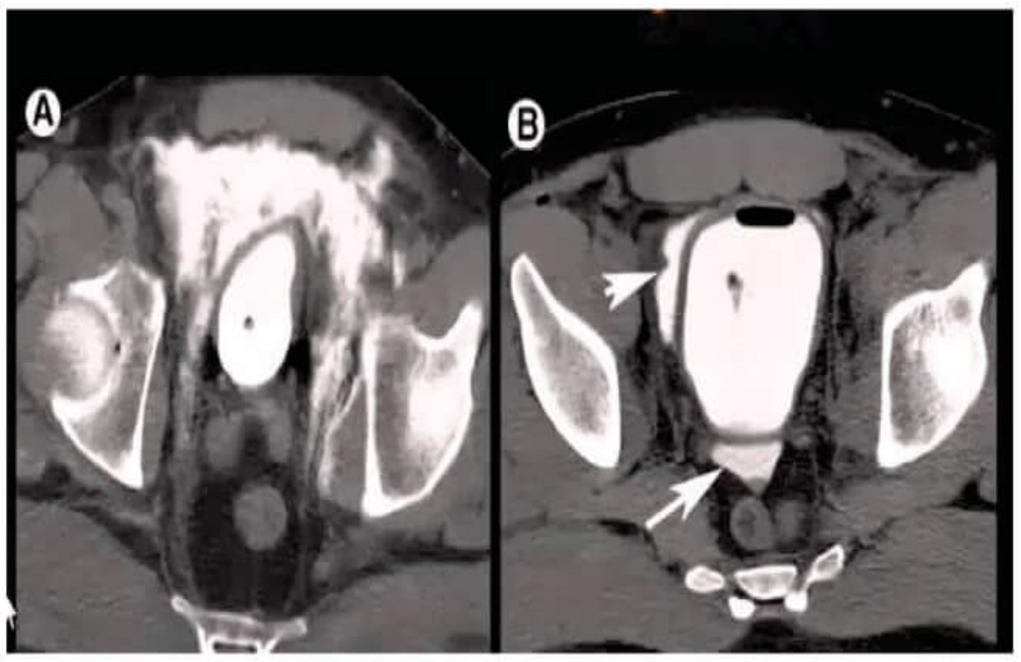


Radiographic anatomy on RGU



Voiding study showing reflux into a ureter on the left side

Bladder injuries

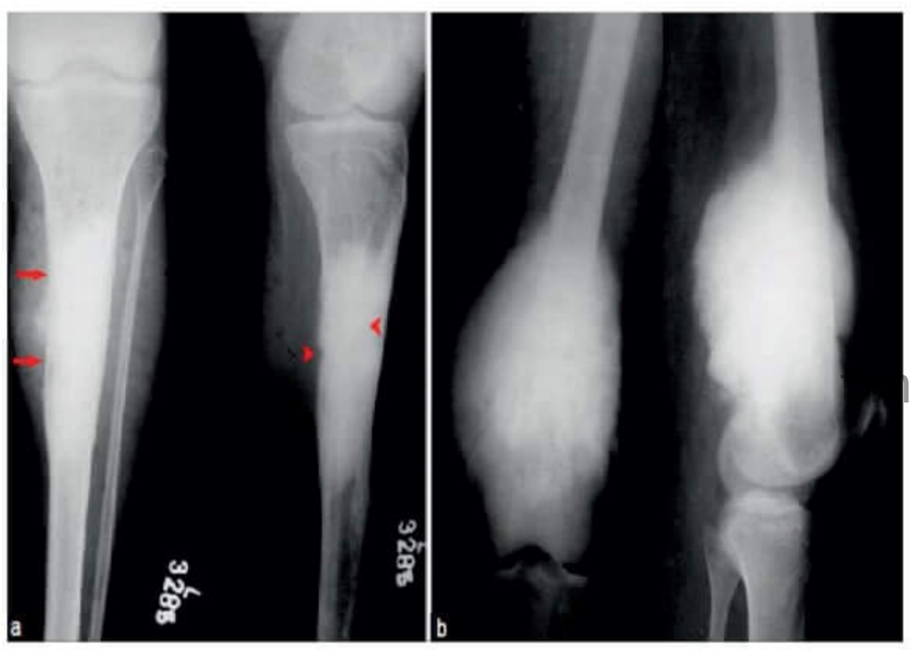
Intra-peritoneal Bladder rupture	Extra-peritoneal Bladder rupture
→ Contrast extravasates into the Peritoneal folds & between bowel loops	→ Contrast extravasates only in the Perineum – Gives **Molar Tooth sign**
 Extravasation of contrast into the Peritoneal folds & between bowel loops	 Molar Tooth sign

MUSCULOSKELETAL RADIOLOGY -PART 1

Matrix of Bone

Osteoid matrix

→ Has dense cloudy matrix

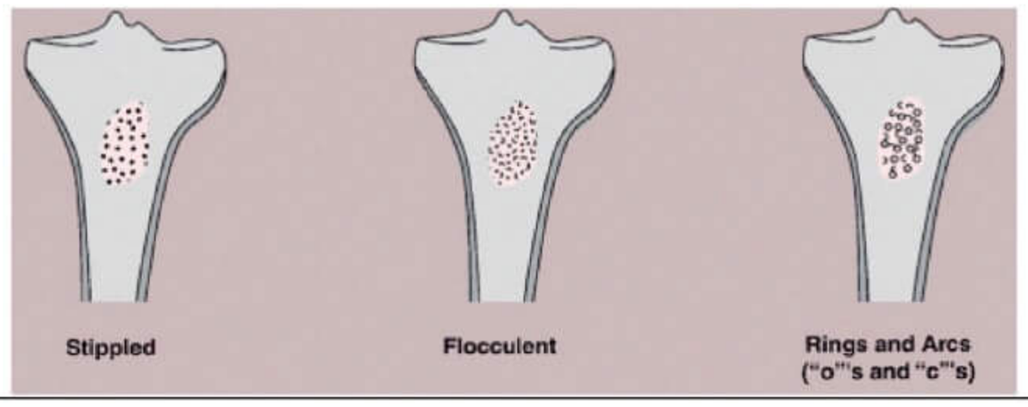


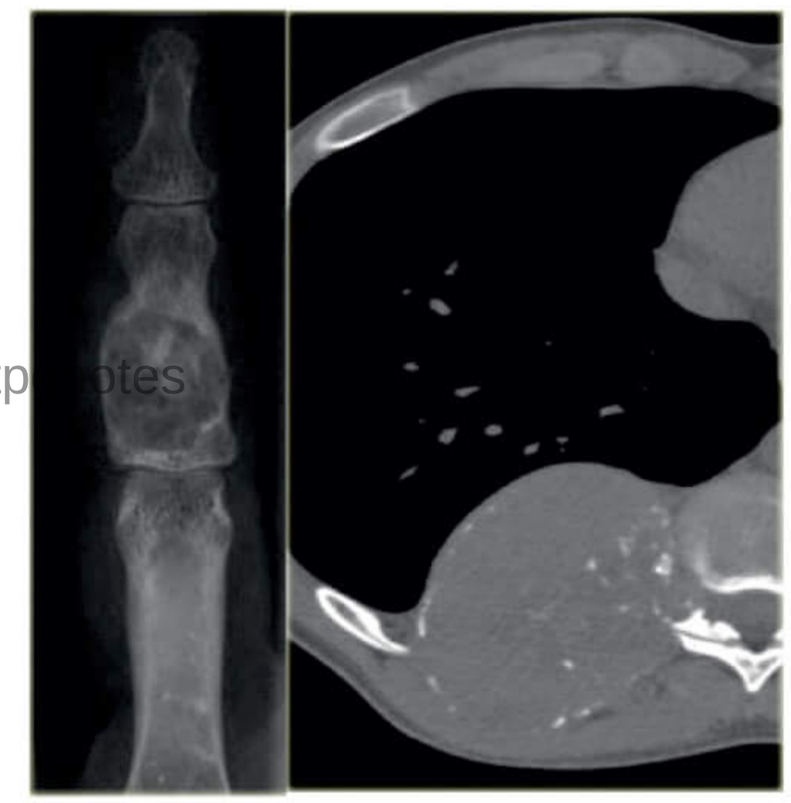
→ Osteosarcoma – showing dense cloudy matrix

Chondroid matrix

→ Shows

1. Rings & Arcs (O & C)
2. Stippled appearance
3. Flocculent or Popcorn appearance





(A) (B)

(C)

(A) – Enchondroma showing Rings & Arc

(B) – Chondrosarcoma showing stippled calcifications

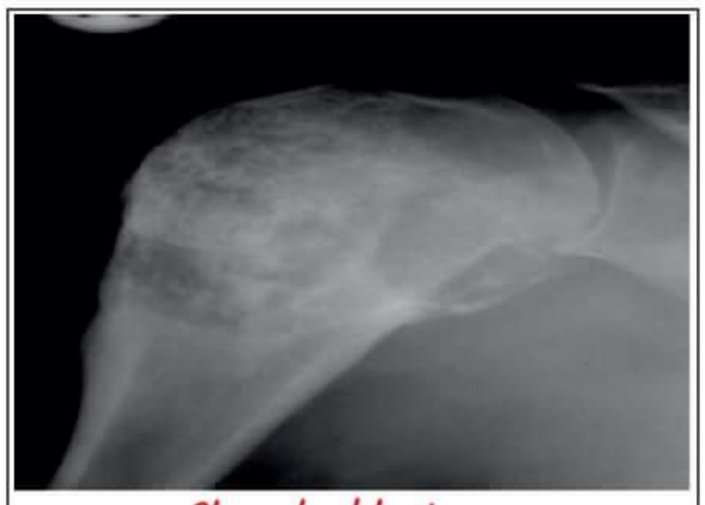
(C) – Chondrosarcoma showing Flocculant or Popcorn calcifications

Popcorn Appearance

• On Pelvic radiograph	– Chondrosarcoma
• On Chest radiograph	– Pulmonary hamartoma
• On Mammography	– Fibroadenoma
• On MRI Brain	– Cavernous angioma

Chondroblastoma

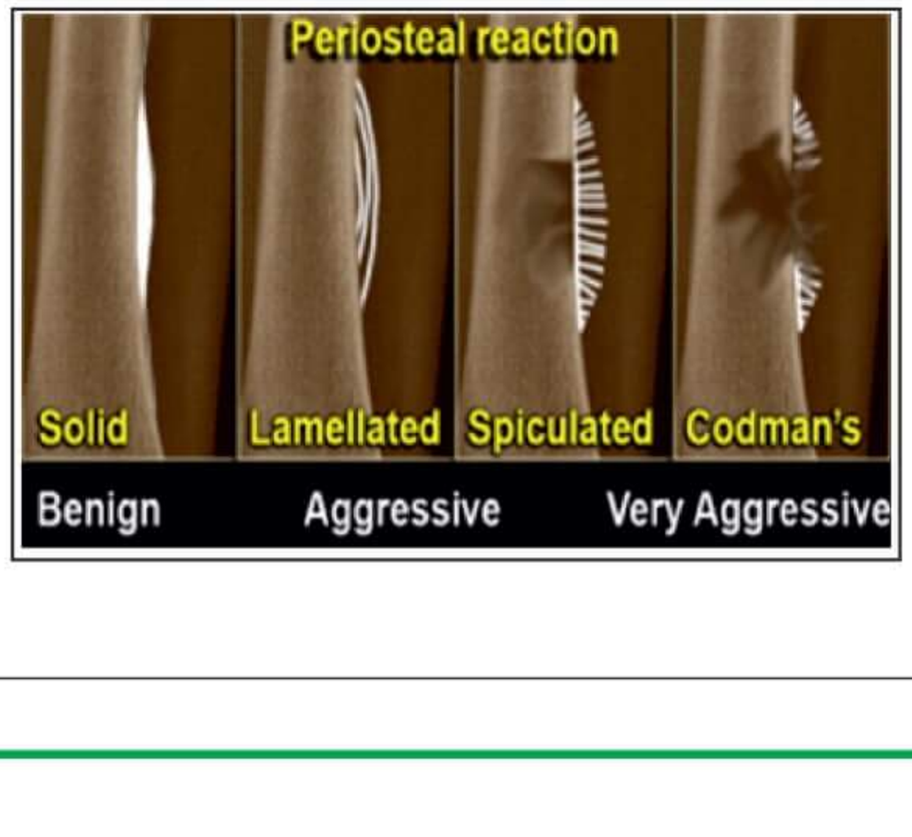
→ Aka CODMANS tumor
→ Epiphyseal in origin
→ Involves Upper end of humerus

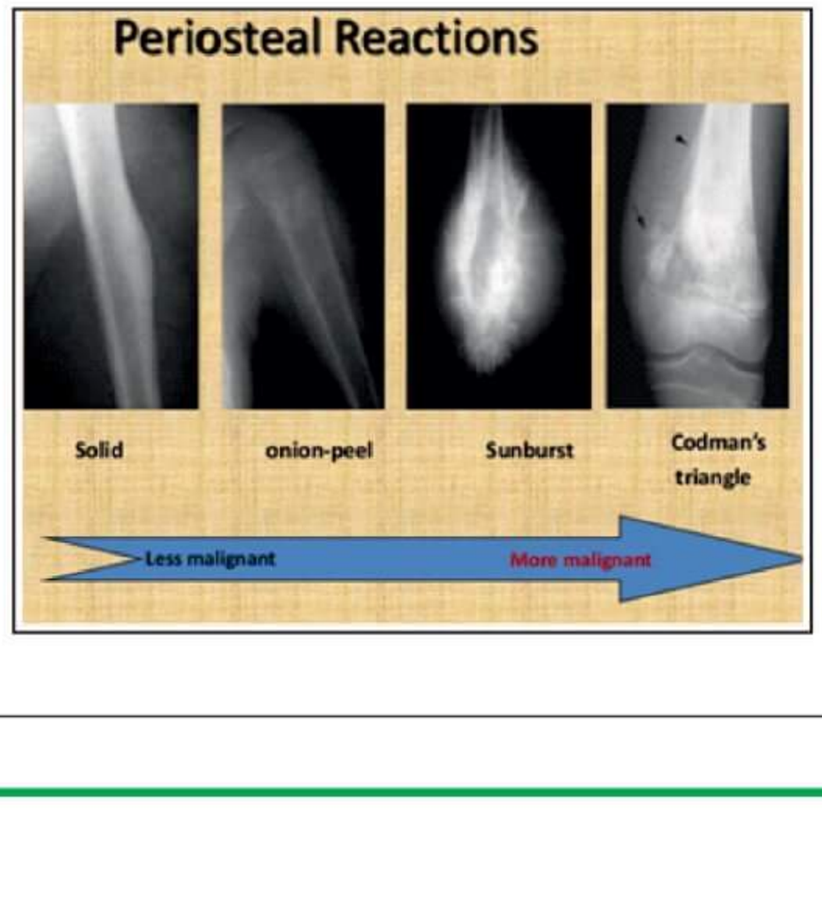


Chondroblastoma

Periosteal reaction

- Benign
  - ↓ Solid Periosteal reaction
- Aggressive
  - ↓ Lamellated
    - ↓ Onion Peel Appearance
      - ↓ Ewing's sarcoma
  - ↓ Spiculated
    - ↓ Sunray Appearance
      - ↓ Osteosarcoma
  - ↓ Codman's triangle
    - ↓ Osteosarcoma



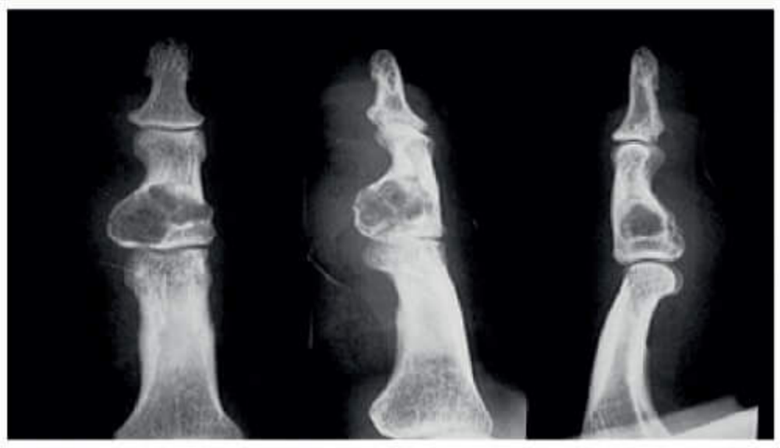


Enchondroma

→ Ring and Arc chondroid lesions present in phalanges with chondroid matrix

→ **Ollier's disease** – Characterised by Multiple enchondromas

→ **Maffuci's syndrome** – Characterised by Multiple enchondromas + Soft tissue hemangioma



Enchondroma – with multiple Rings & Arcs

Ollier's disease

Maffuci's syndrome

Exostosis

→ Triangular bony projection in upper end of tibia or lower end of femur – Known as **Exostosis**

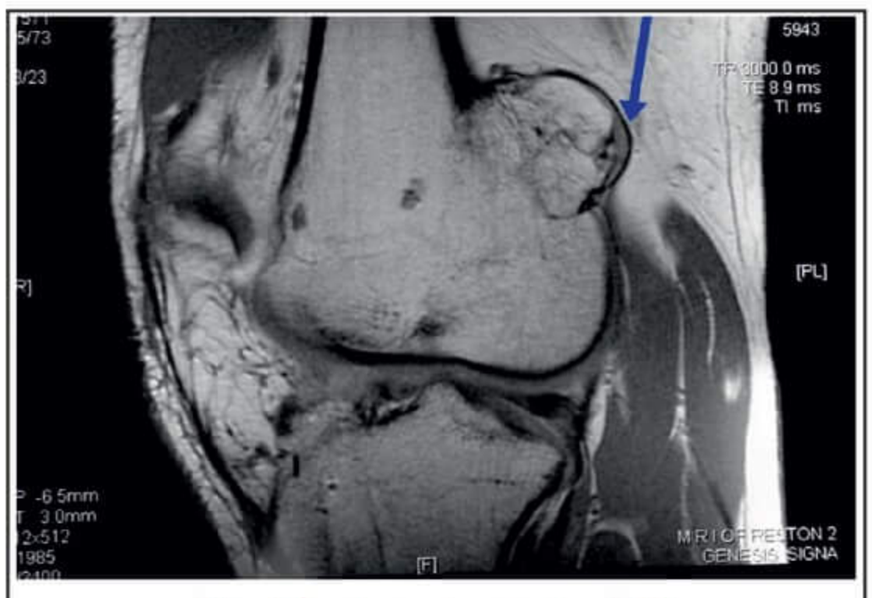
→ **Aka Osteochondroma**

→ covered by cartilaginous cap that is evaluated by MRI

→ **Cartilaginous cap** has premalignant potential - can lead to Chondrosarcoma

→ **Diaphyseal Aclasia**– Characterised by Multiple exostosis

Exostosis / Osteochondroma



Cartilaginous cap in MRI

Diaphyseal Aclasia

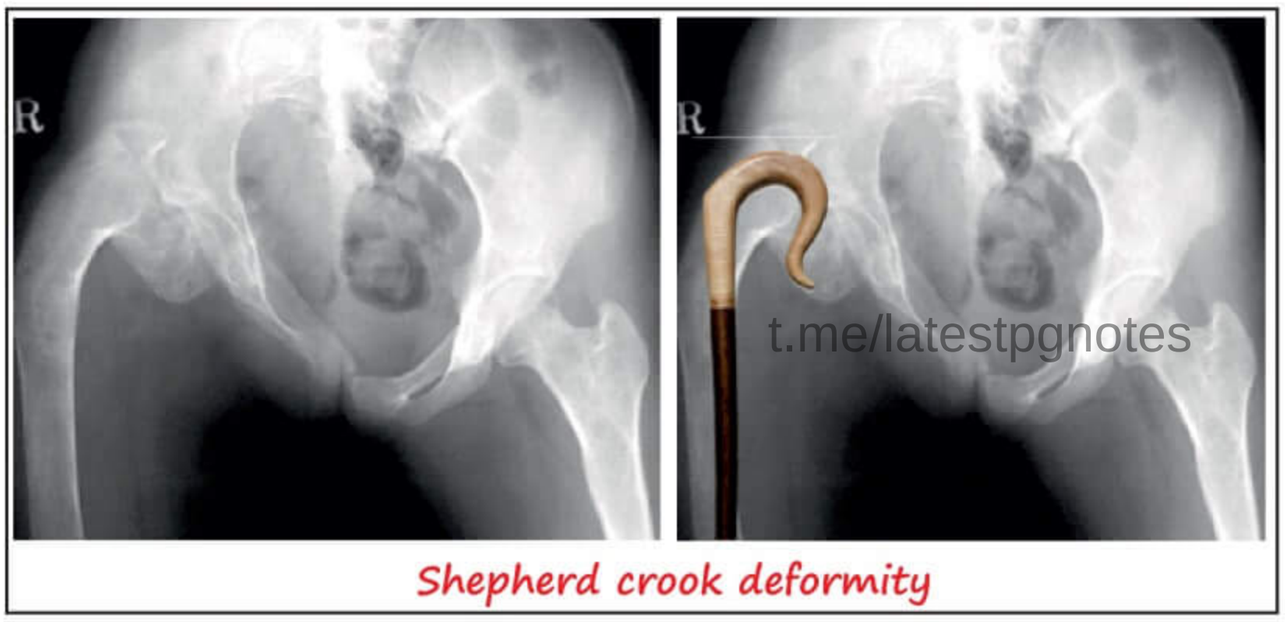
Fibrous dysplasia

→ Characterised by

- Ground glass opacities + Rind sign (sclerotic rim around ground glass opacities)
- Shepherd crook deformity

→ Has increased proliferation of cancellous/ spongy bone

→ Shows Hot uptake on bone scan – due to increased Osteoblastic activity



Shepherd crook deformity

Ground glass opacities + Rind sign

Note:

→ Fibrous dysplasia + Café au lait Spots + Precocious puberty in female –**McCune Albright syndrome**

→ Fibrous dysplasia + Intramuscular myxomas – **Mazabraud Syndrome**

Acromegaly

→ Characterised by

- Broadening of the distal phalanges – Spade like phalanges
- Increased Heel pad thickness

Spade like phalanges

Increased Heel pad thickness

Turner's syndrome

→ Has short 4th Metacarpal

Pseudohypoparathyroidism

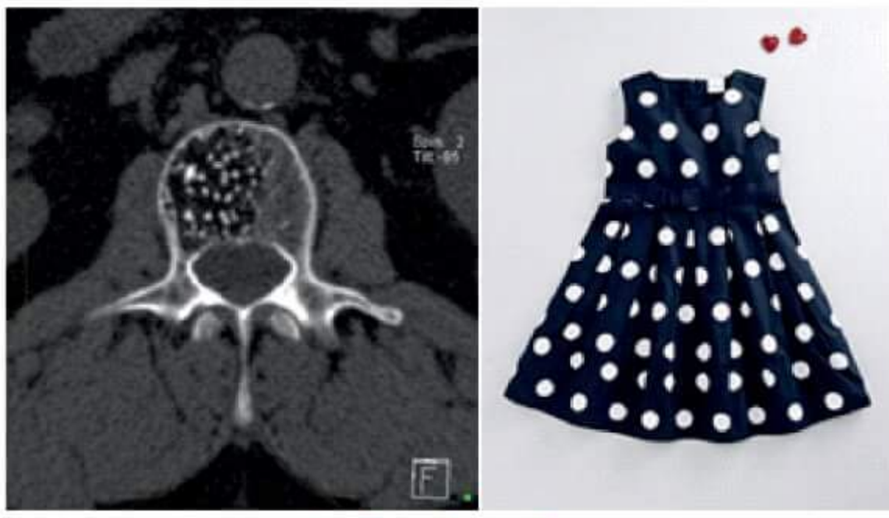
→ Has short 4th& 5th metacarpal

Vertebral Hemangioma

→ **Radiological features**

- On Sagittal view – shows vertical on striations the vertebral body known as **Corduroy appearance**
- On Axial view – shows **Polka dot sign**

Corduroy appearance

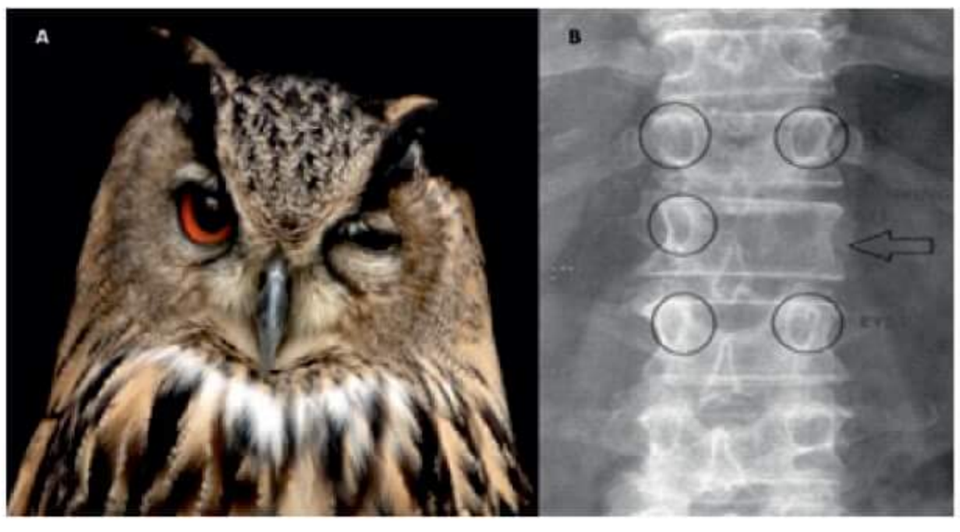


Polka dot sign

Vertebral metastasis

– **Shows "WINKING OWL SIGN"**

- Normally – Spinous process appears like beak of owl and pedicles appear like eye of owl
- Damage to pedicles of vertebrae because of metastasis cause this sign



Radiological features seen on Various Vertebral pathologies

→ H – shaped vertebra

- Seen in Sickle cell anemia

→ Fish mouth/Cod fish vertebra

- Seen in Sickle cell anemia&Osteoporosis

→ Bullet shaped vertebra

- Feature of Achondroplasia

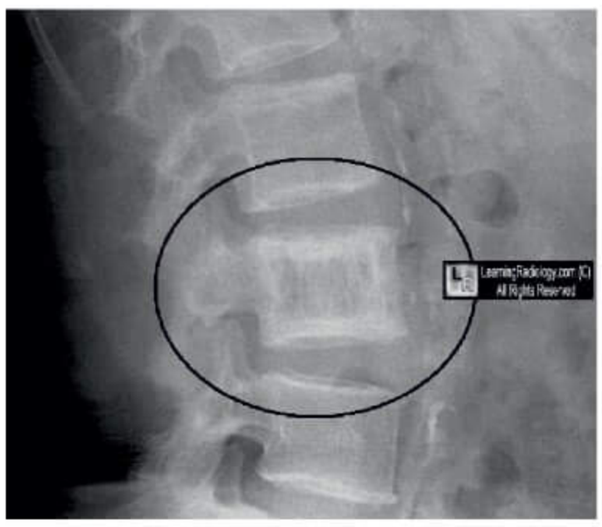
→ Sandwich vertebrae

- Feature of Osteopetrosis

→ Rugger jersey spine

- Seen in Renal osteodystrophy & Osteopetrosis

→ Picture frame vertebra

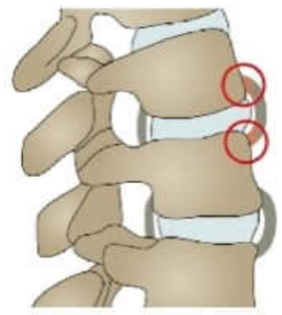
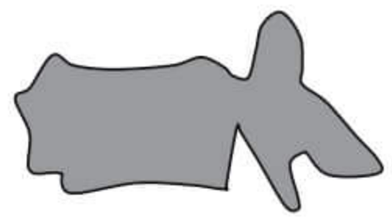
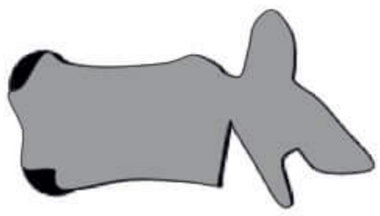
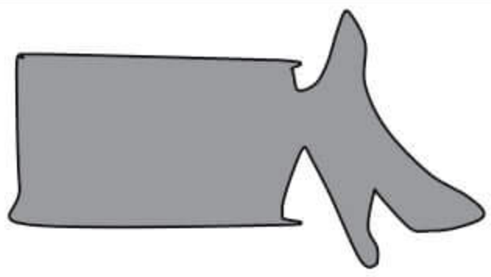


- Seen in Paget's disease (mixed phase)

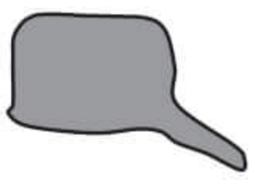
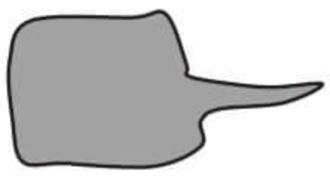
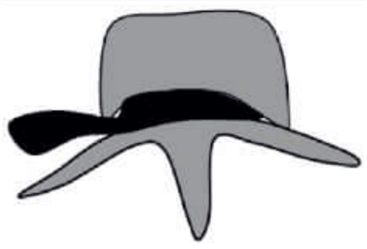
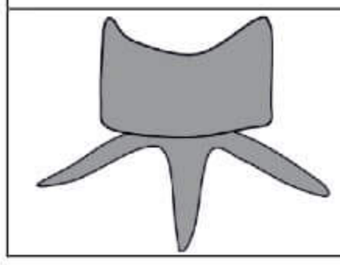
→ Dense sclerotic vertebra / Ivory vertebra

- Seen in
  - Paget's disease (sclerotic phase)
  - Hodgkin's Lymphoma
  - Osteoblastic metastasis

Sequence of vertebral changes in Ankylosing spondylitis

Enthesitis	Inflammation along site of insertion of tendonsand ligaments or vertebrae	
Romanus lesion	Erosions along the edges of vertebra	
Shiny corner sign	After repair, sclerosis occurs in corner of vertebra	
Squaring of vertebra		

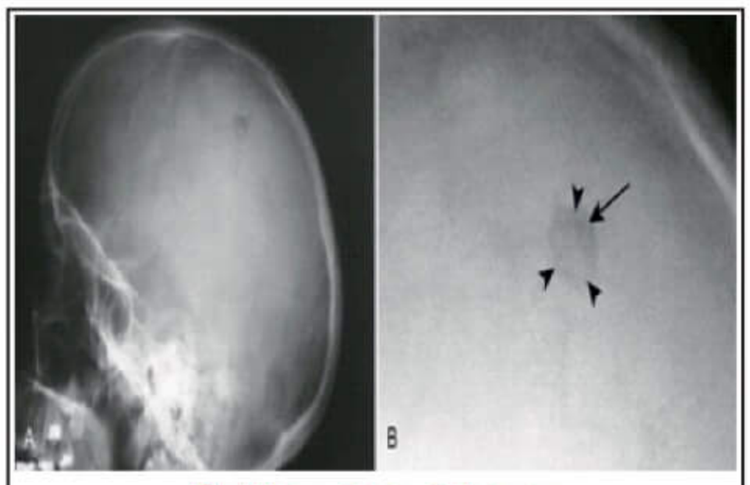
Importants point to know

	Vertebral morphology	Seen in
	• Antero inferior beaking of vertebrae	→ Hurler's syndrome (MPS)
	• Central breaking of vertebrae	→ Morquio syndrome (MPS)
	• Posterior scalloping of vertebral body	→ Intramedullary tumors (spinal cord tumor) → Neurofibroma → Achondroplasia
	• Anterior scalloping of vertebral body	→ Aortic aneurysm

Eosinophilic Granuloma

→ **Radiological findings**

- Vertebra plana- Flattening of vertebral body
- Beveledges of skull - Asymmetric erosion of inner and outer table
- Button sequestrum- Sclerotic area in the center of beveled edges
- Floating teeth of mandible - due to lysis of mandible
- Geographical skull - multiple fusing lucencies producing map like area on the skull



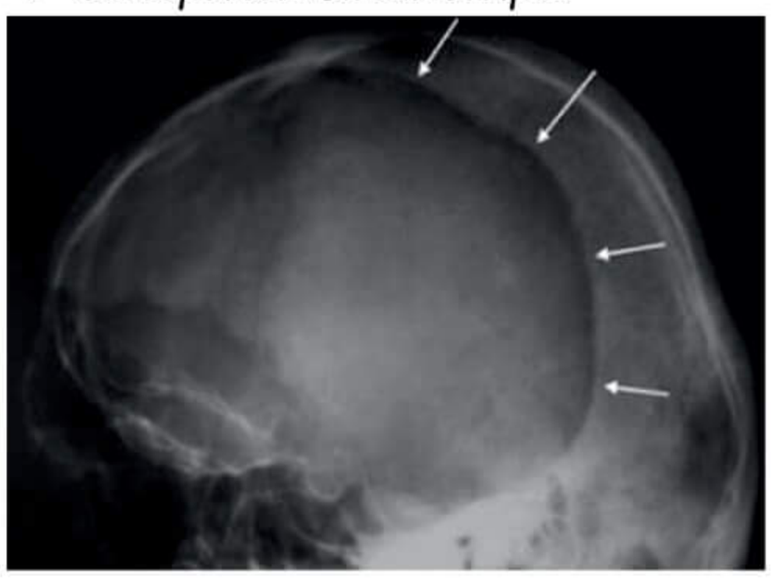
Button sequestrum

Floating teeth of mandible

Geographical skull

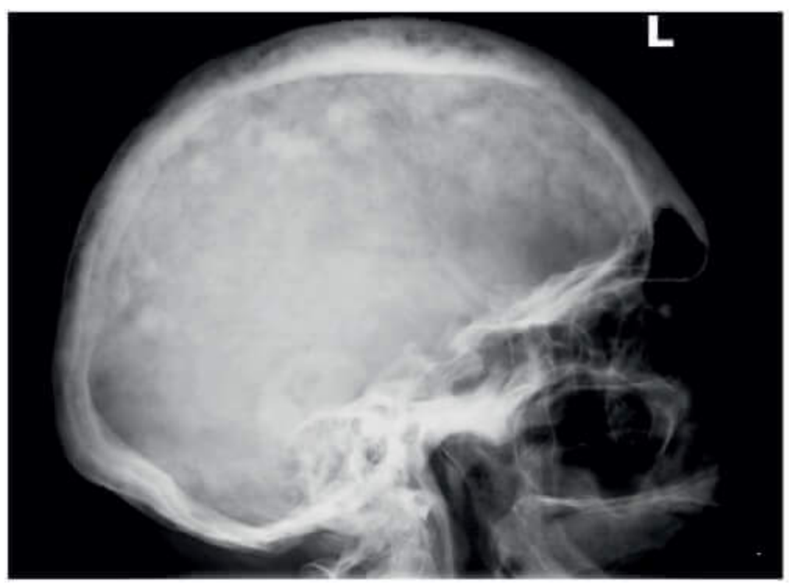
Radiological features in various Skull pathologies

→ **Osteoporosis Circumscripta**



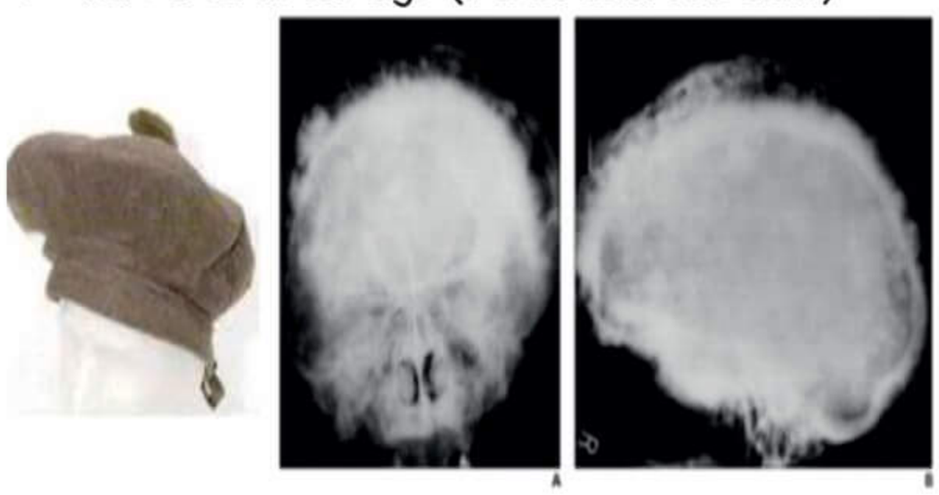
- Focal area of osteoporosis in skull
- Feature of Paget's disease (lytic phase)

→ **Cotton wool skull**



- Feature of Paget's disease (Mixed phase)

→ Tam'O Shanter sign (Dense sclerotic skull)

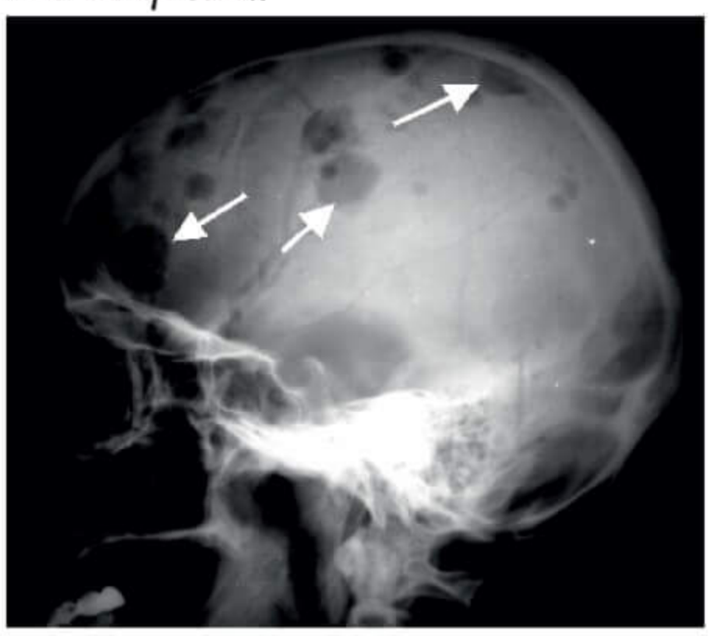


- Feature of Paget's disease (Sclerotic phase)

→ Geographical skull

- Feature of Eosinophilic granulomatous

→ Raindrop skull



- Varying size, scattered lucency
- Feature of Multiple myeloma

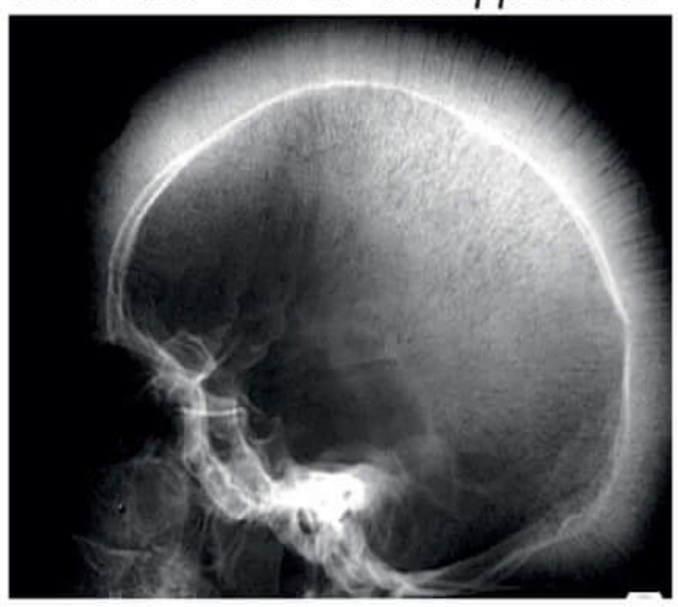
→ Pepper pot skull

- Uniform small lucencies and appears like pepper pot
- Feature of Hyperparathyroidism

→ Salt and pepper skull

- Feature of hyperparathyroidism

→ Crew out / hair on end appearance



- Feature of Thalassemia

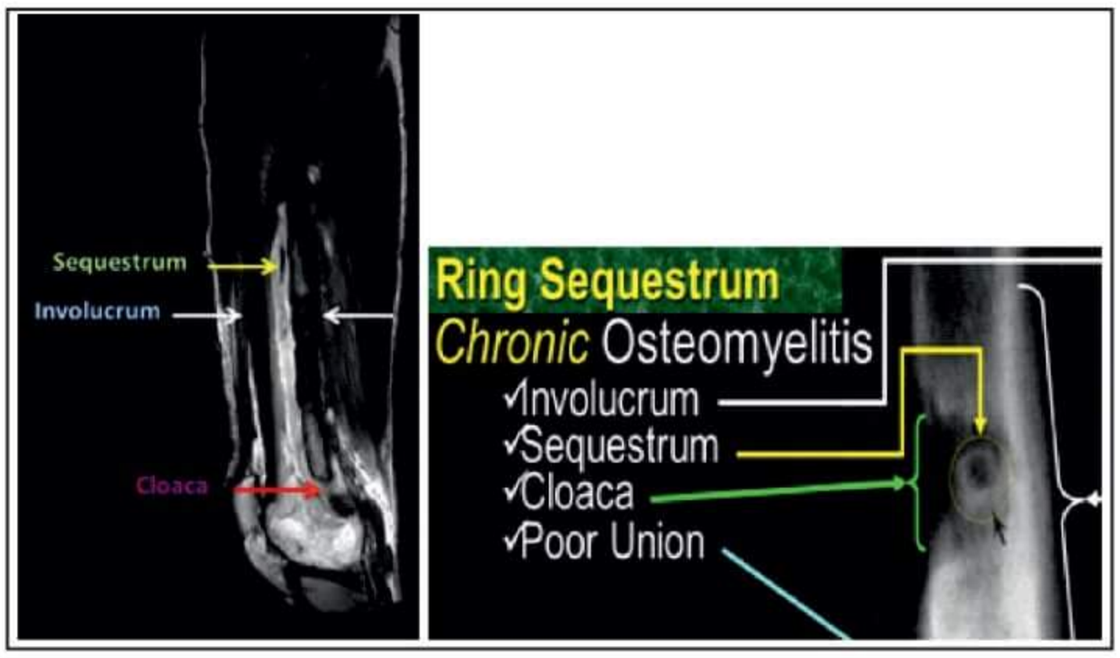
Osteomyelitis

→ Acute Osteomyelitis

- MCC of Acute Osteomyelitis – Staph aureus
- IOC for Acute Osteomyelitis – MRI

→ Chronic osteomyelitis

- Dead dense bone in center known as sequestrum
- Periosteal new bone formation - Involucrum



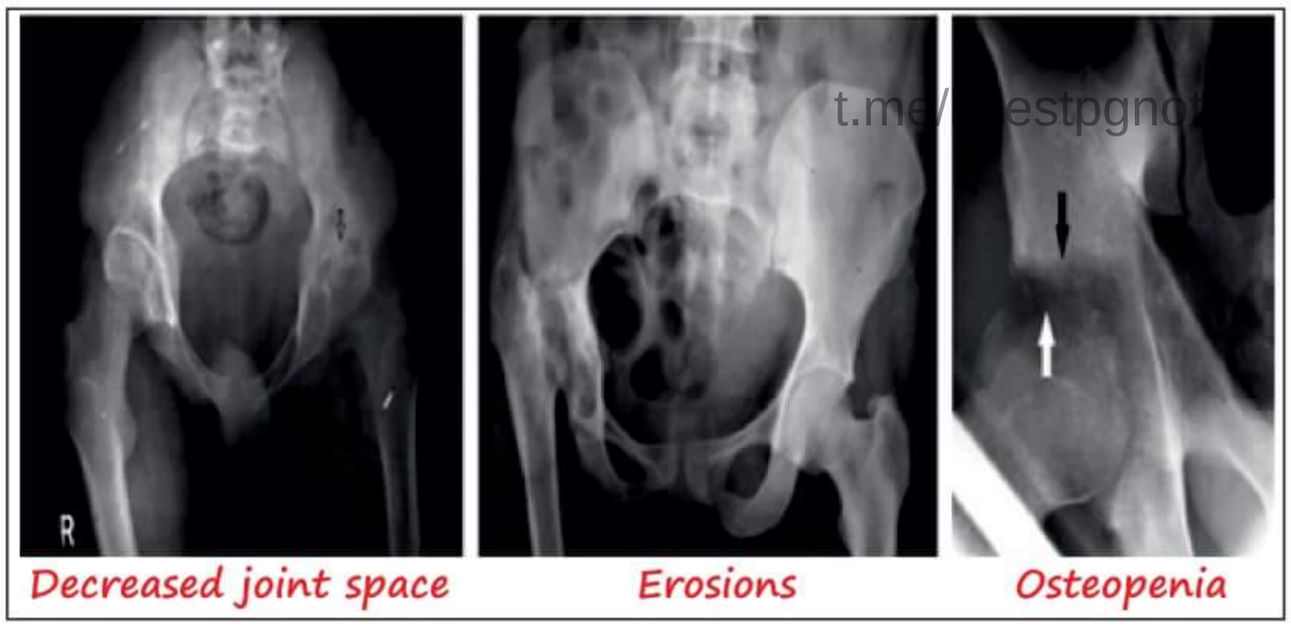
Tuberculous Arthritis

→ **Characterised by – Phemister Triad**

- Decreased joint space
- Erosions
- Osteopenia

→ **TB Hip**

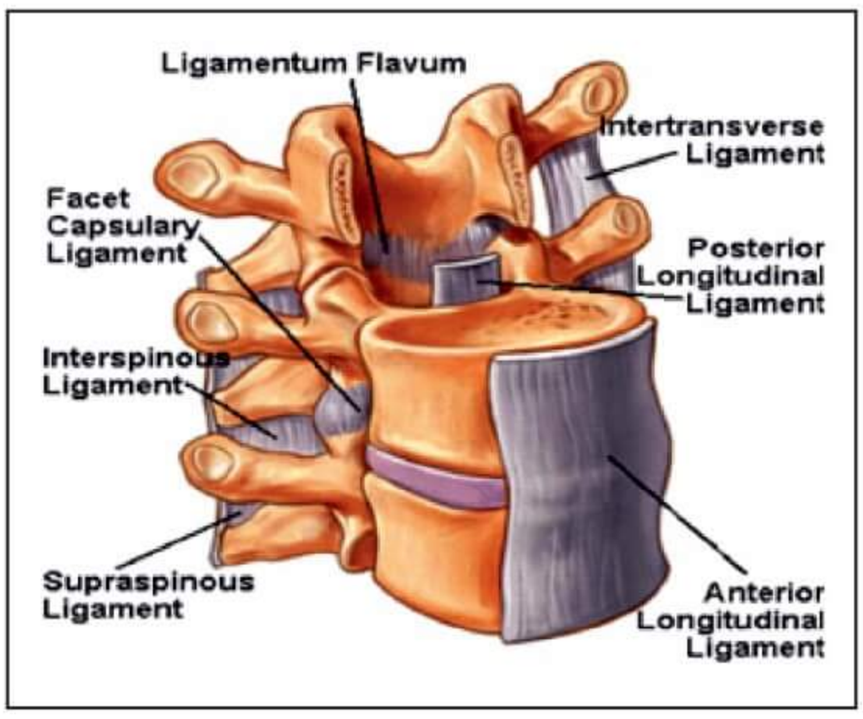
- Radiological findings
  - Wandering acetabulum
  - Mortar or Pestle appearance



Decreased joint space Erosions Osteopenia

Mortar or Pestle appearance

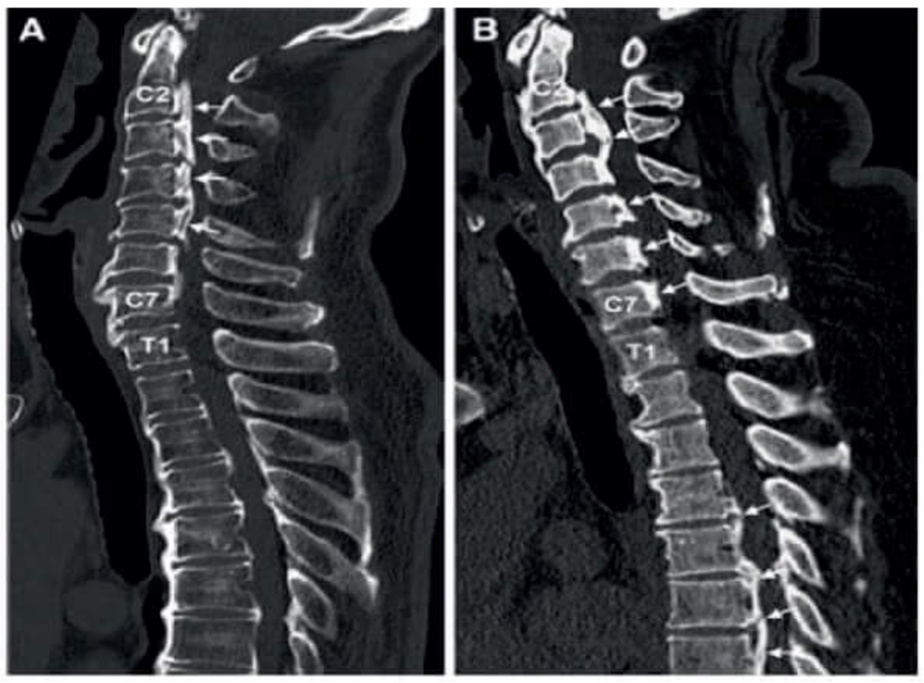
Ligaments supporting the vertebra



Calcification of Anterior longitudinal ligament

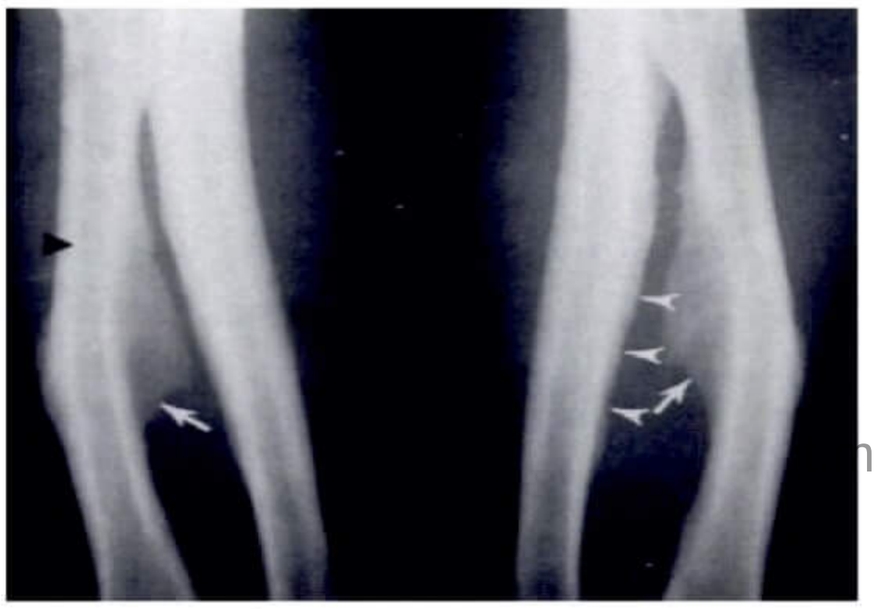
→ Feature of **DISH** (Diffuse Idiopathic skeletal hyperostosis)

Calcification of posterior longitudinal ligament



→ Feature of **Japan's disease**– shows Ossified Posterior longitudinal ligament

Calcification of interosseous membrane



→ Feature of **Fluorosis**

Meniscal calcification

→ Feature of **Pseudogout/ Chondrocalcinosis**

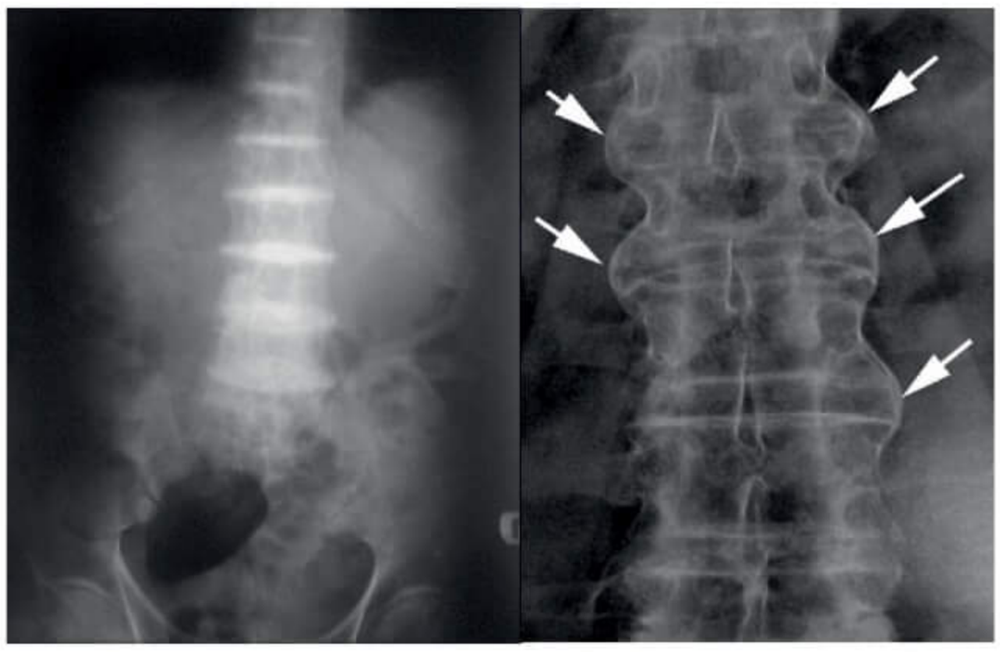
→ MC site involved in pseudogout- **knee joint**

→ **Calcium pyrophosphate** is deposited which is responsible for calcification.

Intervertebral disc calcification

→ Feature of **Alkaptonuria/ Onchronosis** (deficiency of Homogentisate dioxygenase)

→ Also seen in **Ankylosing spondylitis** (But only periphery of intervertebral disc iscalcified – gives bamboo spine appearance)



Alkaptonuria Ankylosing spondylitis

Ankylosing spondylitis

→ Earliest finding –Sacroiliitis

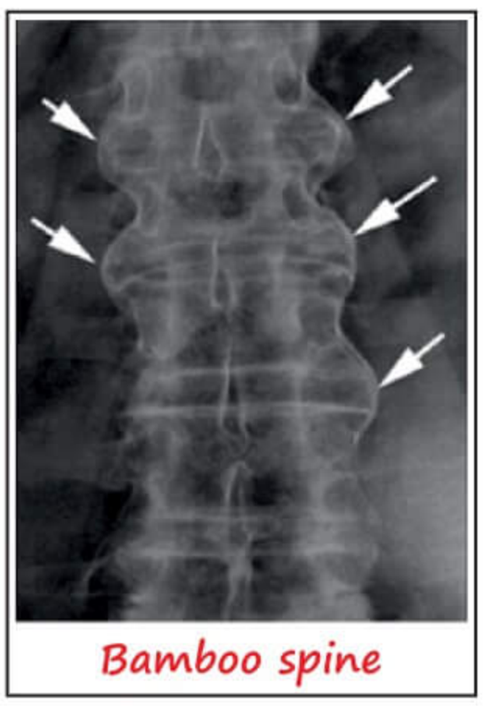
→ IOC for diagnosis – STIR – MRI

→ Radiological findings

- Bamboo spine
- Dense Calcification of interspinous ligament –Dagger spine
- Trolley track/ Tram track appearance- Peripheral calcification of intervertebral disc & calcification of interspinous ligament
- On MRI – Shows Bilateral symmetrical Sacroiliitis

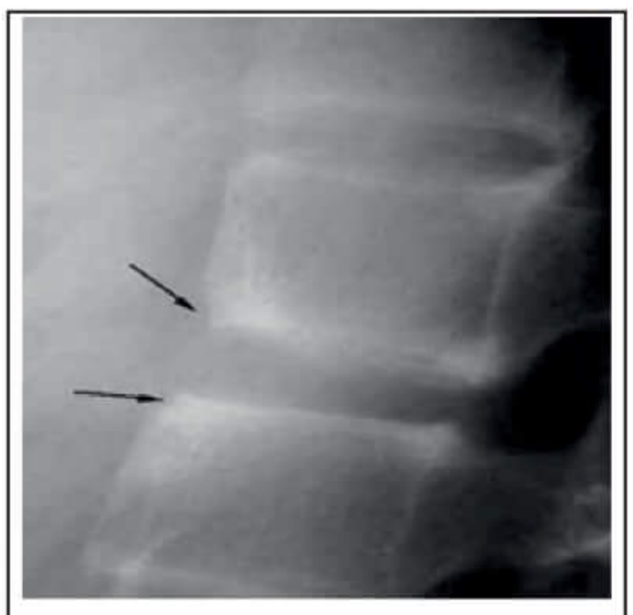
→ Other features seen are

- Enthesitis
- Romanus lesion
- Shiny corner sign
- Squaring of vertebra

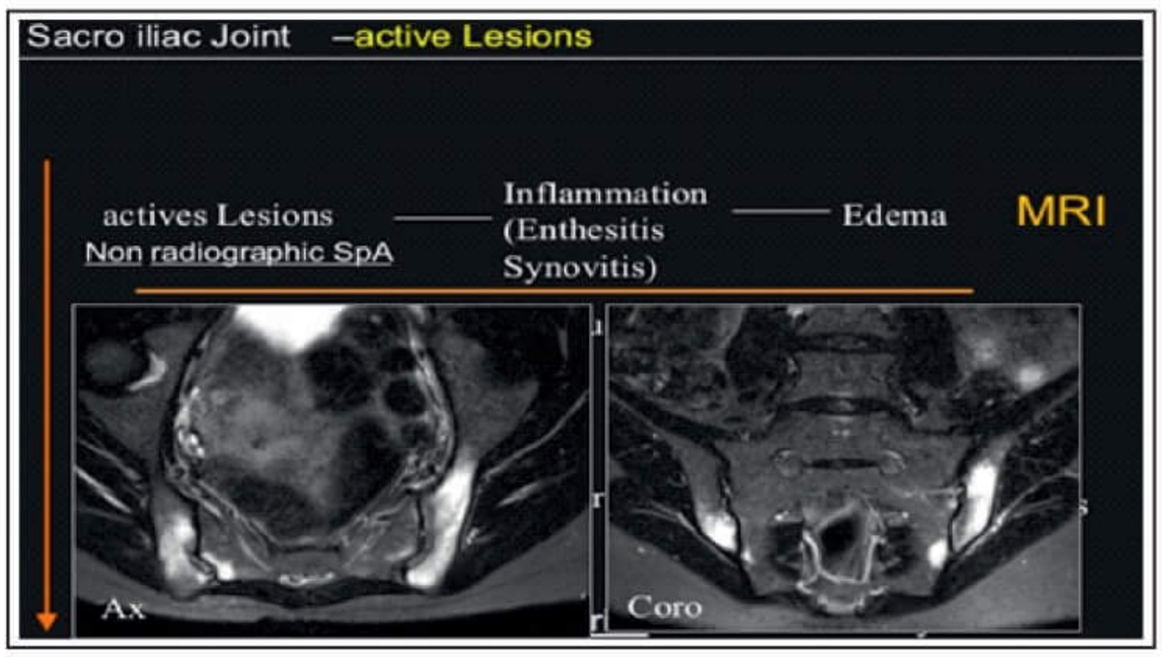


Bamboo spine

Dagger spine



Romanus lesion



MUSCULOSKELETAL RADIOLOGY -PART 2

Rickets

→ **Vitamin D deficiency**

→ Decreased mineralization of bones

→ Earliest finding of Rickets-Loss of Provisional zone of calcification

↓

Epiphysis compresses over metaphysis causing metaphysis to undergo

- Cupping (deepening of metaphysis)
- Splaying (broadening of metaphysis)
- Fraying (irregularities of metaphysis)

→ Widening of growth plate

→ In Rickets the acetabulum is pulled medially inward known as **Protrusio acetabuli**

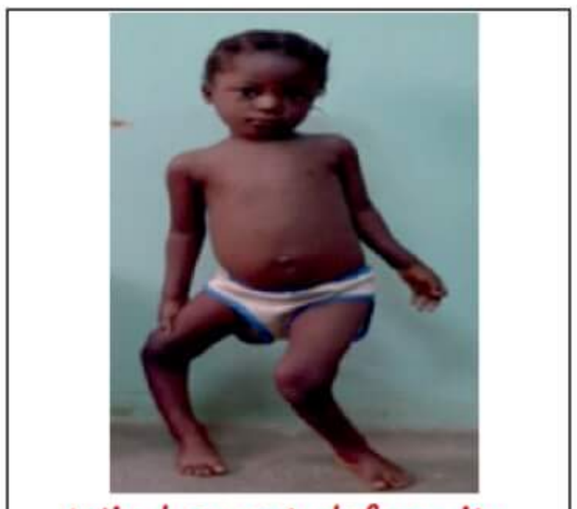
→ Triradiate Pelvis

→ There is combination of genu valgus and genu varus known as wind swept deformity of knee.

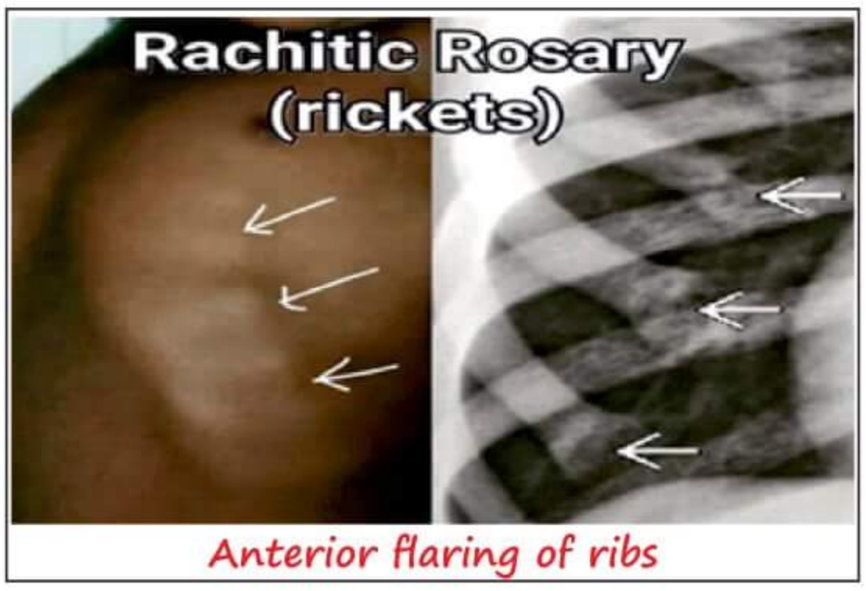
→ Anterior flaring of ribs (broadening of anterior end attached to costal cartilages)- Rachitic rosary

Widening of growth plate, Cupping, Splaying and Fraying Of metaphysis is seen

Protrusio Acetabuli & Triradiate Pelvis



Wind swept deformity



Anterior flaring of ribs

Osteomalacia

→ LOOSER ZONE (lucent weight bearing area involving cortex

→ Aka Pseudo fracture / Milkman fracture

osteomalacia

Juvenile Rheumatoid Arthritis / stills disease

→ Epiphyseal enlargement

Epiphyseal enlargement

Hypothyroidism

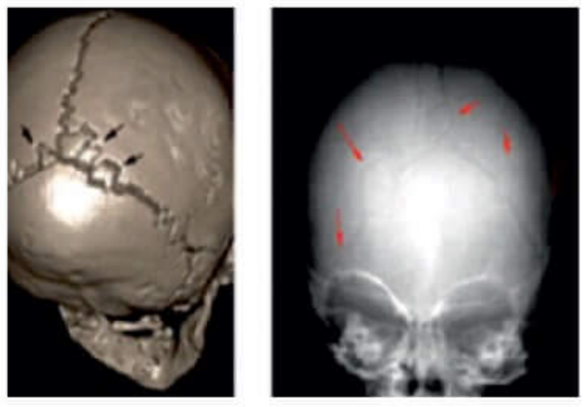
→ Epiphyseal dysgenesis

Epiphyseal dysgenesis

Wormian bones

→ Intra sutural bones associated with

- Osteogenesis imperfecta
- Hypothyroidism



Wormian bones

Scurvy

→ **Deficiency of Vitamin C**

→ Vitamin C is responsible for **lysine and Proline hydroxylation associated with Collagen synthesis**

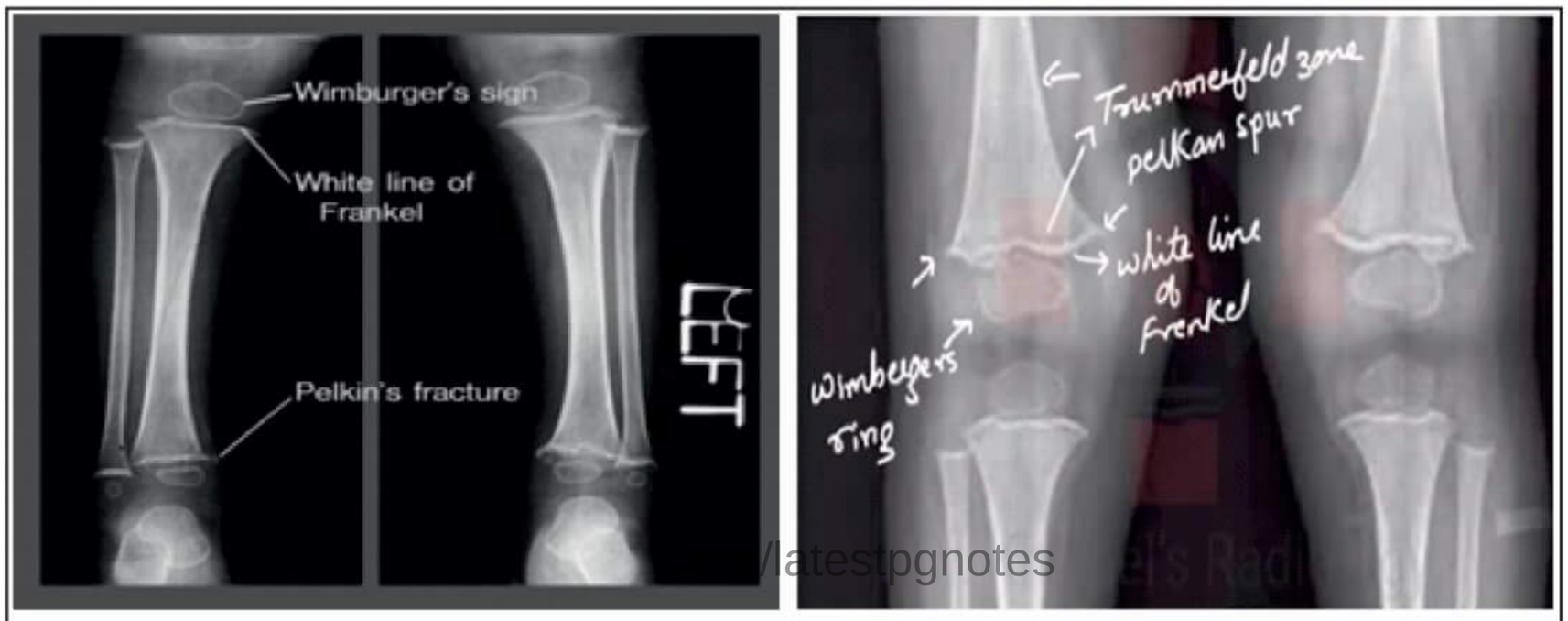
→ Therefore, Defect in collagen synthesis and Defect in osteoid matrix

→ **Radiological findings**

- Pencil thin cortex
- Dense provisional zone of calcification
- White line of Frenkel
- Pelkan spurs
- Trummerfeld zone
- Sub periosteal Hemorrhages
- Wimbergers RING

→ **Subperiosteal Erosions** - feature of Hyperparathyroidism

→ **Subperiosteal hemorrhages** - feature of Scurvy



scurvy

Wimbergers Sign

→ Erosion of medial tibial condyle seen in **congenital syphilis**

→ **In congenital syphilis,**

- **Sabre tibia** - Anterior bowing of tibia
- **Clutton joints** - swollen knee joints

Sabre tibia

Celery stalk appearance

→ Vertical striations at end of long bone

→ Feature of **Congenital rubella**

Celery stalk appearance

Fish mouth / Cod fish vertebrae-

→ It is a feature of Osteoporosis / Sickle cell anemia

Fish mouth vertebrae

Scottish Dog appearance

→ Normal appearance of lumbar spine on posterior oblique view.

Scottish Dog Collar Sign

→ Seen in Spondylos - is Pars interarticularis fracture

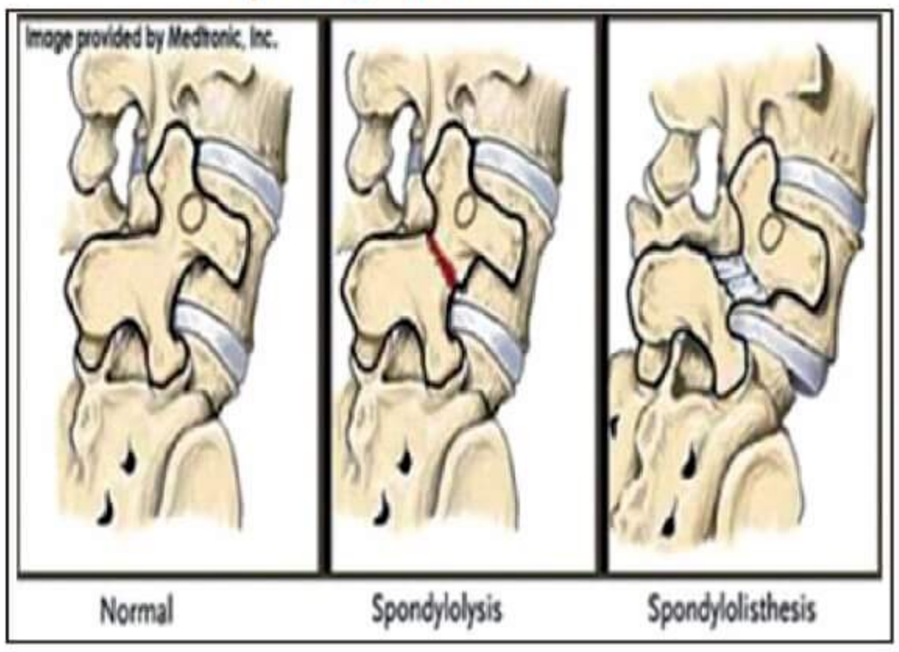
Scottish dog appearance

Scottish dog collar sign

Beheaded scottish dog appearance

→ Along with the fracture of pars interarticularis there is an anterolisthesis

→ feature of spondylolisthesis



Inverted Napoleon Hat sign

→ Bilateral severe L_5 listhesis over S_1 / spondylolistheses on Frontal view

Inverted napolean hat sign

Osteoporosis

→ ↓ Bone mineral density

→ Bone mineral density is measured by - DEXA scan (females > 65 years)

DEXA scan

T-score
(Healthy young individual)
↓
Defined by WHO

Z- score
(same age group)

Osteoclastoma- GIANT CELL TUMOR

→ Soap bubble appearance around the knee joint

→ Epiphysiometaphyseal, Subarticular, eccentric

→ Occurs only after fused growth plate is > 20 years age

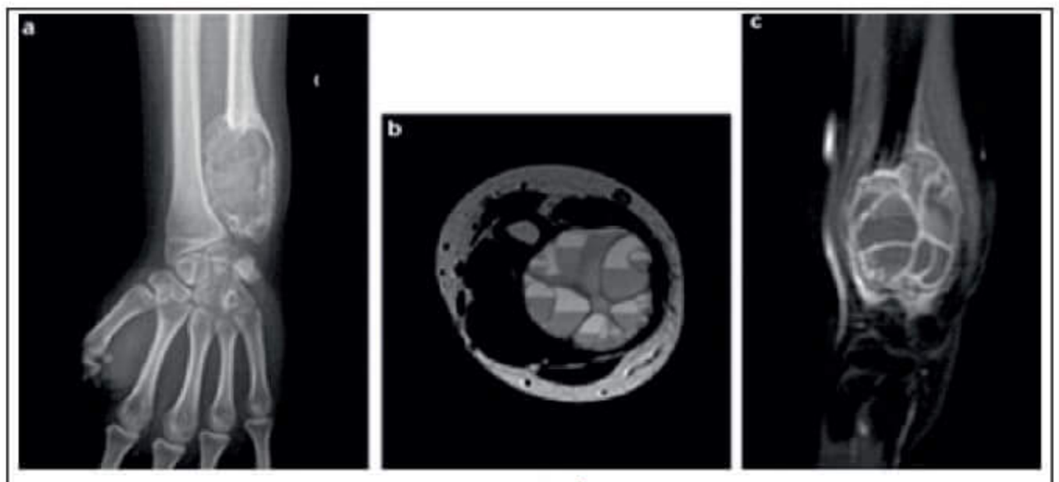
Giant cell tumor

Aneurysmal Bone cyst

→ Metaphysis – Multiloculated

→ Unfused growth plate

→ **Fluid – fluid level** on MRI (Also seen in telangiectatic osteosarcoma, GCT)



Aneurysmal bone cyst

Giant cell tumor	Aneurysmal Bone cyst
• Fused growth plate	• Unfused growth plate
• > 20 – 40 Years	• < 20 years
• Epiphyses metaphyseal subarticular	• Metaphyseal

Soap Bubble lesion in MANDIBLE

→ It is a feature of Adamantinoma / Ameloblastoma

Note

→ **Soap Bubble appearance**

- **Around the knee** → Osteoclastoma / GCT
- **Mandible** → Adamantinoma
- **Antenatal scan** → Multicystic dysplasia kidney
- **MRI Brain** → Cryptococcus neoformans
- **Abdominal radiograph** → Meconium ileus

Simple bone cyst / Unicarmel bone cyst

→ Fallen leaf / fallen fragment sign

→ Unfused growth plate metaphyseal lesion

→ Unilocular

Fallen leaf / fragment sign

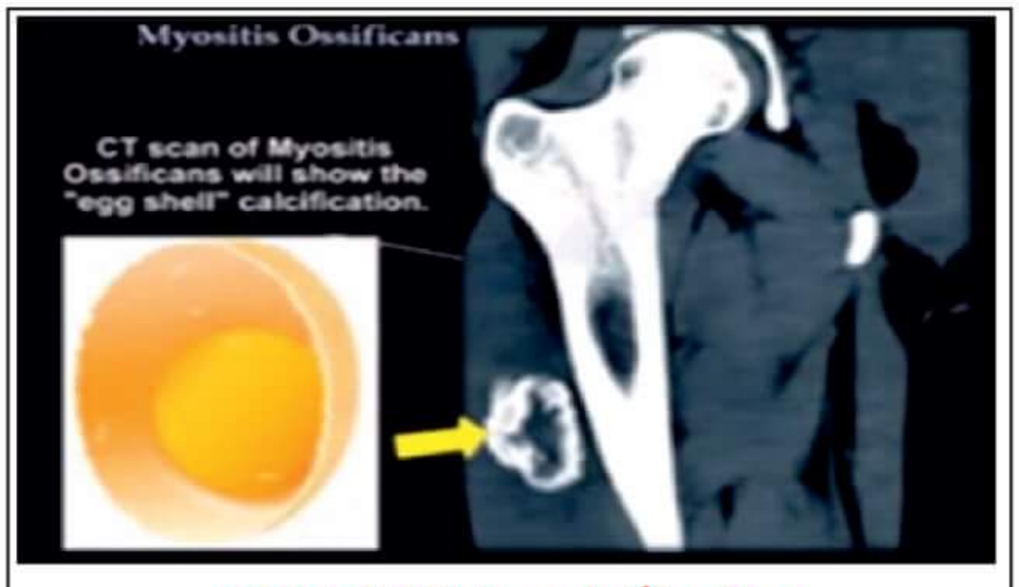
Terry Thomas sign

→ Seen in Scapho-lunate dislocation

Terry Thomas sign

Myositis Ossificans

→ Peripheral calcification with central lucency- Egg Shell calcification



EGG SHELL calcification

Parosteal osteosarcoma

→ Central calcific area surrounded by lucency

→ Commonly in posterior aspect of lower end of femur

Parosteal osteosarcoma

Monteggia Fracture

→ Upper end of ulna

→ Superior radioulnar joint dislocation

→ ANTERIOR MONTEGGIA (MC)

→ Mnemonic- "MUSA"

Monteggia fracture

Galeazzi Fracture

→ Fracture of distal end of radius with dislocation of inferior radio ulnar joint

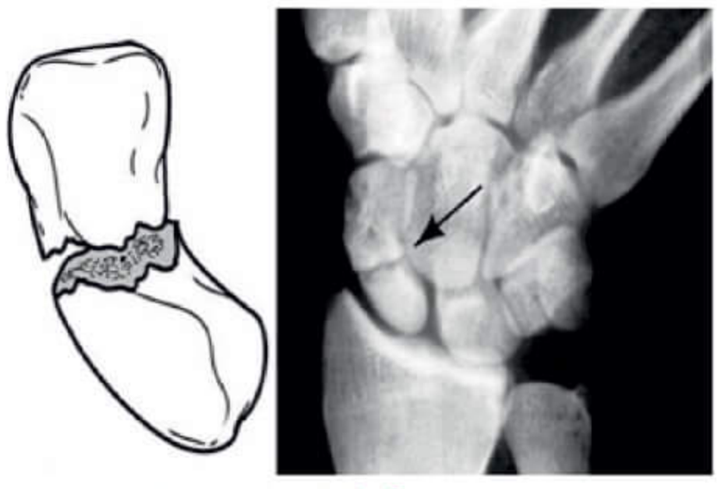
→ Mnemonic - "GRI"

Galeazzi fracture

Scaphoid Fracture

→ Avascular necrosis of **base and proximal portion** of scaphoid (because blood supply is retrograde)

→ Most common site of fracture is waist of scaphoid



Scaphoid fracture

Metaphyseal Densities

→ Lead poisoning

→ Scurvy

→ Healing rickets

Metaphyseal lucencies

→ Leukemia

Metaphyseal densities

Bankart lesions

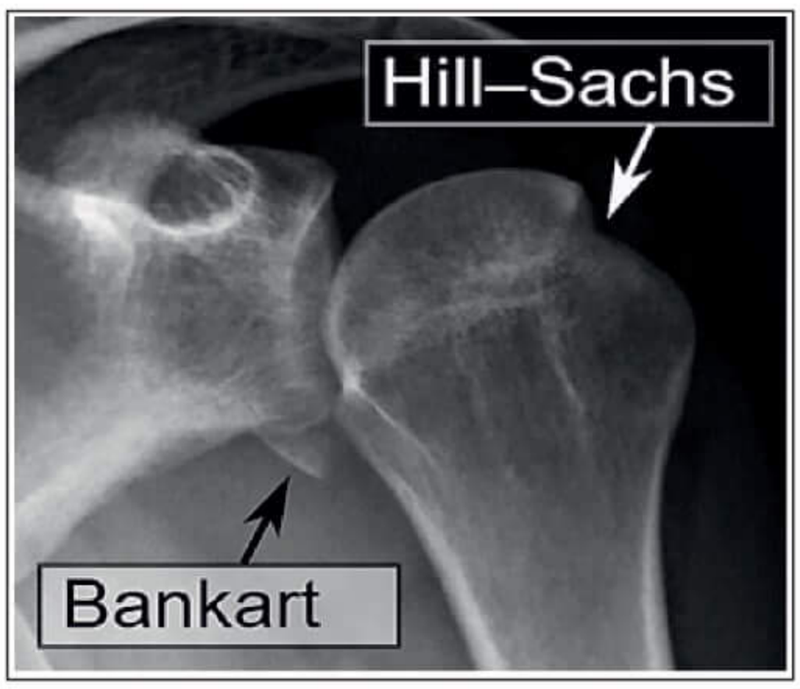
→ Repeated shoulder dislocation

→ Erosion in anterior inferior aspect of glenoid cavity

Hill Sachs lesions

→ Seen in recurrent shoulder dislocation

→ Lesion on the posterolateral aspect of the humerus



Myositis ossificans

→ Most common joint involved is elbow

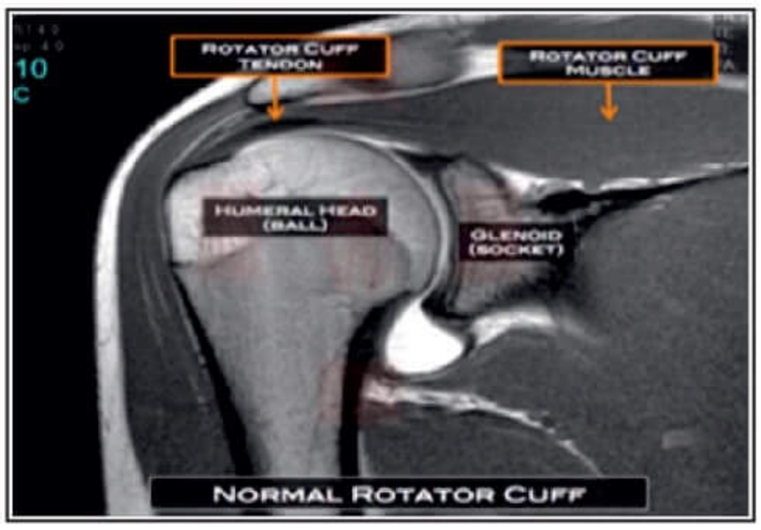
→ Peripheral calcification with central lucency

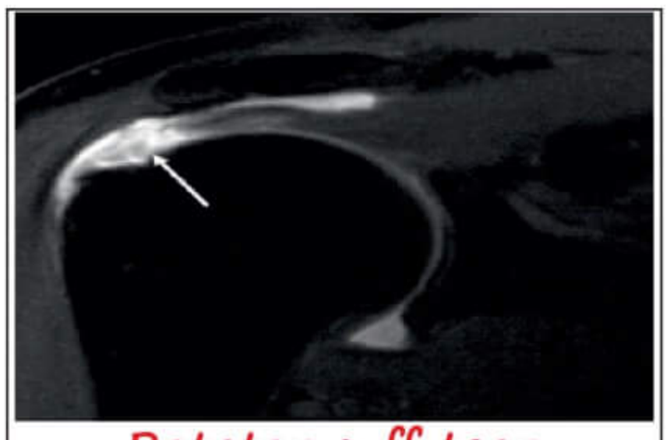
Myositis ossificans

NOTE:

→ Subscapularis muscles – 'Forgotten muscle'

→ MC muscle involved in **ROTATOR CUFF syndrome** – supraspinatus





Rotator cuff tear

Hand radiograph

→ Carpal bones are arranged in two rows from latera to medial
(Mnemonics – "She Looks Too Pretty Try To Catch Her")

→ Medial bones – Hamate & Pisiformis

→ Lateral bones - Scaphoid & Trapezium

→ Thumb rotates over Trapezium

→ Largest carpel bone- Capitate

→ MC Fracture carpal bone- Scaphoid

→ MC dislocated carpal bone- Lunate

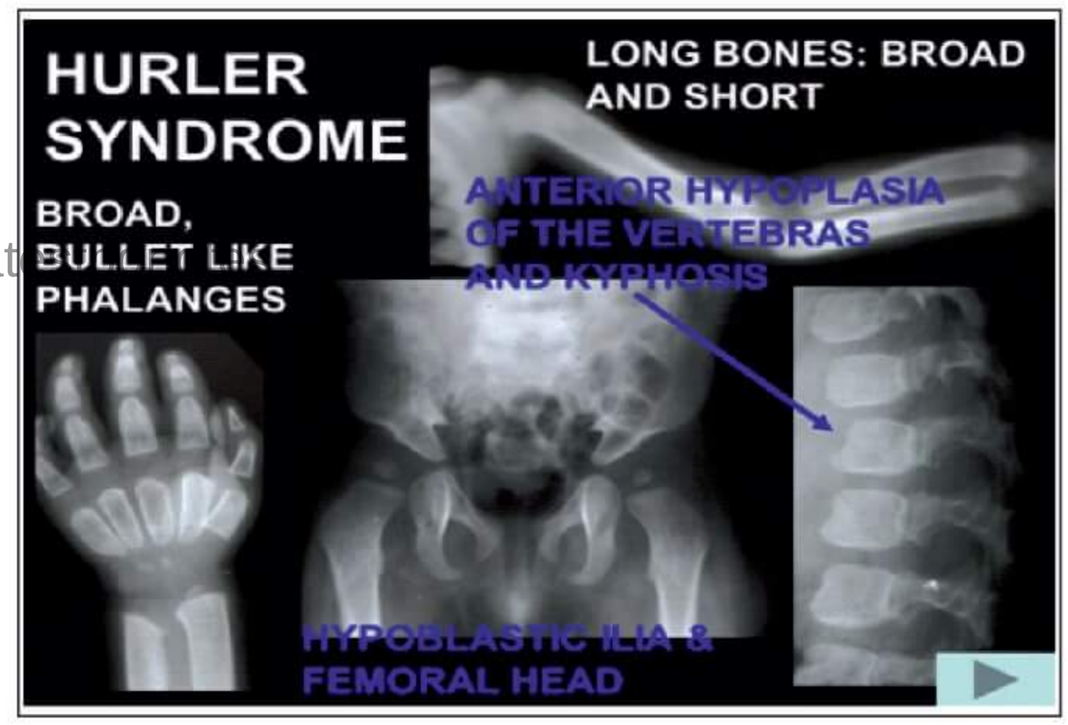
Proximal pointing of metacarpals

→ Feature of MUCOPOLYSACCHAROIDOSIS / Hurler syndrome

→ Other findings in hurler syndrome:

- Oar shaped ribs
- Anteroinferior beaking of vertebra
- J shaped Sella / macrocephaly

Hurler syndrome



Oar shaped ribs -hurler

Nail Patella syndrome

→ Iliac horns

→ Absent patella

→ Nail defects

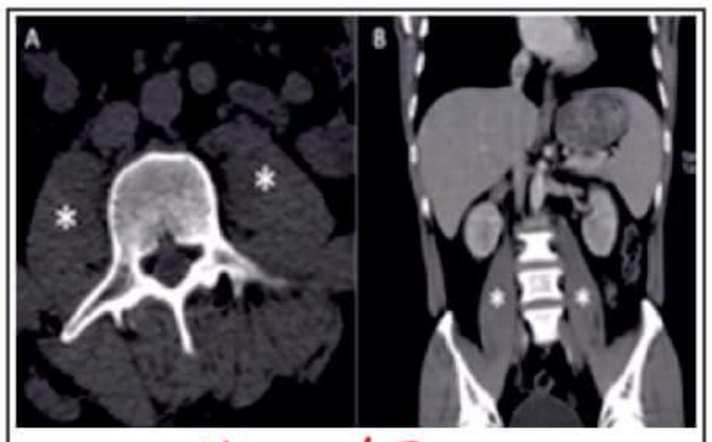
Absent patella

Nail defect

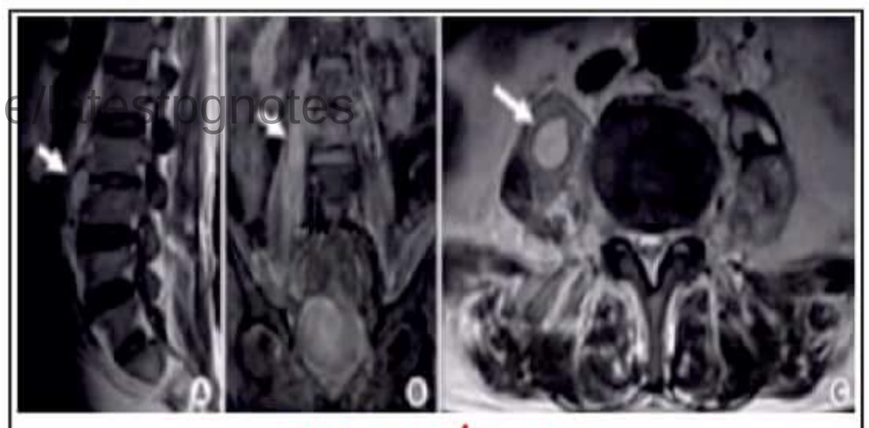
Iliac horns

Psoas abscess:

→ Fluid filled psoas as well as swollen psoas muscle is seen



Normal Psoas



psoas abscess

Colles Fracture

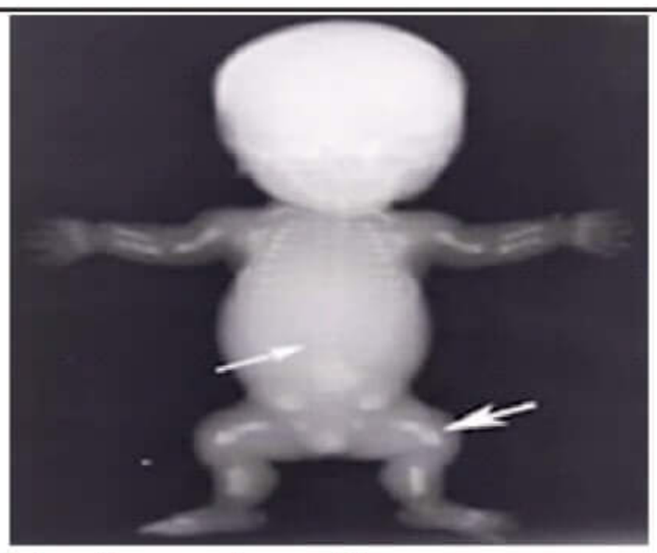
→ Fracture at distal end of radius in the corticocancellous junction

→ Reflex sympathetic dystrophy - Osteopenia (Sudecks Dystropy)

Sudecks Dystrophy

Telephone Handle appearance in femur

→ Feature of **Thanatophoric Dysplasia**

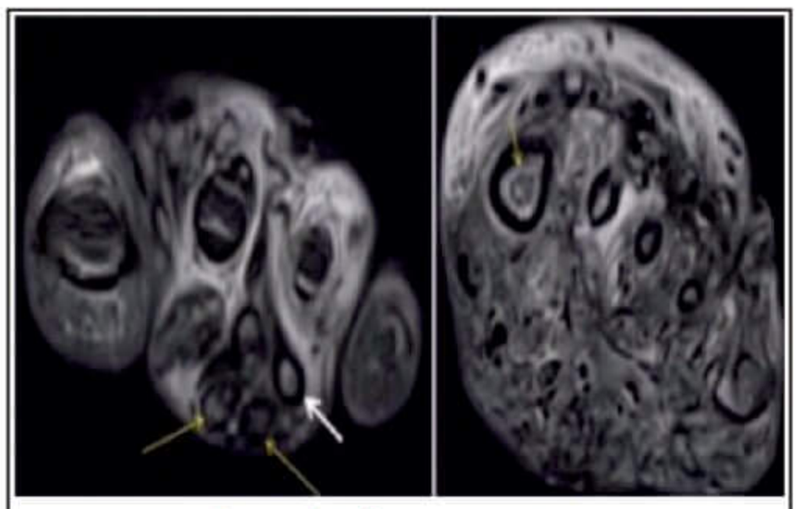


Telephone handle appearance

Dot in Circle appearance in MRI

→ Feature of **Madura mycosis**

→ Fungal element in the Centre with surrounding granulation tissue



Dot in circle appearance

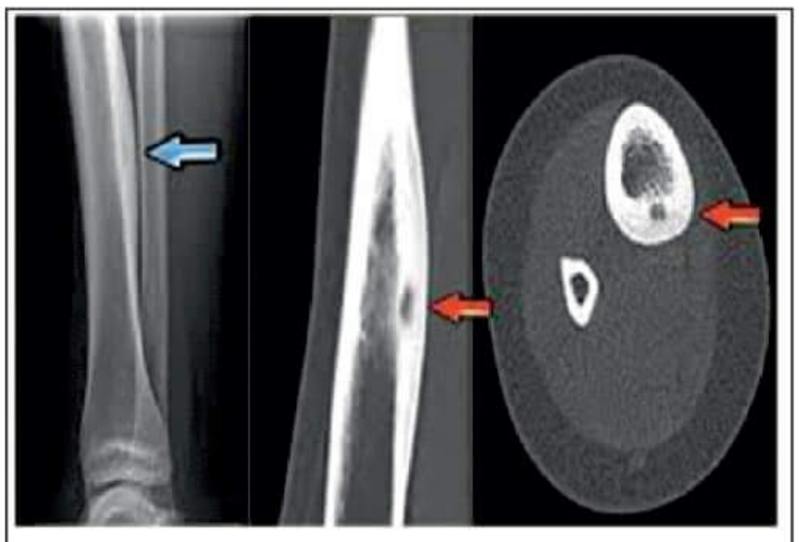
Osteoid Osteoma

→ Central lucent nidus < 2 cm

→ Surrounded by scleroticrim

→ Commonly involves diaphysis

→ **Double density sign** on nuclear scan



Osteoid osteoma

MUSCULOSKELETAL RADIOLOGY PART 3

Rheumatoid arthritis

→ Most commonly involved joint is **MCP** (metacarpophalangeal joint)

→ Erosion of lateral end of clavicle

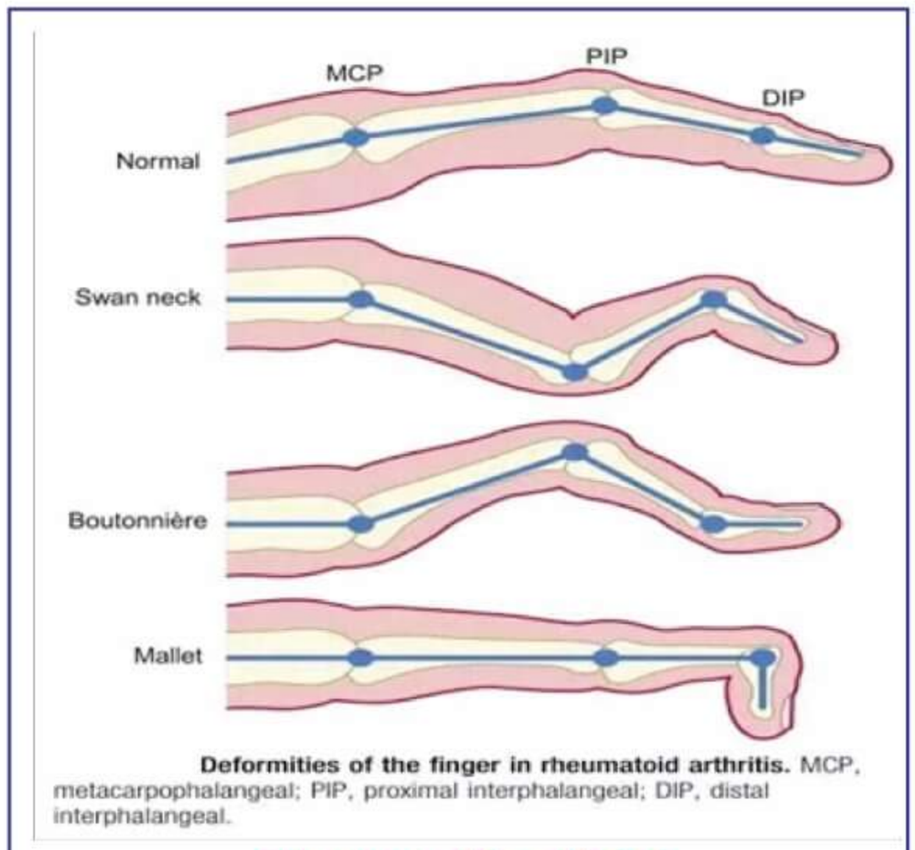
→ Osteopenia

→ **Swan neck deformity** – Flexion of DIP & extension of PIP

→ **Boutonniere deformity** – flexion of PIPand Extension of DIP

→ **Hitch hikers thumb** (boutonniere deformity involving the thumb)

→ Atlantoaxial subluxation



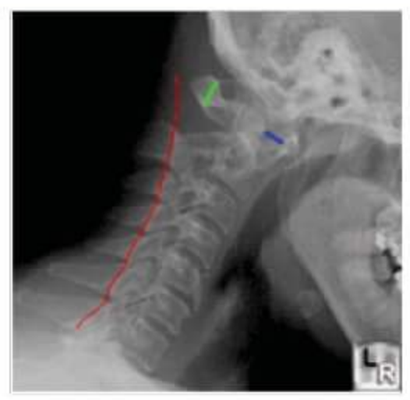
Deformities of the finger in rheumatoid arthritis. MCP, metacarpophalangeal; PIP, proximal interphalangeal; DIP, distal interphalangeal.

Rheumatoid arthritis

Figure 1

Figure 2

erosion of clavicle



atlantoaxial subluxation

Feltys Syndrome:

→ RA + splenomegaly + neutropenia

splenomegaly (feltys syndrome)

Osteoarthritis

→ Narrowing of medial ends of knee joint

→ Subchondral sclerosis

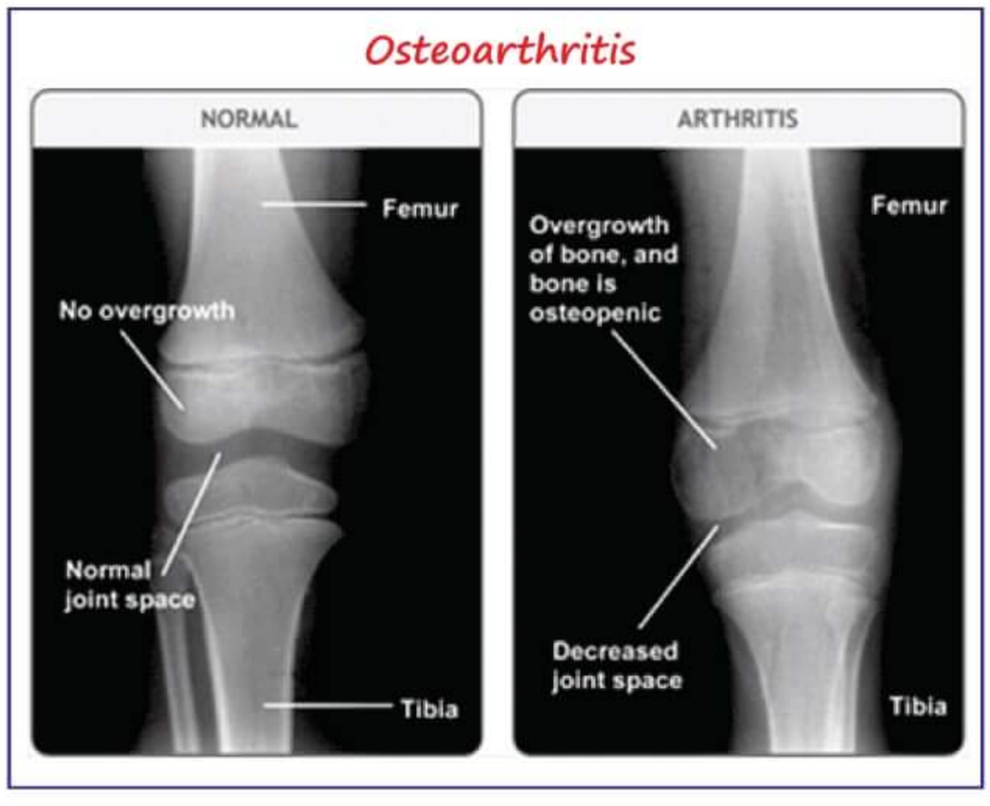
→ Osteophytes

→ Reduced joint space

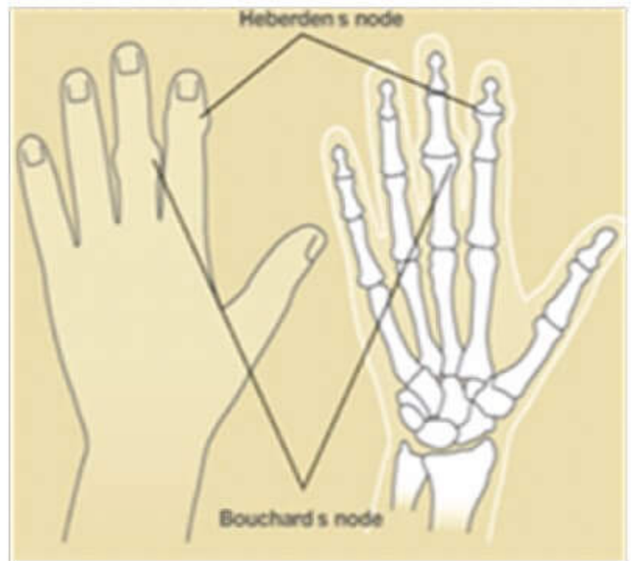
→ **Bouchards Node** – OA involving PIP

→ **Heberden's Node** – OA involving DIJ

→ **Gull wings sign** – seen commonly in erosive osteoarthritis



Gull wings sign

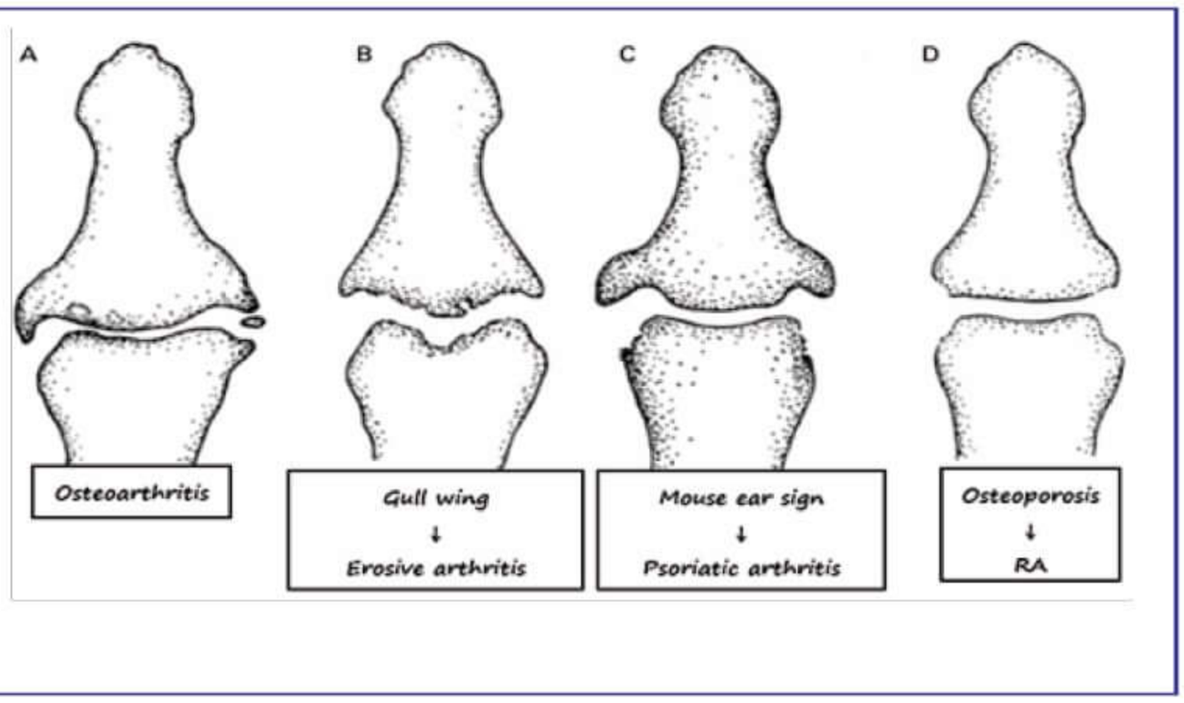


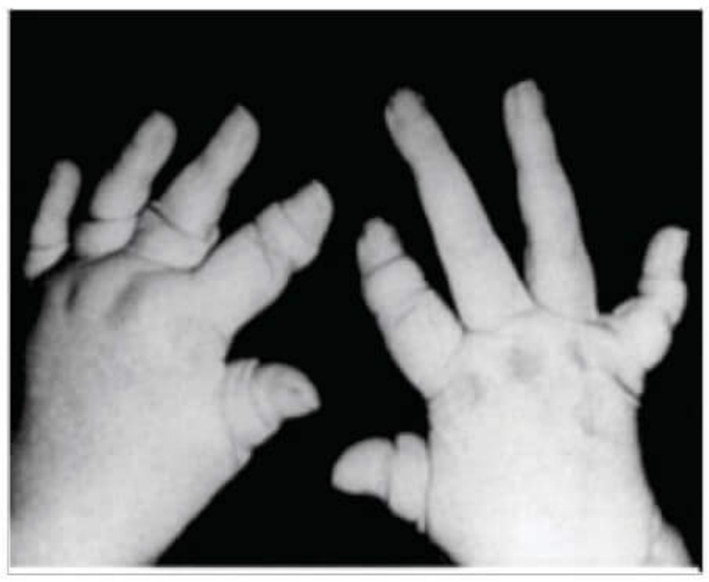
Heberden's and Bouchards

Psoriatic arthritis:

- → Involvement of IP joints (interphalangeal)
- → **Radiological findings**
  - Saucerization of digits
  - Tapering of pharynges
  - Pencil in cup deformity
  - Telescoping sign positive
  - Arthritis mutilans / erosive arthritis
  - Opera glass deformity (La Main en Lorgnette)
  - Mouse ear sign
  - Periostitis at edges of bone

Psoriatic arthritis

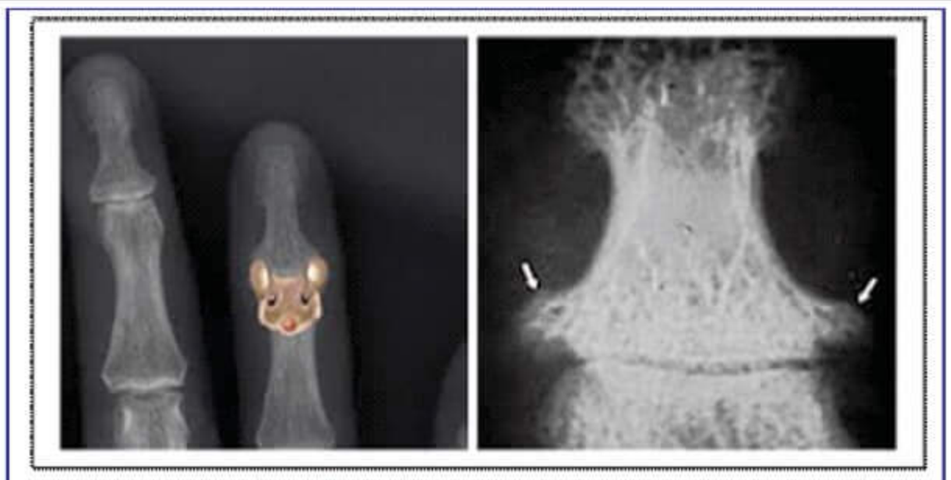




Opera glass deformity

Gouty arthritis

- → **Rat bite erosions**
- → Overhanging edges – MARTEL'S SIGN

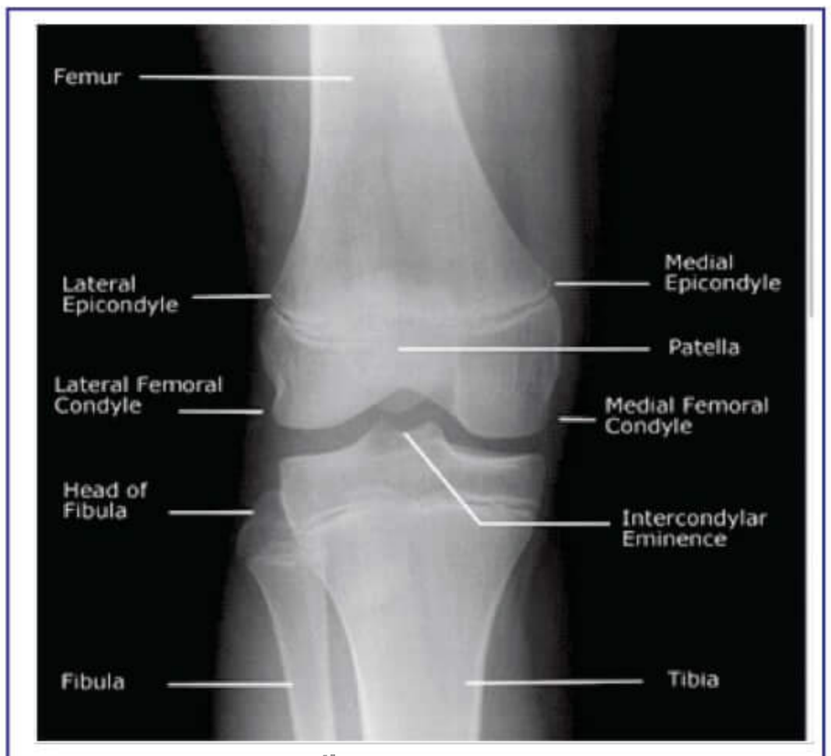


Mouse ear sign

MARTERL'S sign

Rat bite erosions

Normal knee joint



Haemophilic arthropathy:

- → Deep intercondylar Notch
- → MC involves – knee joint

Deep intercondylar notch

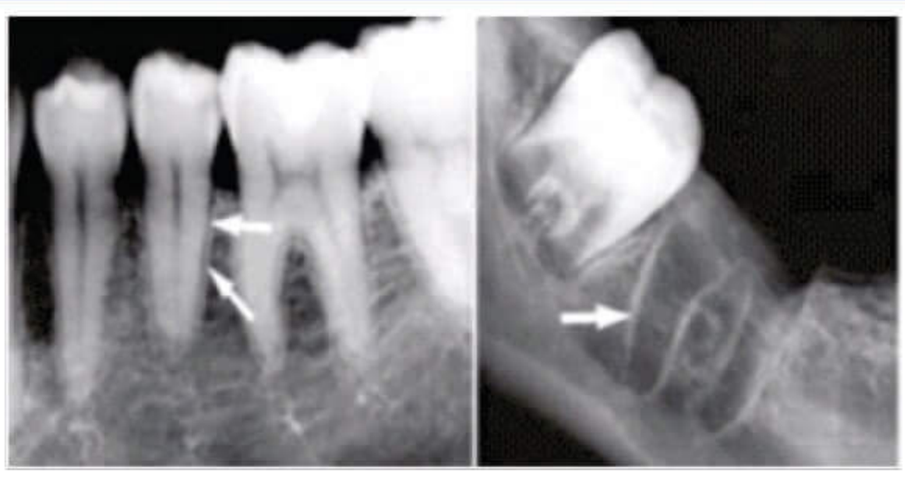
Hyperparathyroidism:

- → Erosion of radial end of middle phalanx
- → Resorption of distal pharynx called acroosteolysis
- → Salt and pepper skull – "**Pepper Pot Skull**"
- → Loss of lamina dura of teeth
- → Osteitis fibrosa cystica / brown tumours

Acroosteolysis and erosion of middle phalanx

Salt and pepper skull

Osteitis fibrosa cystica



lamina dura of teeth

Melorrheostosis:

→ Molten wax like ossification of long bones

melorrheostosis

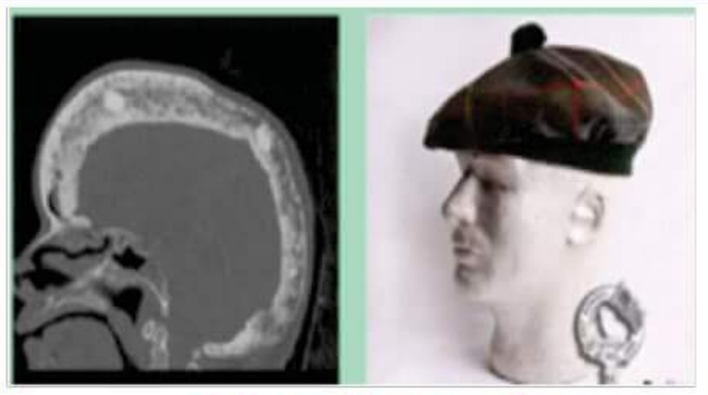
Paget's disease

Altered bone remodelling		
Lytic	**Mixed**	**Sclerotic**
• Osteoporosis circumscripta	• Mosaic / jigsaw	• TAM o SHANTER sign
• Blade of Grass/ flame sign	• Cotton wool skull • Picture frame vertebra	• Ivory vertebrae

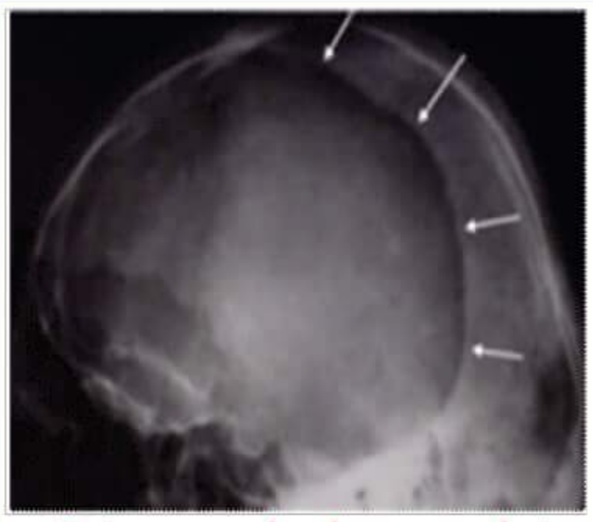
Blade of grass

Picture frame vertebrae

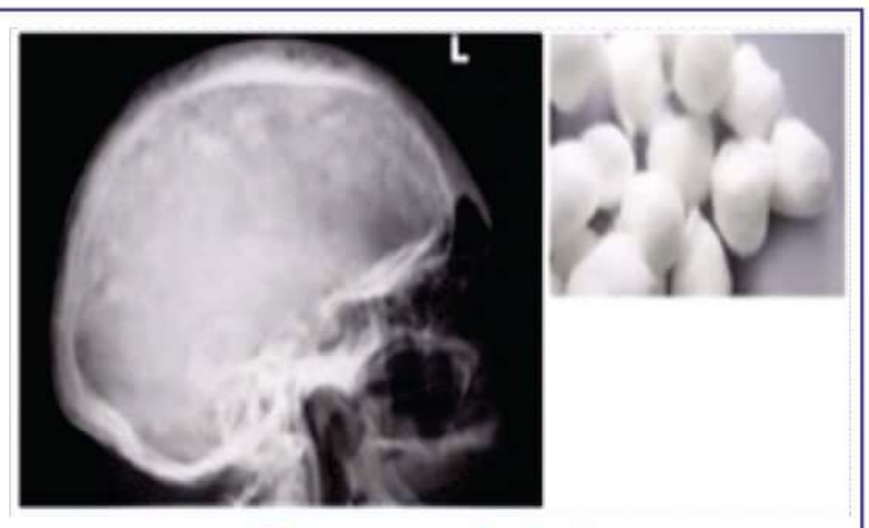
Ivory vertebrae



Tam o shanter sign



Osteoporosis circumscripta
(lytic phase)



Cotton wool skull

NOTE:

→ Ivory Vertebra is also seen in lymphoma and osteoblastic metastasis.

Osteopetrosis

→ Defective **osteoclastic resorption**

→ Dense sclerosis of the superior and inferior end plates of the vertebral body produce Sandwich vertebra

→ Bone within bone appearance

→ hazy sclerosis of the superior and inferior aspect of the vertebral body is called as Rugger jersey spine

→ **Rugger Jersey Spine** seen with Renal osteodystrophy and osteopetrosis.

Sandwich vertebrae

Rugger jersey spine

Achondroplasia

→ **Defect in enchondral ossification**

- Trident hand
- Rhizomelic dwarfism
- Large skull and narrow skull base
- Horizontal acetabulum
- Tombstone iliac bone

Champagne glass pelvis

Trident hand

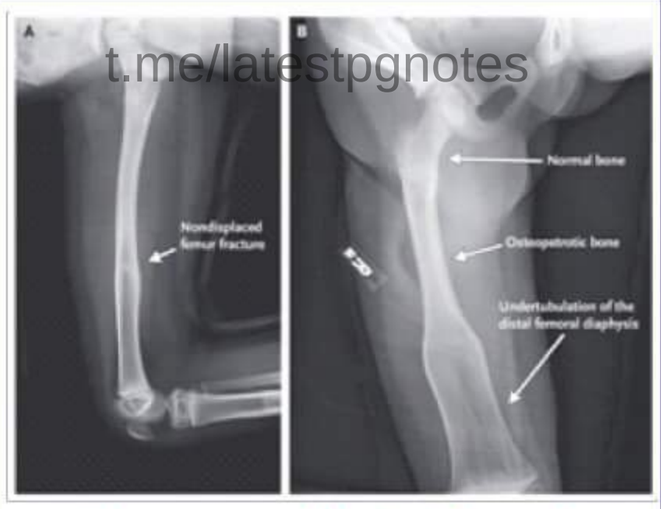
Rhizomelic dwarfism

Osteopetrosis

- → Defective osteoclastic action
- → Generalized sclerosis
- → Bone within bone appearance
- → Expansion of metaphyseal ends of the bone is called as Erlenmeyer flask deformity
- → Dense sclerosis of the superior and inferior end plates of the vertebral body produces sandwich vertebra or rugger jersey spine

Erlenmeyer Flask deformity

- → Seen in
  - Osteopetrosis
  - Thalassemia
  - Gaucher's disease



Erlenmeyer flask deformity

Bone within bone appearance

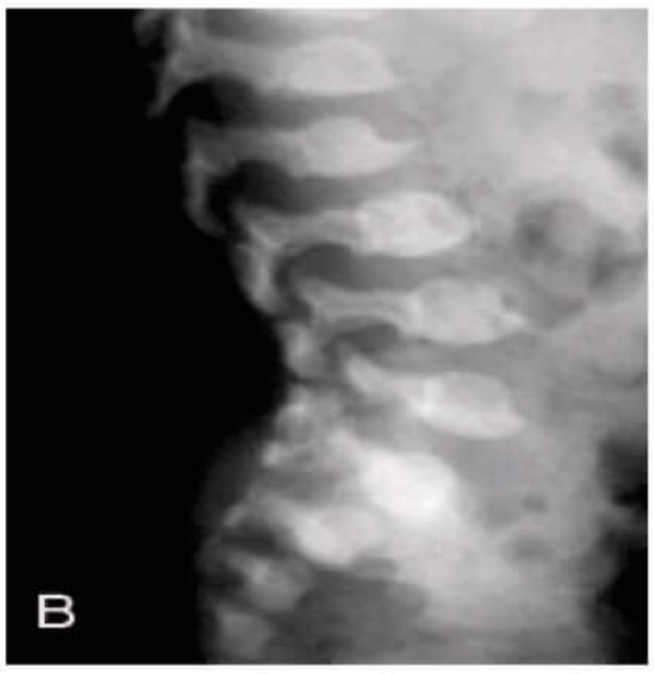
Musculoskeletal Radiology PART – 4

Mucopolysaccharidosis

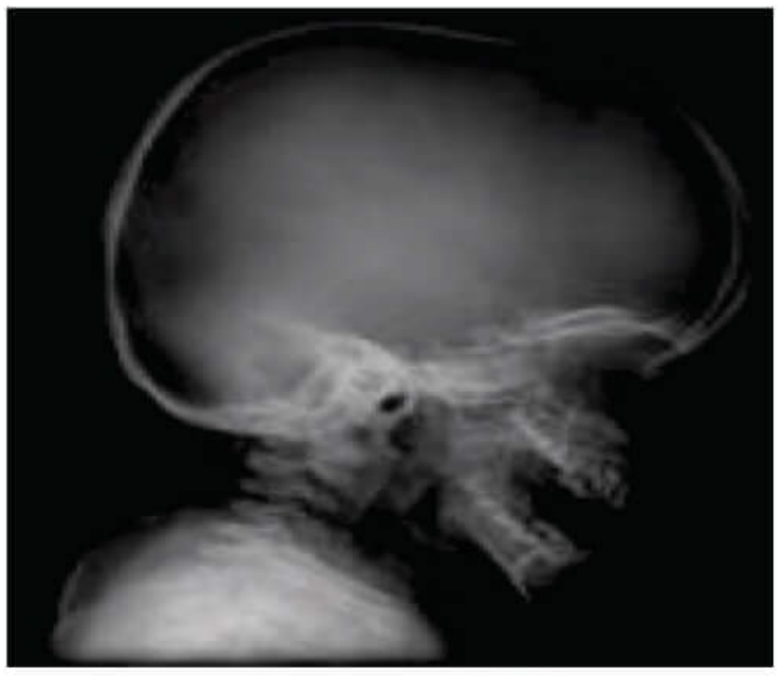
1) **Hurler's syndrome**
   - → Autosomal recessive
   - → **Clinical features**
     - Mental Retardation
     - Cloudy cornea
     - Deafness
     - Oar shaped ribs
     - Macrocephaly, J-shaped Sella
     - Proximal pointing of metacarpals
     - Short & wide long bones
     - Antero-inferior beaking of vertebral bodies

Proximal pointing of metacarpals

Oar shaped ribs



Antero-inferior beaking of VB



Macrocephaly

2) **Morquio's syndrome**

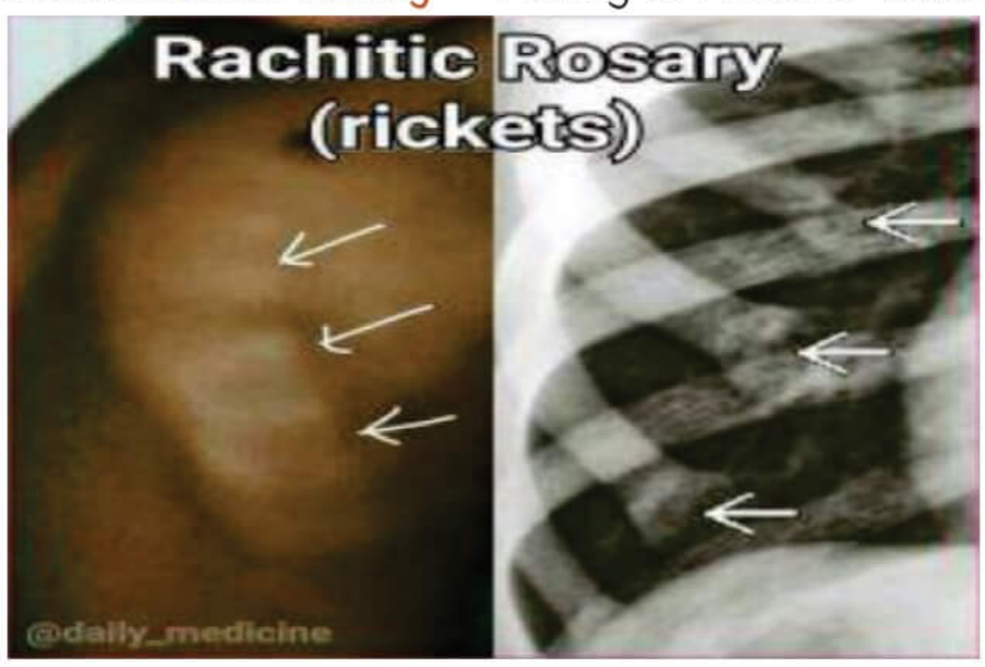
→ Autosomal recessive

→ **Clinical feature**

- Severe dwarfism (< 4 foot)
- Platyspondyly (A)
- Anterior-Central beaking of Vertebral bodies (B)
- Proximal pointing of metacarpals (C)
- Short & wide long bones (D)

Rickets

→ Shows Rachitic Rosary – Flaring of Anterior ends of ribs

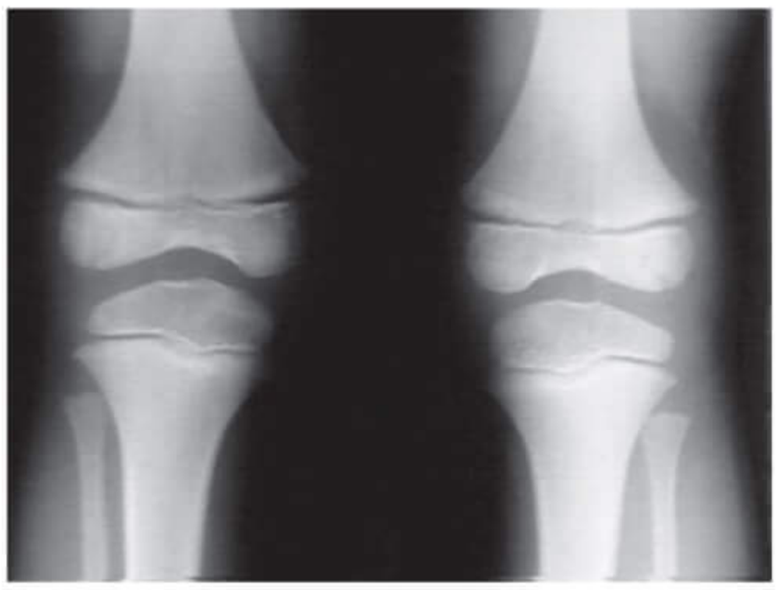


Nail-Patella syndrome

→ **Characterized by**

- Triangular lunula
- Absent Patella
- Radial head deformity
- Presence of Iliac horns / Fong prongs

Iliac horns / Fong prongs



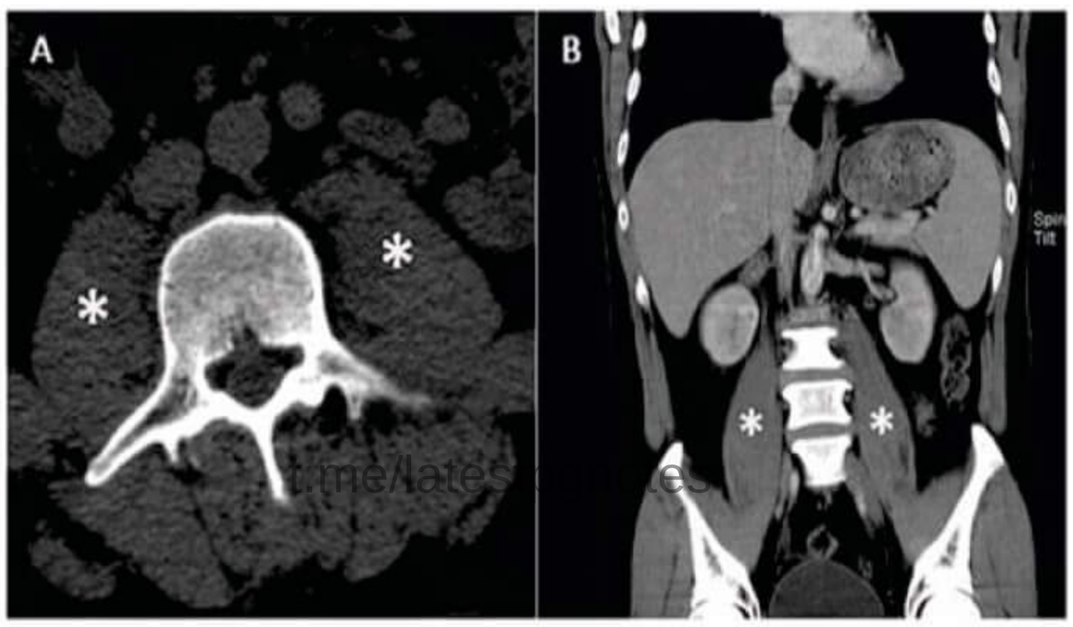
Absent Patella

Triangular lunula

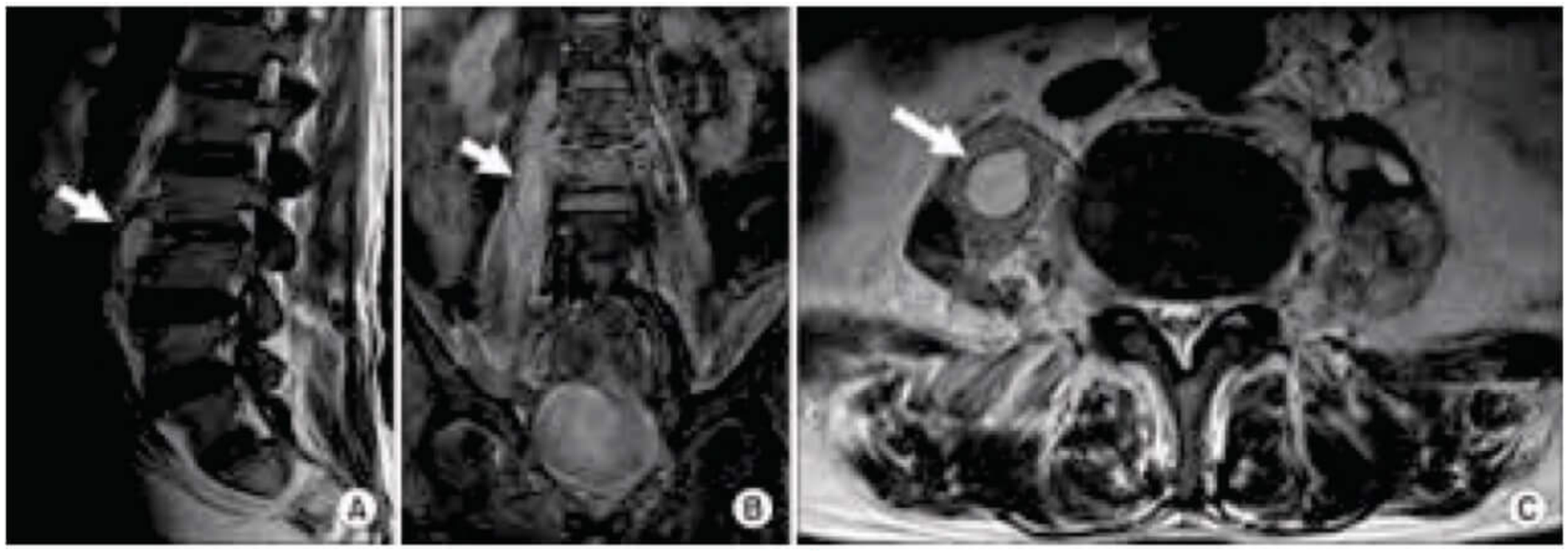
Psoas Abscess

→ **Psoas major muscle** – Present on either side of Vertebral body

→ Altered signal on Psoas muscle – Indicates **Psoas abscess**



Psoas major muscle (A) Sagittal view (B) Coronal view



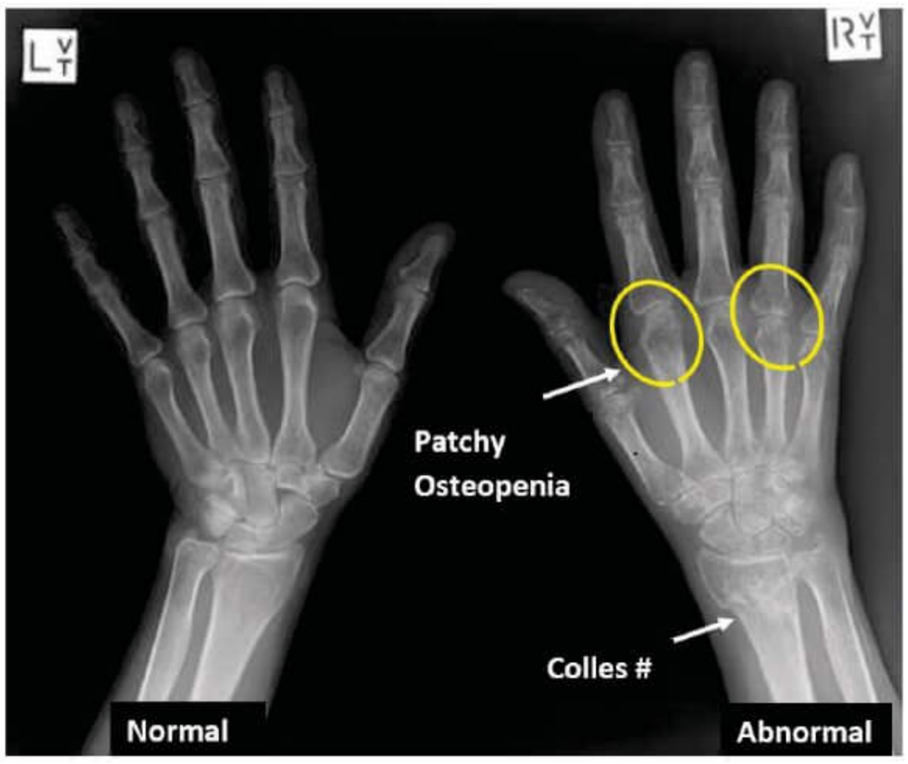
Psoas Abscess

Sudeck's dystrophy

→ **Aka Reflux sympathetic dystrophy (RSD)**

→ Characterised by

- Periarticular Osteopenia
- Hx. of Trauma
- Ass. With Colle's fracture



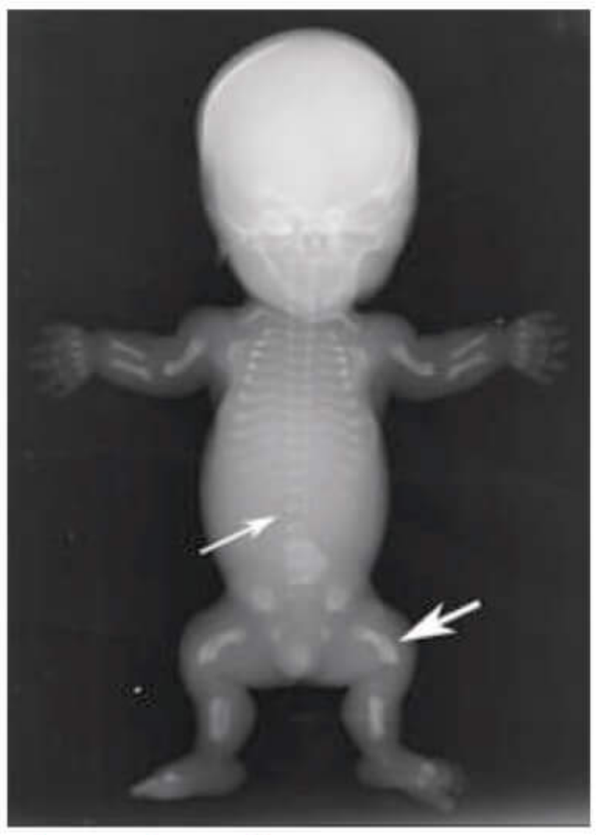
Thanatophoric Dysplasia

→ MC lethal skeletal dysplasia

→ Has defect in **Fibroblast GF receptor – 3**

→ **Has 2 Subtypes**

- **Type 1** – has Skeletal underdevelopment & Telephone handle appearance of femur
- **Type 2** – has Clover leaf skull



Telephone handle appearance of femur

GCT / Osteoclastoma

→ Characterised by **Soap bubble lytic lesion** in Epiphyseo-metaphyseal region

→ Occurs only with a fused growth plate

→ Peak incidence between 20 - 30 yrs. of age

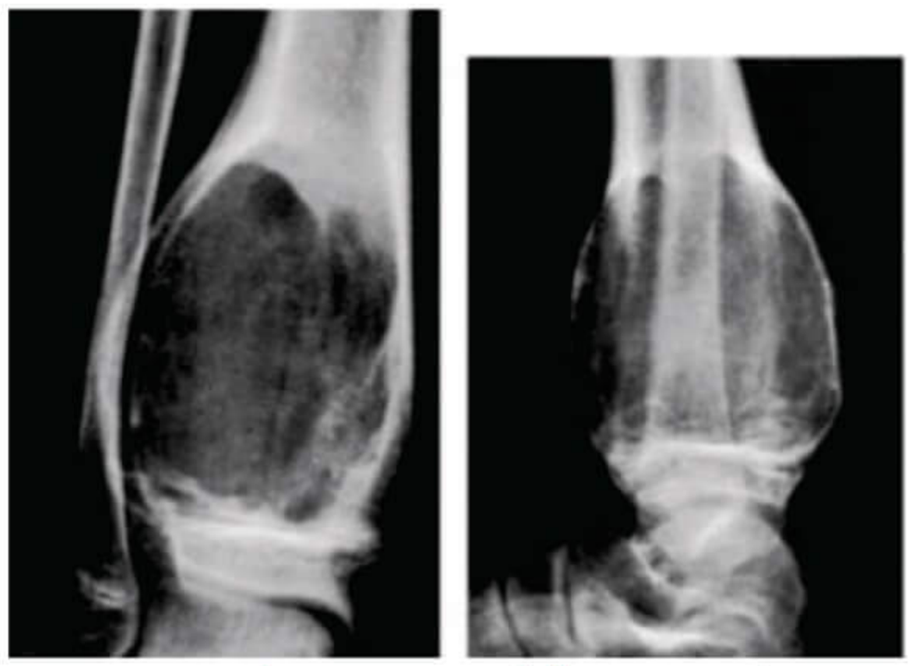
Osteoclastoma

Aneurysmal bone cyst

→ Eccentric, Expansile lytic lesion that elevates the Periosteum but remains contained by a thin shell of cortical bone

→ Seen only with a non - fused growth plate

→ Shows Fluid-fluid level in MRI



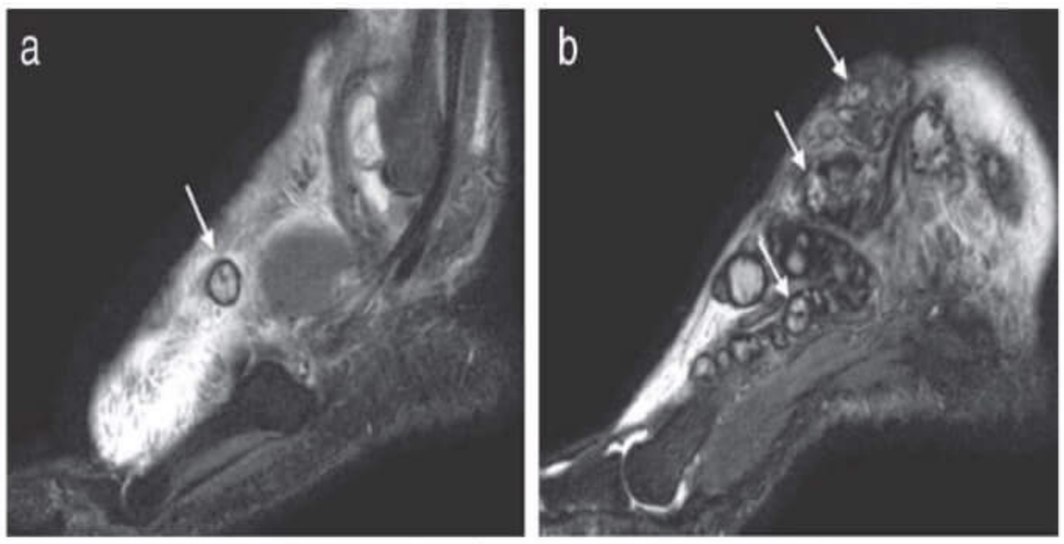
Aneurysmal bone cyst

Madura mycosis

→ Metatarsal region shows

- **Granulations** - hyperintense circle
- **Fungal element** - central dot

→ Gives **Dot in circle sign** on T_2W MRI of Foot



 Dot in circle sign (T_2W MRI)

Osteoid Osteoma

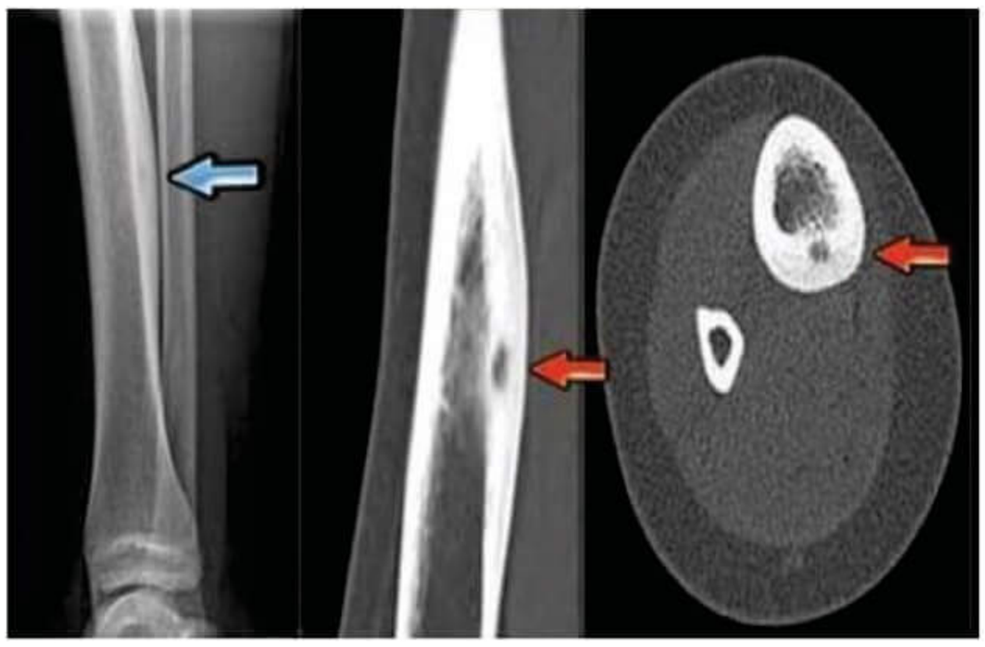
→ It is cortical based

→ They have characteristic **Central lucent nidus (< 2 cm)** within surrounding sclerotic reactive bone

→ Classically cause night pain that is relieved by the use of aspirin

→ **On Scintigraphy / Bone scan** – shows **double density sign**

- **Central focus** - shows intense Hot uptake
- **Surrounding Sclerotic area** – Also shows hot uptake (But comparatively less)

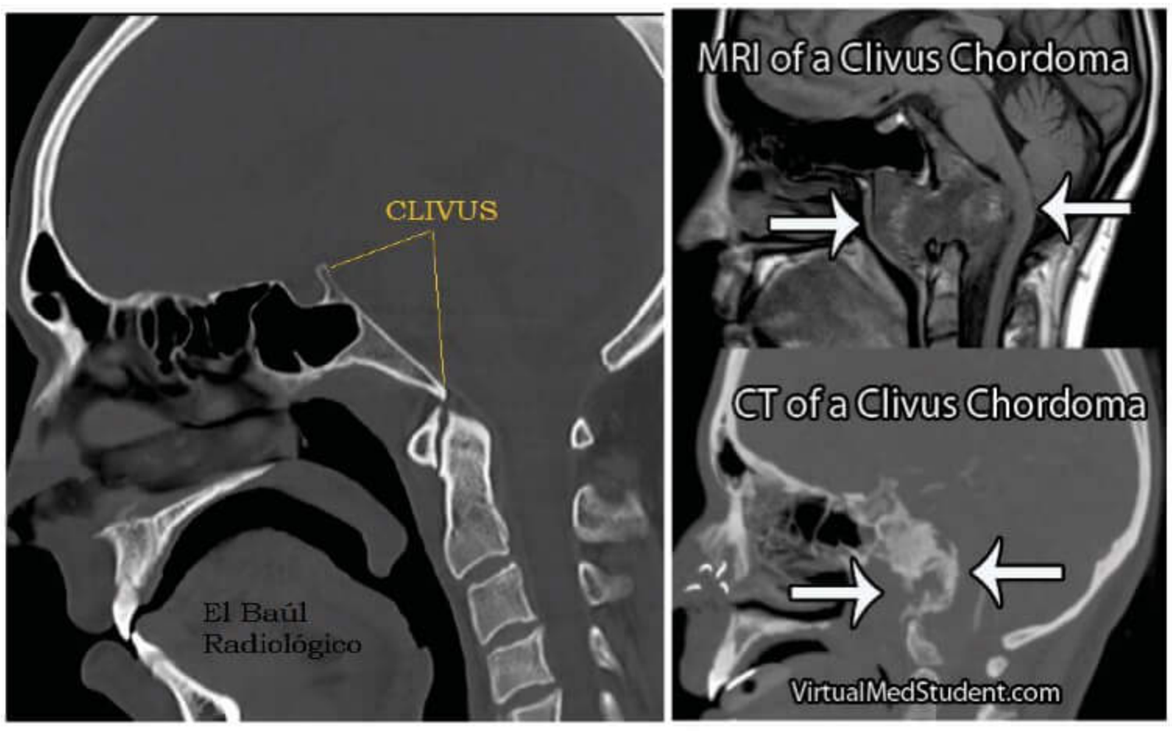


Osteoid Osteoma

Sacrococcygeal Chordoma

→ MC Primary malignant tumors developing at the Sacrococcygeal region
→ Arises from Notochord remnant
→ Most common site – Sacrococcygeal area
→ 2nd MC site – Clivus (Spheno-occipital region)
→ **Characteristic features**
- Large soft tissue tumor
- Centrally located
- Destructive & Lytic
- Intra-tumoral calcifications

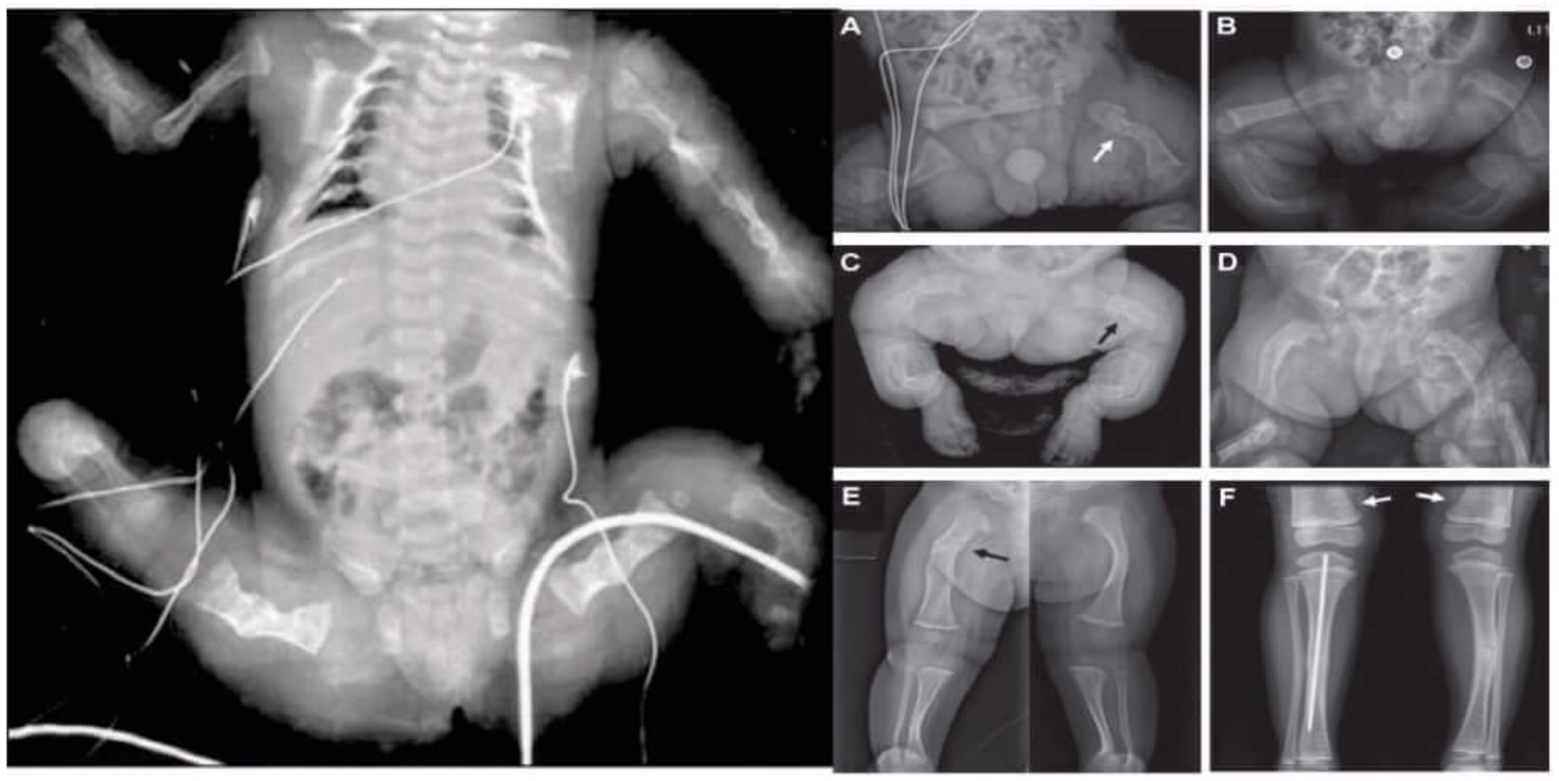
Sacrococcygeal Chordoma



Clivus chordoma

Osteogenesis imperfecta

→ **Aka Lobstein's disease**
→ Has Defect in Type I collagen
→ **Characteristic features**
- Defect in Osteoid matrix formation – Pencil thin Cortex
- Multiple transverse diaphyseal fractures
- Presence of Antenatal fractures **(Pathognomic)**
- Wormian bones
- Blue sclera



Osteogenesis imperfecta

Osteogenesis imperfecta	Battered baby syndrome / child abuse
• Blue sclera	• Absent
• Dentigerous imperfecta	• Absent
• BMD↓	• Normal BMD
• Wormian bones (intra sutural bones)	• Absent
• Antenatal fractures	• Absent
• Transverse Diaphyseal fractures 	• Metaphyseal corner fracture 

CARDIO VASCULAR RADIOLOGY

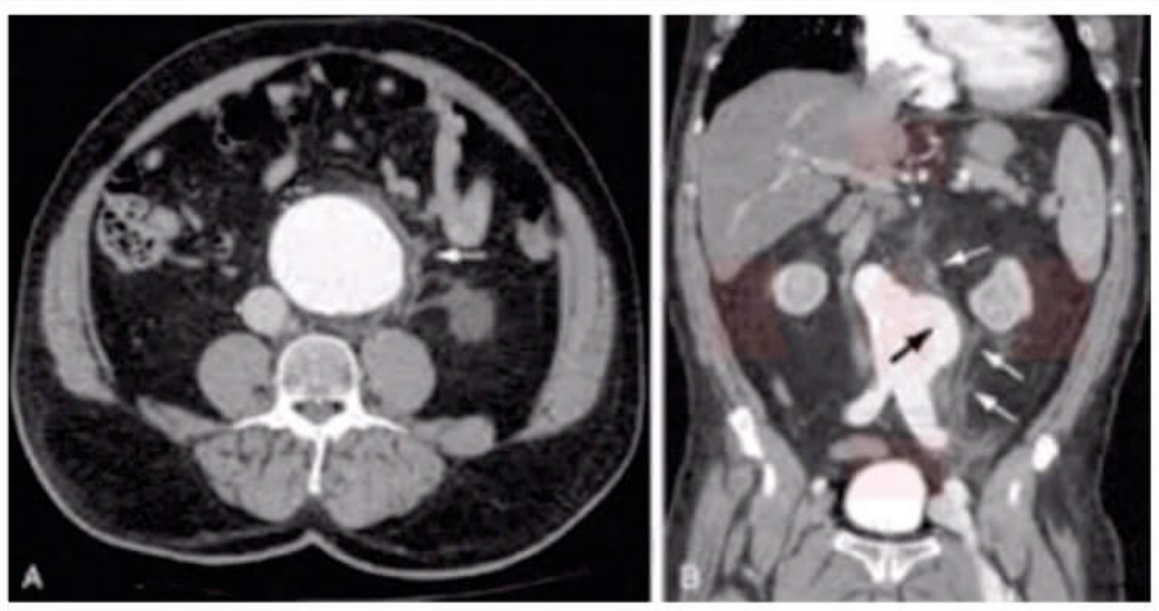
Aortic aneurysm:

→ Involve either ascending aorta, thoracic aorta & abdominal aorta

→ Syphilitic aortitis commonly involve ascending aorta causing aortic aneurysm

→ M/C cause for abdominal & thoracic aortic aneurysm – Atherosclerosis

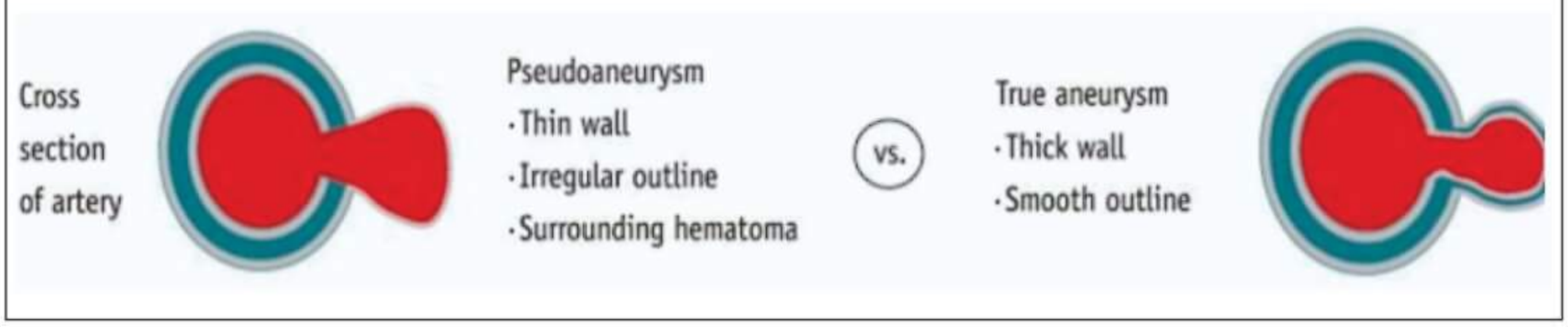
Ascending aortic aneurysm



Abdominal aortic aneurysm (axial & coronal view)

Ruptured aortic aneurysm (collection noted around the vessel)

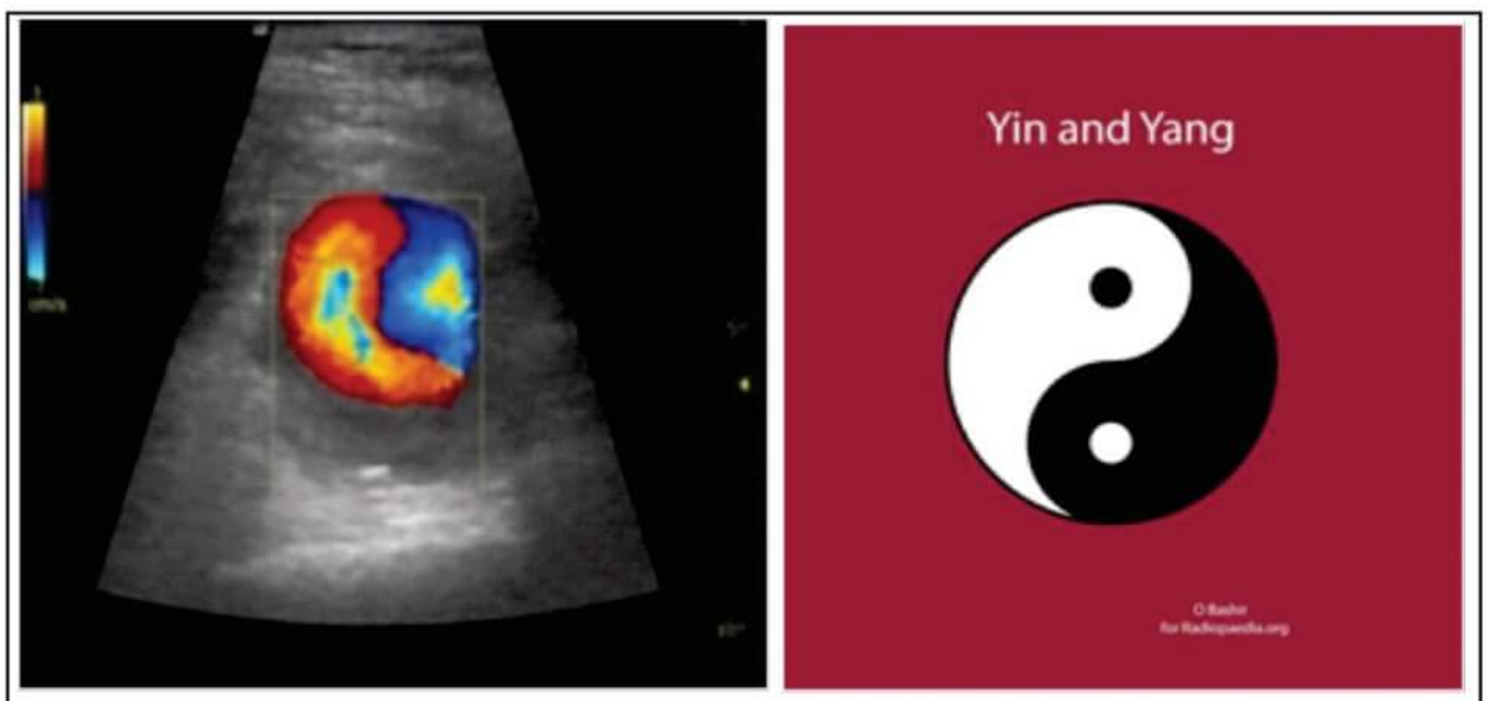
Draped aorta sign on CECT-seen in Contained Rupture of Abdominal Aortic Aneurysm



Color doppler image of Pseudo aneurysm

→ Bidirectional flow of blood is seen which gives Yin-yang sign

→ Also seen in Pseudo Aneurysm and in large true aneurysm



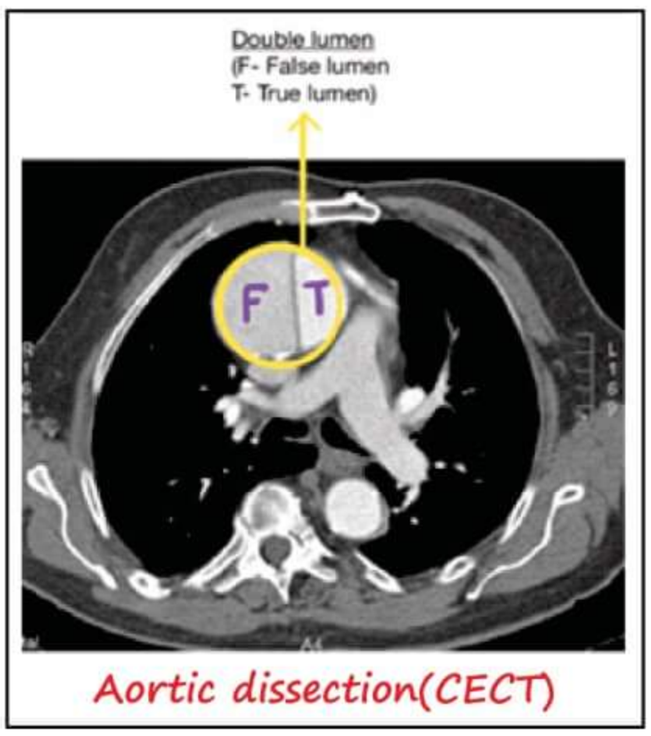
Yin-yang sign

Aortic dissection:

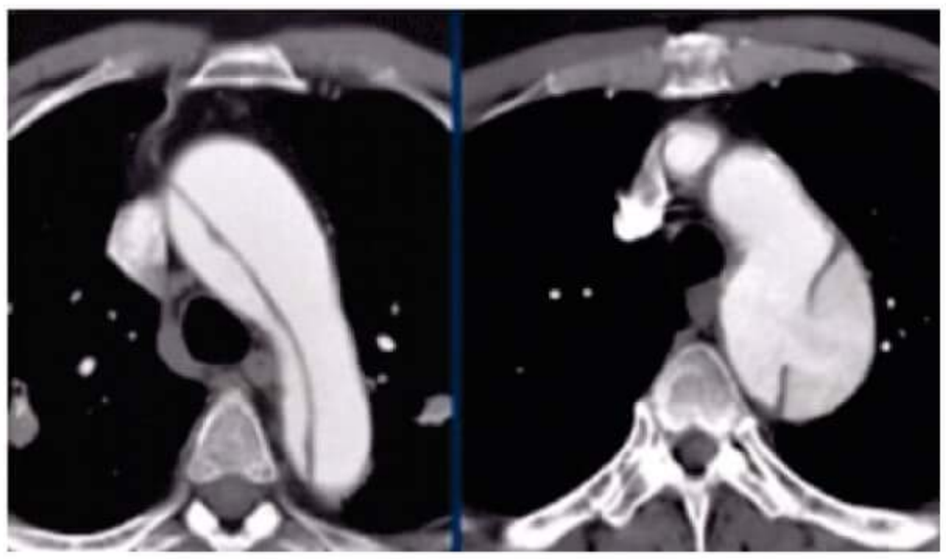
→ Double lumen appearance with an intimal flap

→ For acute aortic dissection – TEE or MDCT with contrast

→ For chronic aortic dissection – MRI



Aortic dissection(CECT)

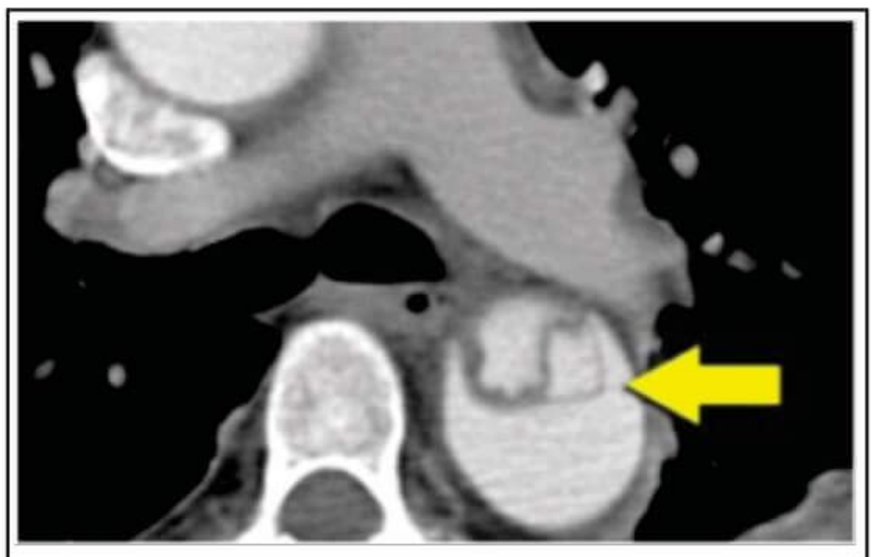


Dissection extending to Arch & decending aorta

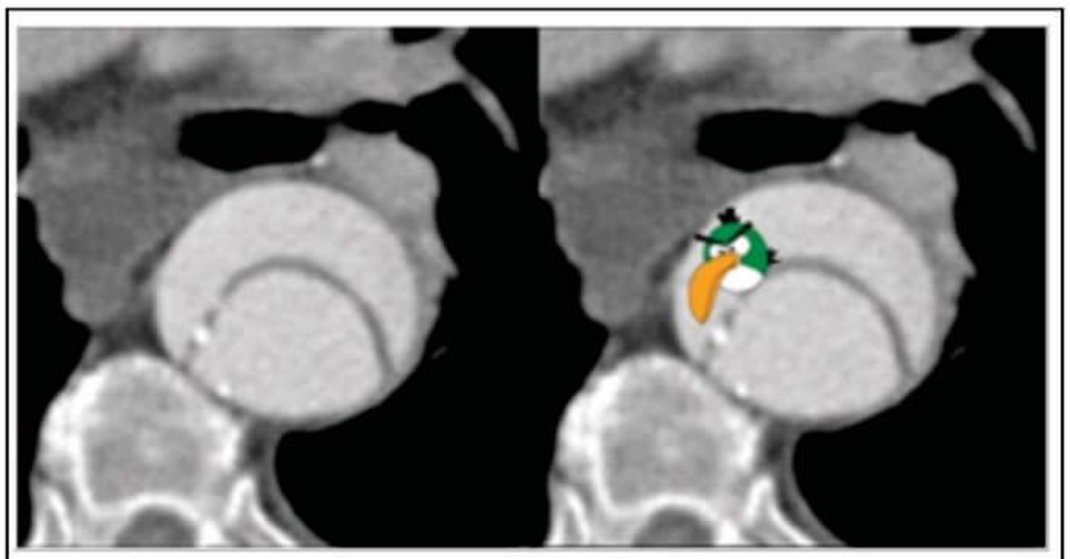
Points to know:

→ Dissection of arterial wall forming shreds within false lumen- "Cob web sign"

→ False lumen forms an acute angle giving "Beak sign" in aortic dissection

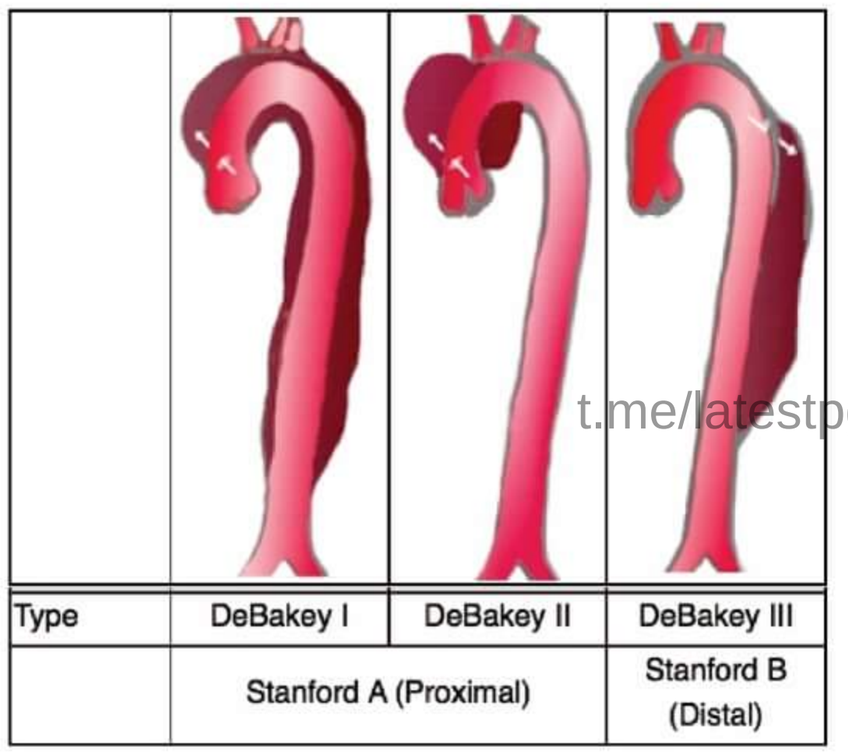


Cob web sign



Beak sign

→ Classification of aortic dissection

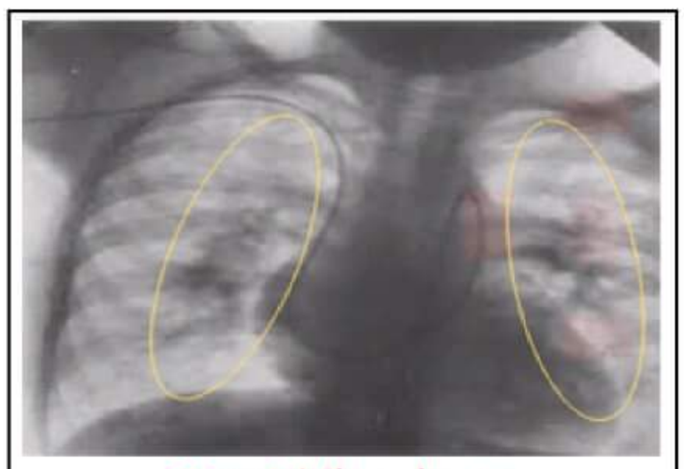


Type	DeBakey I	DeBakey II	DeBakey III
	Stanford A (Proximal)		Stanford B (Distal)

Congenital heart disease:

→ ASD:

- Causes pulmonary plethora - seen in fluoroscopy is known as "Great hilar dance"

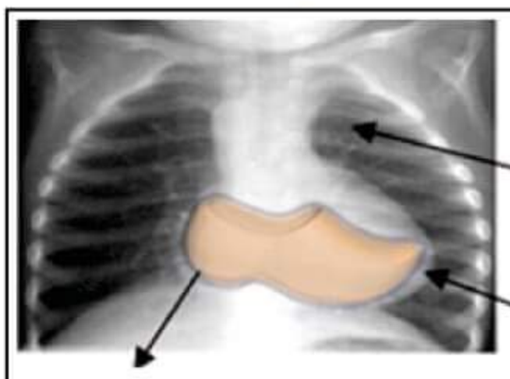


Great hilar dance

→ Tetralogy of Fallot:

- Features of TOF:
  - Pulmonary stenosis
  - Overriding aorta
  - Membranous VSD
  - RVH

– "Boot shaped of heart" in X-ray



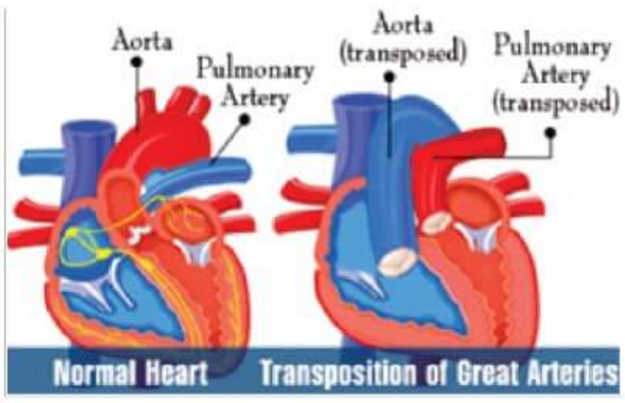
→ Gooseneck deformity:

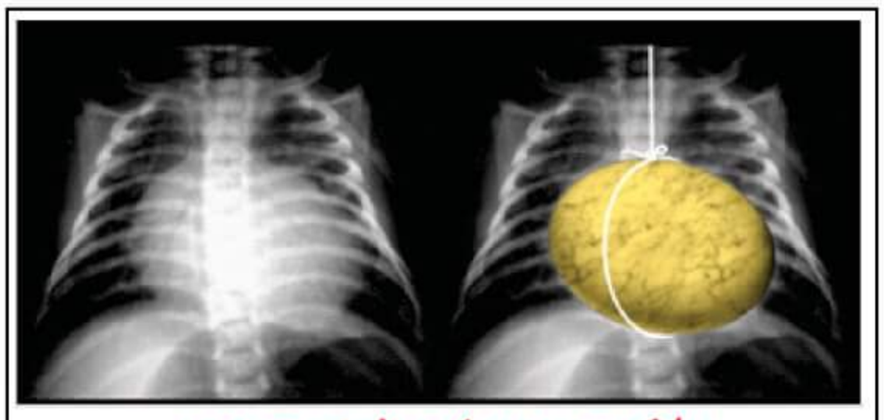
- Seen in AVSD & also in endocardial cushion defect -Primum type of ASD
- Aortic valve is pushed anteriorly &elongated – gives goose neck deformity in USG & cardiac angiogram
- Leads to sub-aortic obstruction

Gooseneck deformity – LVOT elongated seen in AVSD(Atrioventricuar septal Defect)

→ TGA: (Transposition of Great Arteries)

- Has 1. Narrow mediastinum
  2. Globular heart
- "egg on string" / "egg on side" appearance in X-ray

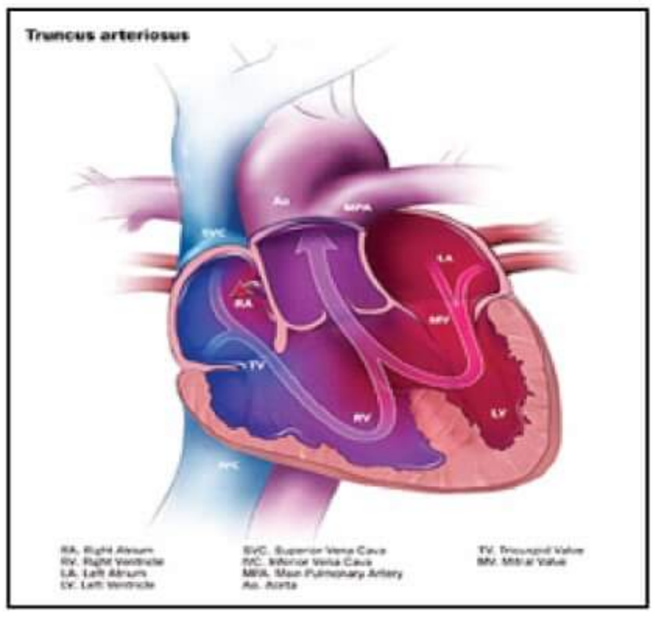


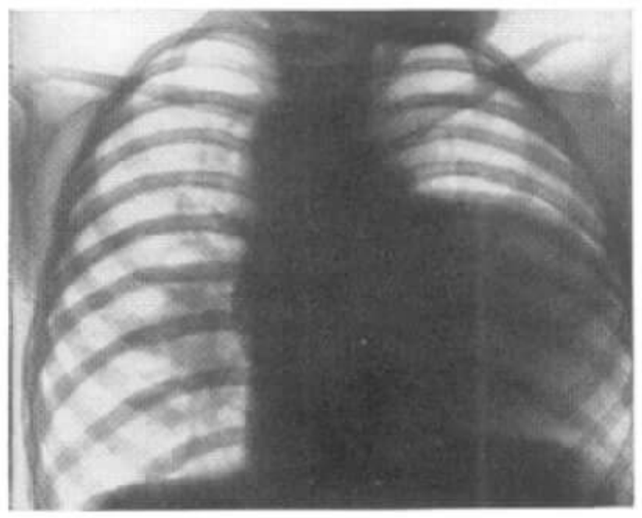


egg on string / egg on side

→ Truncus arteriosus:

- Persistent truncus arteriosus gives "sitting duck" appearance in radiograph
- Associated with VSD

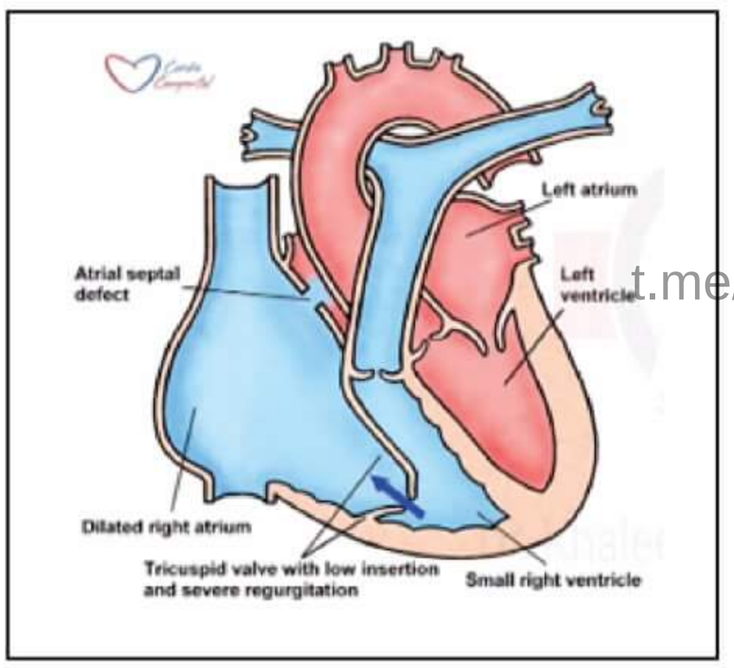


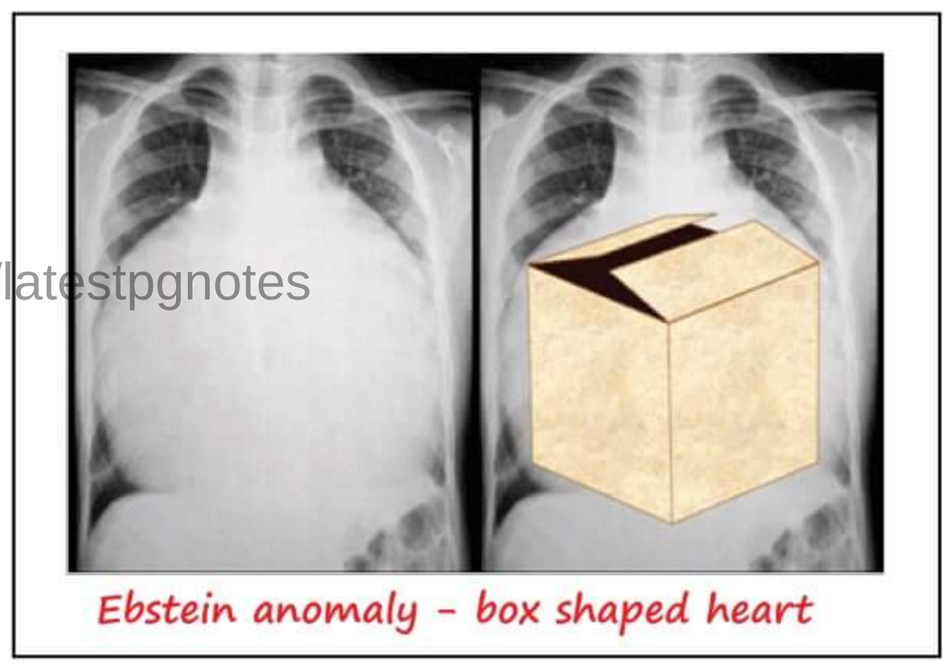


sitting duck appearance

→ Ebstein anomaly:

- Has low insertion of tricuspid valve causing arterialization of Rt ventricle
- Small right ventricle
- Associated with ASD&PDA
- Gives "box shaped heart"
- Pulmonary oligemia is also seen

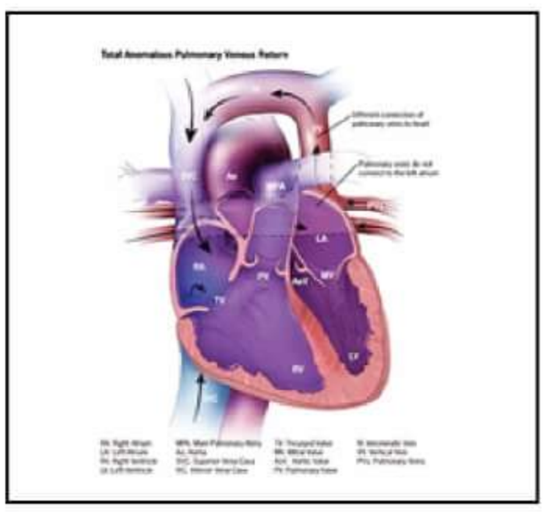


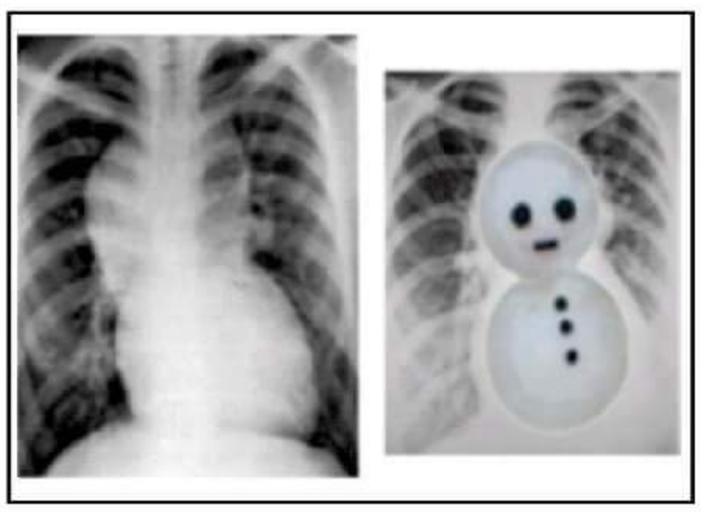


Ebstein anomaly - box shaped heart

→ Total anomalous pulmonary venous connection

- Supra cardiac TAPVC
- Snowmen / figure of 8 / cottage loaf appearance



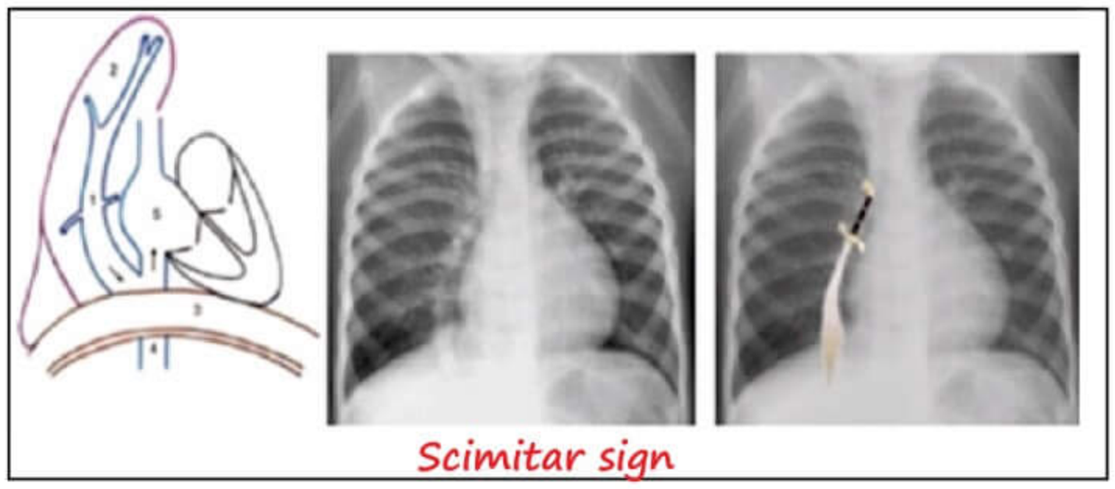


Note:

→ Figure of 8 appearance is seen only in supra cardiac TAPVC & not in infra cardiac TAPVC

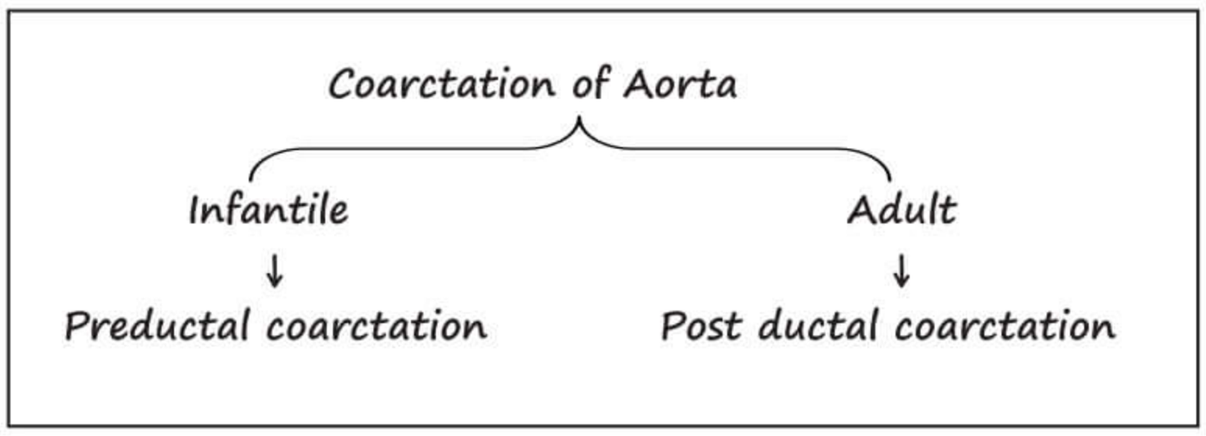
→ Partial anomalous pulmonary venous connection

- "Scimitar sign" is seen in PAPVC
- It is more common on right side



Scimitar sign

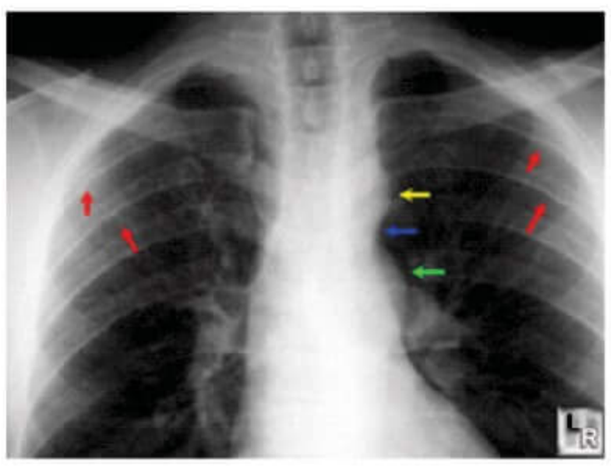
→ Coarctation of Aorta:



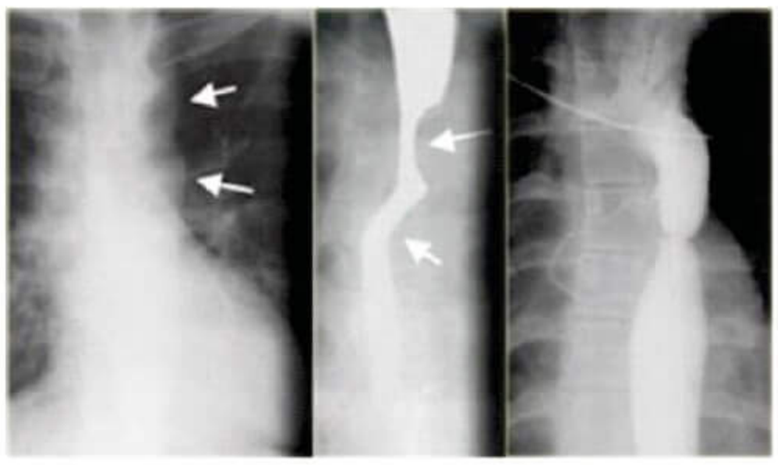
- M > F
- Turners syndrome female – more prone
- Inferior rib notching is seen – if > 10 years
- "3 sign" – seen in CXR
- "Reverse 3 sign"-seen in in barium swallow
- Inferior rib notching is seen in 3-9 ribs & usually seen in 4-8 ribs

Note:

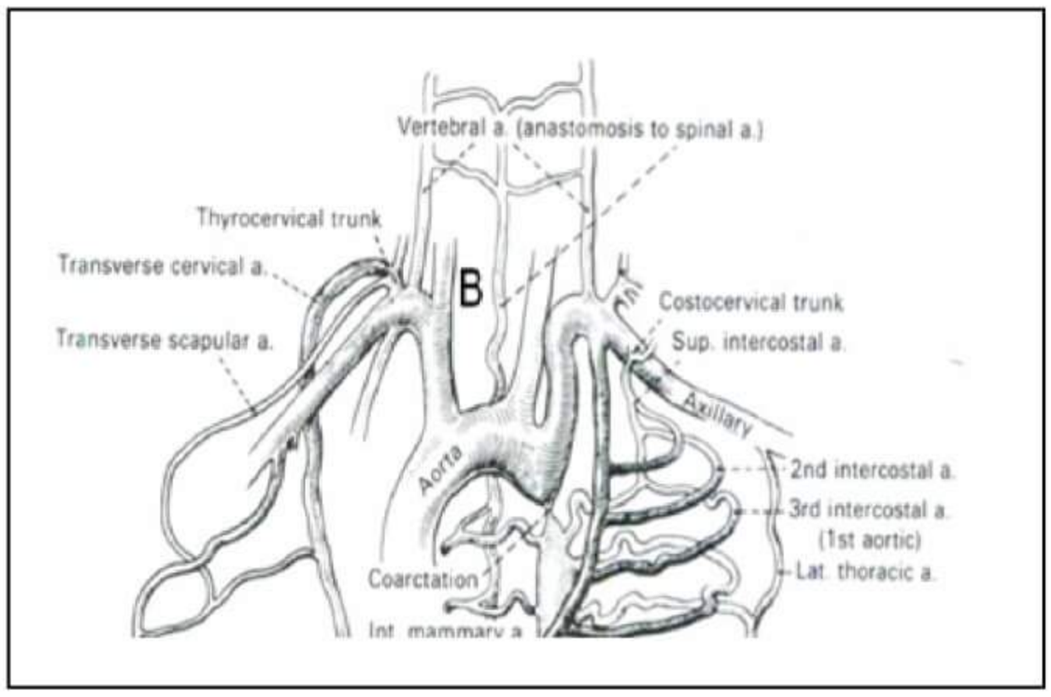
→ Both superior & inferior rib notching can occur in hyperparathyroidism & Neurofibromatosis

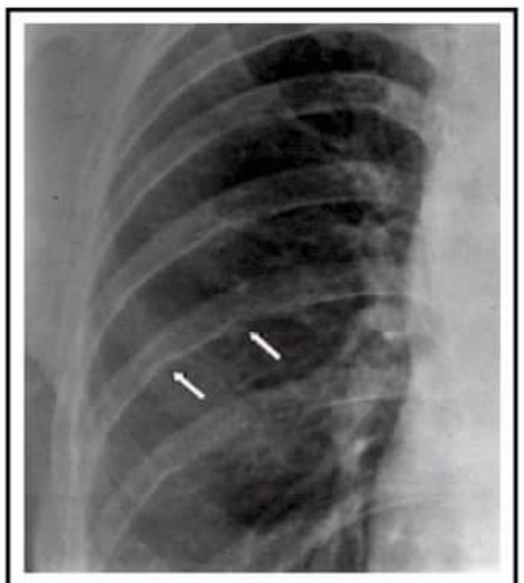


3 sign (X-ray)



Reverse 3 sign (barium swallow)

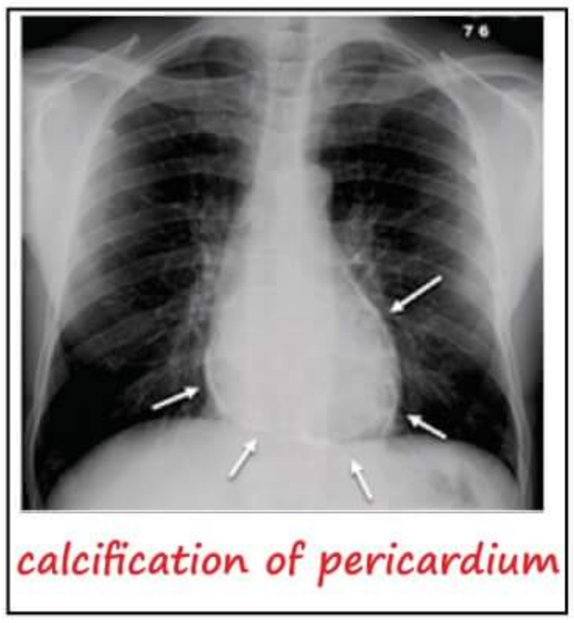




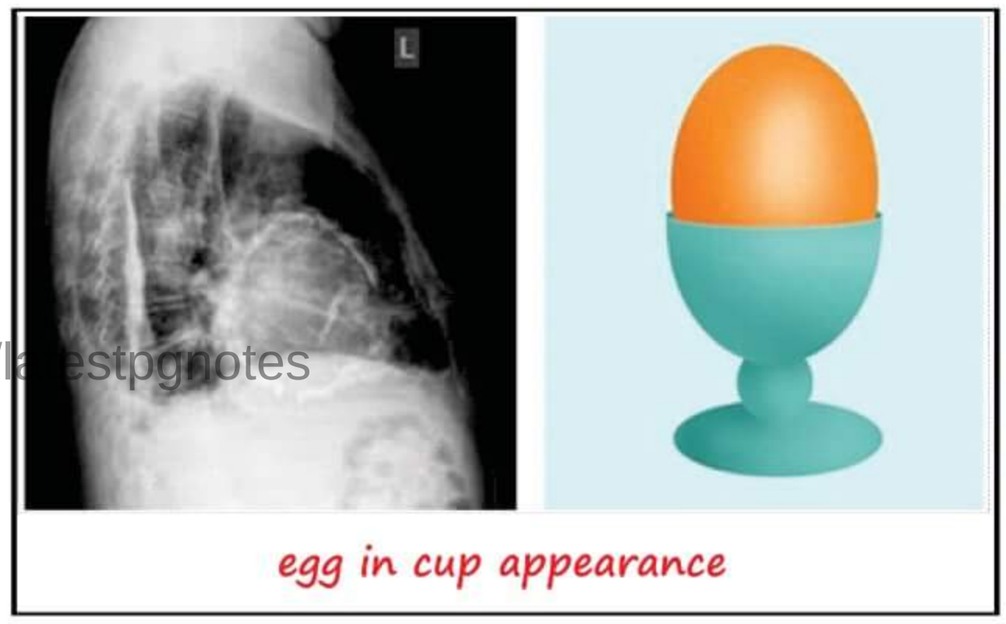
Inferior rib notching

→ **Constrictive Pericarditis:**

- Shows calcification of pericardium in a radiograph
- Gives "egg in cup "appearance



calcification of pericardium



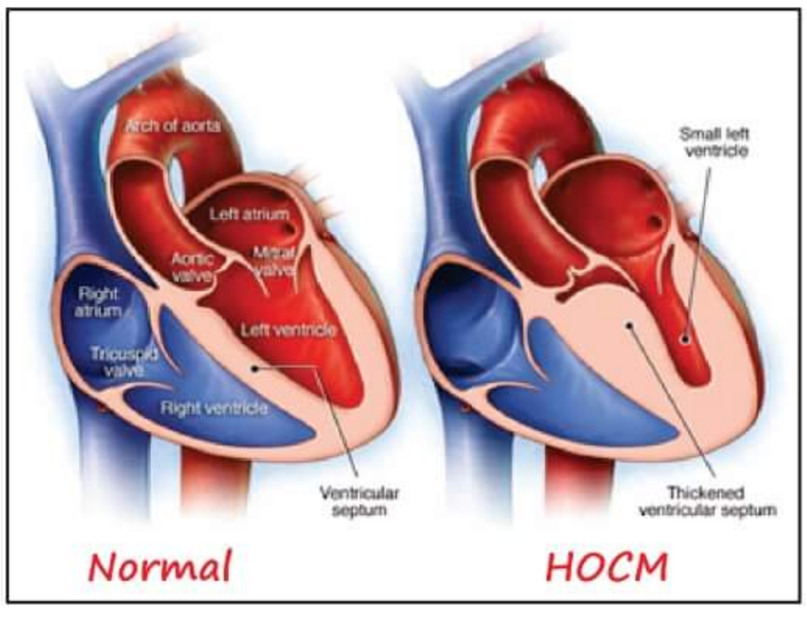
egg in cup appearance

Hypertrophic obstructive cardiomyopathy (HOCM):

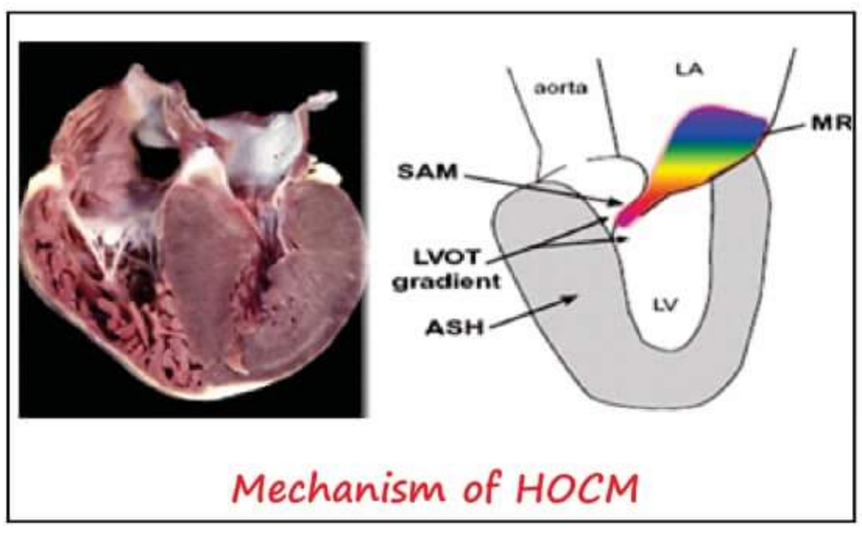
→ Has asymmetrical thickening of interventricular septum

→ Has systolic anterior motion of mitral valve

→ Associated with mitral regurgitation



Normal HOCM

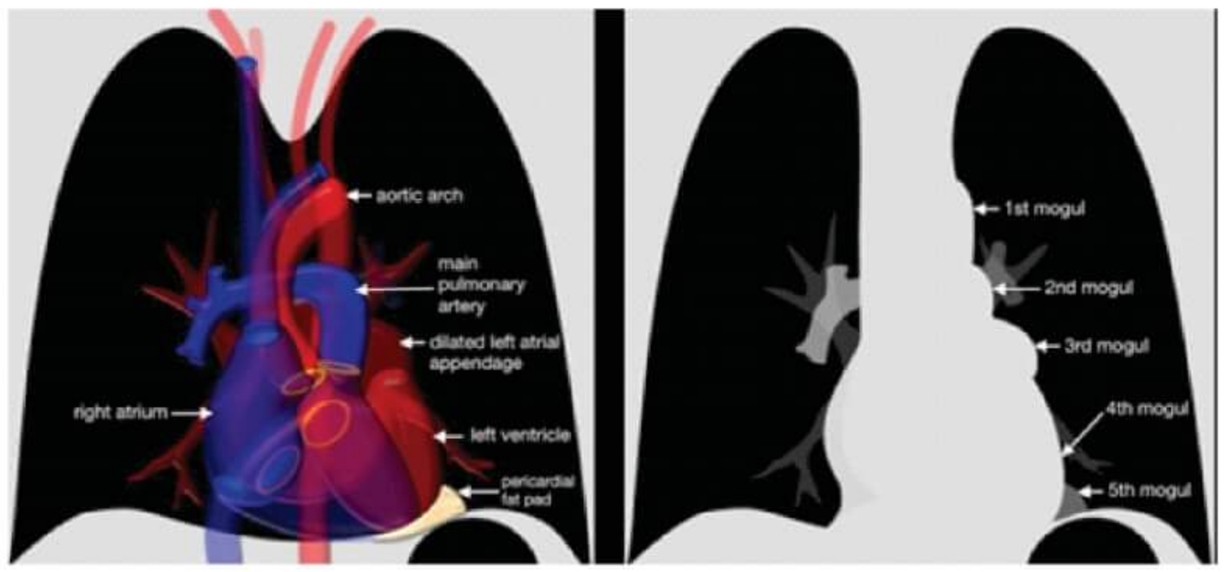


Mechanism of HOCM

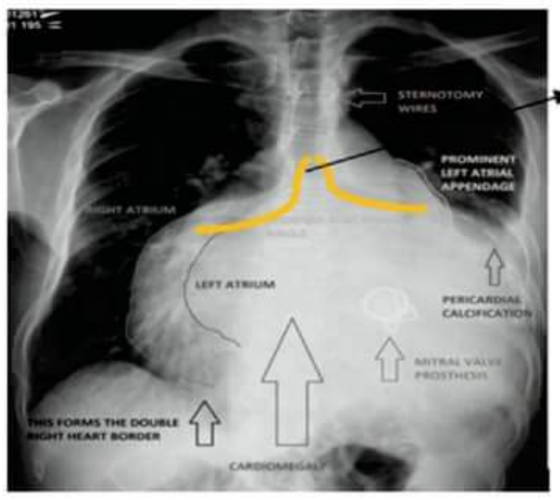
Left atrial enlargement / mitral stenosis:

→ **Features:**

- Straightening of left heart borders
- Widening of carina with elevated left main bronchus
- Walking man sign
- Double Right Heart Border /Double density sign
- Third mogul sign

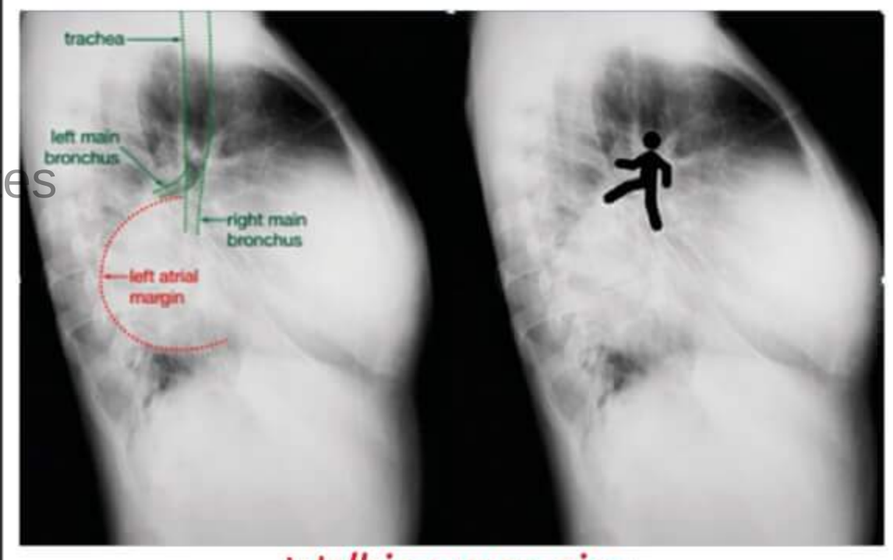


Third mogul sign – dilated left atrial appendage



Widening of carina

Radiograph showing Widening of carina; Double density sign, Third mogul sign



Walking man sign

Note:

→ Obliteration of Retrosternal space is seen in Right ventricular hypertrophy

Important points to remember:

Agatston scoring

→ Used to look at calcium scoring of different coronaries

→ Predictive for coronary artery disease

Pulmonary artery hypertension:

→ Gives "Jug handle" appearance on radiograph

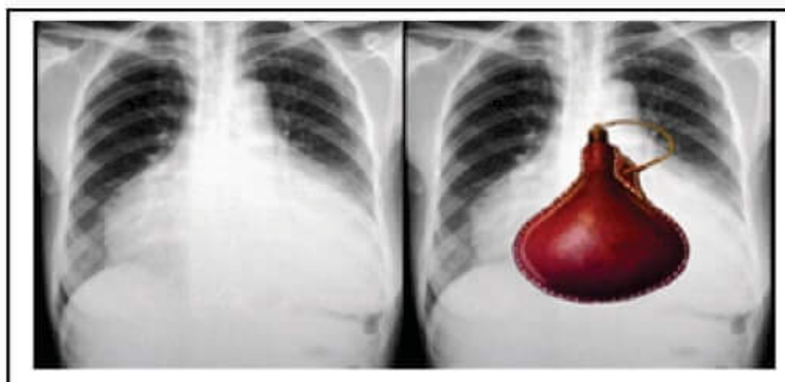
→ Has a diameter of > 17 cm in descending right pulmonary artery

Prominent Descending Right Pulmonary Artery

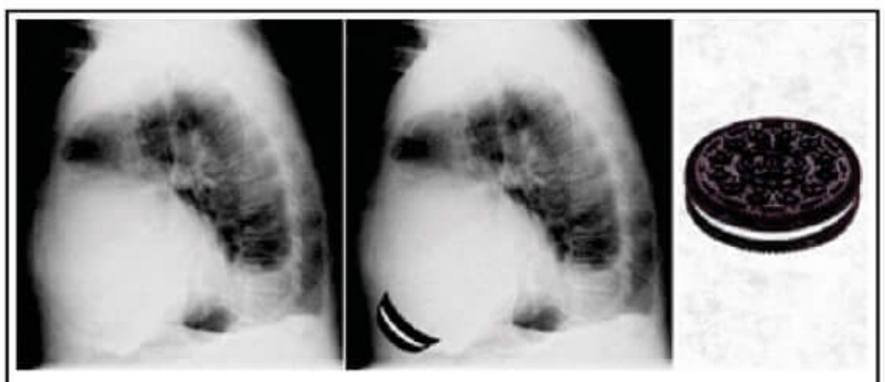
Pericardial effusion:

→ Shows money bag / leather bottle appearance on radiograph

→ Also shows Oreo cookie sign– fluid in between the pericardial fat gives this sign



money bag / leather bottle appearance



Oreo cookie sign

Congestive heart failure:

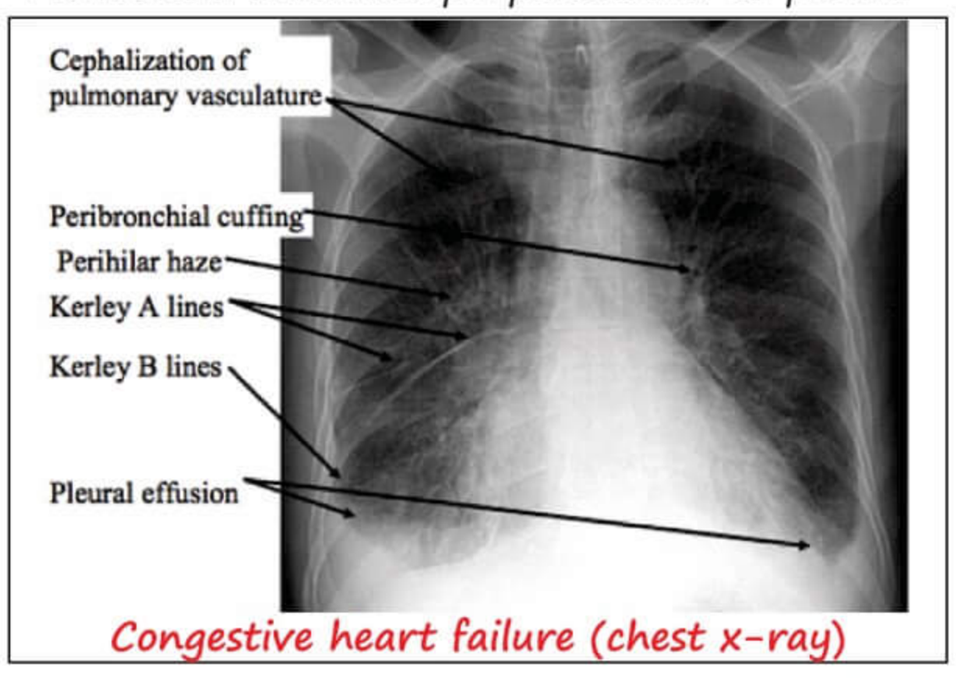
→ Equalization of upper lobe & lower lobe vessels (Normal → LL vessels are more proximal than UL vessels)

→ Over a period of time – cause prominence of UL vessels called

- Cephalization
- Stag antler sign
- Reverse moustache sign
- Hands up sign

→ Lymphatic engorgement causing septal thickenings -Kerley A &Kerley B line

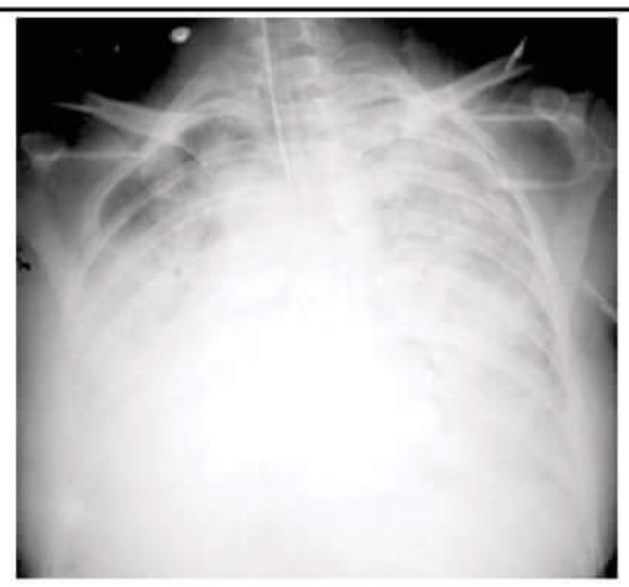
- Kerley A – perihilar
- Kerley B – base of lung
  - Horizontal thin lines perpendicular to pleura



Congestive heart failure (chest x-ray)

ARDS:

- Gives complete white out lung on radiograph
- Has ground glass opacification with decreased lung volume



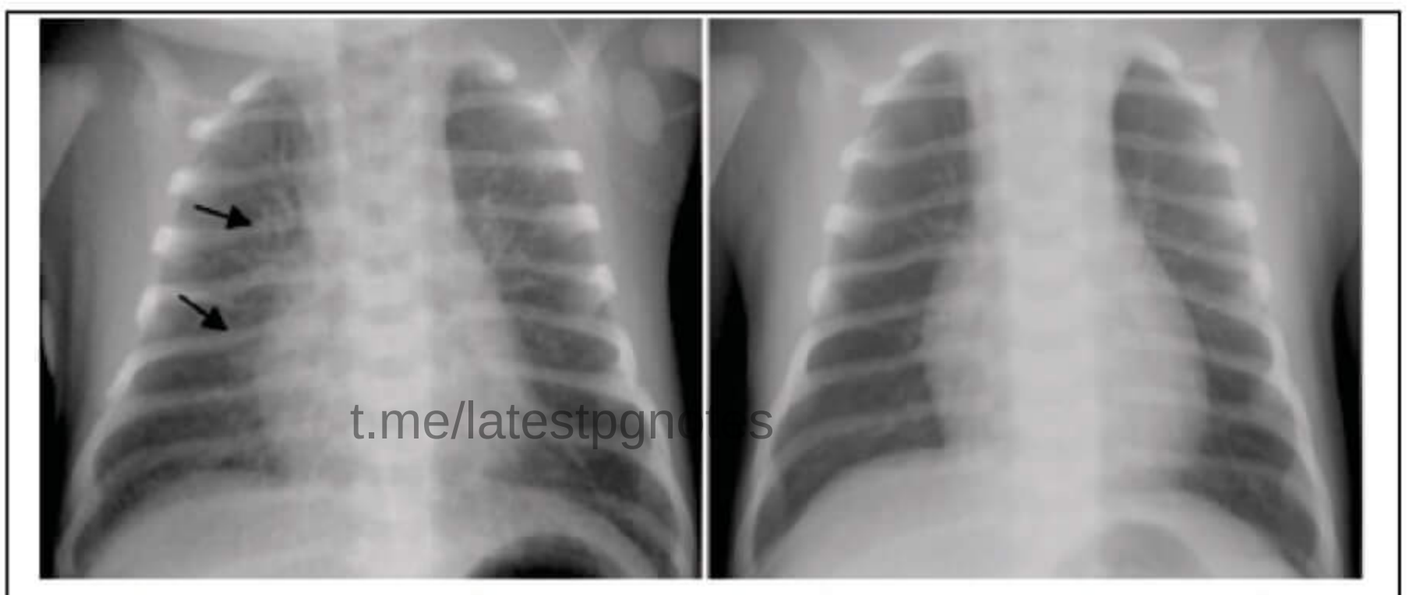
white out lung/ ground glass opacification

Transient tachypnea of newborn:

→ Lung volumes are normal / increased

→ Seen in CS Delivered / precipitous labor baby

→ Shows engorged perihilar fissures on radiograph that gets cleared spontaneously, sunray appearence



Transient tachypnea of newborn - Showing engorged perihiarfissures

Scimitar syndrome:

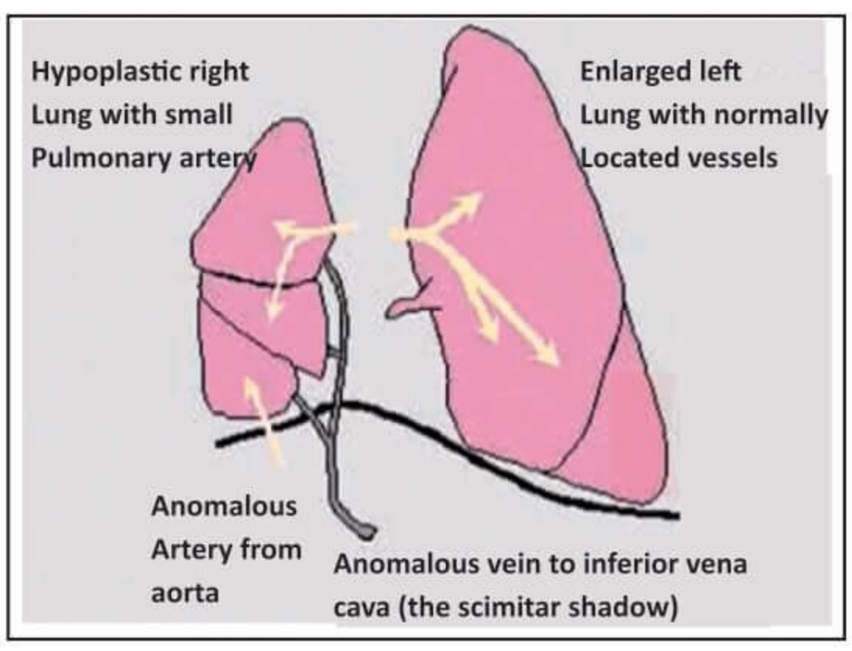
→ Partial anomalous pulmonary venous communication

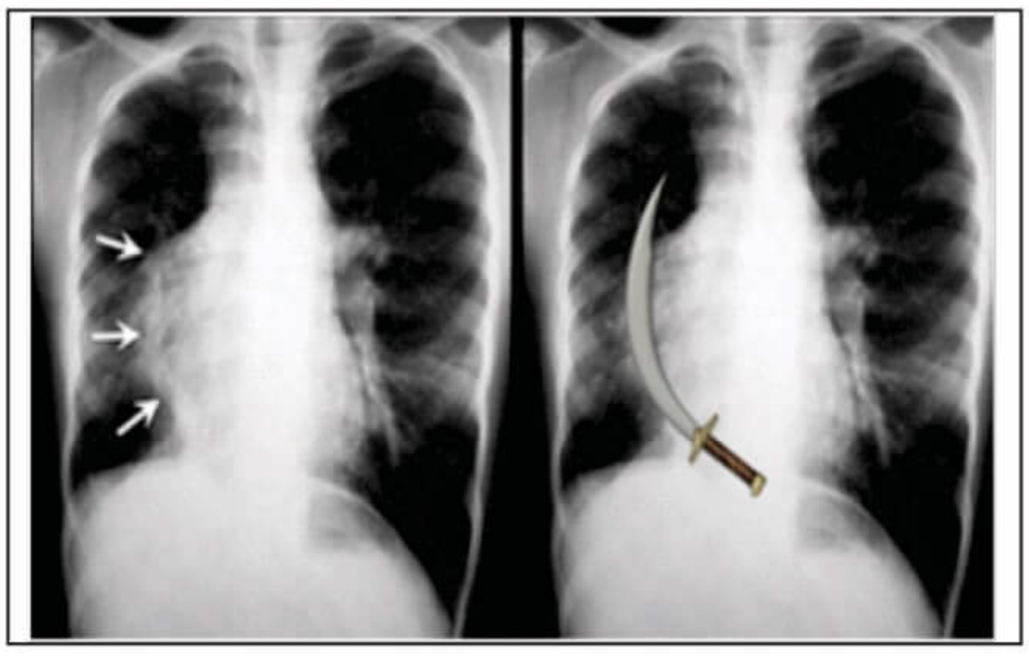
→ AKA

- Hypogenetic lung syndrome
- Pulmonary venolobar syndrome

→ Right sided pulmonary veins crosses diaphragm and drains into IVC.

→ Cause Hypoplastic lung & Small pulmonary artery





RESPIRATORY RADIOLOGY PART -1

Normal Chest x ray:

→ Medial end of clavicle is equidistant from spinous process

→ Trachea in midline

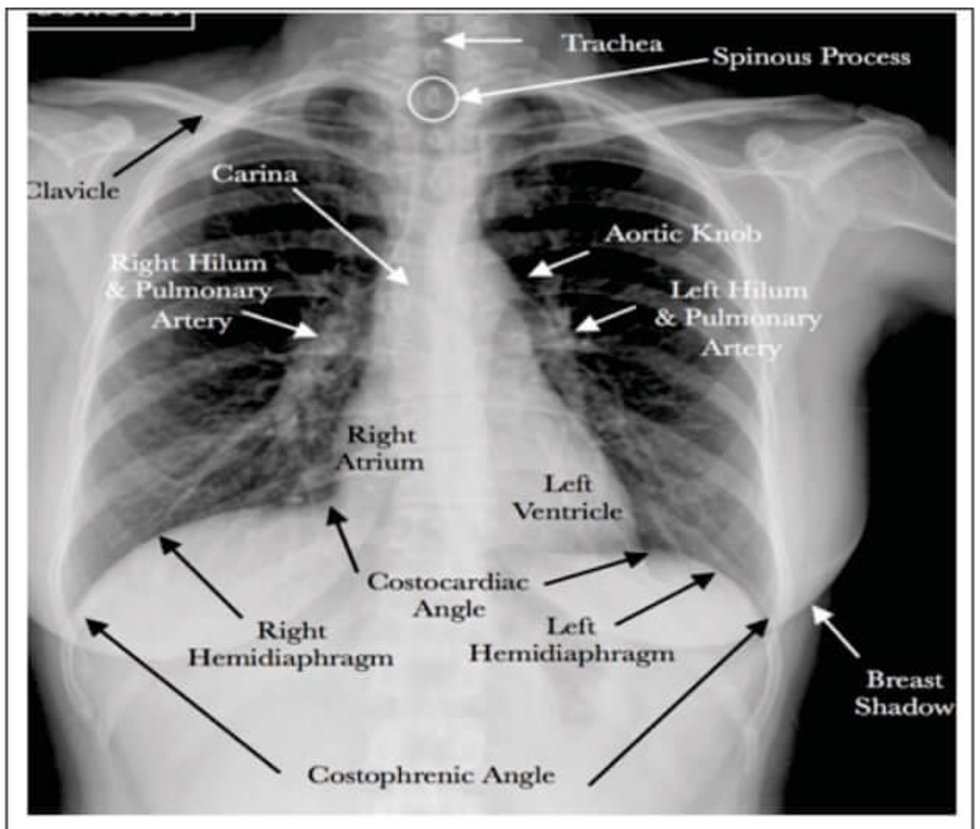
→ **Pneumothorax:** trachea deviates to **opposite** side

→ **Lung collapse**: trachea moves to **same** side

→ **Mitral sclerosis**

- Elevation of left main bronchus
- Splaying of carina

→ **Pneumonia / consolidation** – No tracheal deviation



Chest x-ray

Hilum

→ Normally left hilum is higher than right hilum

→ **Hilar shadow:**

– Formed by **pulmonary arteries** (**Major component**) & **upper lobe pulmonary vein** and **Bronchus**

Heart Border

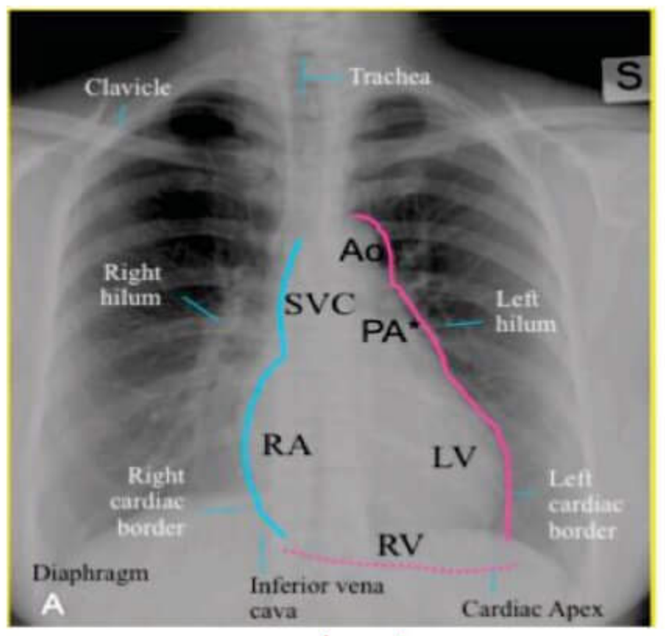
→ **IVC, RA, SVC** - forms Right heart border

→ **Left auricle & left ventricle** - form Left heart border

→ Normally left hemidiaphragm lower than Right hemidiaphragm - because of heart on left side

→ **Lucency of air under the diaphragm:**

- Left side - gastric bubble or fundic gas (normal)
- Right side – Hollow viscus Perforation (Abnormal)

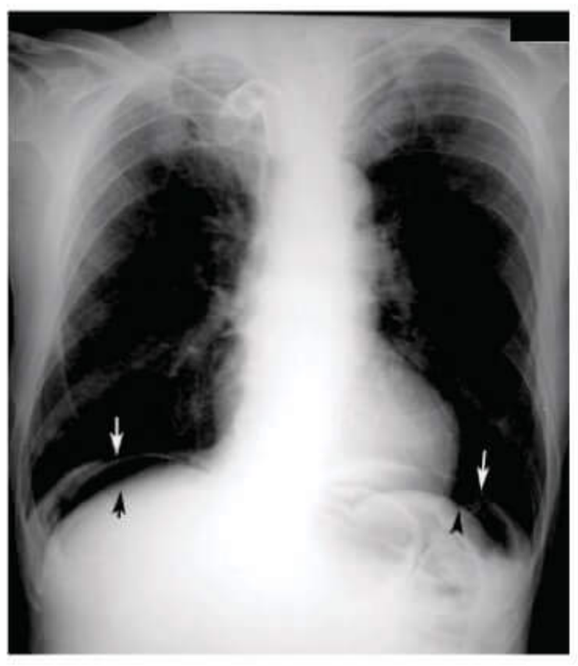


Heart borders

→ Preferred X-ray view for Pneumoperitoneum – **CXR erect**

→ **Review areas of Chest X-ray**

- Costophrenic angle
- Cardiophrenic angle
- Hilum
- Apex of Trachea



Pneumoperitoneum

RIBS

→ **Posterior ribs** – more horizontal

→ **Anterior ribs** – oblique

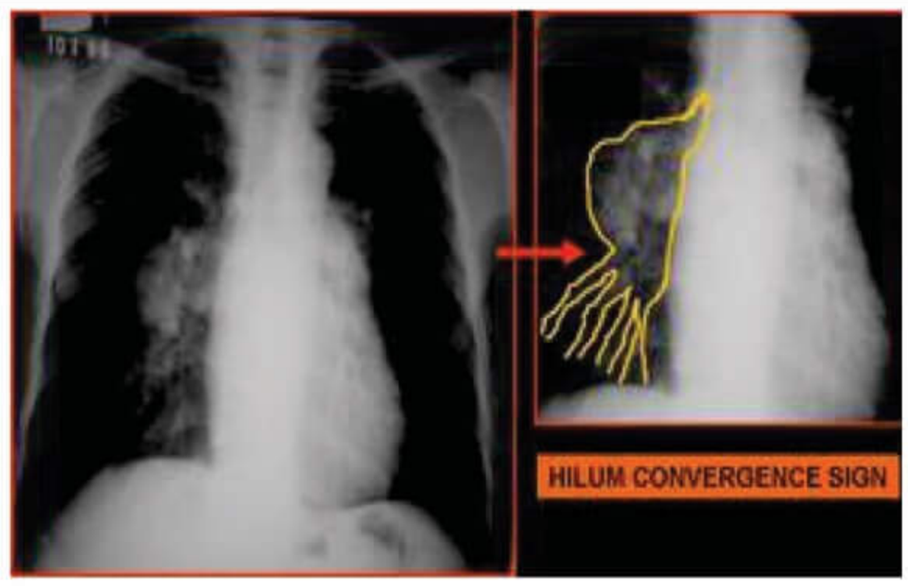
→ **Based on No. of ribs seen in an X-ray**

- 5-7 Anterior ribs or 9-10 Posterior ribs– Good expiratory effort
- < 5 Anterior ribs – Poor expiratory effort
- > 7 Anterior ribs – Hyperinflated lung fields

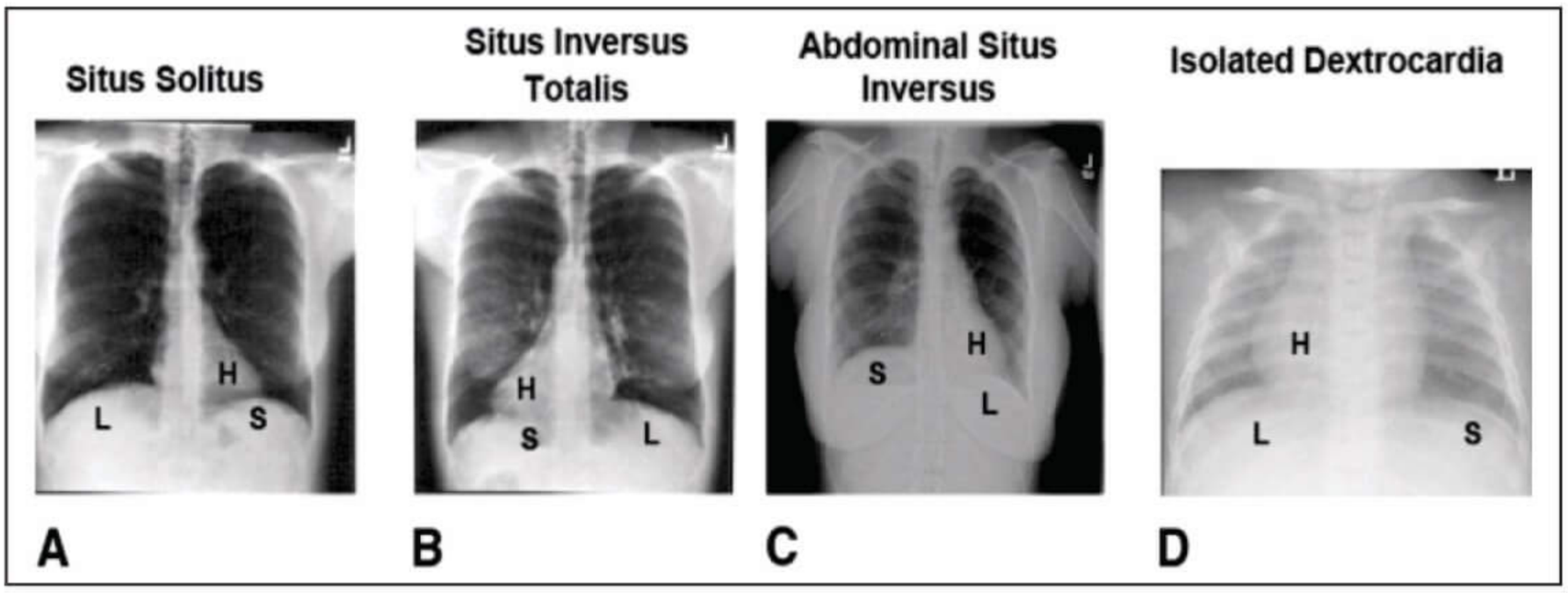
Hilum convergence sign

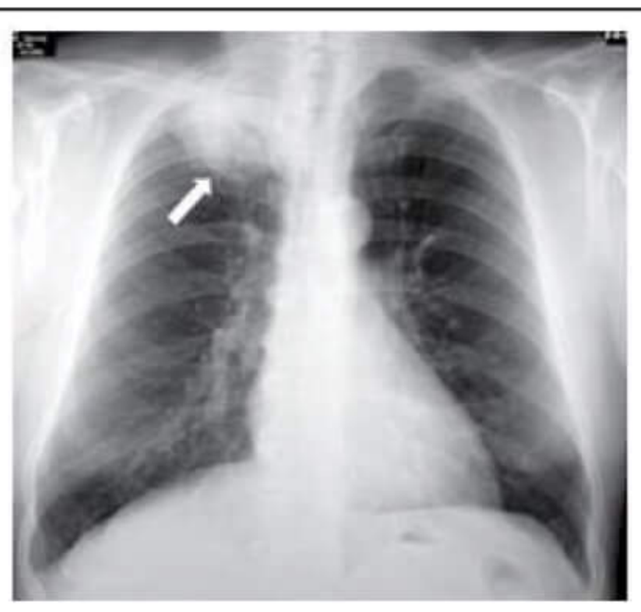
→ Used to differentiate between dilated pulmonary artery vs hilar mass / lymph node

- If pulmonary vessels are converging onto that area it is prominent pulmonary artery → dilated pulmonary artery
- If pulmonary vessels pass across but do not converge at hilum (vessels converge medial to opacity) → hilar mass

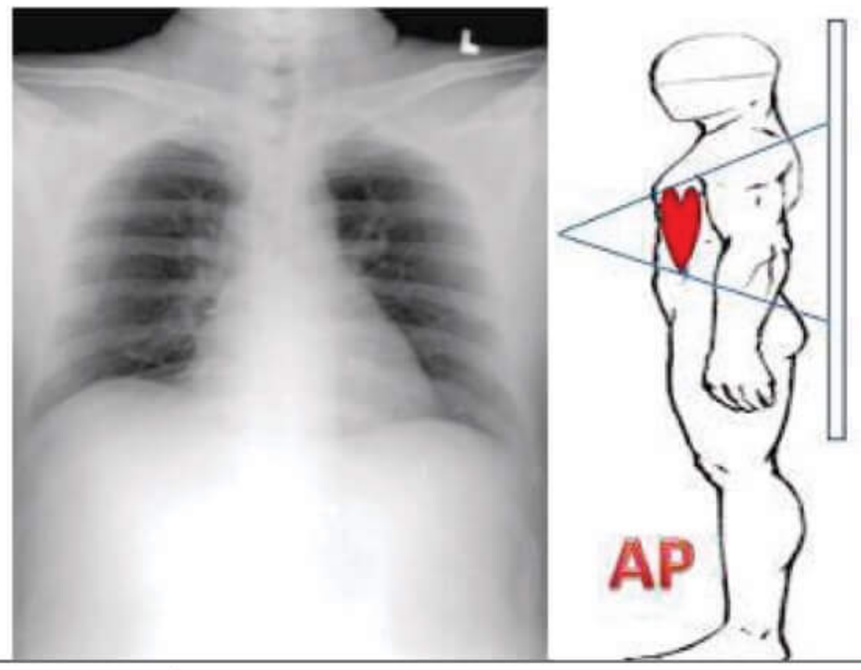
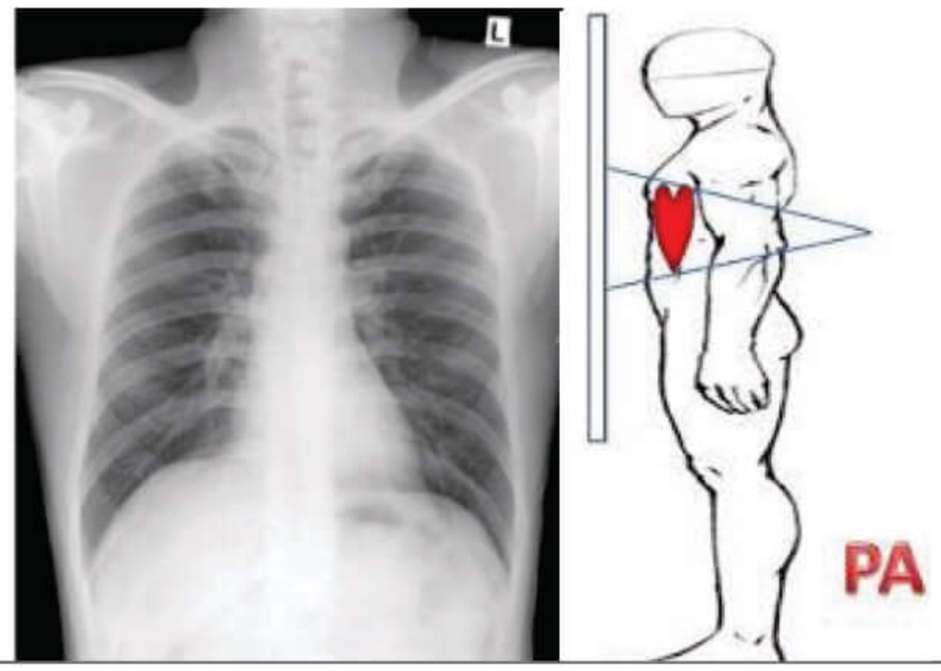


→ In dextrocardia, Right hemidiaphragm is lower than left hemidiaphragm (Normally left hemidiaphragm lower than right)





Pancoast tumor

AP view	PA view
	
→ It used for • Trauma • Condition where patient cannot move (supine)	→ It is the most commonly used Chest X-ray view
→ In normal CXR, Film Focus distance = **180 cm** (in any other Conventional radiology, it is 100 cm)	
→ **Apparent** cardiomegaly (Heart close to x ray source)	→ No apparent cardiomegaly (heart closer to film)
→ **No** gastric bubble appearance	→ Gastric bubble appearance of left side
→ Clavicle **above** lung apex	→ Clavicle **on the** lung apex
→ Medial border of scapula – more **medially** oriented	→ Medial border of scapula more **laterally** oriented in a PA view.

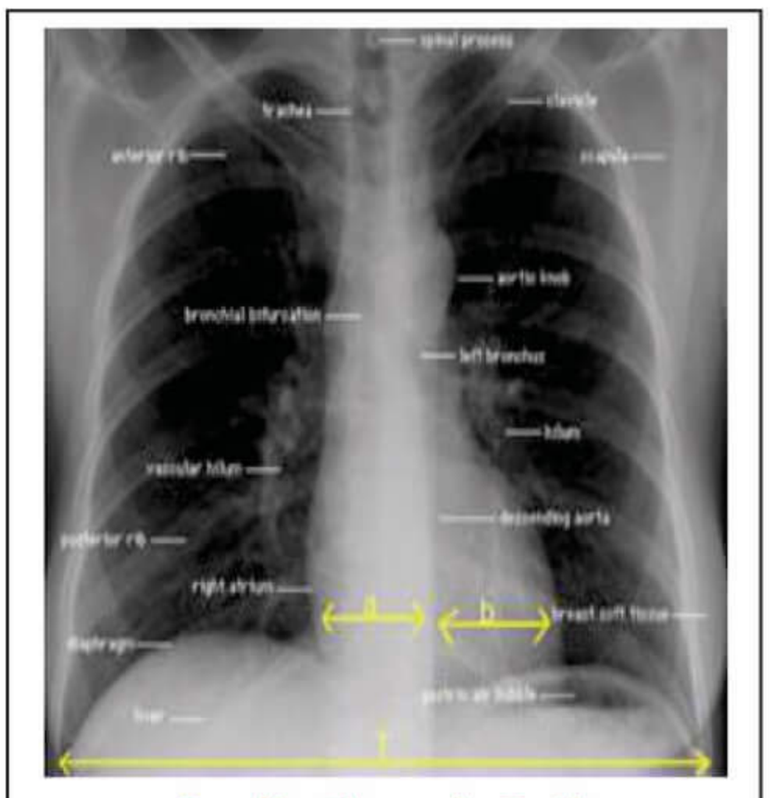
CTR (Cardio Thoracic Ratio)

→ **Cardio Thoracic Ratio (C/T)**

- C/T – **>0.5** (Indicates **Cardiomegaly**)

→ **Normal CXR**

- PA view
- In full inspiration

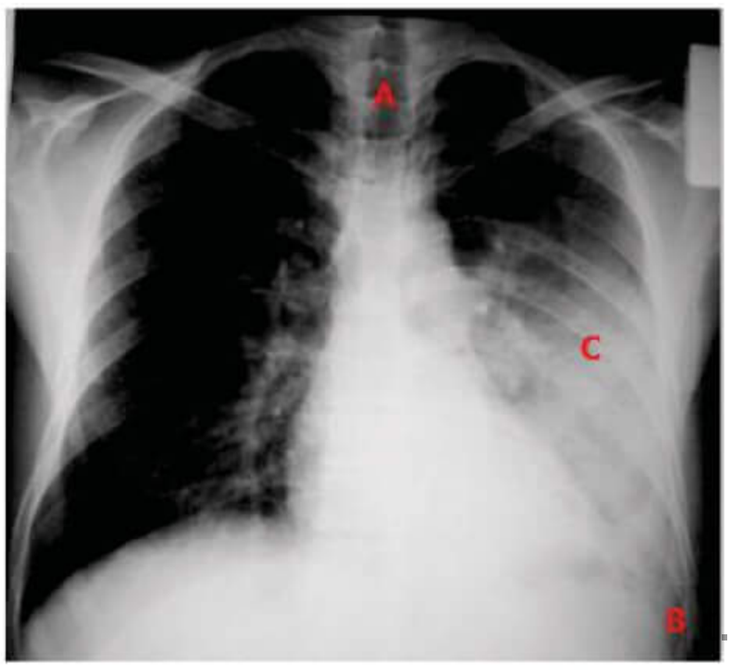


Cardio Thoracic Ratio

Points to know

- → Expiratory films – For pneumothorax
- → Best view for pneumoperitoneum – Chest X Ray erect
- → Best view for pleural effusion – ipsilateral lateral decubitus
- → **Lordotic view** – Used to evaluate
  - Lung apex
  - Middle lobe
  - Lingular Pathology

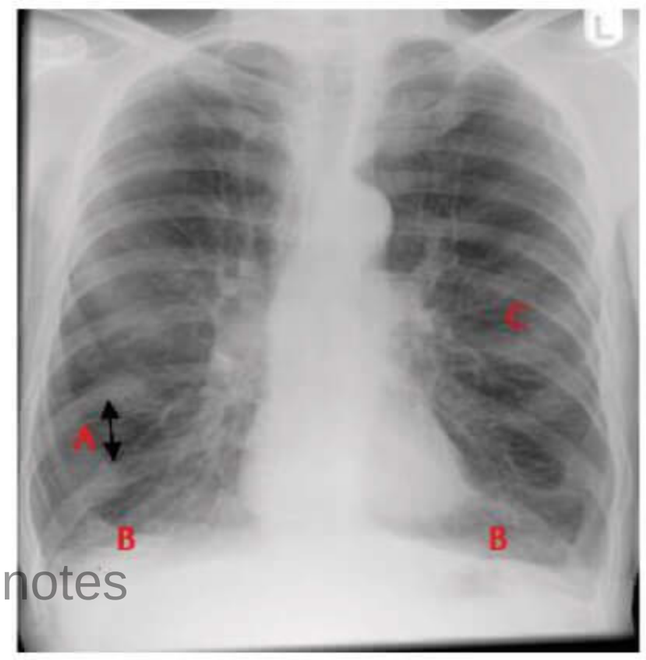
Consolidation



Left lower lobe consolidation

A. No Tracheal deviation
B. Lucency of air in CP angle intact
C. Opacities with hazy irregular border

COPD



A. Widening of intercoastal space
B. Flattening of domes of diaphragm
C. Hyperinflated lung fields

Left lung collapse

- → Ipsilateral shift of Trachea, Carina & Mediastinum
- → Bronchial cut-off sign (left mainstem bronchus)
- → Rib crowding
- → Compansatory huperinflation of right lung

Left lung collapse

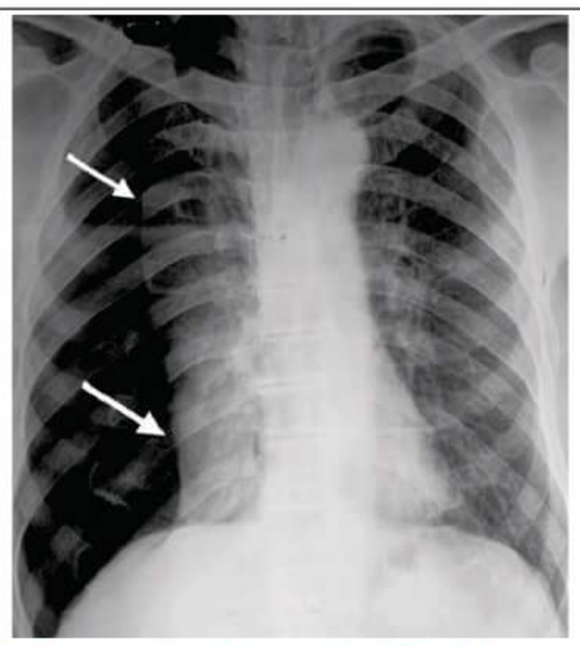
Pneumothorax

→ Best X- ray view – Expiratory film

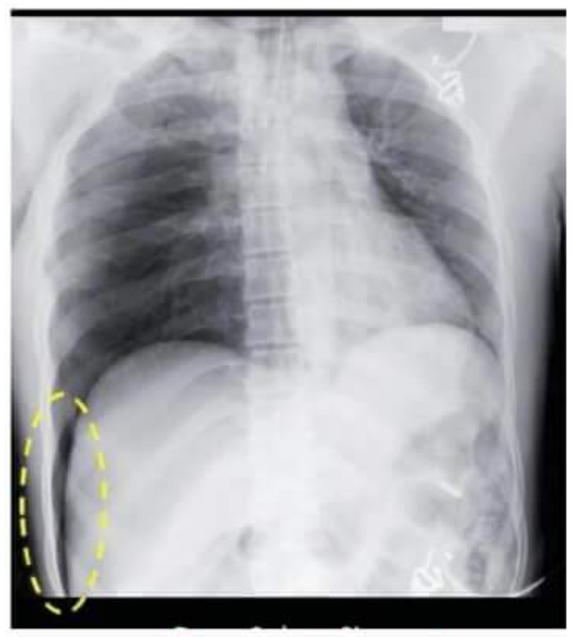
→ IOC – CT

→ **CXR signs of Pneumothorax**

- Absent bronchoalveolar markings
- Visceral pleural refection
- Deep sulcus sign in supine patient



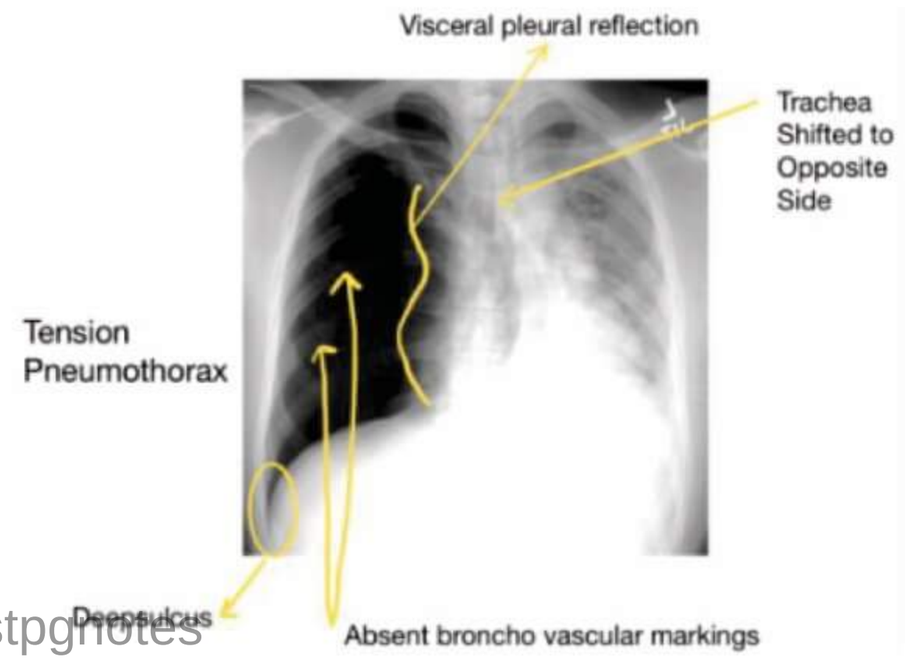
Visceral pleural refection



Deep sulcus sign

Tension pneumothorax:

- Pneumothorax with mediastinal shift



Tension pneumothorax

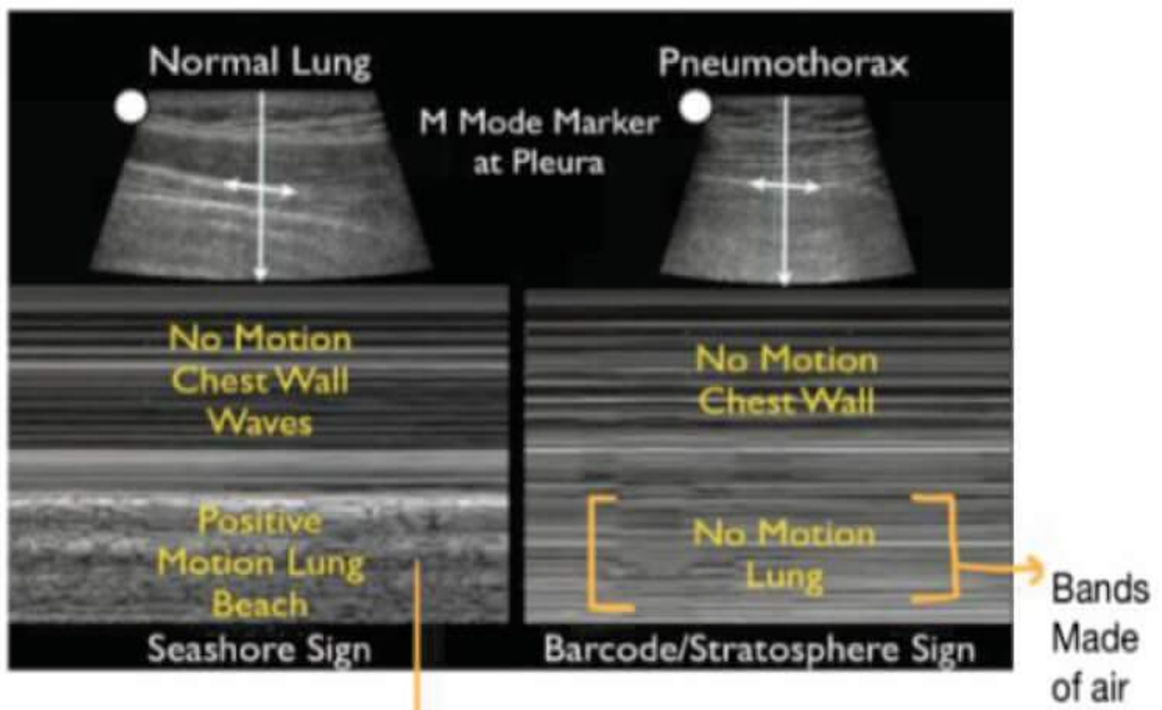
USG signs of pneumothorax

→ Seashore appearance

- Seen in normal Lung USG
- **Chest wall muscle** – Hypoechoic/dark giving a waves of stagnant sea appearance
- **Lung** – Hyperechoic (because of presence of air) giving sand like appearance

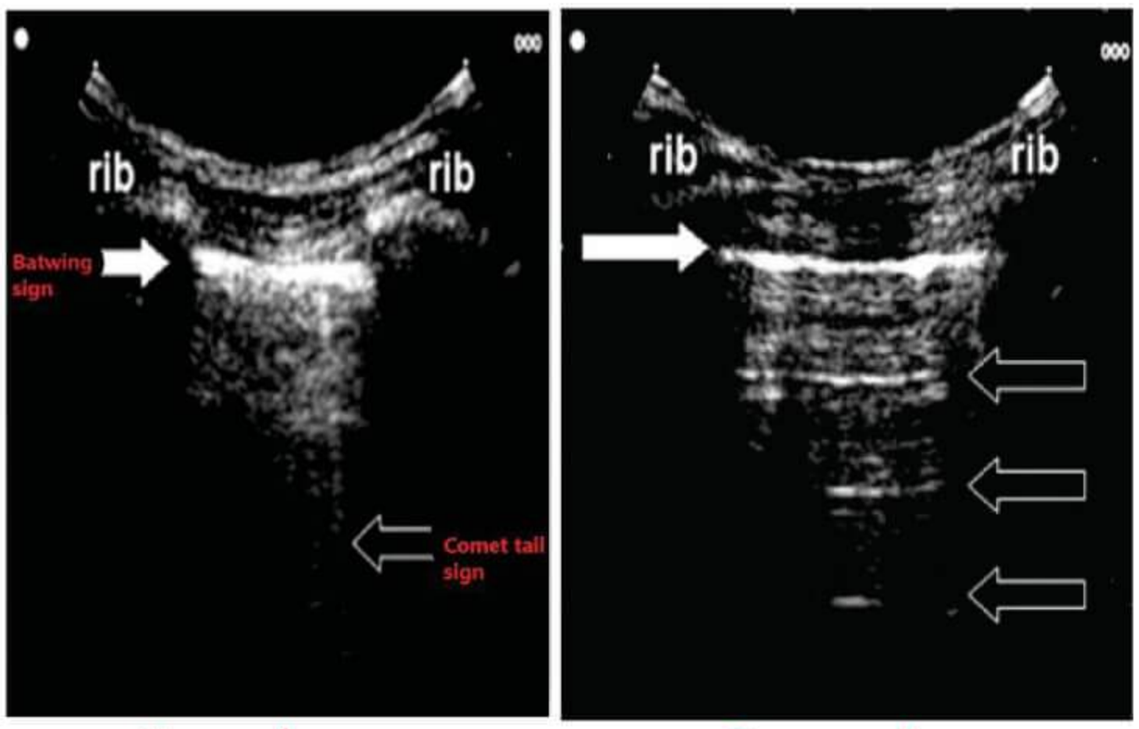
→ Normal lung ultrasound has

- BATWING appearance of ribs and pleura
- Seashore sign
- Comet tail appearance
- B Lines



→ **USG signs of pneumothorax**

- Absent seashore sign
- Bar code sign } on M-mode USG
- Stratosphere sign
- Absent B lines / absent comet tail
- Absent comet tail



Normal Pneumothorax

Fallen Lung sign

→ Seen in Fracture of bronchus

↓

Lungs collapses

- inferiorly and laterally in an upright posture
- Posteriorly in a supine posture

Note:

→ Lung collapses medially and towards the hilum in pneumothorax

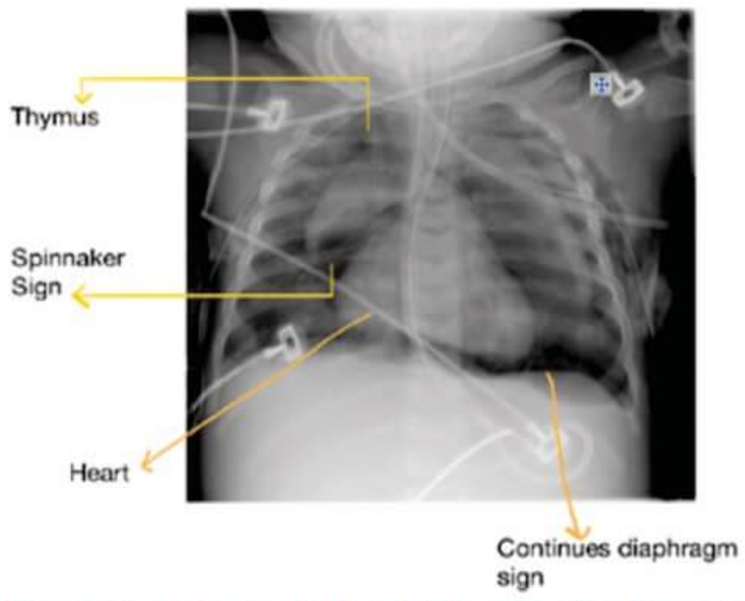
Fallen Lung sign

CXR signs of Pneumomediastinum

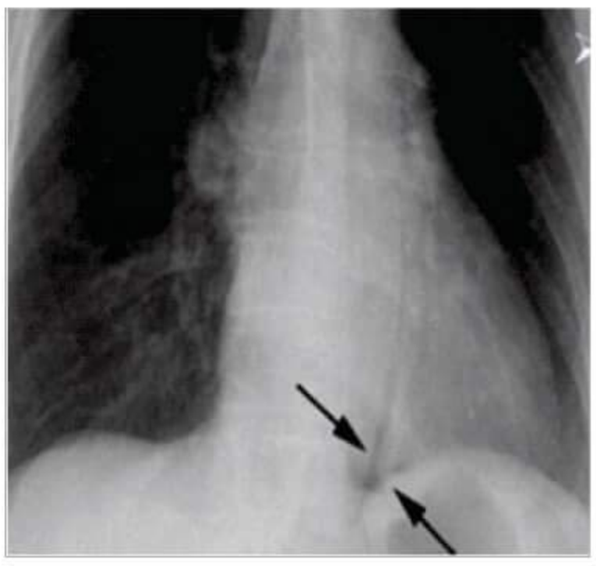
→ Thymic sail sign / Spinnaker sign – Air comes between thymus & heart, Lifting the thymus away from heart

→ Continuous diaphragm sign – Air lucency under the heart

→ V sign of Naclerio – Air lucency under lining the lateral border of the descending thoracic aorta and left medial hemidiaphragm (secondary to esophageal perforation)

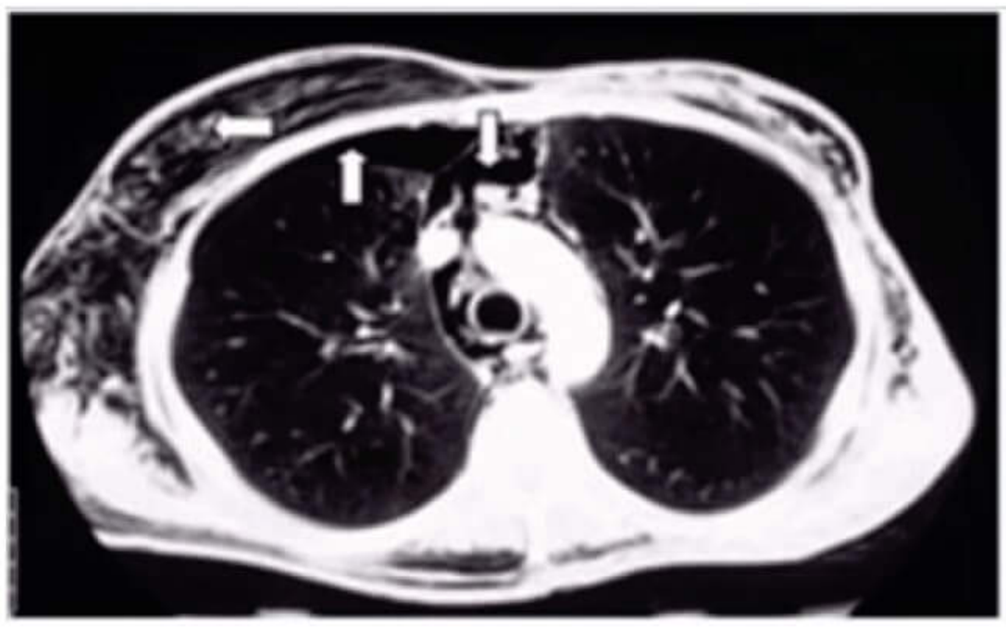


Spinnaker sign / Continuous diaphragm sign



V sign of Naclerio

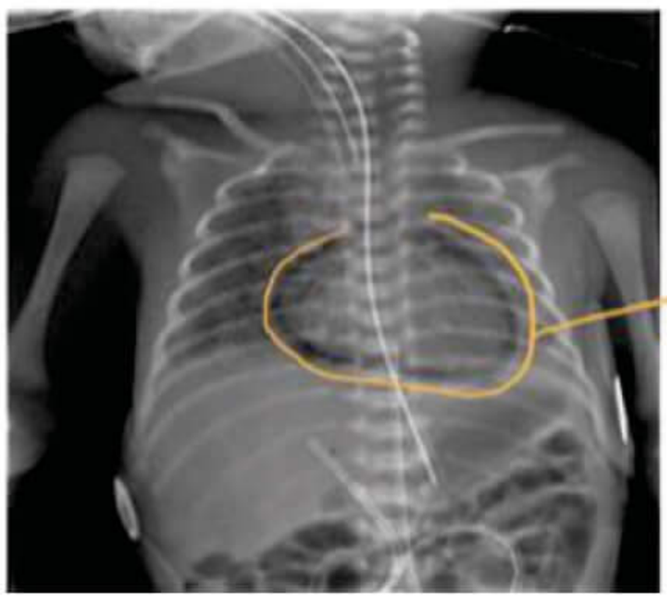
→ IOC for air involving pathologies – CT scan
(E.g. Pneumothorax, pneumoperitoneum)



Pneumothorax + pneumomediastinum

Pneumopericardium

→ Lucency of air around the heart, which is limited by the pericardial space

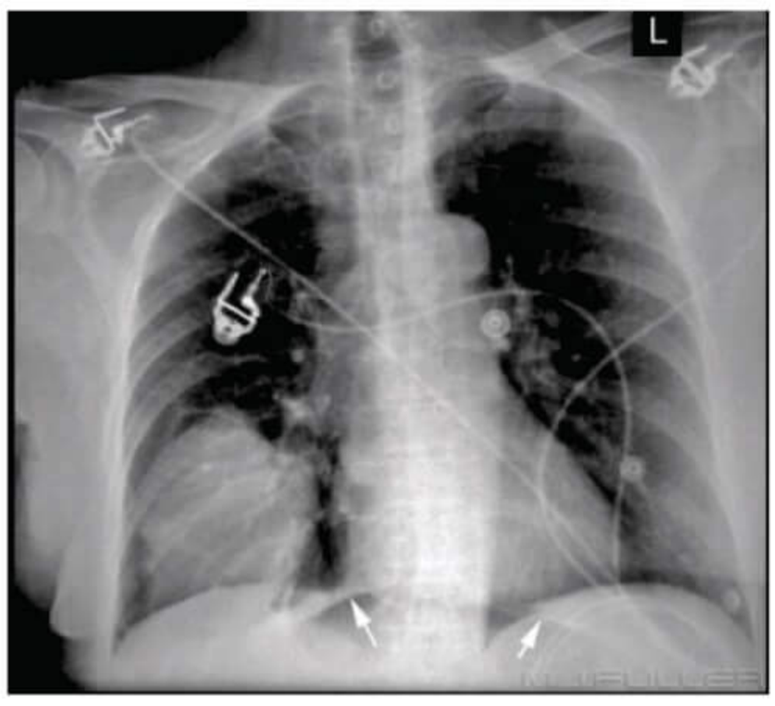


Pneumoperitoneum

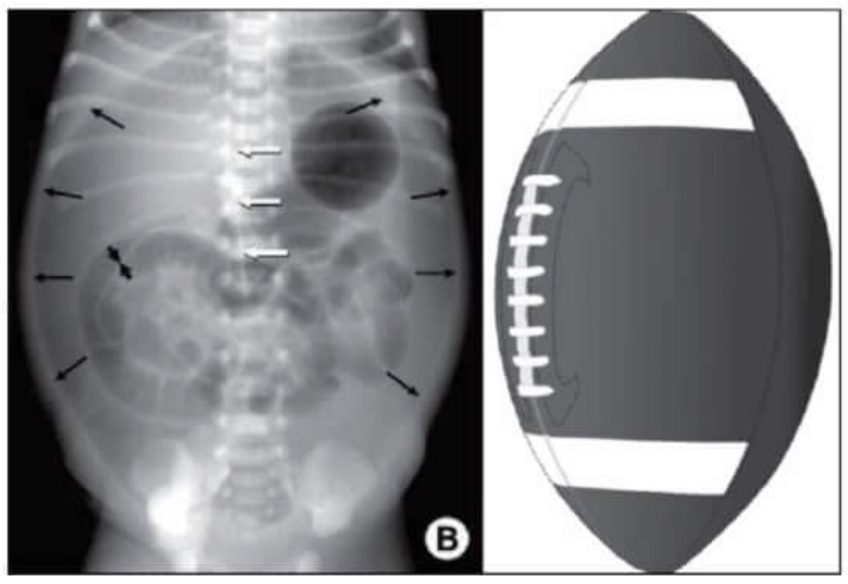
→ Air under right dome of diaphrgram – suggestive of Hollow viscus perforation
→ Football sign
→ Umbilical ligament sign
→ Inverted V sign
→ Rigler's sign
→ Falciform ligament sign
→ Ligamentum teres sign
→ Uranus sign
→ Telltale triangle sign
→ Morrison gas sign / Doges Cap sign

Cupola sign:

→ Air under central tendon of diaphrgram



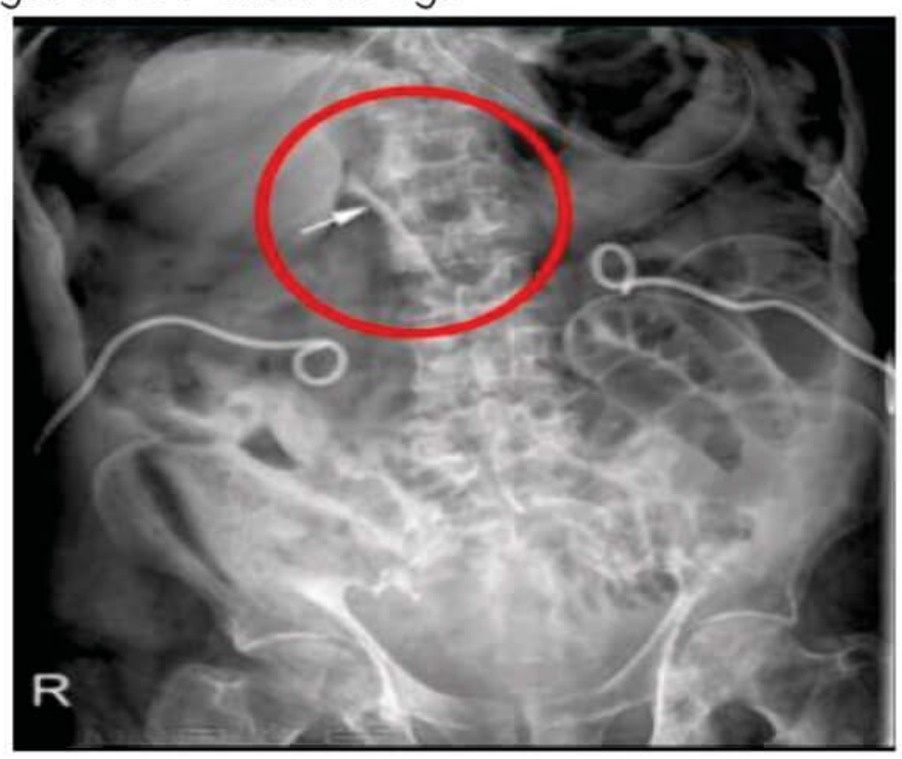
Football sign:



Falciform ligament sign:

→ Because of free air in abdomen all ligaments stand out clearly

→ Falciform ligament sign / ligament teres sign / lateral umbilical ligament / inverted V sign /medium umbilical ligaments / urachus sign

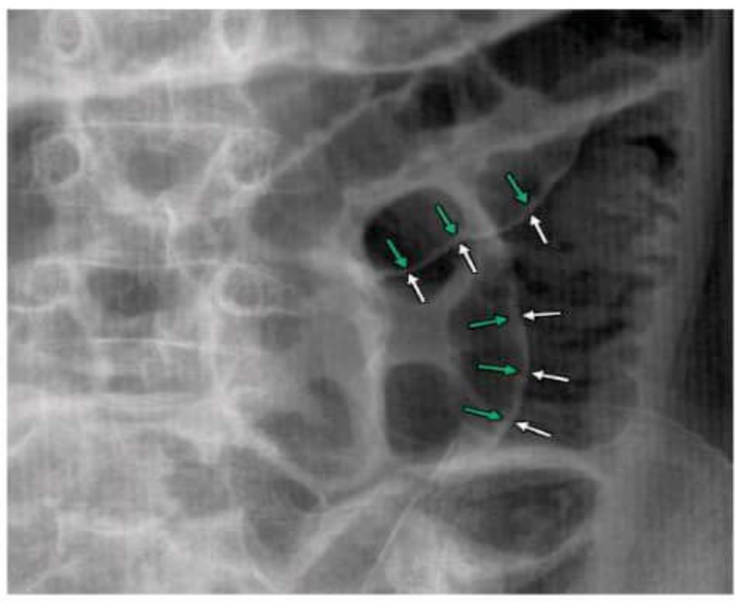


Doges cap sign:

→ Free air in Morrison's pouch

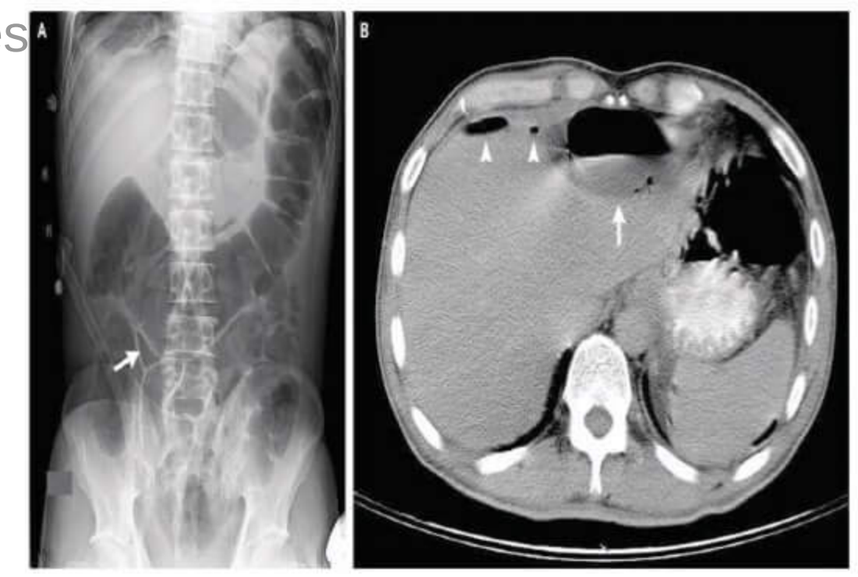
Rigler sign:

→ Air on either side of bowel wall



Telltale triangle sign:

→ Triangular air lucency

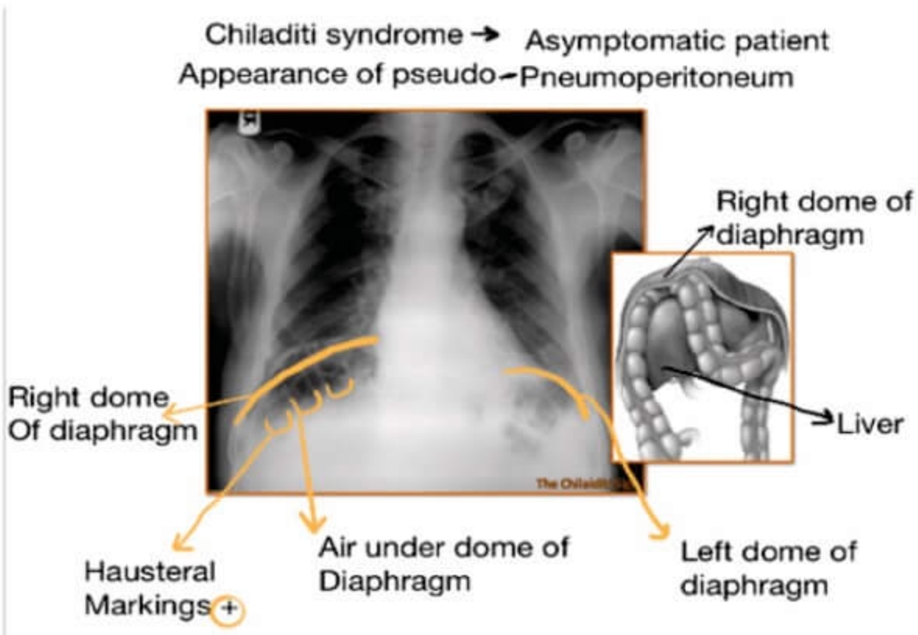


Pseudo pneumoperitoneum

→ Chilaiditi syndrome – Bowel inter scoped between right hemidiaphragm and liver

→ Other causes:

- Subphrenic abscess
- Basal atelectasis
- Subpulmonic pneumothorax



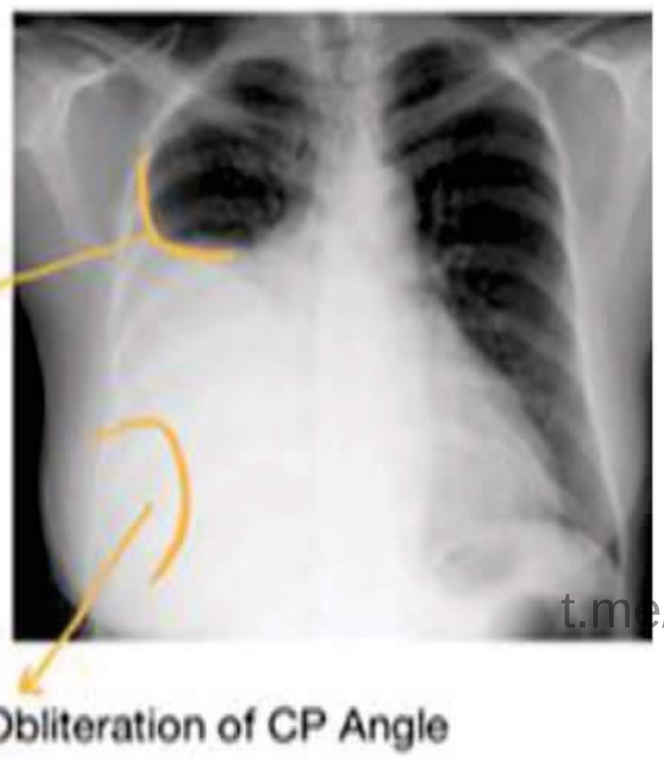
Pleural effusion

→ **CXR findings**
- Obliteration of CP angle
- Distinct border
- Concave upward curve called ELLIS CURVE

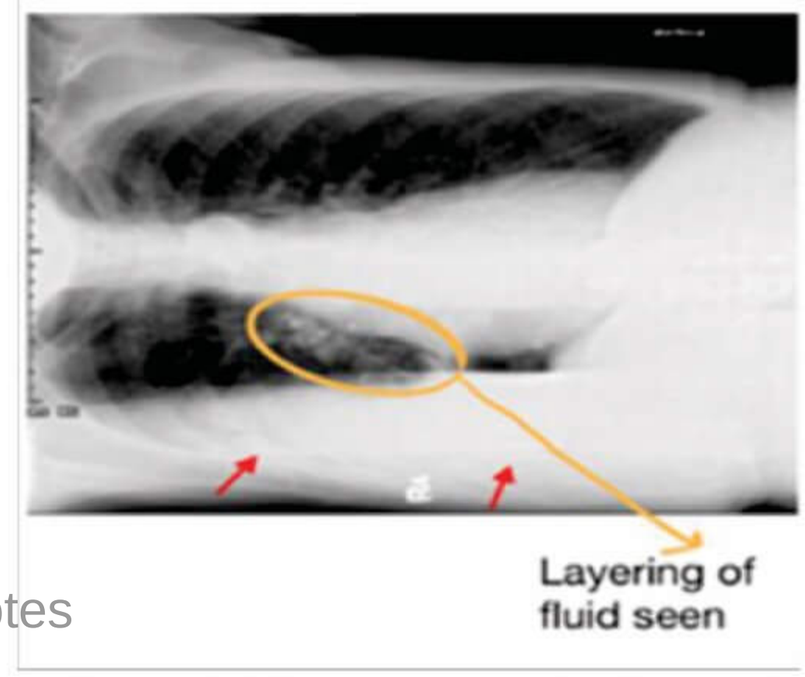
→ Best X-ray view for Pleural effusion – Lateral decubitus view

→ **Amount of fluid required to get detected on X-ray**
- 150-200 ml of fluid - on PA view
- 75 ml of fluid - on lateral view
- 15-25 ml of fluid - on lateral decubitus view

→ IOC for minimal Pleural effusion (<10ml) - USG

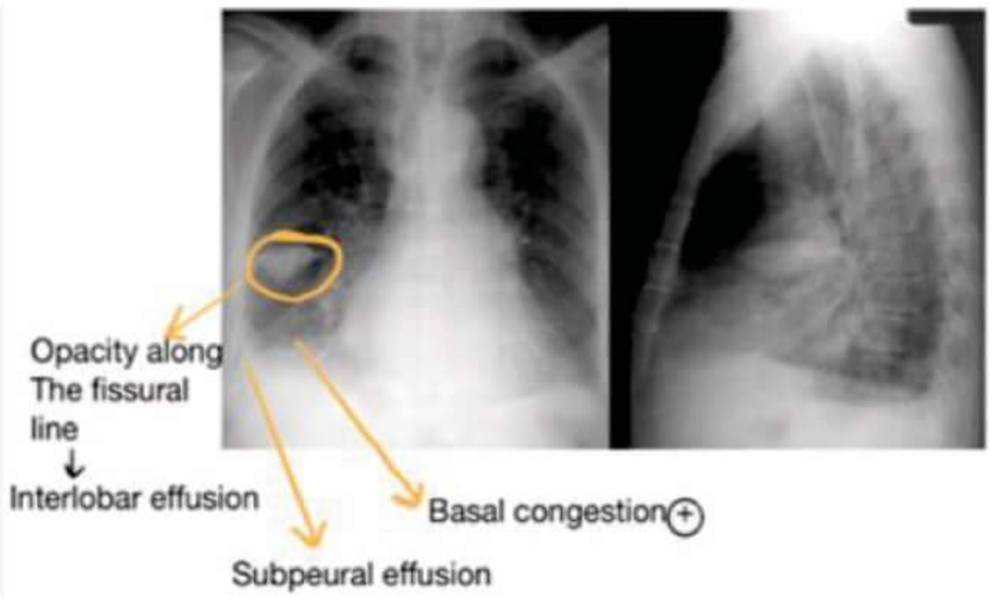


ELLIS curve

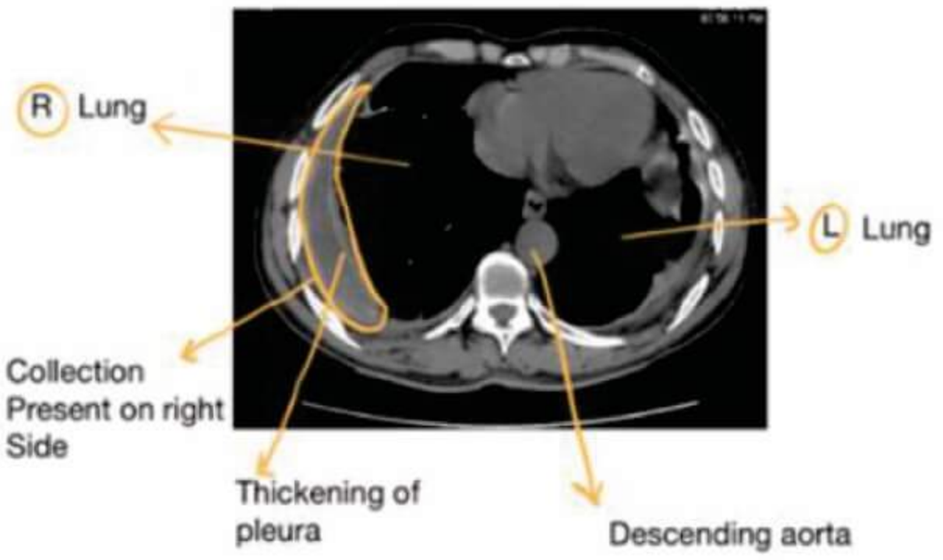


Pleural effusion - Right lateral decubitus view

Interlobar effusion / Phantom tumor



Empyema

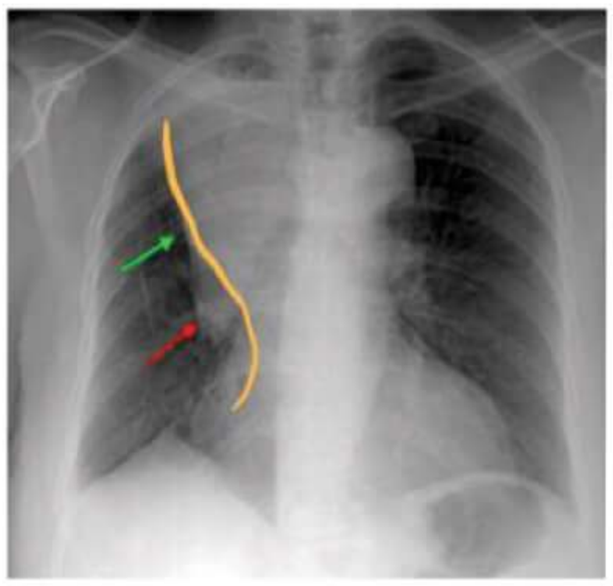


→ *Split pleura sign* on CT

Hydropneumothorax

→ *Horizontal air fluid levels* in the right hemithorax

Golden S sign



→ **Aka Reverse S–Sign**

→ Seen in *Bronchogenic carcinoma with right upper lobe collapse*

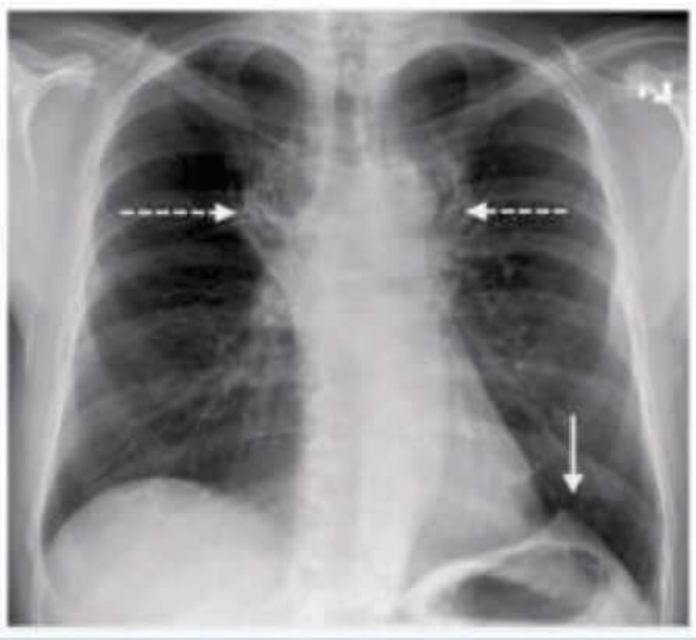
→ **Lower convexity** – Formed by mass (*Bronchogenic CA*)

→ **Upper concavity** – Formed by *RUL collapse*

Juxta phrenic peak sign

→ It is a small triangular shadow that obscures the dome of the diaphragm 2° to upper lobe atelectasis

→ The shadow is caused by traction on the lower end of the major fissure / inferior accessory fissure / inferior pulmonary ligament

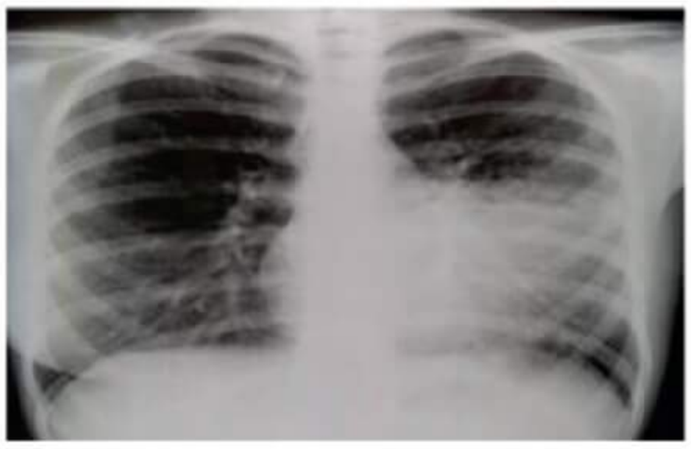


Juxta phrenic peak sign

Silhouette sign:

→ Mediastinal border **obscured** by a pathology which is in close anatomical contact with it

- Obstruction of left heart border – Lingular pathology
- Obstruction of Aortic Knuckle – Left apico-posterior Pathology
- Obstruction of right heart border – Right middle lobe pathology



Silhouette signs

Hilum overlay sign

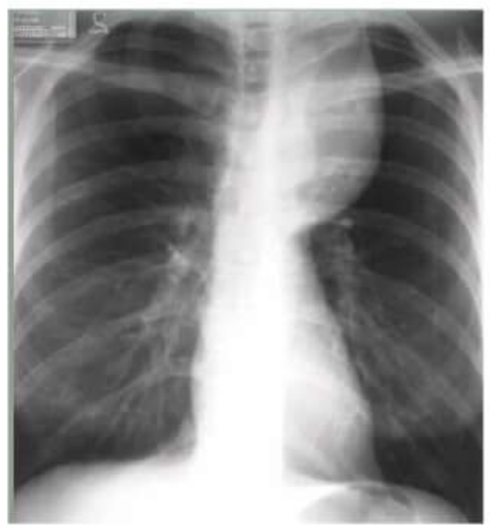
→ Used to Differentiate a **hilar mass** from a **mass in anterior or posterior mediastinum**

Cervicothoracic sign

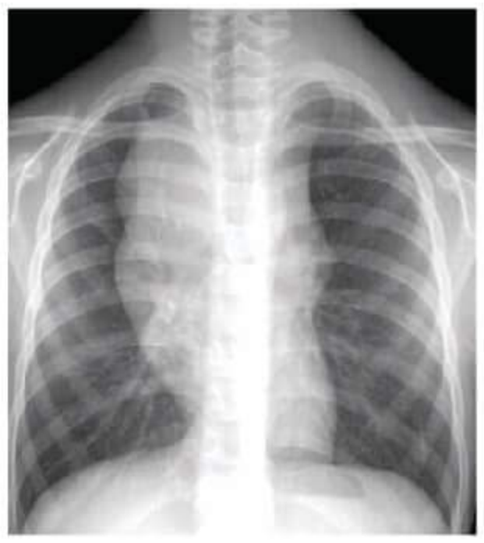
→ Differentiate Lesion in Thoracic inlet – **Anterior / Posterior mediastinum / Cervical region**

→ Anterior mediastinum stops at the level of the superior clavicle

→ Therefore, when a mass extends above the superior clavicle, it is located either in the neck or in the posterior mediastinum



Ant. mediastinal mass



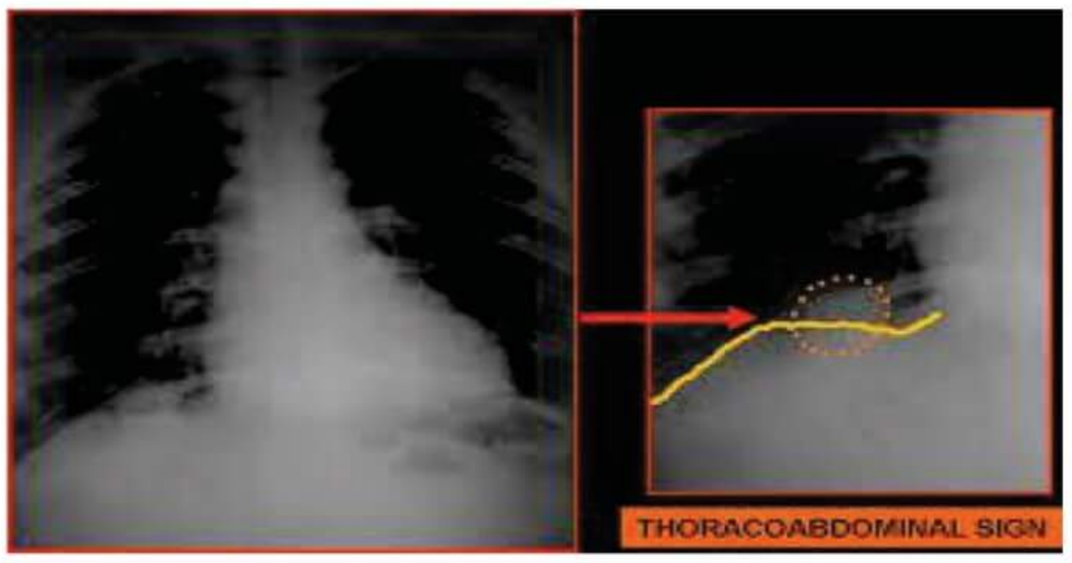
Post. mediastinal mass

Thoracoabdominal sign

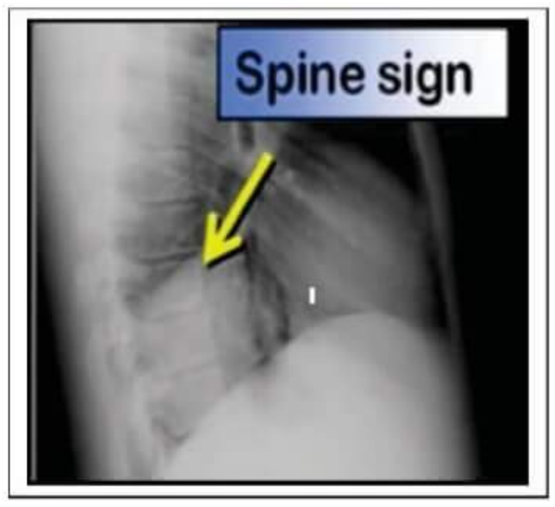
→ Differentiate lesions located close to Hemi-diaphragm

→ **Anterior mass in lung** – Mass terminates at diaphragm

→ **Posterior mass in lung** – Mass appears to terminate below diaphragm with sharp distinct margin



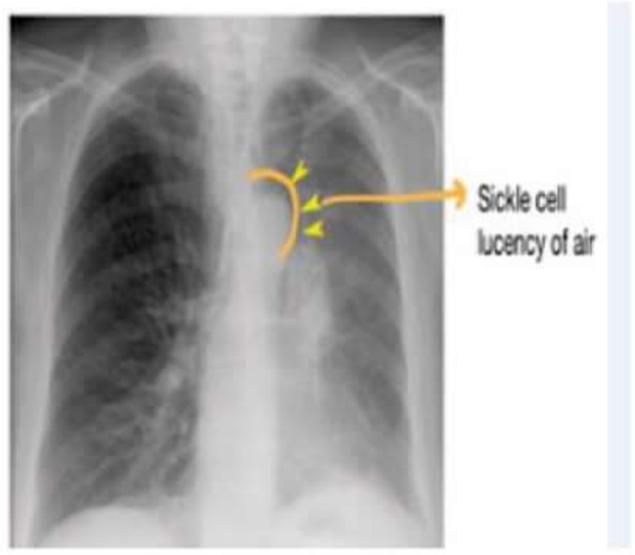
Spine sign



→ In lateral X- ray
- The vertebral body lucency increases as you go downwards (normally)
- But sudden interruption of this lucency is called as spine sign

→ Commonly occur in left lower lobe pneumonia

Luftsichel sign



→ Sickle shaped lucency of air in CXR

→ Seen in Left upper lobe collapse

↓

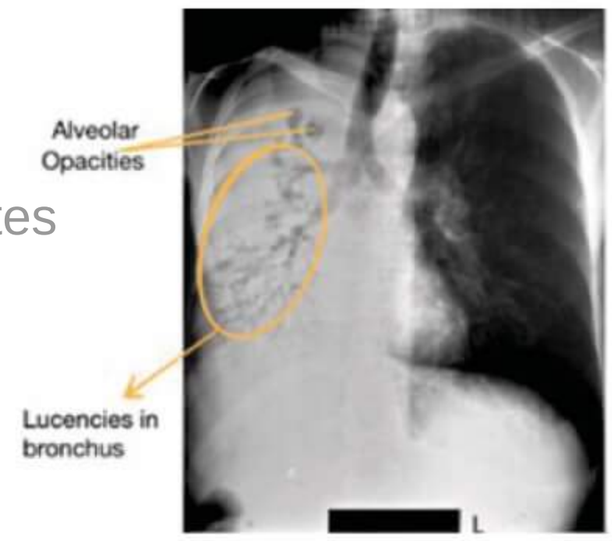
Due to compensatory hyperinflation of superior segment the left lower lobe

Flat waist sign

→ Seen in left lower lobe collapse

→ Caused by leftward displacement and rotation of heart

Air bronchogram sign



→ Alveolar opacities with air inside bronchus intact

→ Seen in
- Consolidation / pneumonias
- Pulmonary oedema
- Bronchoalveolar carcinoma
- ARDS / hyaline membrane disease

CT angiogram sign

→ Identification of vessels within an airless portion of lung on CECT

→ The vessels are prominently seen against a back ground of low attention material

→ **Associated with:**

- Broncho alveolar cell carcinoma
- Lymphoma
- Infectious pneumonias

RESPIRATORY RADIOLOGY PART -2

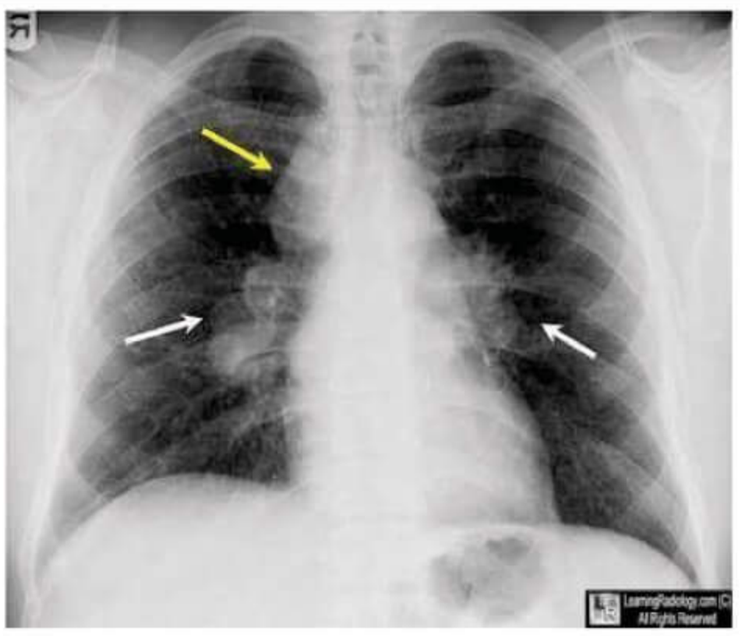
Sarcoidosis

→ On Chest X-ray
- Bilateral hilar lymph nodes and right paratracheal LN
- 1,2,3 sign / Garland sign

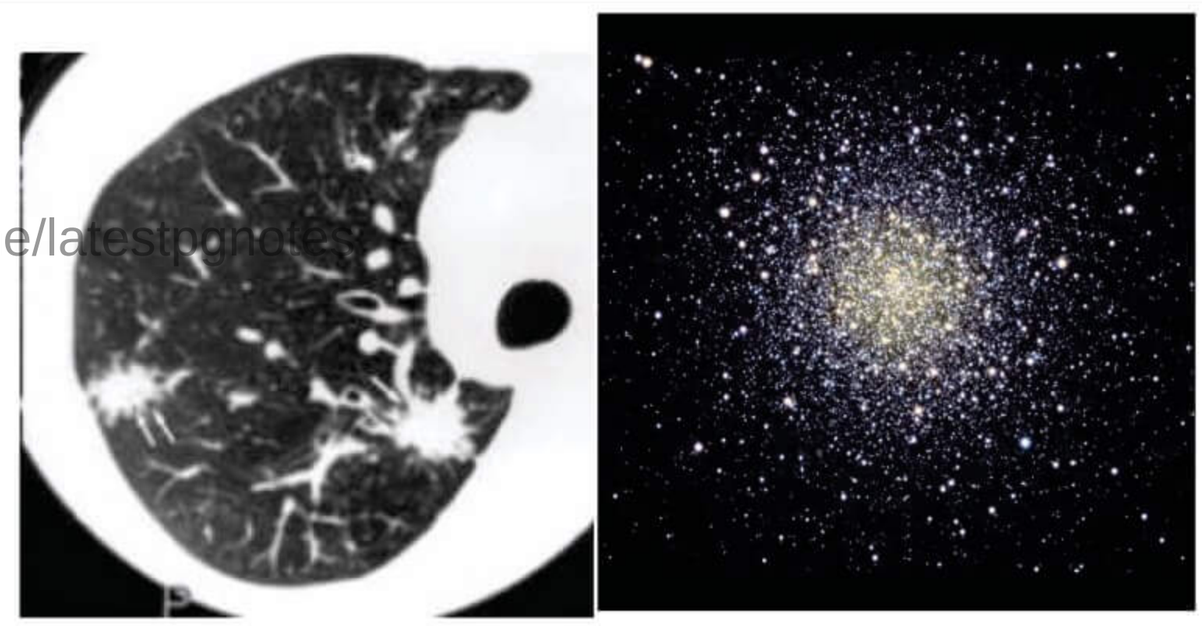
→ On CT
- Galaxy sign

→ On Gallium 67 scan – taken up by lymphocytes
- Panda sign – gallium uptake in bilateral uveal tracts, bilateral parotids and also in the nasopharyngeal region (on face)
- Lambda sign – gallium uptake in bilateral hilar lymph nodes & also in right paratracheal region (on thorax)

→ Egg shell calcification
- Seen in
  1. Sarcoidosis
  2. Silicosis

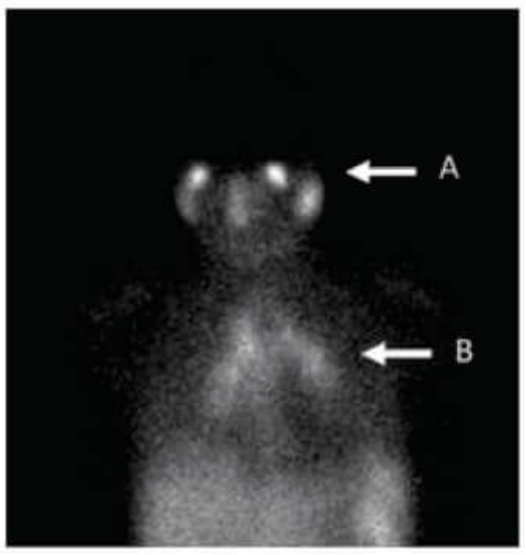


1,2,3 sign / Garland sign

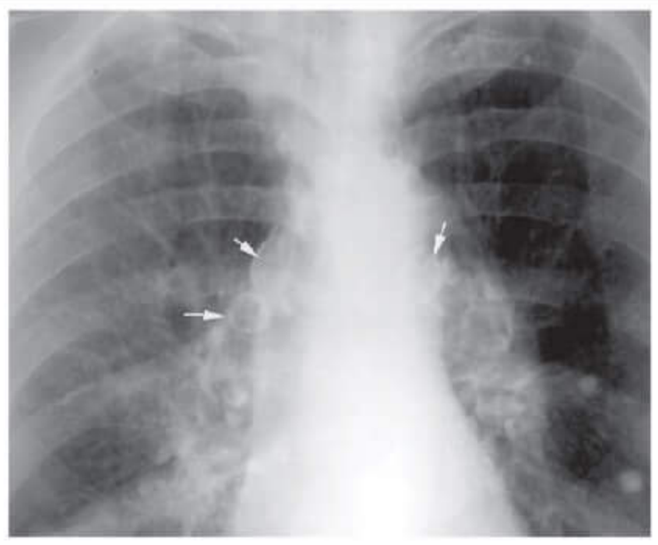


Galaxy sign

Panda sign



Lambda sign

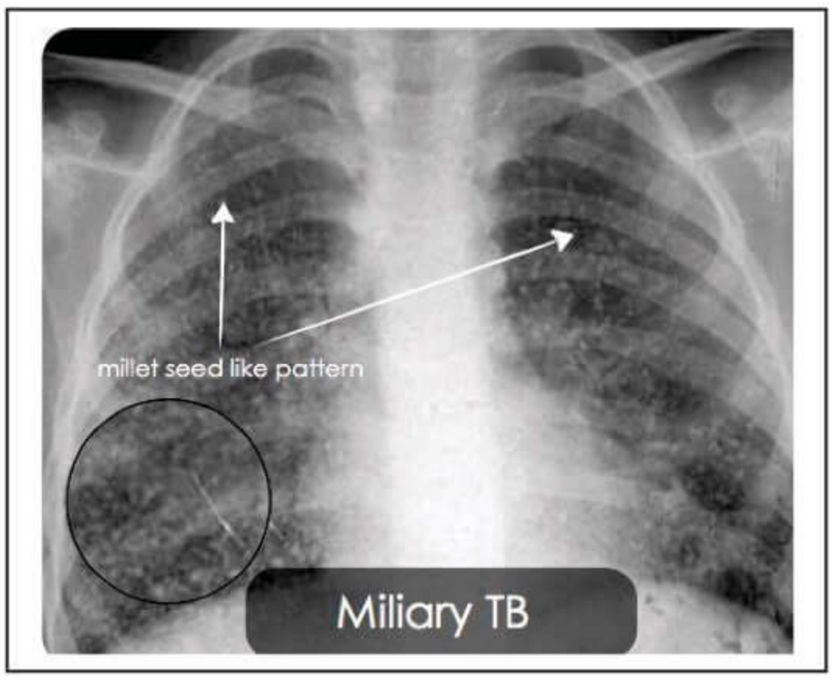


Egg shell calcification

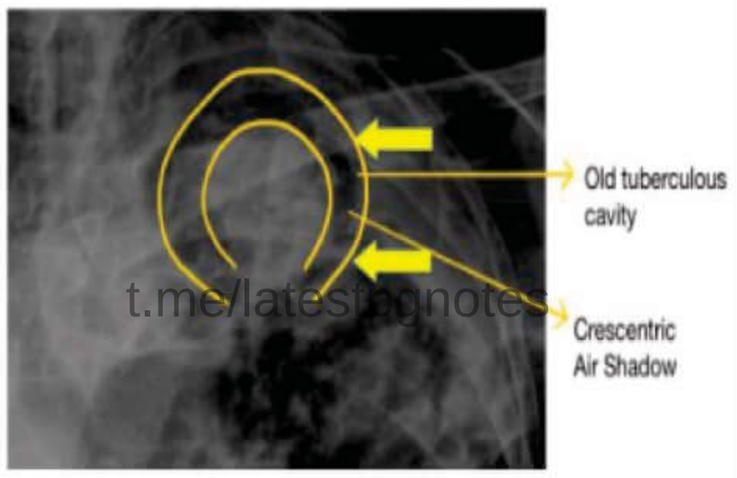
Millet seed appearance

→ **Seen in**

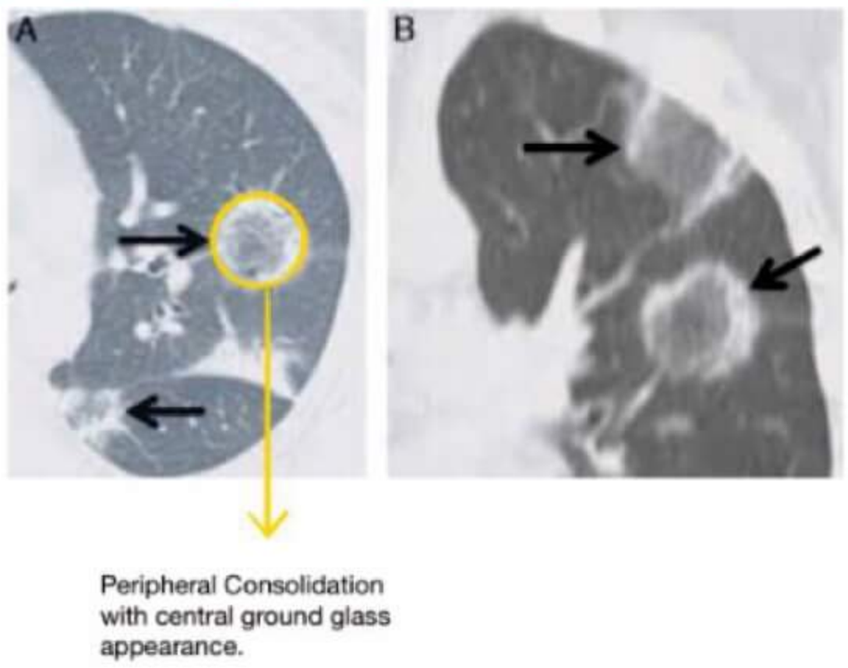
- Military TB
- Healed varicella pneumonia
- Pulmonary hemosiderosis in patients of mitral stenosis



Aspergillosis

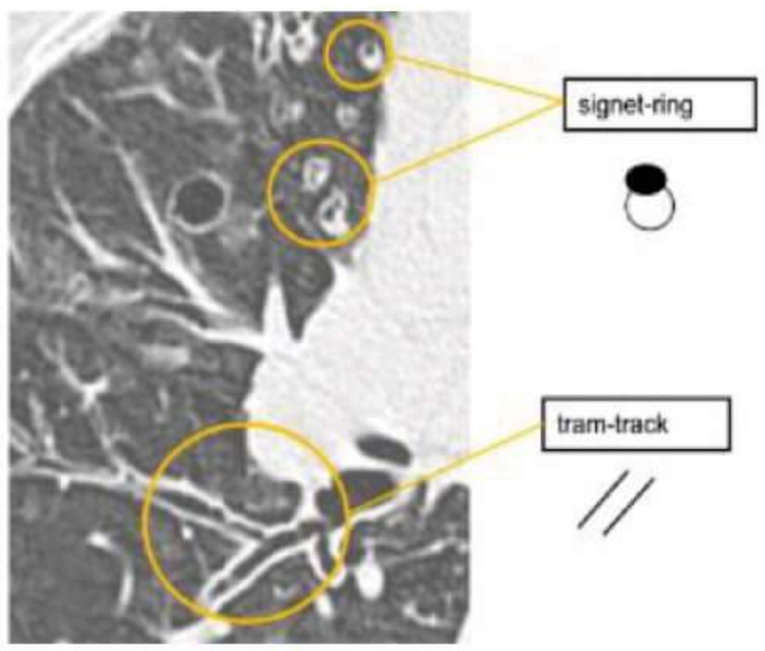
ABPA (Allergic Broncho Pulmonary Aspergillosis)	Aspergilloma fungus ball	Angioinvasive Aspergillosis
→ Finger in gloves appearance  → Bronchoceles & mucoceles → Central bronchiectasis	→ Monod sign / Air crescent sign 	→ Halo sign – Ground glass attenuation around the lesion 

Cryptogenic organizing pneumonia



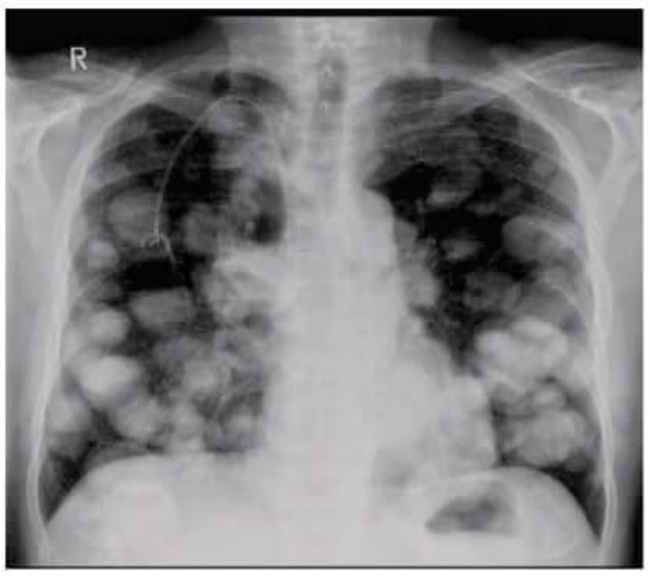
→ Shows Reverse Halo sign / ATOLL sign

Bronchiectasis



→ Shows Signet ring sign & Tram track appearance

Cannon Ball Opacities

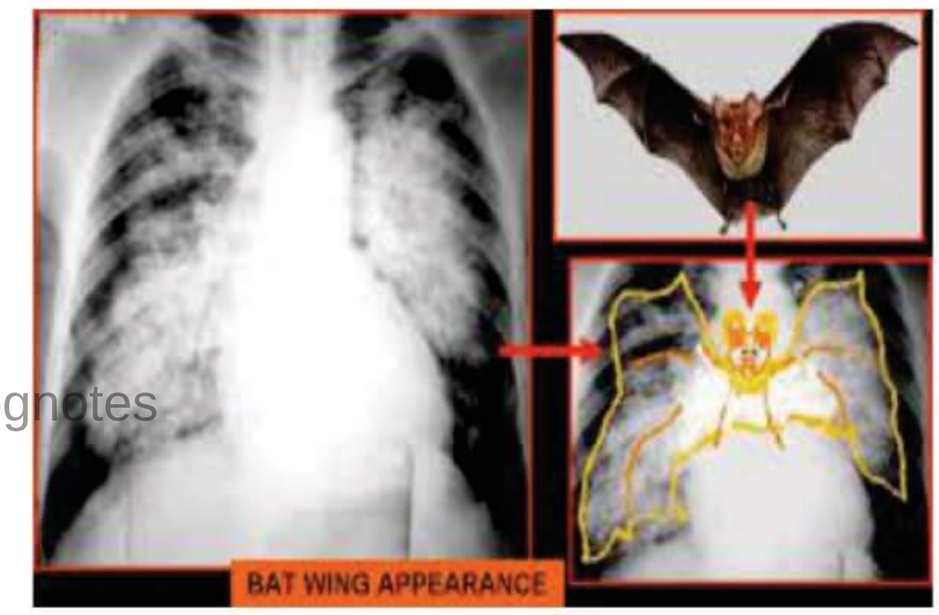


→ Feature of Pulmonary metastasis

→ Common causes of cannon ball opacities

- RCC
- Choriocarcinoma

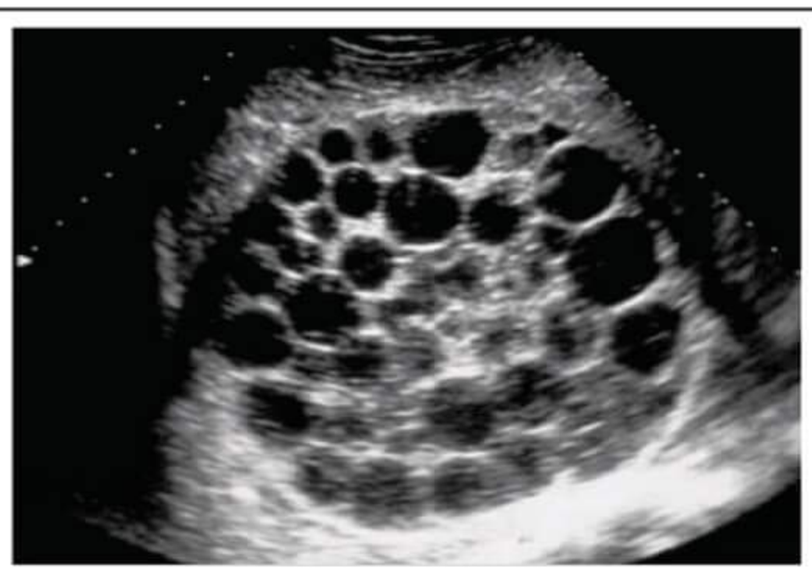
Pulmonary Edema



➢ Shows Bilateral perihilar confluent opacities in Batwing configuration

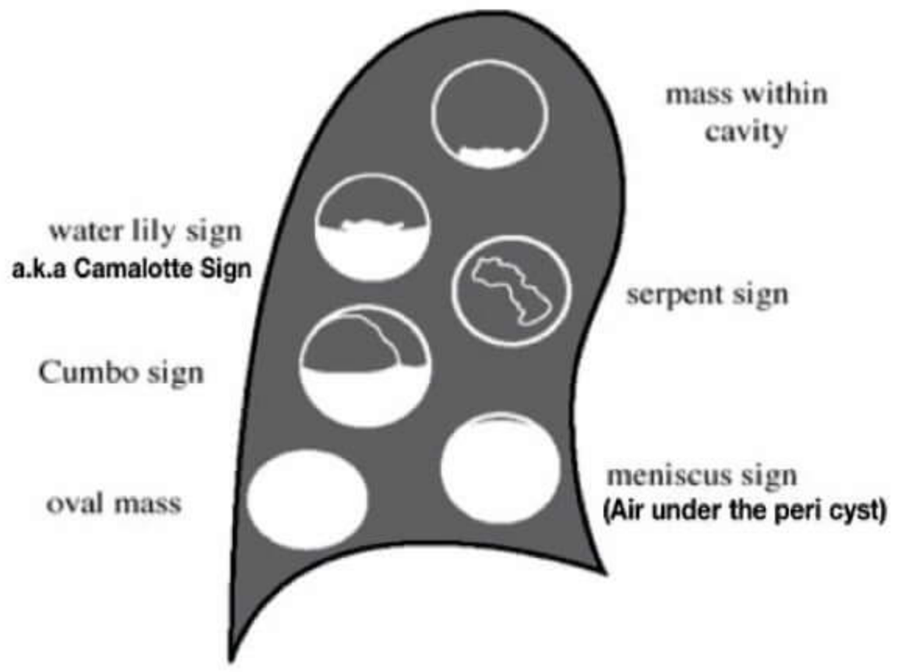
Hydatid cyst

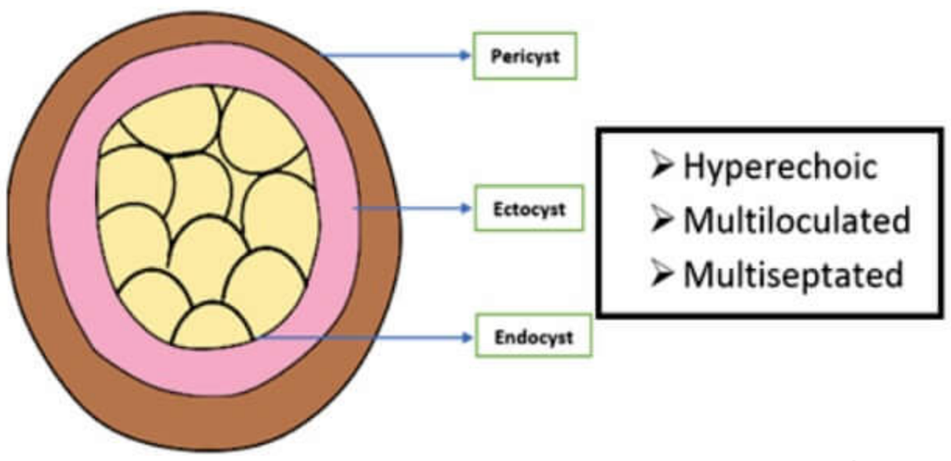
➢ Multiple, multi lobulate, Honeycombing in USG

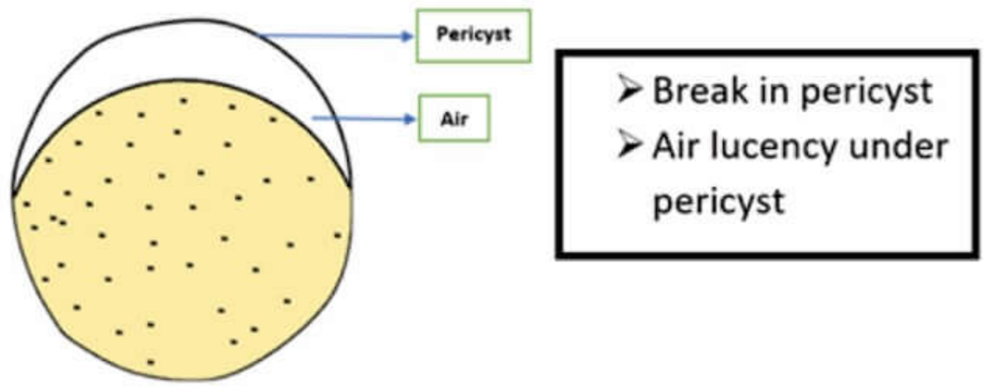


Hydatid cyst

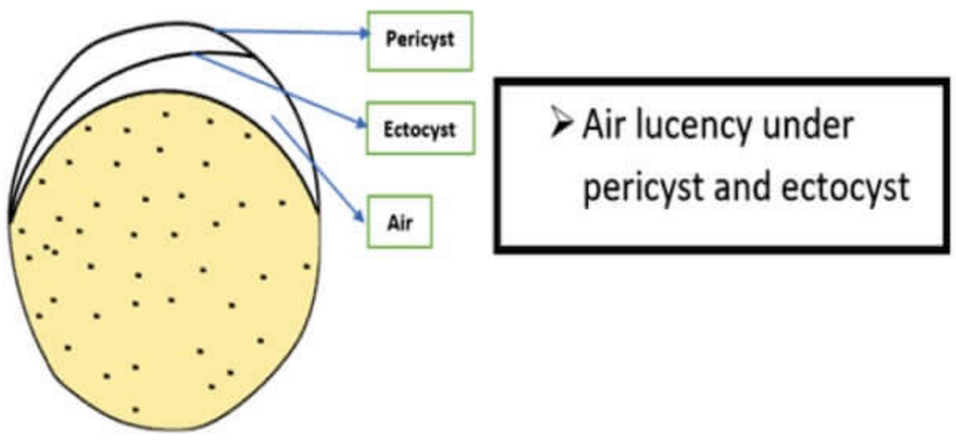
Chest X-ray findings of Hydatid cyst



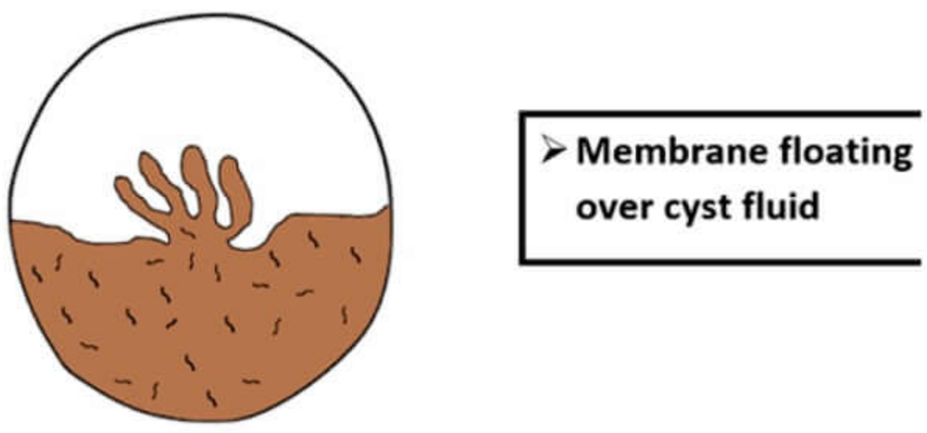




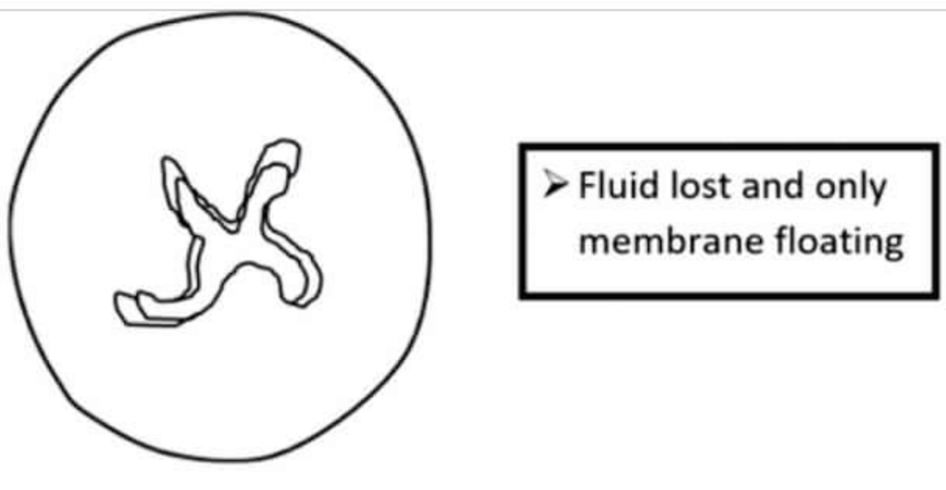
Meniscus sign



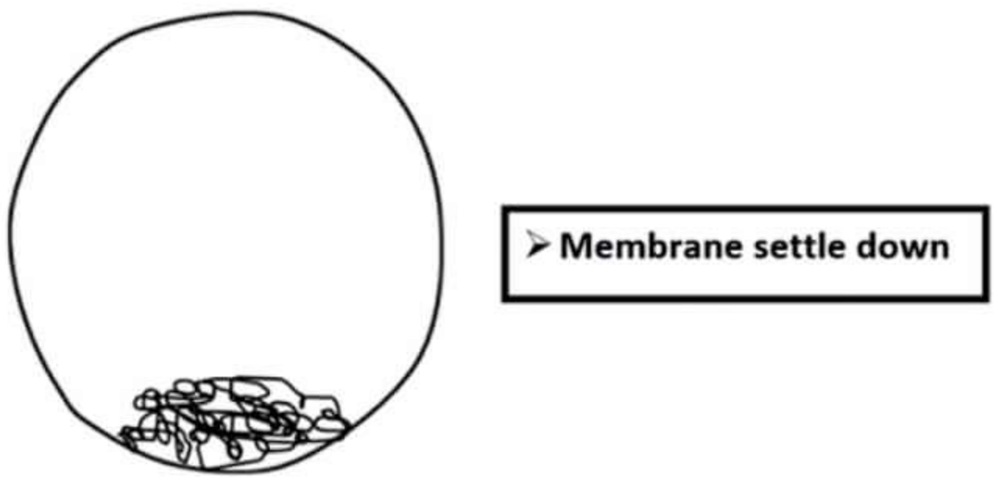
Cumbo sign



Water lily sign/ Camalote sign/ floating membrane sign

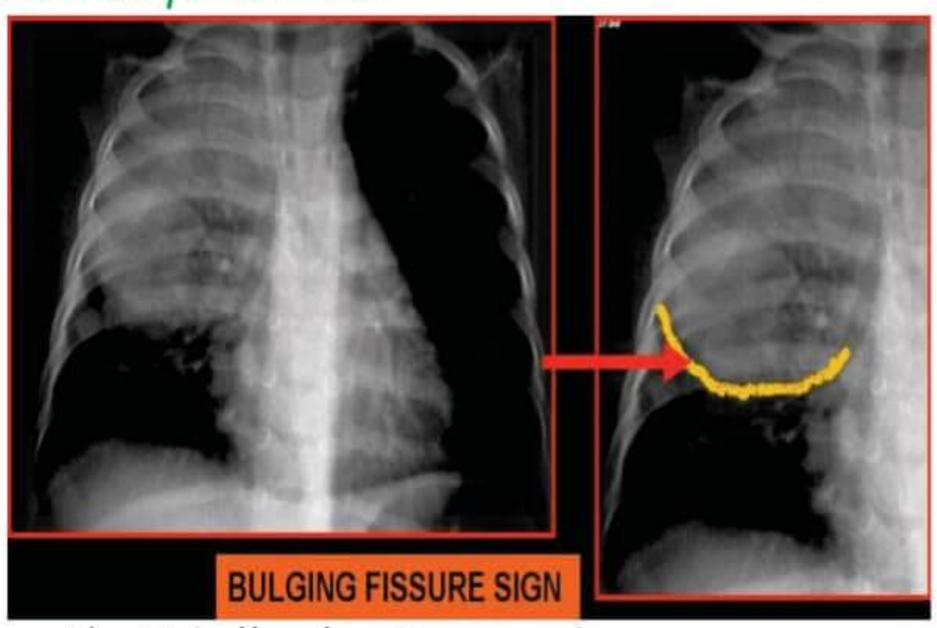


Serpentine sign



Sunrise/ Sunset sign

Klebsiella pneumonia



→ Aka Friedlander Pneumonia

→ Shows Bulging fissure sign

↓

Consolidation spreading rapidly, causing lobar expansion and bulging of the adjacent fissure inferiorly

Pulmonary alveolar Proteinosis

→ Shows Crazy pavement appearance on CT chest

Pulmonary Alveolar Microlithiasis – shows sandstorm appearance on Chest X – ray

CXR findings in Congestive heart failure

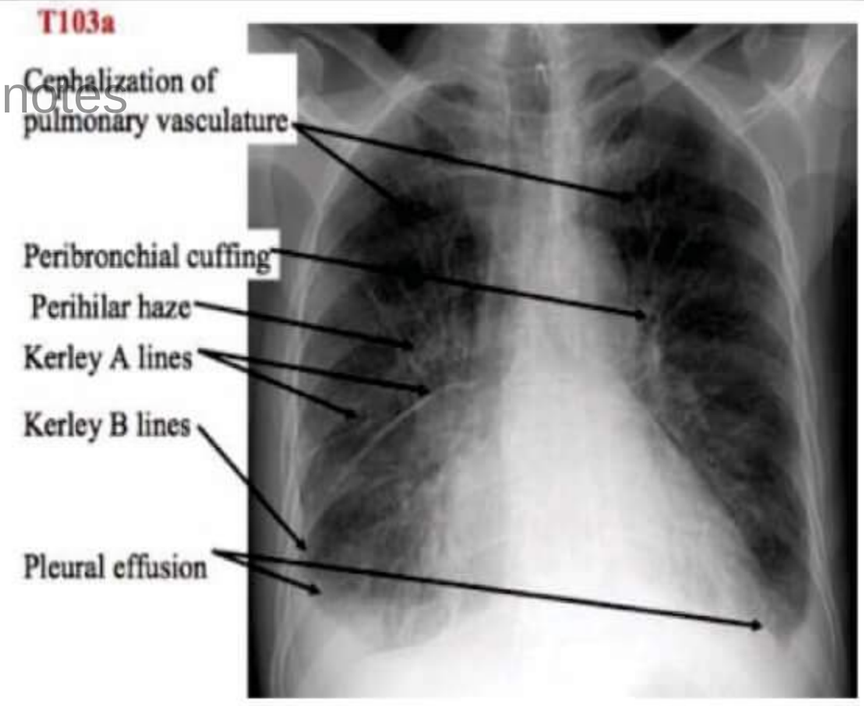
→ Equalization of upper lobe and lower lobe vessels

→ Prominence of UL vessels – known as

- Cephalization
- Stag antler sign
- Reverse moustache
- Hands up sign

→ **Kerley A** – perihilar septal engorgement

→ **Kerley B** – thin horizontal lines perpendicular to pleura at base of lungs



Congestive heart failure

Pulmonary thromboembolism

→ **Hampton hump sign** – Peripheral wedge-shaped area of infarction

→ **Westermark sign** – Pulmonary oligemia

→ **Pallas sign** – Prominence of descending right pulmonary artery

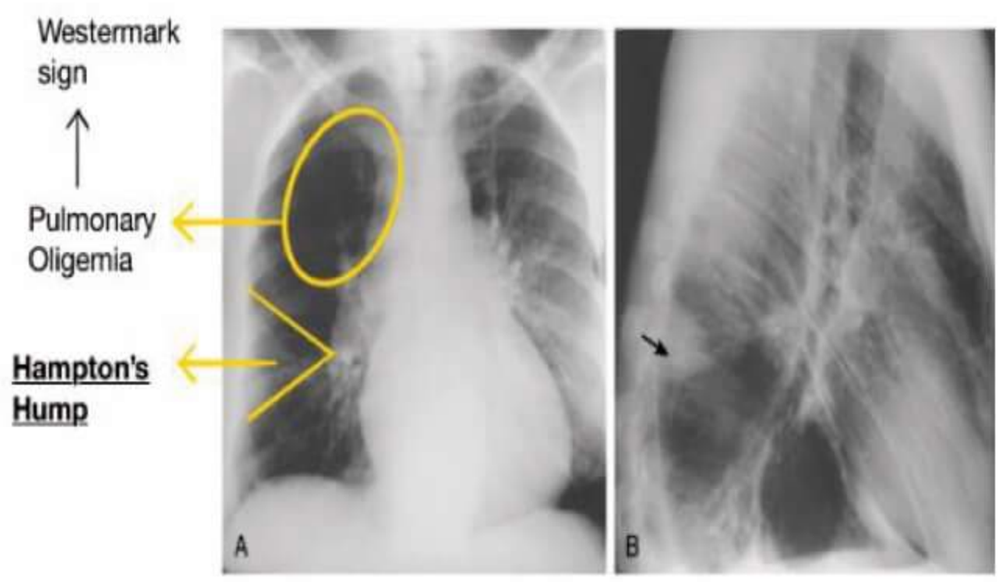
→ **Fleischner sign** – Prominence of main pulmonary artery

→ **Chang sign** – abrupt change in caliber of the descending right pulmonary artery

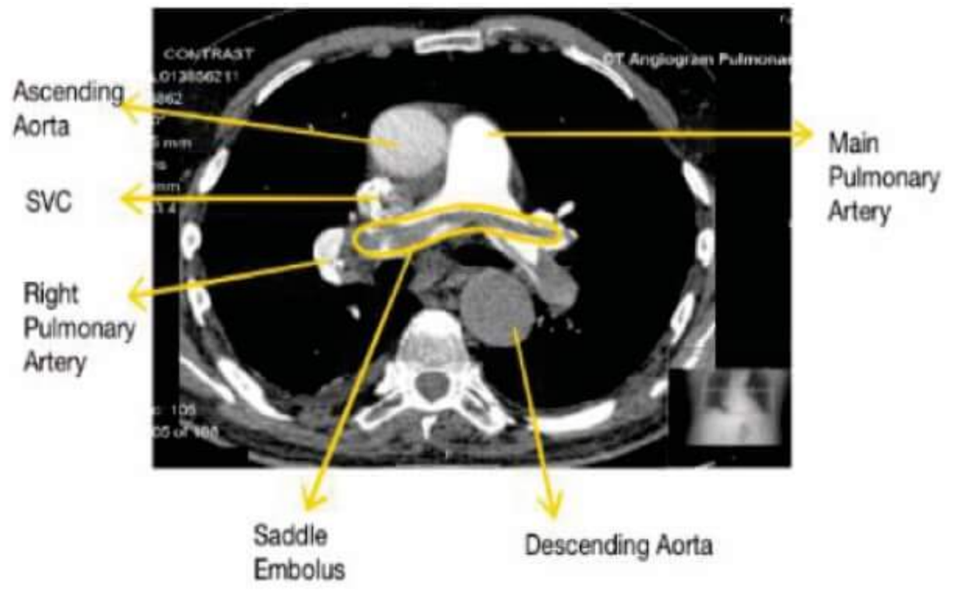
→ IOC for Pulmonary thromboembolism – CT Angio (MDCT with contrast)

→ In iodine allergies and pregnancy IOC for pulmonary thromboembolism – V/Q Scan

→ Gold standard for PTE – Pulmonary Angiography



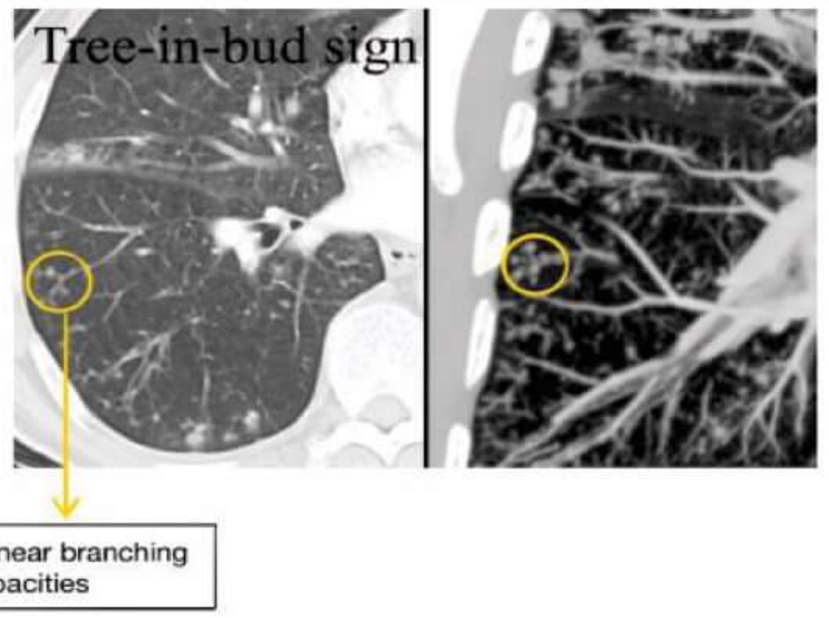
Pulmonary thromboembolism (X-ray)



Pulmonary thromboembolism (CECT)

Tree in bud sign

→ Feature of Endobronchial spread of active TB

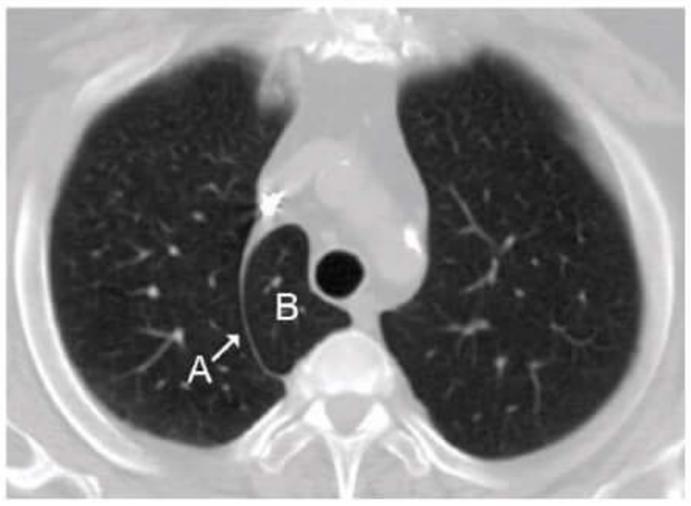


Interstitial Lung Disease

→ IOC for ILD - HRCT

Interstitial Lung Disease	
UIP (Usual interstitial pneumonia)	NSIP (Non – specific interstitial pneumonia)
→ Reticular opacities → Traction bronchiectasis → Subpleural honeycombing	→ Subpleural sparing
	

Azygous Fissure



A-azygous fissure

B-azygous lobe

Mediastinal evaluation

→ To evaluate Anterior and middle mediastinum – CT

→ To evaluate Posterior mediastinum – MRI

Anterior Mediastinal Mass	Middle Mediastinal Mass	Posterior Mediastinal Mass
• Thymoma (MC) • Teratoma • Terrible Lymphoma • Ectopic thyroid	• Vascular (Aneurysm of Arch of Aorta) • Bronchogenic Cysts	• Neurogenic Tumors (MC)

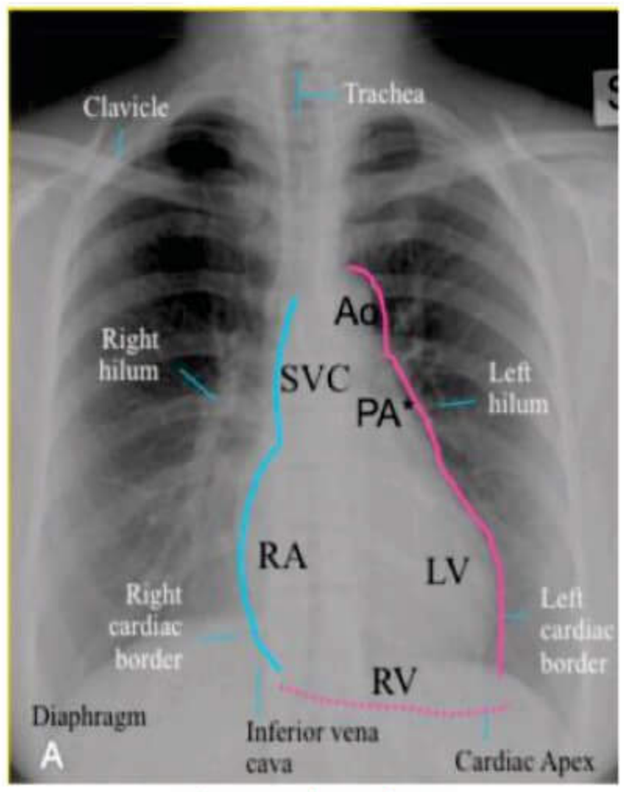
Important point to know

→ **Right Ventricle Hypertrophy** – Retrosternal space is obliterated.

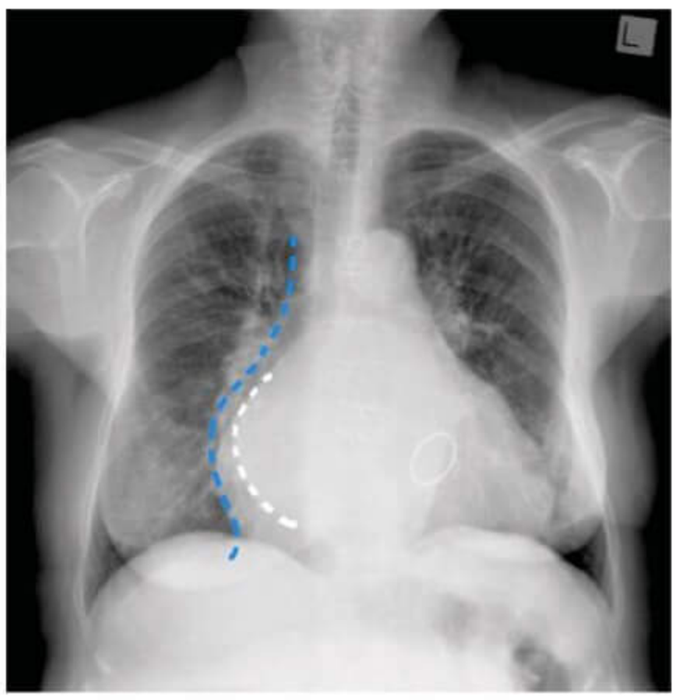
→ **Heart borders**

- Right heart border on chest X-ray – formed by SVC, Right atrium and IVC
- Right ventricles form the anterior surface of the heart, not the right heart border
- Left heart border – formed by aortic knuckle, aortic arch, main pulmonary artery, left auricle and left ventricle.

→ **Double right heart border** – seen left atrial enlargement



Heart borders

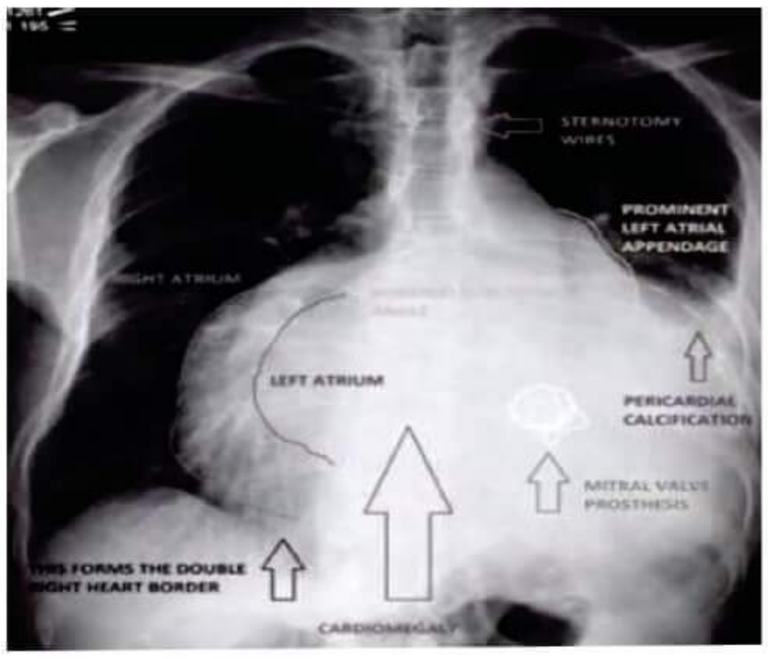


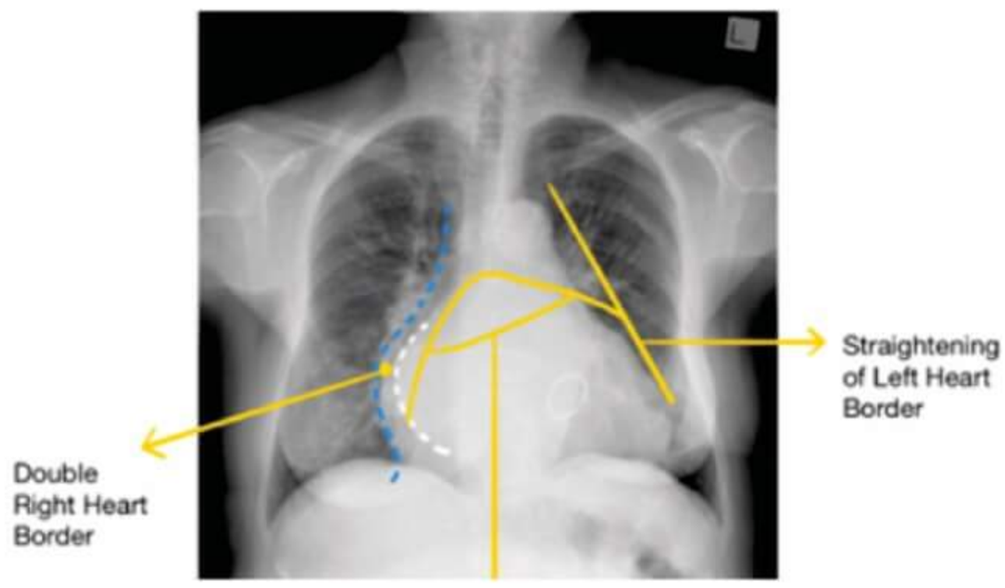
Double right heart border – LA Enlargement

Cardiomegaly

→ **Signs of mitral stenosis / Left atrial enlargement**
- Straightening of heart border
- Splaying of carina
- Double left heart border

→ **Dilated left atrial appendages**
- 3rd mogul in seen



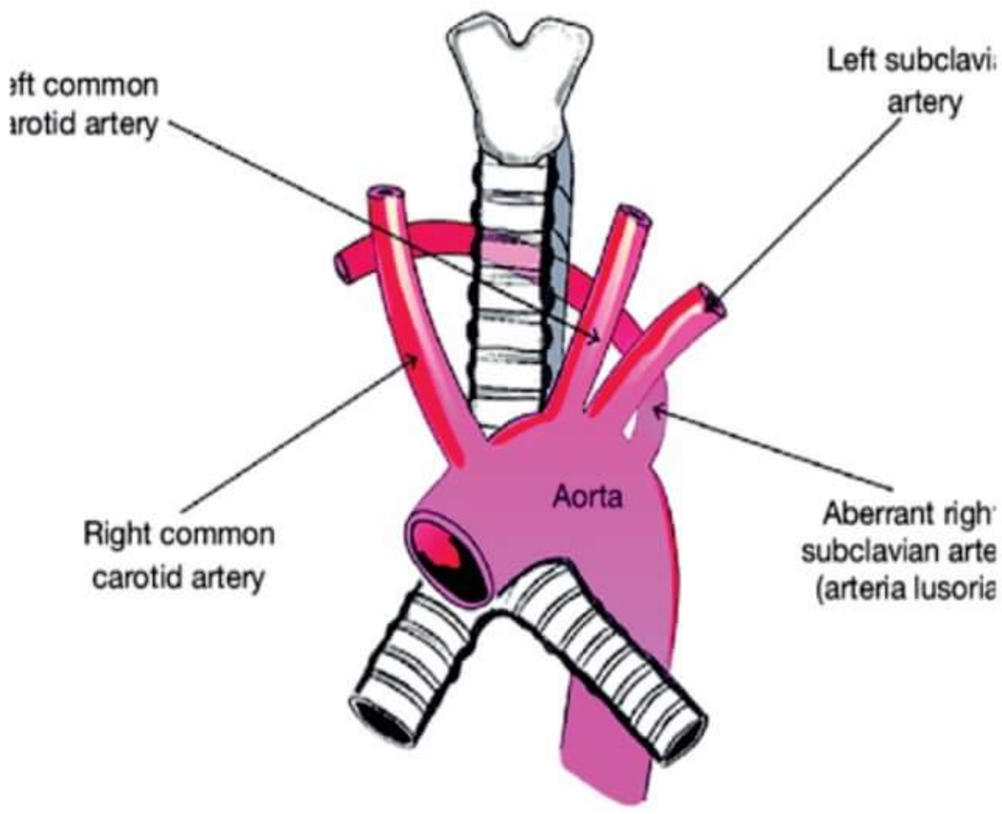


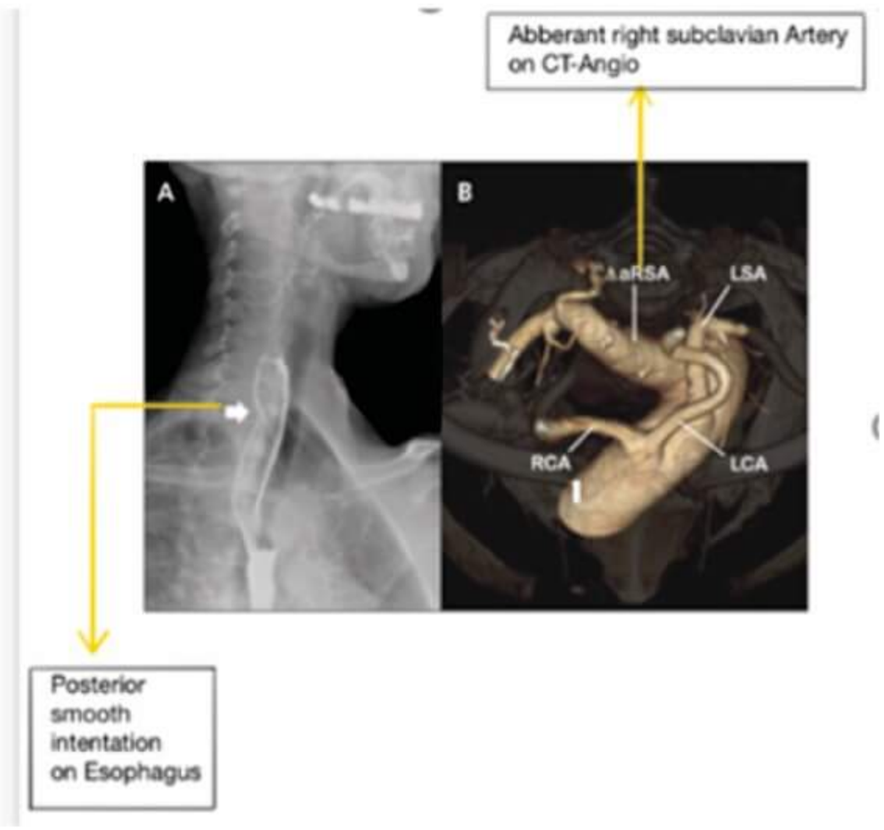
Cardiomegaly

Dysphagia Lusoria

→ Aberrant right subclavian artery

→ Leads to posterior smooth indentation of esophagus
- Dysphagia
- Dysphonia



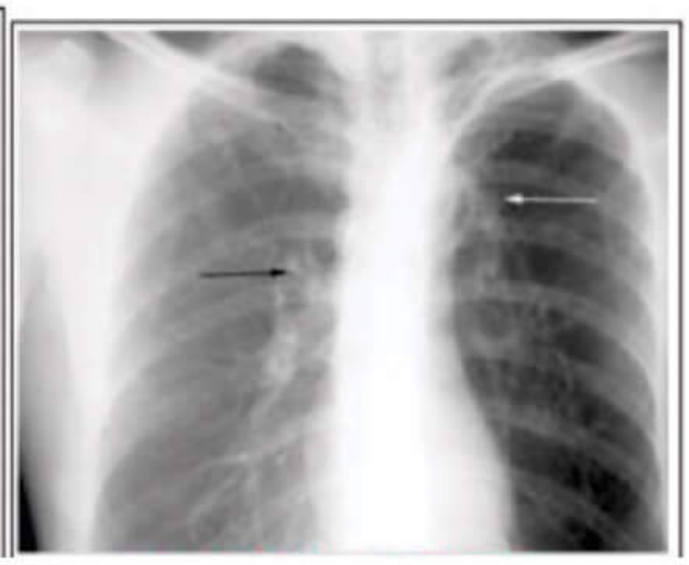


Lucent hemithorax

→ Can be cause by

- Pneumothorax
- Congenital lobar emphysema
- Airway obstruction
  - Foreign bodies
  - Obliterative bronchiolitis
- Poland syndrome
- Post mastectomy
- **Swyer – James Mcleod syndrome** - Post infective obliterative bronchiolitis

Left Pneumothorax



Lucent hemithorax

Poland syndrome

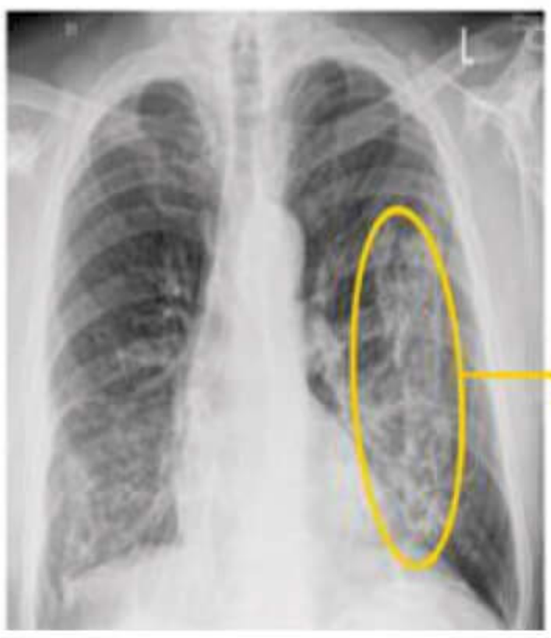
Lucent / opaque hemithorax in a child

→ Strongly suggest foreign body

Asbestosis

→ Dense pleural thickening and calcification

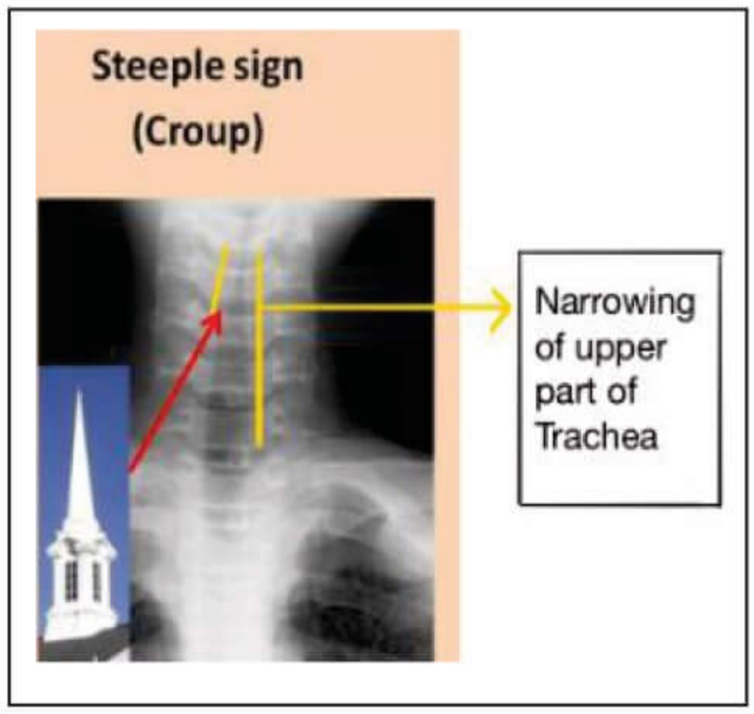
→ Malignant pleural mesothelioma



Holly Leaf Sign -Asbestosis

Croup

→ Narrowing of lucency of the trachea in the upper part, especially when you have an upper airway infection.



Acute epiglottitis

→ Characterised by **Edematous epiglottis**

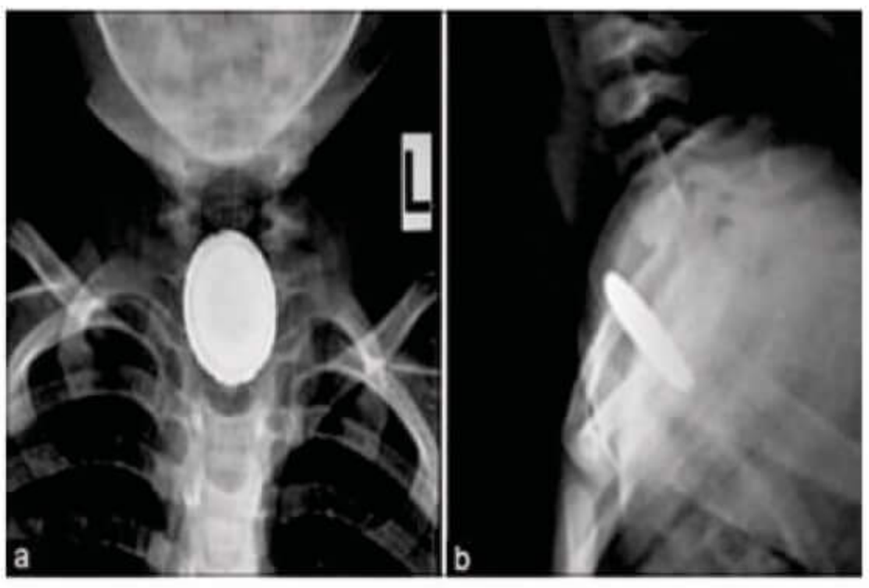
→ This gives a **Thumb like appearance** on X-ray

Thumb sign

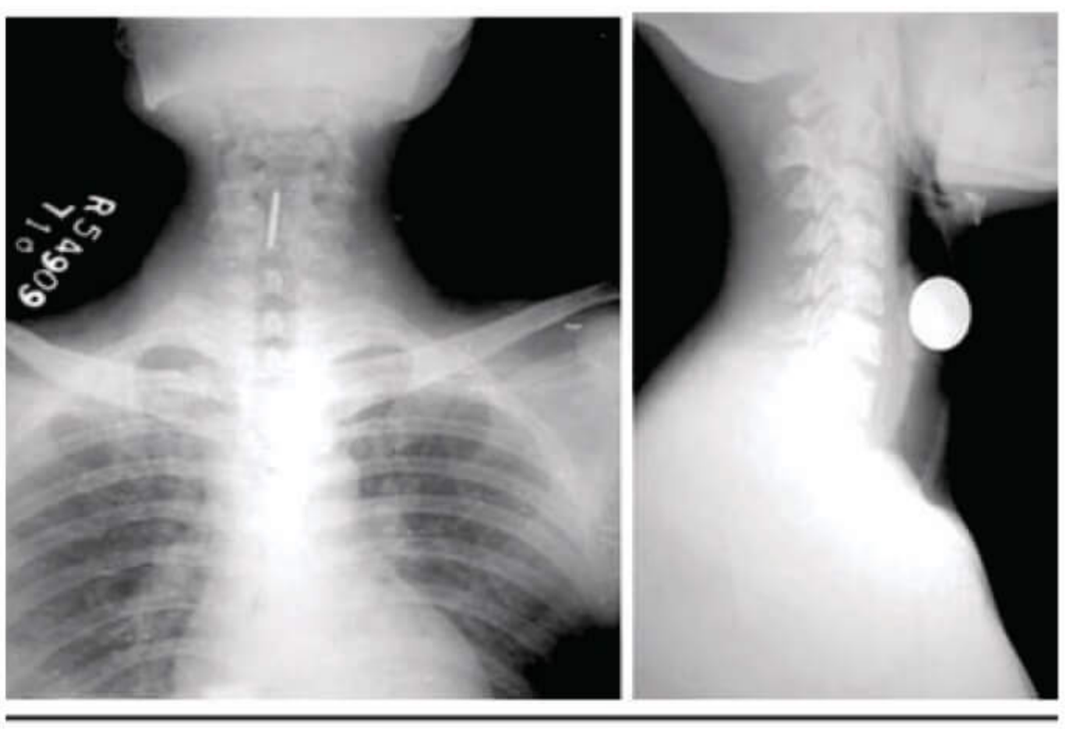
Location of foreign body

→ **Coin in Larynx** – Appears in sagittal plane

→ **Coin in Esophagus** - Appears in coronal plane



A Round, radio-opaque body seen at the level of C7-T1 in the prevertebral region behind the airway = (Coin in esophagus)

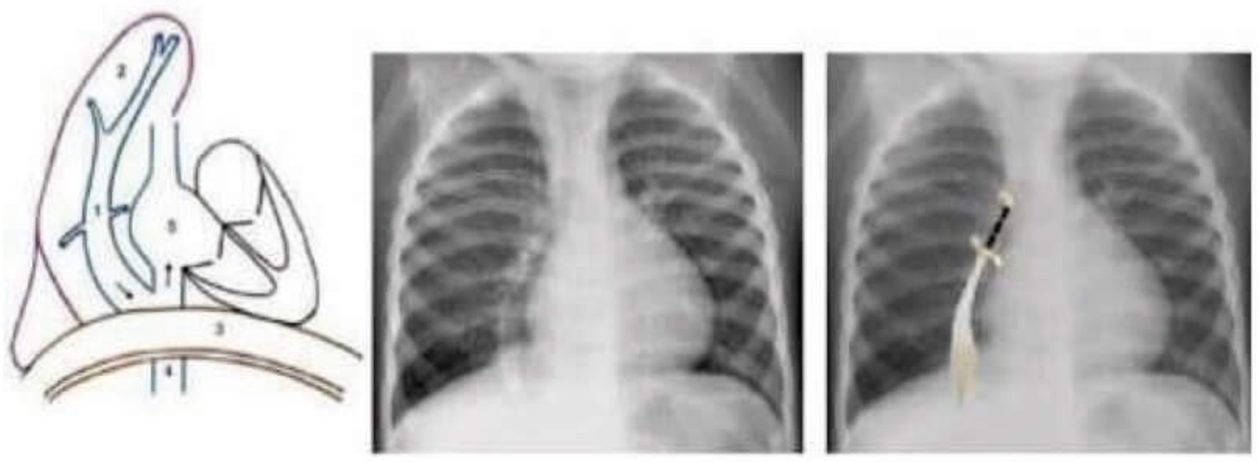


Coin in in larynx

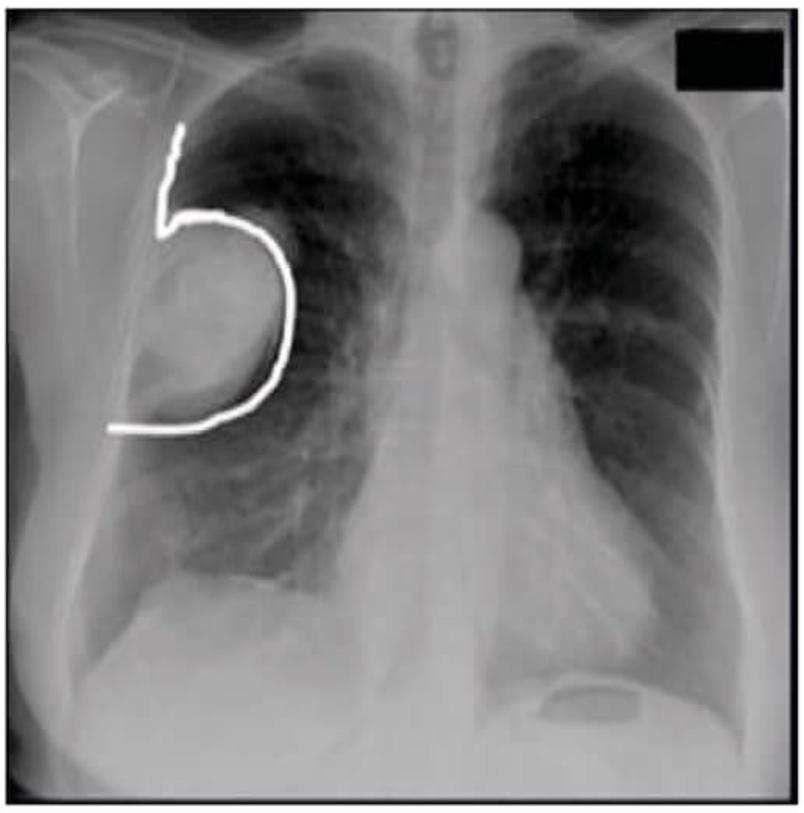
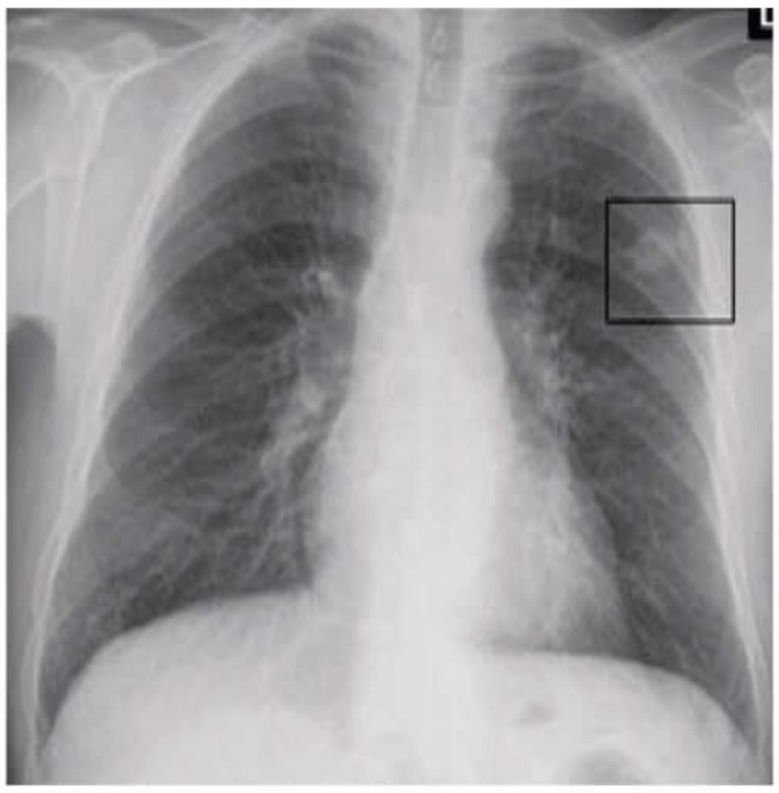
PAVPC (Partial Anomalous Pulmonary Venous Return)

→ **Aka Scimitar syndrome**

→ Pulmonary vein on the right side going below the diaphragma opening into the inferior vena cava/systemic veins.



Scimitar syndrome

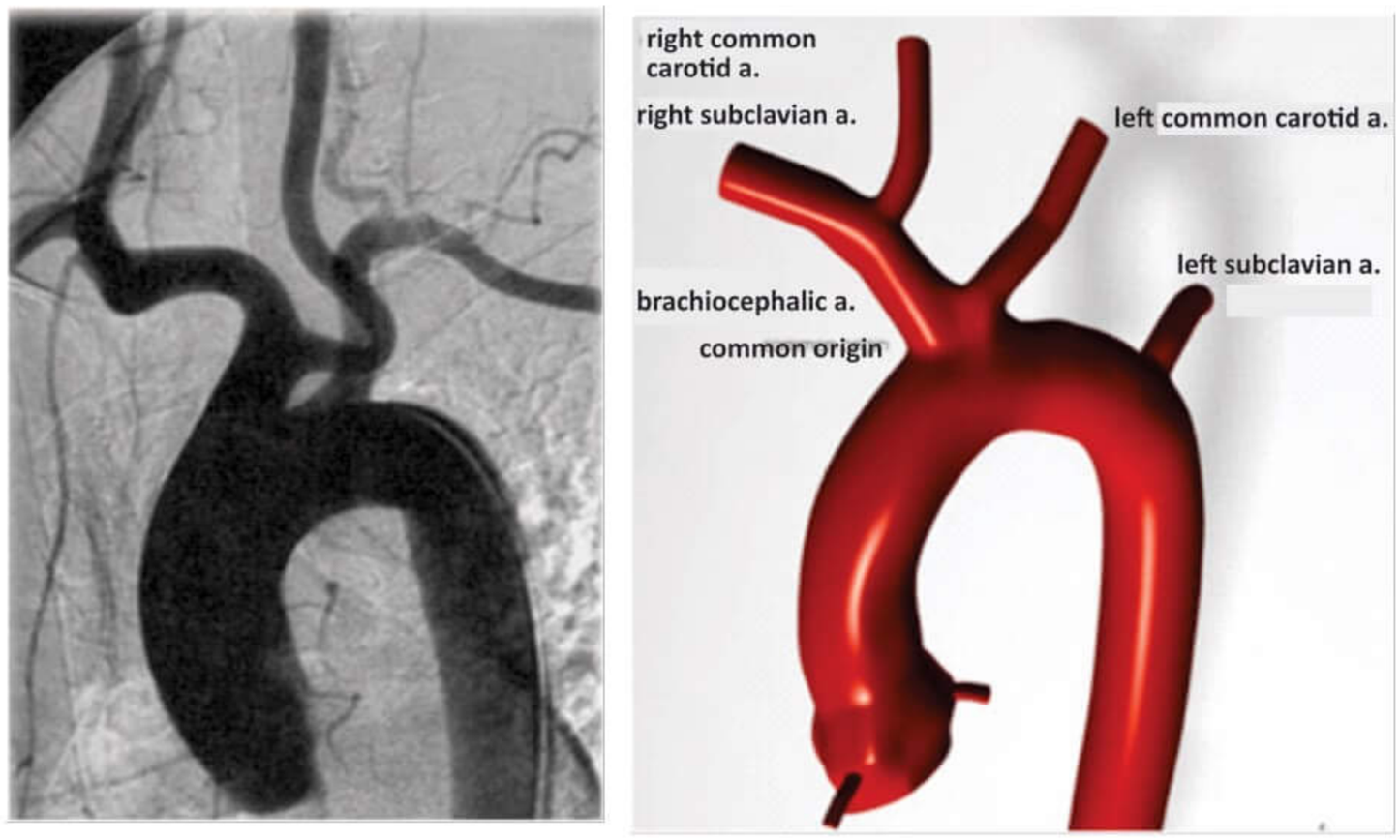
Pleural Based Lesion	Intra-parenchymal lung-based lesion
→ Well defined border in lung but incomplete border on chest wall	→ All borders are clearly seen
→ Obtuse angle formed with lung parenchyma	→ Acute angle formed with lung parenchyma
	

ANGIOGRAPHY

Bovine arch

→ M/C congenital anomaly associated with arch of aorta

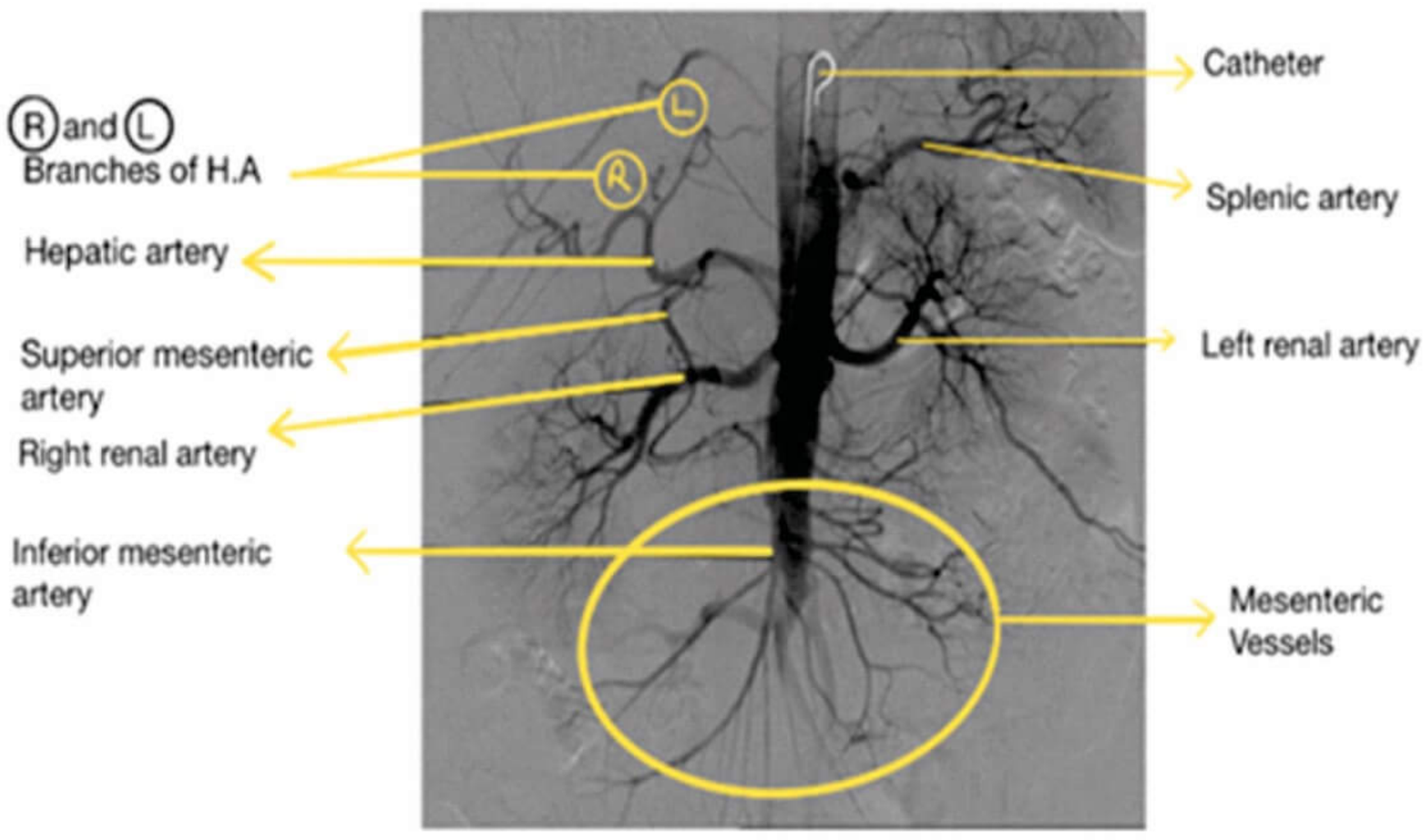
→ Right brachiocephalic & Left common carotid artery takes common origin



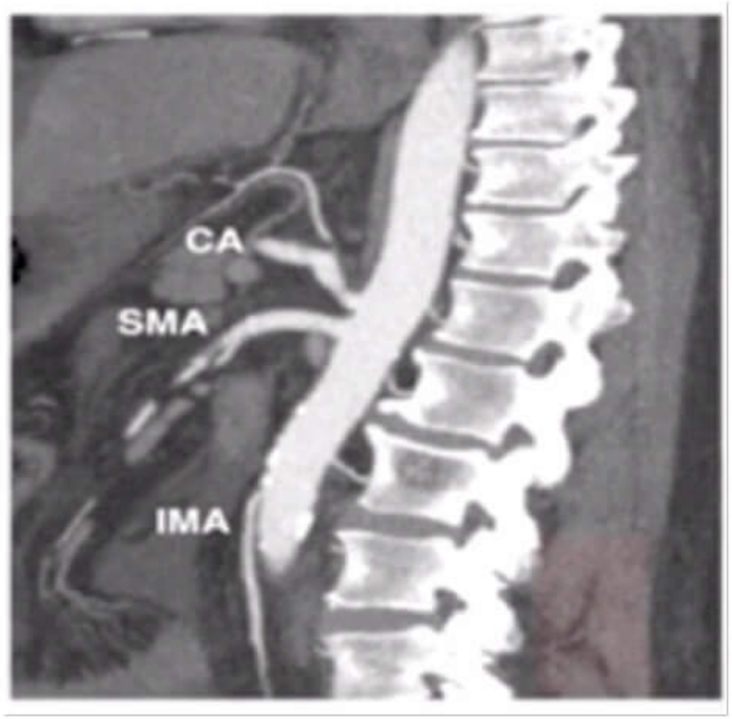
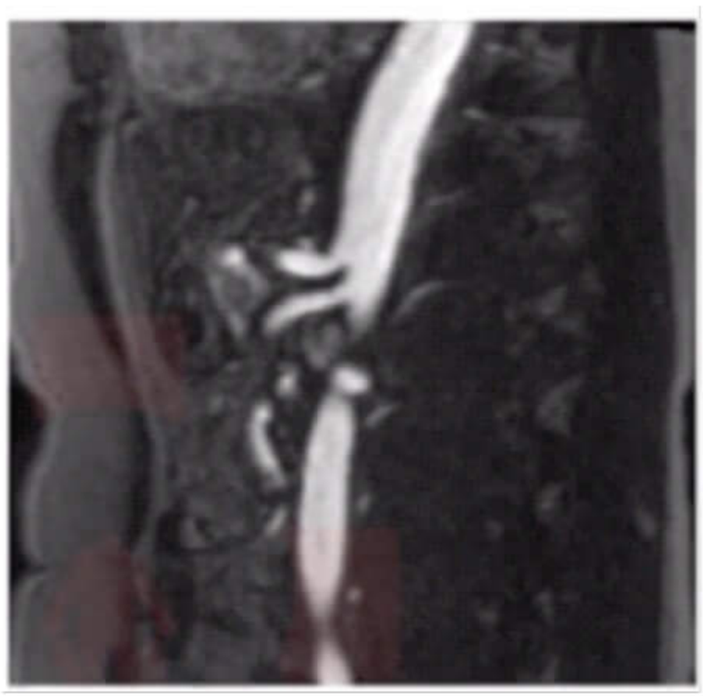
Bovine arch on Angiography

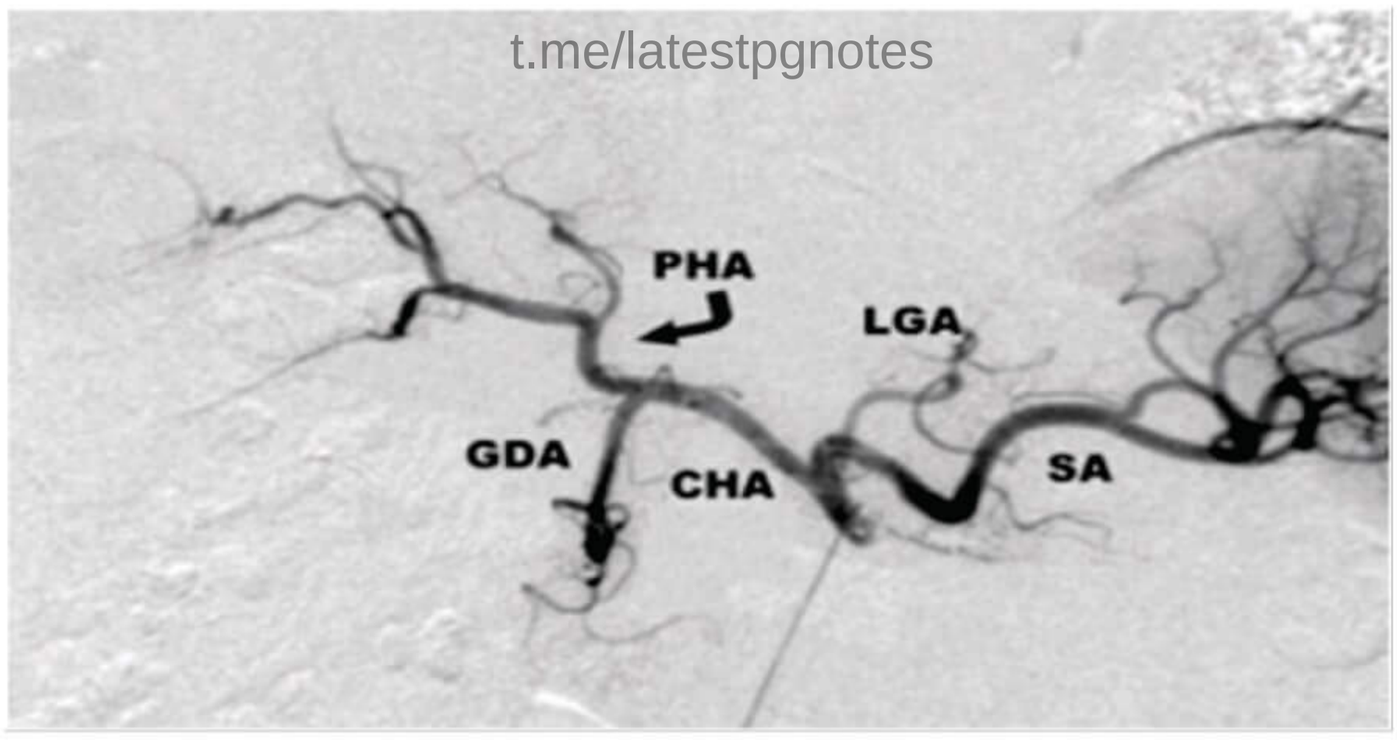
Digital subtraction angiography

→ An X-ray procedure where pre-contrast & post contrast images are digitally subtracted – giving contrast opacified vessels



Digital Subtraction Angiography- Abdominal Aorta

CT angiography	MR-angiography
– Bones are white & vessels are Visible	– Bones are black & vessels are white – Gadolinium is used as contrast – "Time of flight" software – used for MR angiography without contrast
	



Celiac artery in angiogram

LGA – Left Gastric artery; CHA – Common Hepatic artery
GDA – Gastroduodenal artery; SA – Splenic artery; PHA – Proper hepatic artery

Superior mesenteric artery:

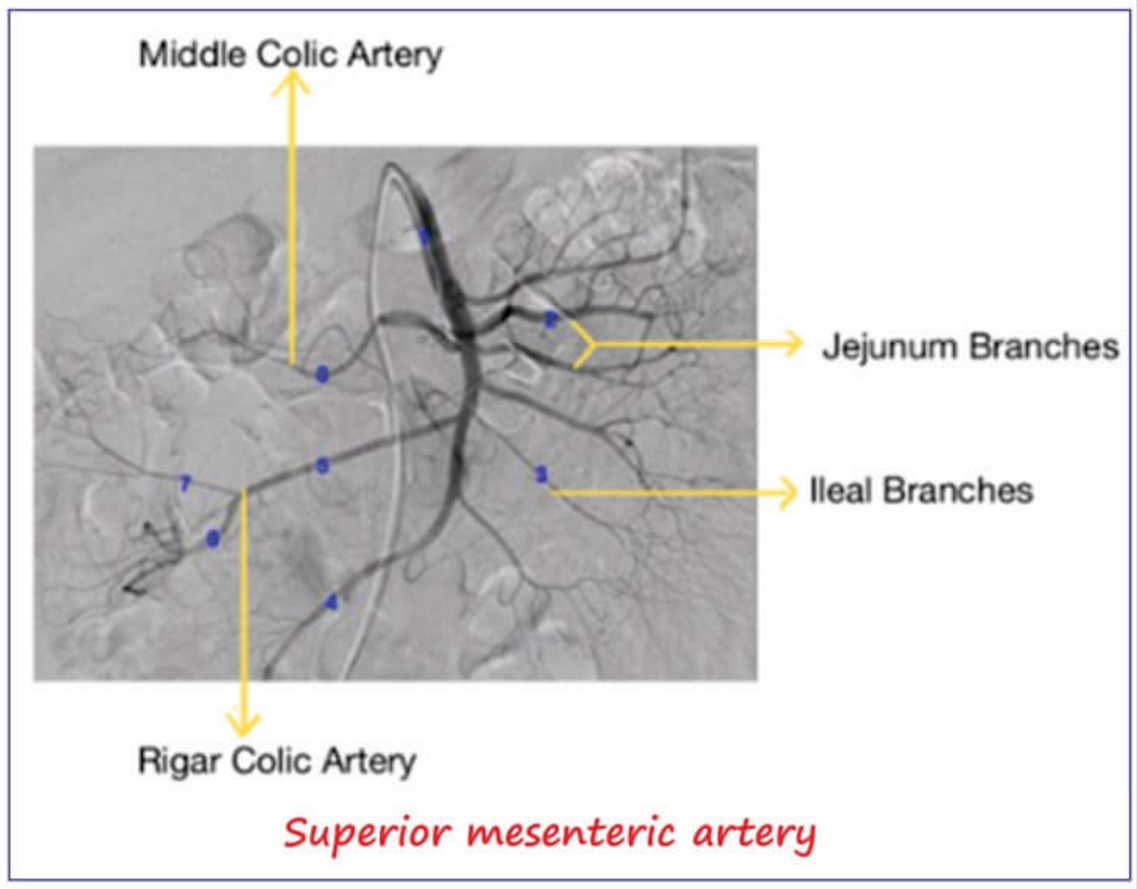
→ Chief artery of Midnight

→ Superior mesenteric vein is always to right of SMA – if there is change in this position, it indicates **midget volvulus**

→ Divides into right & left branches:

✓ Right side branches:
- Middle colic A.
- Right colic A.

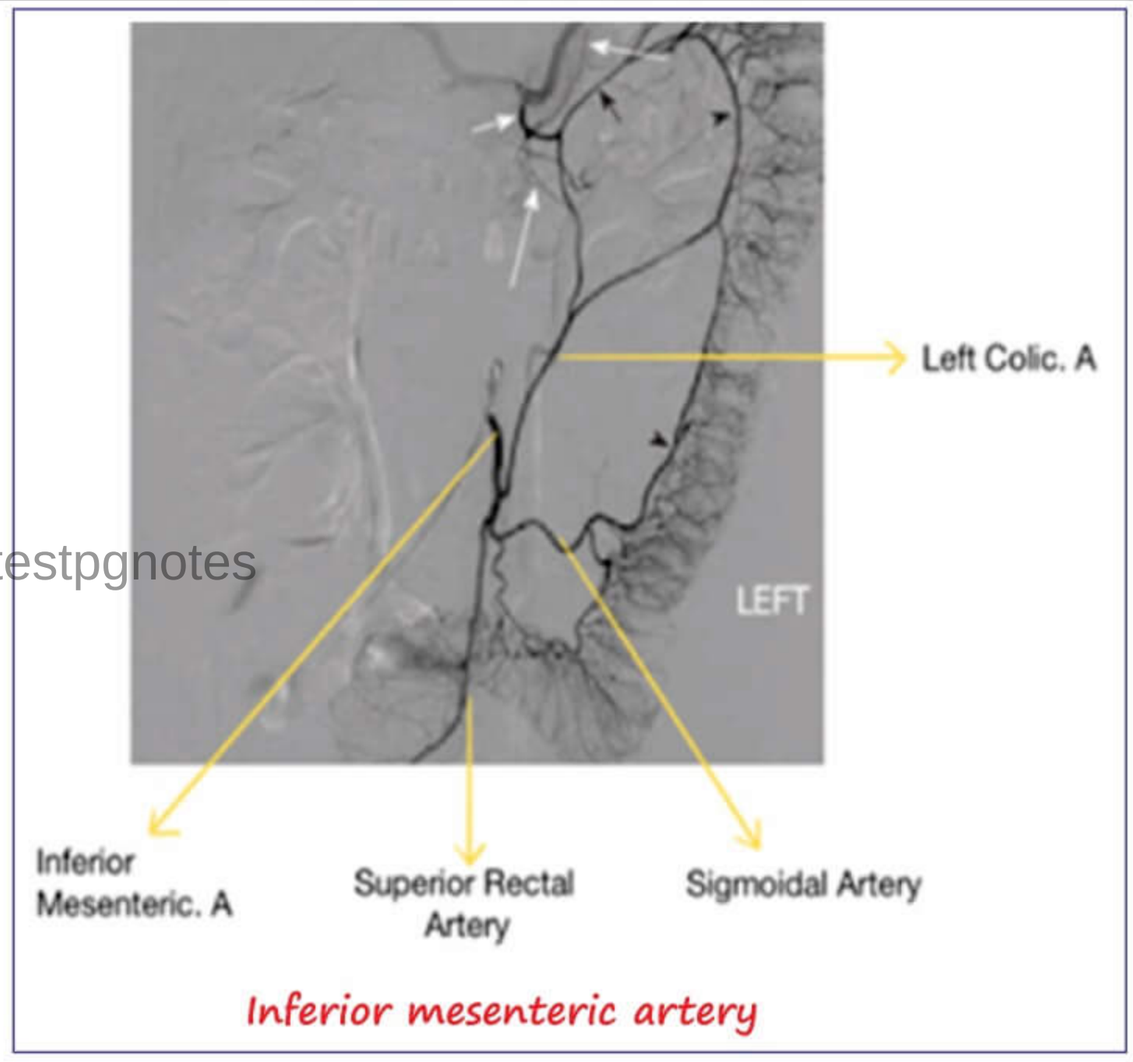
✓ Left side branches:
- Jejunal A.
- Ileal A.



Superior mesenteric artery

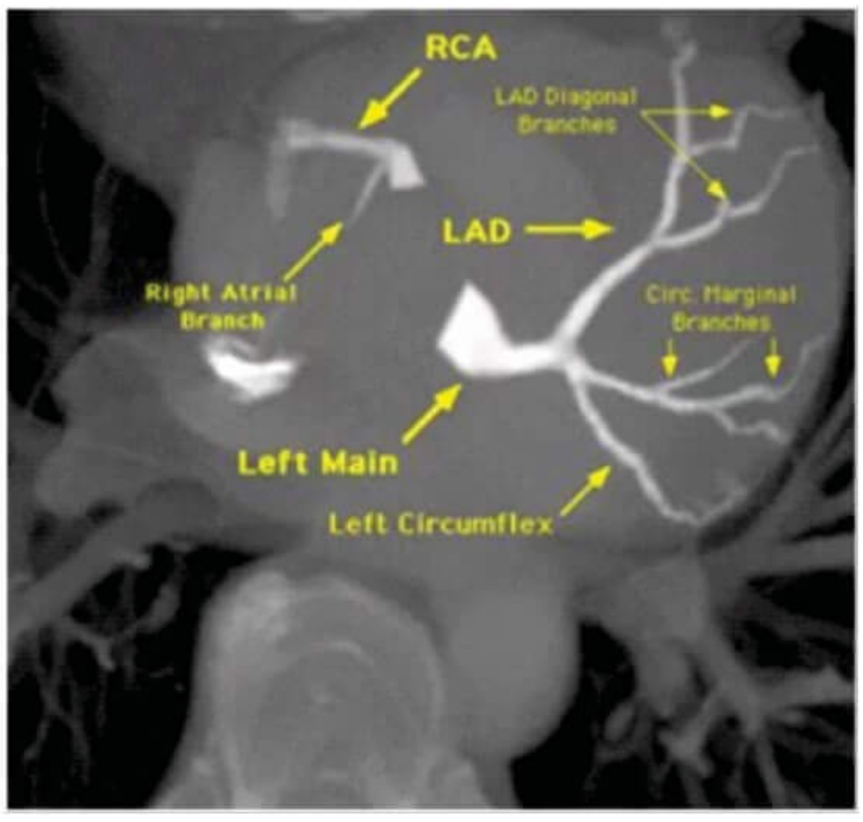
Inferior mesenteric artery:

→ Has left sided branches
- Left colic A.
- Sigmoidal A.
- Superior rectal A.

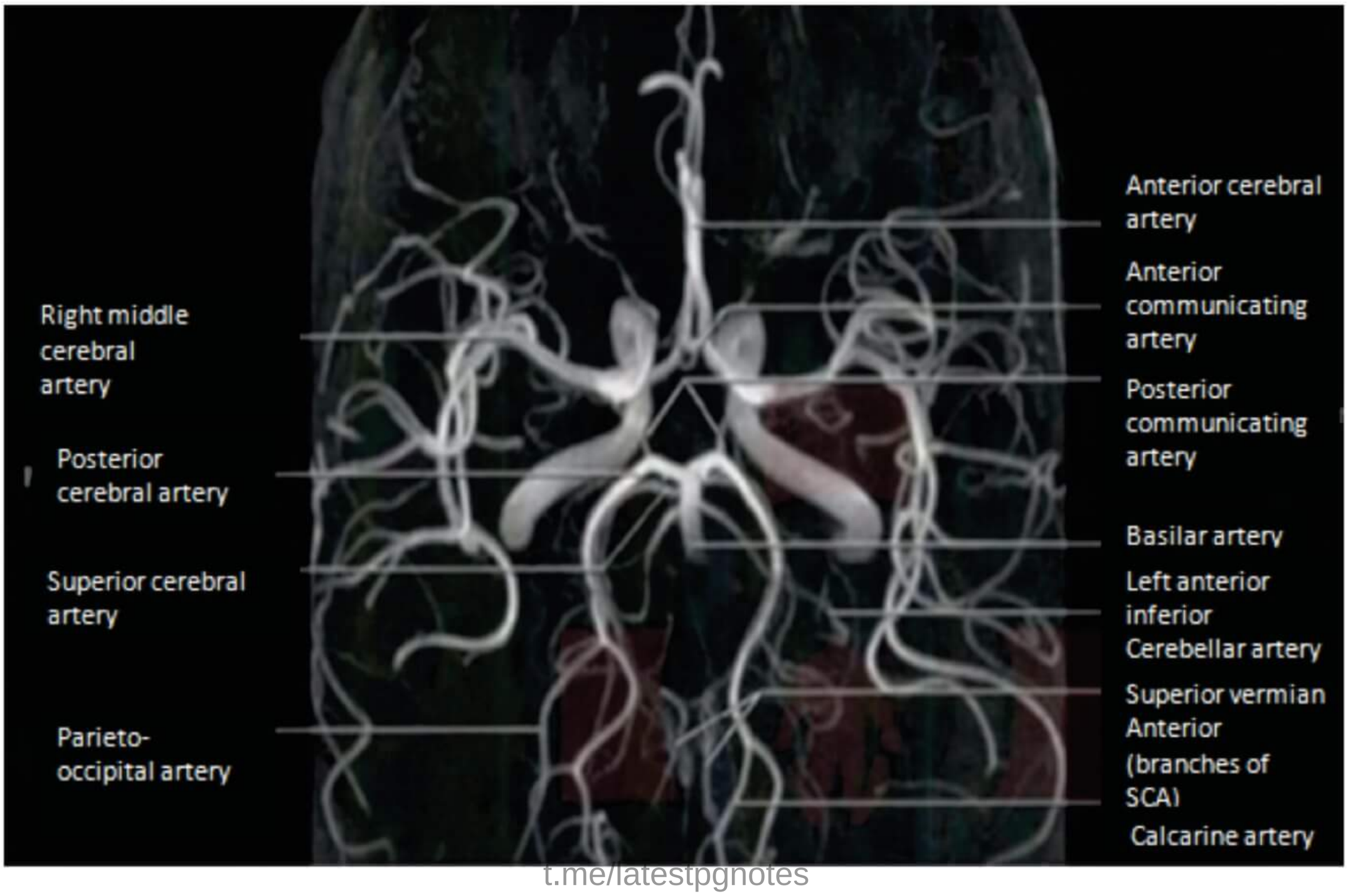


Inferior mesenteric artery

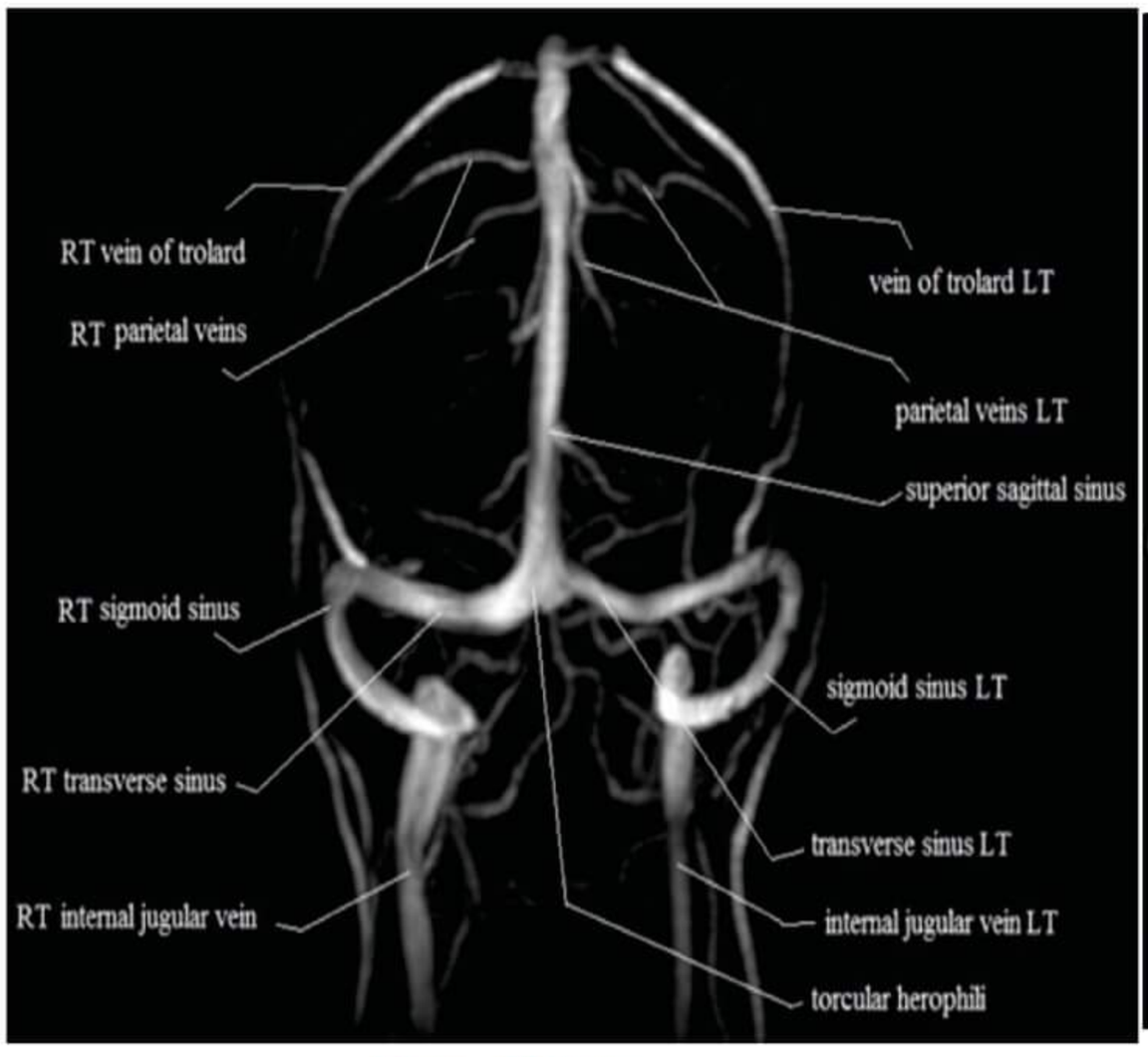
CT scan image showing coronary vessels:



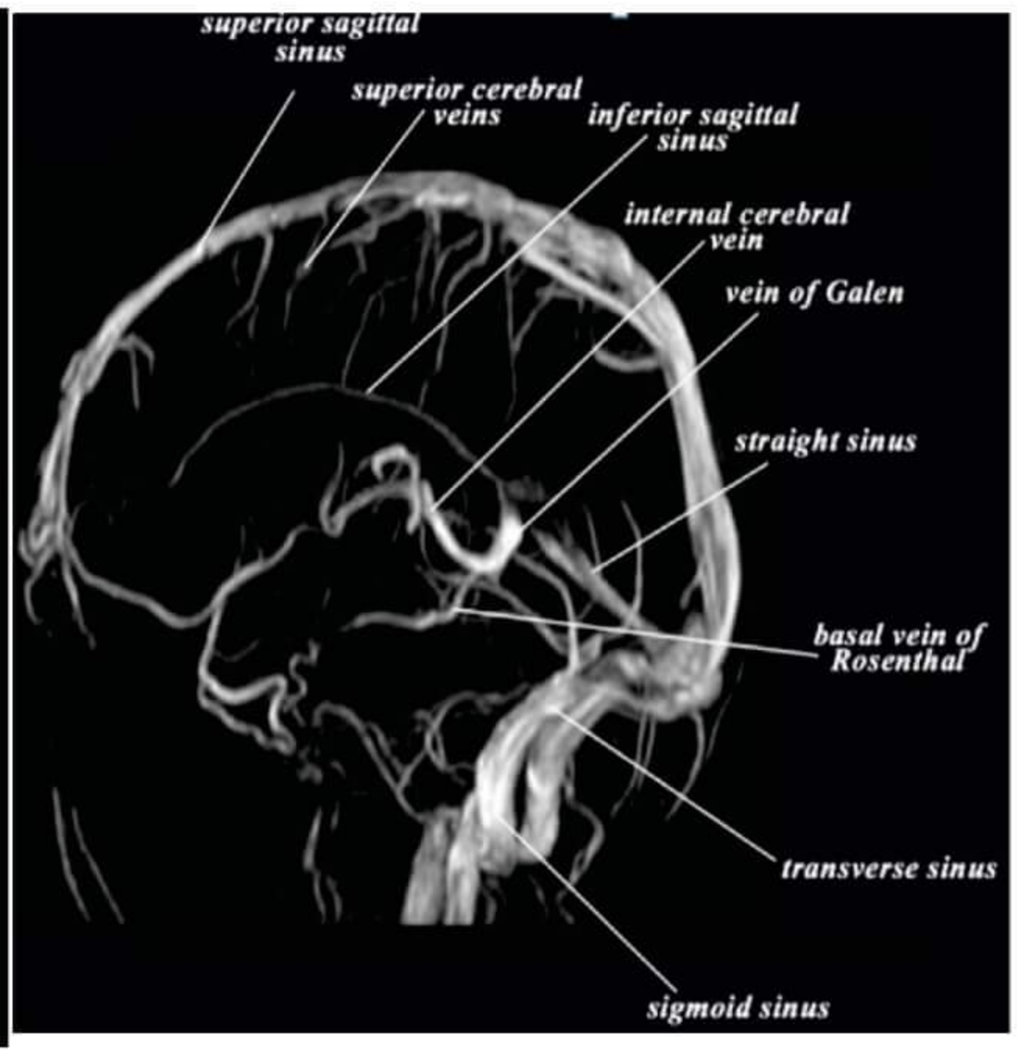
MR angiography showing circle of Willis:



MR venography showing Dural venous sinuses:



Coronal view

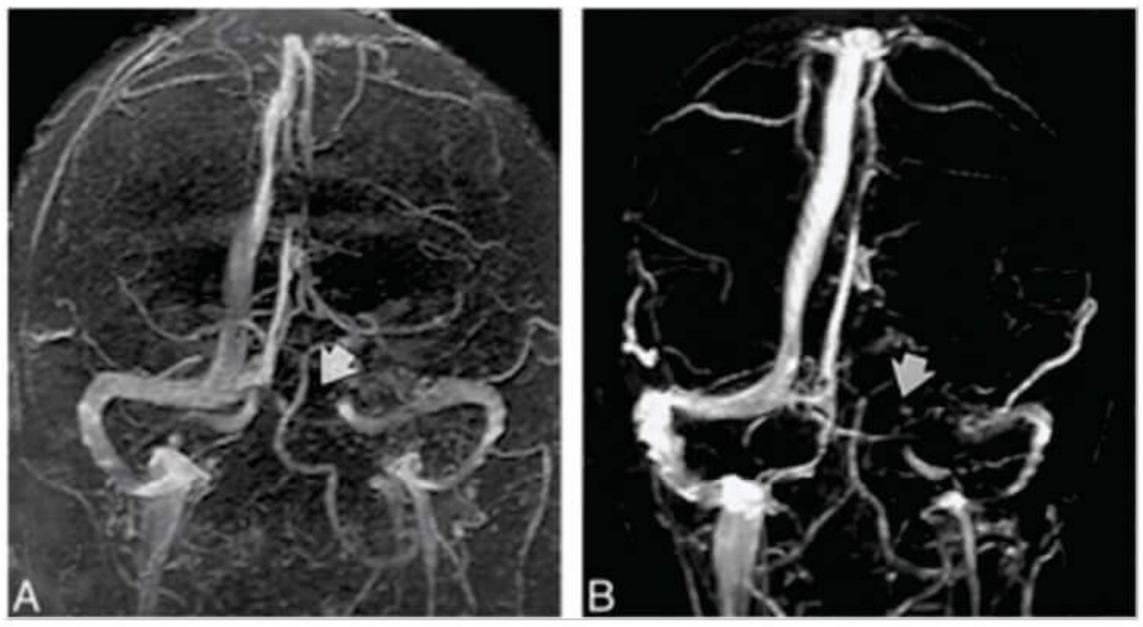


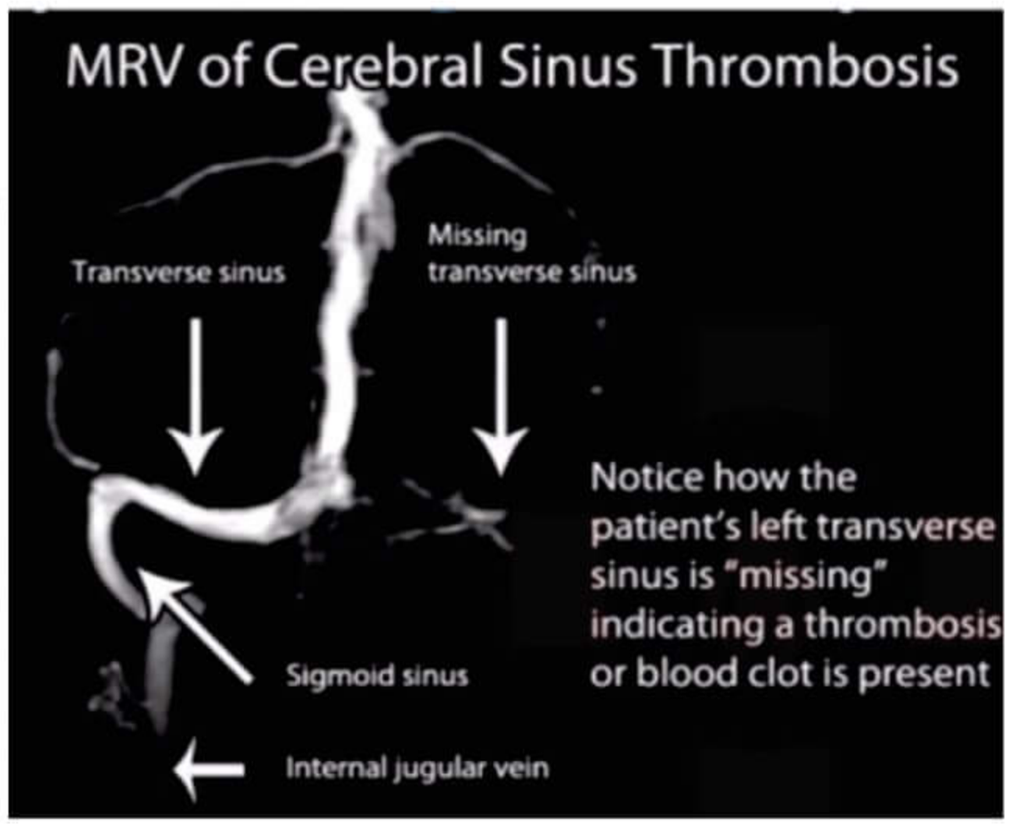
Sagittal view

Transverse / lateral sinus thrombosis

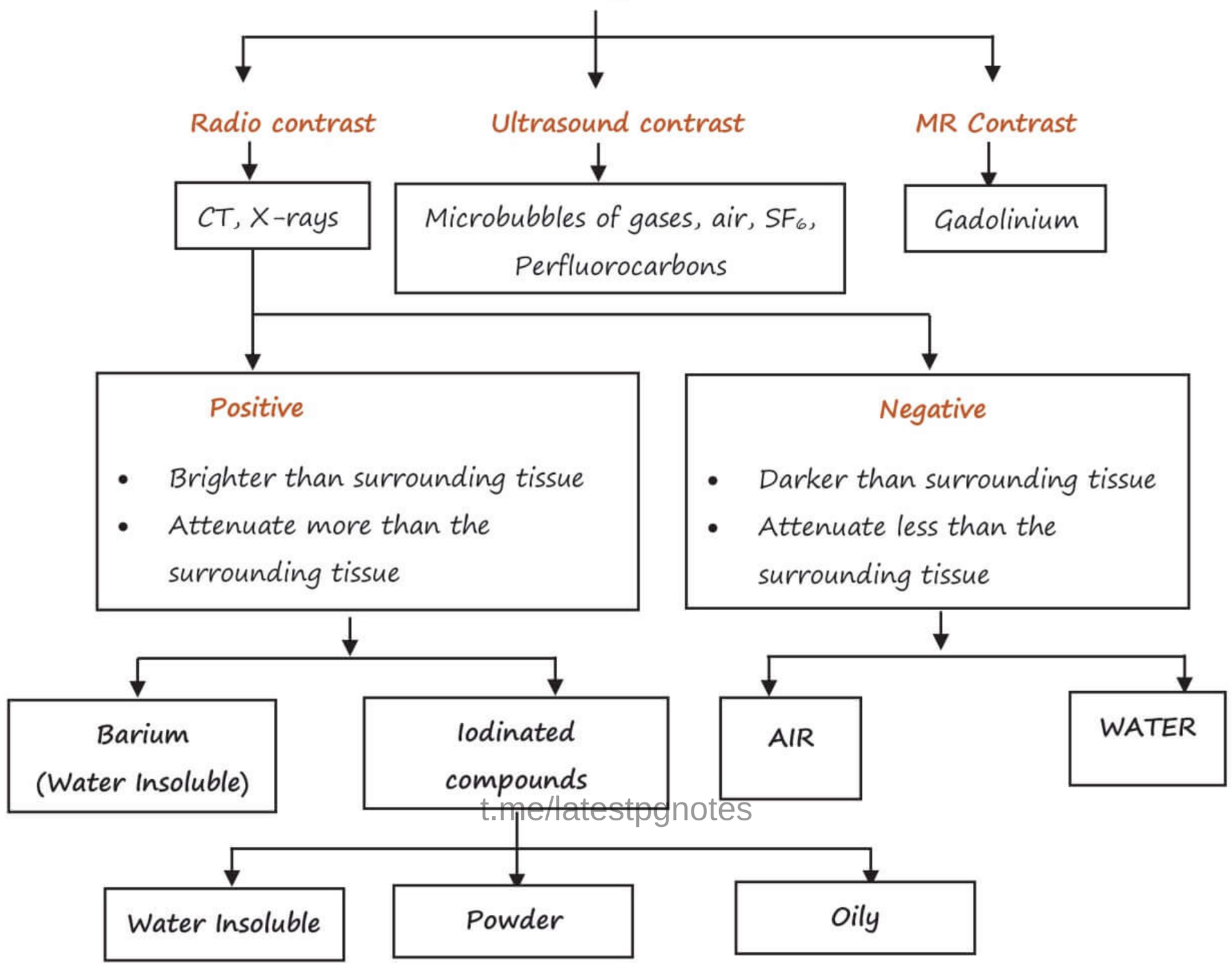
→ Shows filling defect in Dural venous sinuses in MR venography or contrast study – known as **Greisinger sign**

→ Seen in CSOM (chronic suppurative osteomyelitis)





CONTRAST AGENTS



$BaSO_4$

→ High Atomic number-56
→ Inert, doesn't interfare in digestion
→ Not absorbed, Non toxic
→ Coat Mucosa Uniformly
→ Water insoluble, used as suspension
→ C/I in Bowel perforation – Peritonitis, Mediastinitis

Barium Studies

• Barium Swallow	– Barium paste for esophagus
• Barium Meal	– Stomach and duodenum
• Barium Meal Follow through	– Small bowel, jejunum & ileum
• Barium enema	– Large Bowel

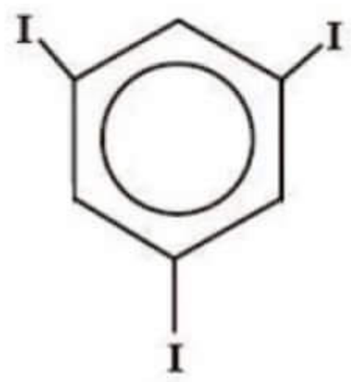
Iodinated Compounds

- **Iodine** - Radiopaque, atomic no. 53

Water soluble	Water Insoluble Suspension	Oily
• Tri-iodinated compounds	• Di-iodopyridines	• Myodil • Lipiodol • Iophendylate

Water Soluble Iodinated compounds

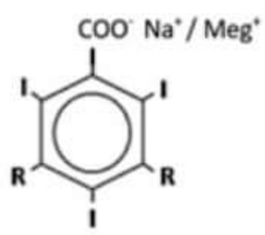
- Tri-iodinated Compounds



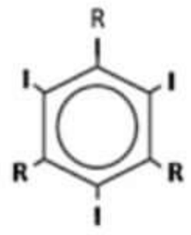
- Iodine particle ratio
  - **Iodine** - Radio opaque, used as Contrast
  - **Particle** - Increases osmolality & increases nephrotoxic
  - I/P = So Ideal contrast should have high I/P ratio

- Iodinated Contrast Agents:-

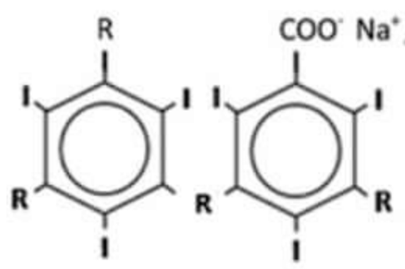
	Iodine: Particle	Osmolarity	Examples
Ionic Monomers	3:2	High Osmolar (1400-1600 mosm)	• Diatrizoate (Gastrograffin, Urograffins) • Metrizoate • Iothalamate
Ionic Dimers	6:2 3:1	Low osmolar (600 – 800 mosm)	• Ioxaglate
Non-Ionic Monomers	3:1	Low osmolar (600 – 800 mosm)	• Iohexol (Omnipaque) • Iopamidole • Ioversol
Non-Ionic Dimers	6:1	Iso Osmolar (290-300 mosm)	• Iodixanol (Visipaque) • Iotrolan



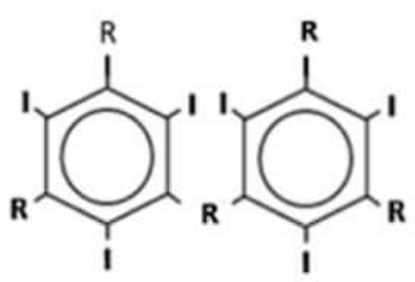
Ionic Monomer
3 Iodine atoms : 2 Particles, Ratio: 1.5



Non-ionic Monomer
3 Iodine atoms : 1 Particles, Ratio: 3.0



Ionic Dimer
6 Iodine atoms : 2 Particles, Ratio: 3.0



Non-Ionic dimer
6 Iodine atoms : 1 Particles, Ratio: 6.0

Water soluble iodinated compounds				
Biliary Excretion	**Renal Excretion**			
• Iopanoic acid (Telepaque) • Calcium ipodate	**High Osmolar**	**Low Osmolar**	**Low Osmolar**	**Iso osmolar**
	• Ionic Monomers	• Ionic Dimers	• Non-ionic Monomers	• Non-Ionic Dimers
	• I/P ratio-3:2 • 1400-1600 mosm	• I/P ratio - 3:1 • 600-800 mosm	• I/P ratio - 3:1 • 600-800 mosm	• I/P ratio - 6:1 • 290-300 mosm
	• Diatrizoate (Gastrograffin, Urograffins) • Metrizoate • Iothalamate (Conray)	• Ioxaglate	• Iohexol (Omnipaque) • Iopamidole • Ioversol	• Iodixanol (Visipaque) • Iotrolan (Isovisit)

CIN (Contrast induced Nephropathy)

- **Definition** - Impairment of renal function within 48-72 hour of intravenous contrast administration. Measured as either
  - 25% increase in serum creatinine from baseline (or)
  - 0.5 mg/dl ↑ in absolute serum creatinine value

- **Markers of CIN**
  - Serum cystatin C Levels
  - Neutrophil Gelatinase associated Lipocalcin (NAGL)
  - eGFR < 60ml/min

Risk Factor for Contrast Medium

– Induced Nephropathy	
Patient-Related	→ eGFR <60 mL/min/1.73m² before intra-arterial administration → eGFR <45 ml/min/1.73m² before intravenous administration → In particular in combination with: • Diabetic nephropathy • Dehydration • Congestive heart failure (NYHA grade 3-4) and low LVEF • Recent myocardial Infraction [<24h] • Intra-aortic balloon pump • Peri-procedural hypotension • Low hematocrit level • Age Over 70 • Concurrent administration of nephrotoxic drugs → Known or suspected acute renal failure
Procedure related	→ Intra–arterial administration of contrast medium → High-Osmolality agents → Large doses of contrast medium → Multiple contrast medium administration within a few day

Severity Classification for contrast – Induced Anaphylactoid Reactions

Minor	Moderate	Severe
• Urticaria (limited)	• Urticaria (diffuse)	• Cardiovascular shock
• Pruritus	• Angioedema	• Respiratory arrest
• Erythema	• Laryngeal edema	• Cardiac Arrest
	• Bronchospasm	

Note

→ Single best step in prevention of CIN – **Maintain Hydration**

→ Iodinated contrast agents should not be given to Pregnant female (Crosses Blood Placental Barrier)

→ Can be given to Breastfeeding mother

Barium

→ Causes Mild mediastinitis & Severe chemical Peritonitis
→ **For Perforation peritonitis / Hollow vicus perforation** – Absolute C/I
→ **For Esophageal Perforation** – Diluted $BaSO_4$ given

Gastrograffin

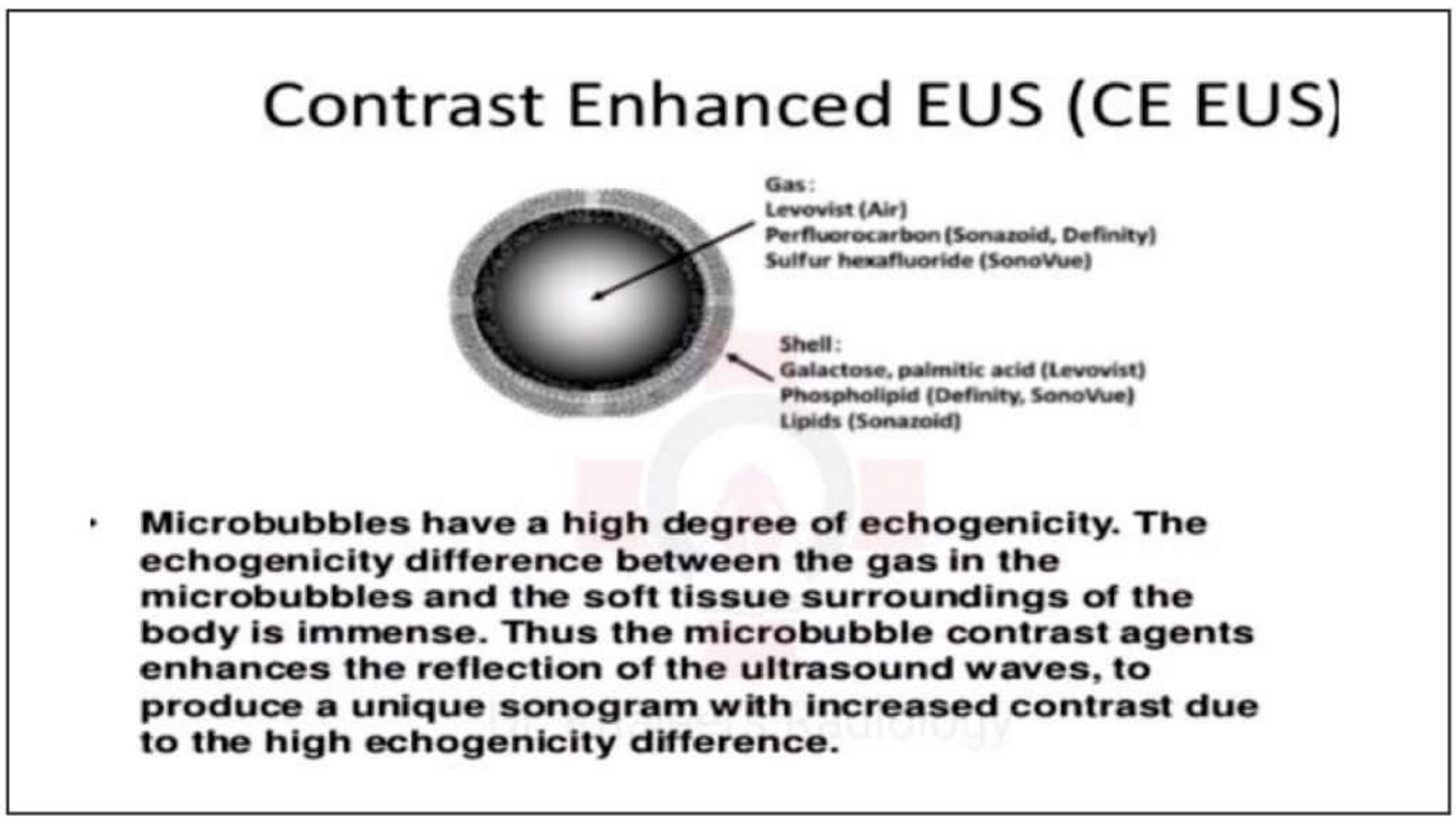
→ It is a Salt of Diatrizoate
  - Ionic monomer
  - High osmolality
→ Avoid Gastrograffin in TEF – because of risk of pulmonary edema
→ Can be used in perforation peritonitis / hollow Viscus perforation
→ Therapeutic enema for constipation / meconium Ileus

Iohexol

→ Aka Omnipaque
  - Non-Ionic Monomer
  - Low Osmolar/ Water Soluble iodinated Contrast
→ **Preferred Contrast In**
  - Hollow Viscera Perforation
  - Esophageal perforation
  - TEF (Dianosil – used for TEF & Bronchography)

USG Contrast Agents

→ Microbubbles of Air, Gases, SF6, Perfluoro carbons
→ Air – Hyperechoic
→ No Need for Baseline Renal Function tests before USG Contrast



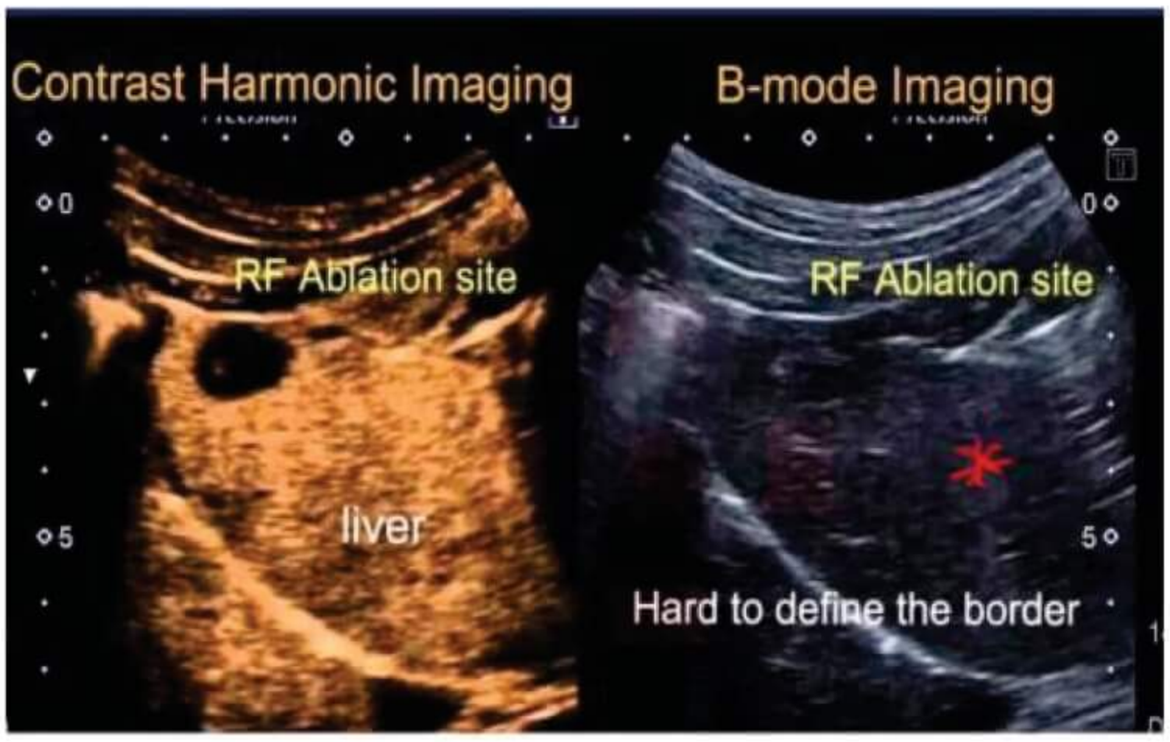
→ Ultrasound contrast agents – **encapsulated Microbubbles**

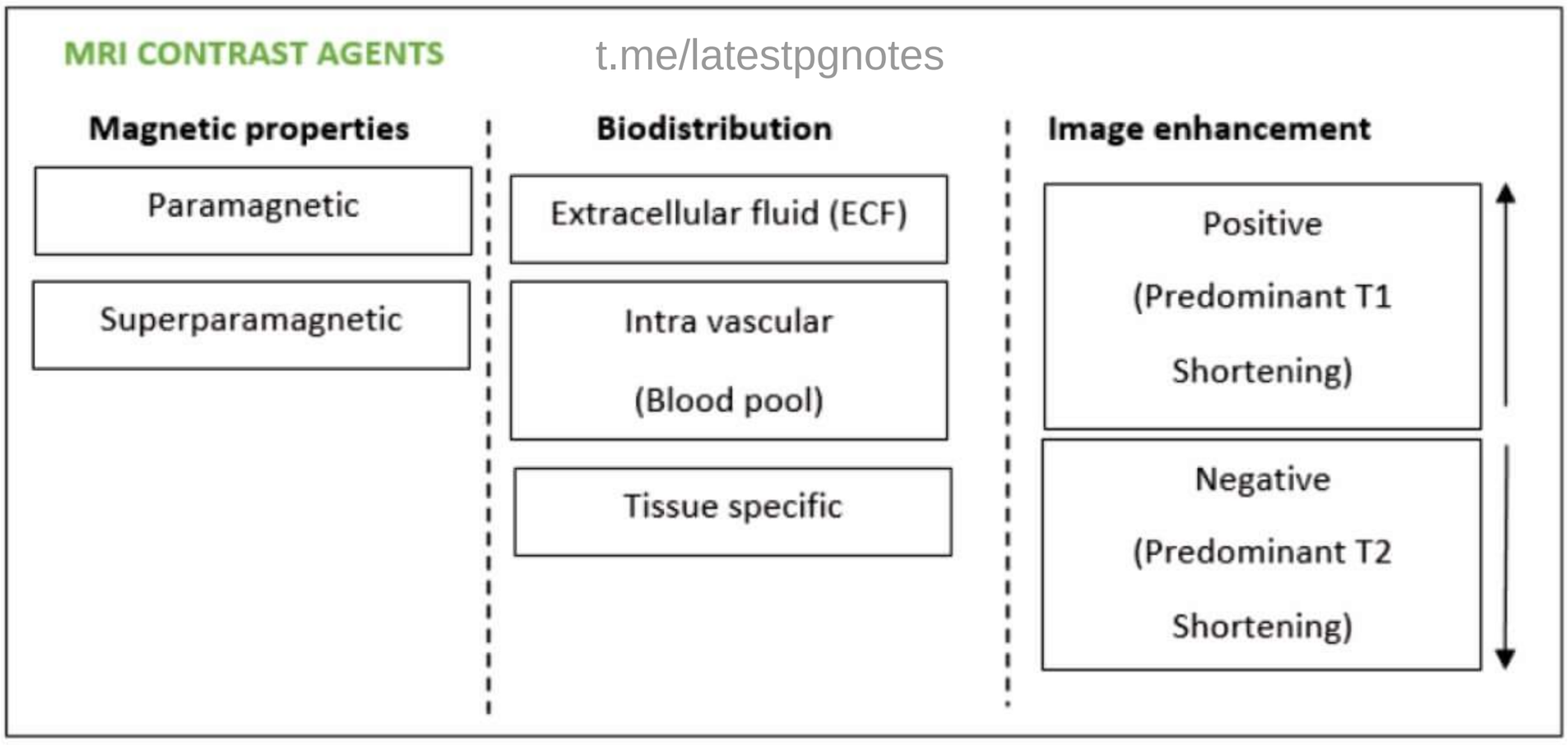
→ **Important USG Contrast agents**

- (i) Sonavist, Levovist, Optison
- (ii) Sonagen / echogen
- (iii) Sonavue – SF6

} I.V

- (iv) Sona R_x – **Oral**





Paramagnetic	Superparamagnetic
• Gadolinium • Manganese	• SPIO (Super paramagnetic Iron Oxide)

Gadolinium

- → Atomic number - 64
- → Paramagnetic Compounds
- → Shortens both T_1 & T_2 relaxation (Predominant effect on T1)
- → **Toxic** – hence, coupled with DTPA
- → **Crosses Placental barrier** - avoid CE-MRI in pregnancy
- → Doesn't cross Blood brain barrier

MRI Contrast agents	
Positive Relaxation Agents	**Negative Relaxation Agents**
• Predominantly Affect T1 Relaxation	• Predominantly Affects T2 Relaxation
• Predominant T1 shortening	• Predominant T2 Shortening
• Increased Signal	• Decreased Signal
• Gadolinium	• Iron oxide (SPIO)

Classification of MRI Contrast Agents	
1) **Intravascular, Extracellular space**	• Gadolinium – DTPA
2) **RES specific agents**	• Ferrumoxide (SPIO)
3) **Hepatocyte Selective Agents**	• GD-BOPTA (Gadobenate Dimeglumine) • Gd-EOB-DTPA (Gadoxetate) • Mangafodipir Trisodium

Gadolinium-Based Contrast Media

Nephrogenic Systemic Fibrosis

A diagnosis of nephrogenic systemic fibrosis (NSF) should only be made if the **Yale NSF Registry clinical and histopathology criteria** are met. The link between NSF and gadolinium-based contrast agents was recognized in 2006.

Clinical features of NSF	• **Onset:** From the day of exposure for up to 2–3 months, sometimes up to years after exposure • **Initially:** → Pain → Pruritus → Swelling → Erythema → Usually starts in the leg • **Later:** → Thickened skin and subcutaneous tissues – 'woody' texture and brawny plaque → Fibrosis of internal organs, e.g. muscle, diaphragm, heart, liver, lungs • **Result:** → Contractures → Cachexia → Death in a proportion of patients
Patients	
→ **At higher risk**	• Patients with CKD 4 and 5 (GFR <30 mL/min) • Patients on dialysis • Patients with acute kidney insufficiency
→ **At lower risk**	• Patients with CKD 3 (GFR 30–59 mL/min)
→ **Not at risk of NSF**	• Patients with stable GFR>60 mL/min

Nephrogenic System fibrosis

Intermediate Risk of NSF	Low Risk of NSF
• Gadobenate Dimeglumine • Gadofosveset trisodium • Gadoxetate disodium	• Gadobutrol • Gadoterate Meglumine • Gadoteridol

ACR CATEGORY	GENERIC NAME	BRAND NAME (US)
GROUP 1 Agents associated with greatest number of NSF cases	• Gadodiamide • Gadoversetamide • Gadopentetate-Dimeglumine	• Omniscan™ • OptiMARK™ • Magnevist
Group 2 Agents associated with Few-if any-unconfounded NSF cases	• Gadoteridol • Gadobutrol • Gadobenate Dimeglumine	• ProHance • Gadovist • MultiHance
Group 3 Agents that have only recently appeared on the US market	• Gadoxetic acid disodium salt • Gadofosveset trisodium	• Eovist • Ablavar

WOMEN IMAGING

Important points to know

1. IOC for routine screening of breast ca → **Mammography** (>40 yrs.)
2. Screening Ix for high risk –
   - (+) family Hx
   - BRCA (+) → **Mammography + MRI**
   - P53 (+)
3. Ix to evaluate a lump in a young female→ **USG**
4. Ix to evaluate painful lump in lactating mothers→ **USG**
5. Ix for differentiating scar Vs residual / recurrence of Ca → **MRI**
6. IOC in Breast / silicone implant → **MRI**

BIRADS: (Breast imaging reporting & data system)

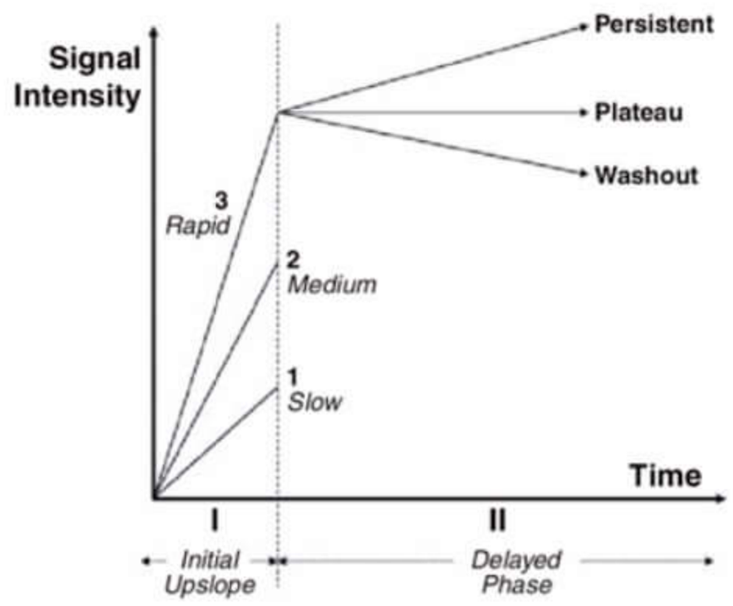
→ System used for reporting breast lesions

→ Can be done on USG / MRI / mammography

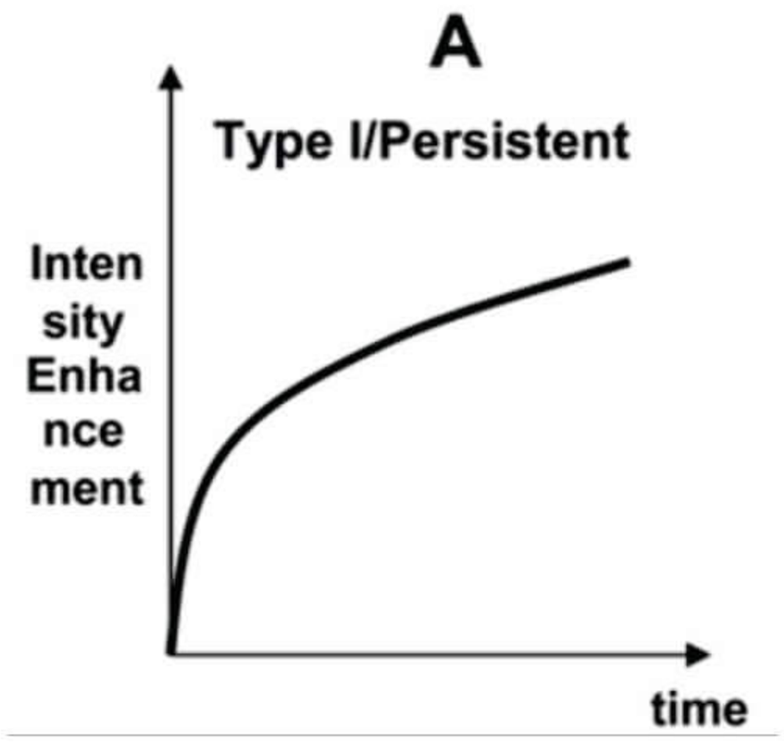
Grading:

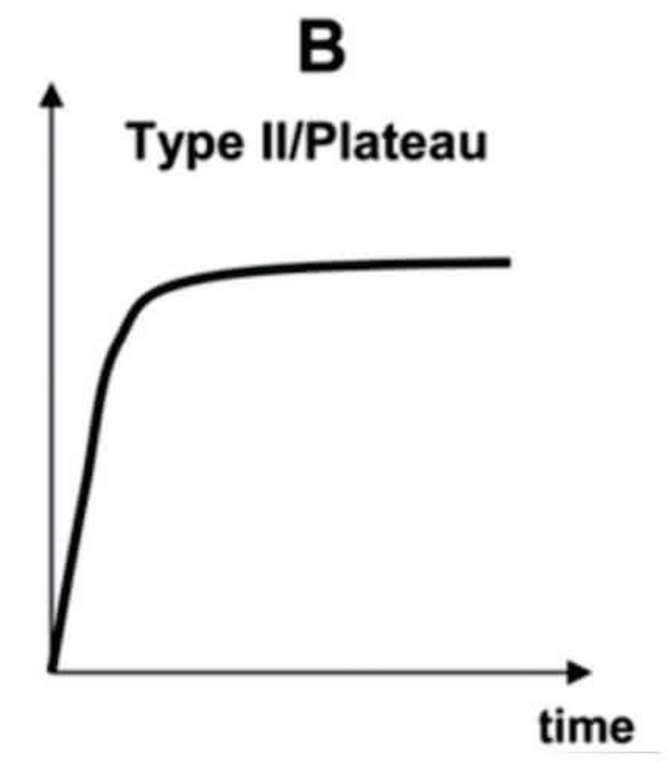
Grade	Findings	Advice
0	Incomplete evaluation	Should be completed
1	Normal	Routine Mammography
2	Benign (e.g. Fibroadenoma)	Routine Mammography
3	Probably benign (> 2 % Chances)	Short term follow up
4	Probably malignant (2–95% Chances)	Biopsy
5	Malignant >95%	Biopsy
6	Biopsy proven malignancy	Definitive Mgt.

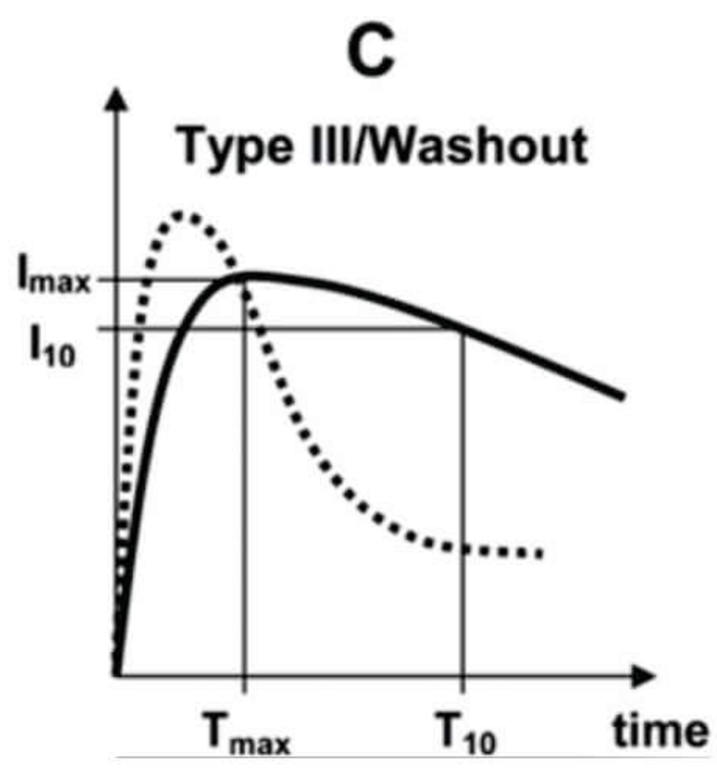
Dynamic contrast enhanced MRI:



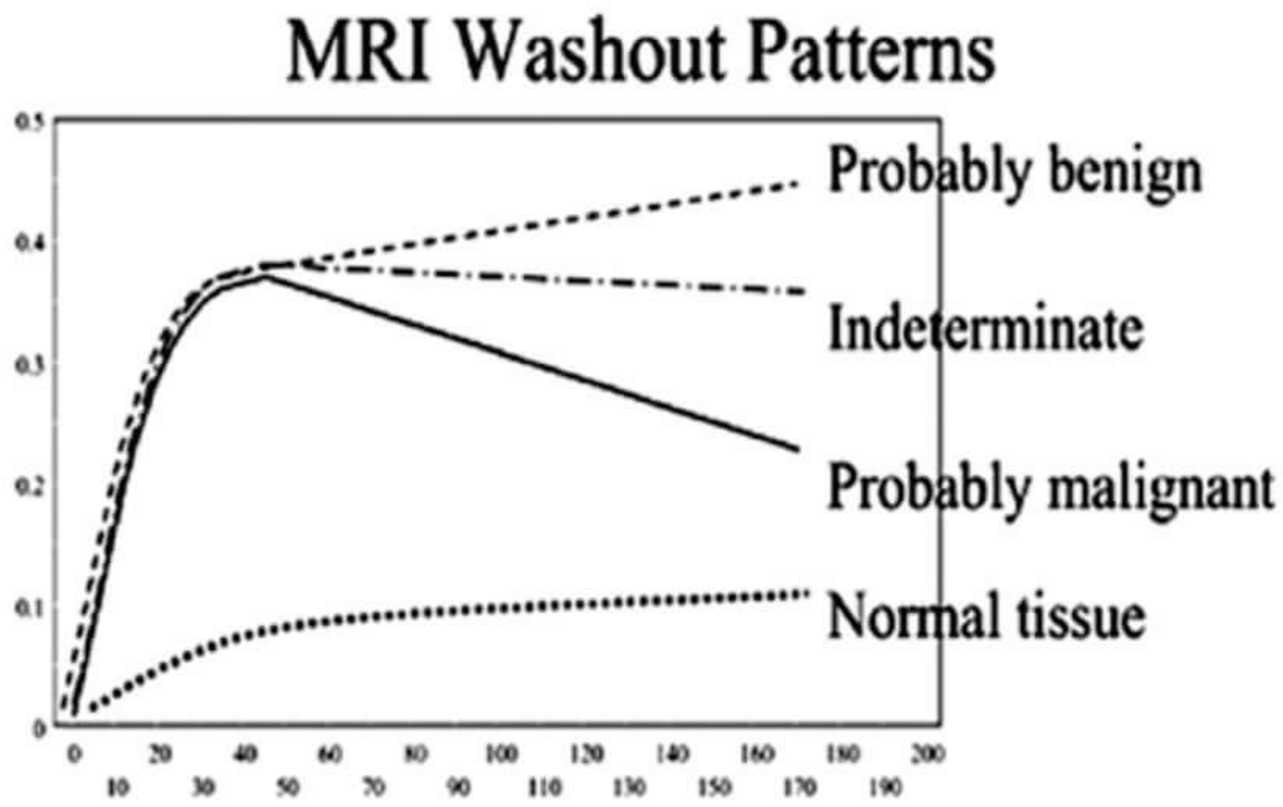
Types:







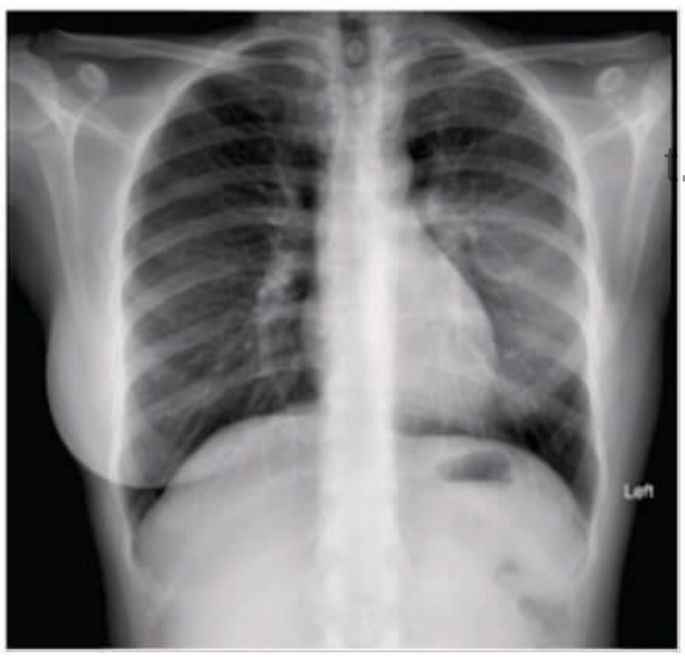
→ MRI wash out pattern:



Points to remember:

→ Absent of breast shadow on one side may indicate

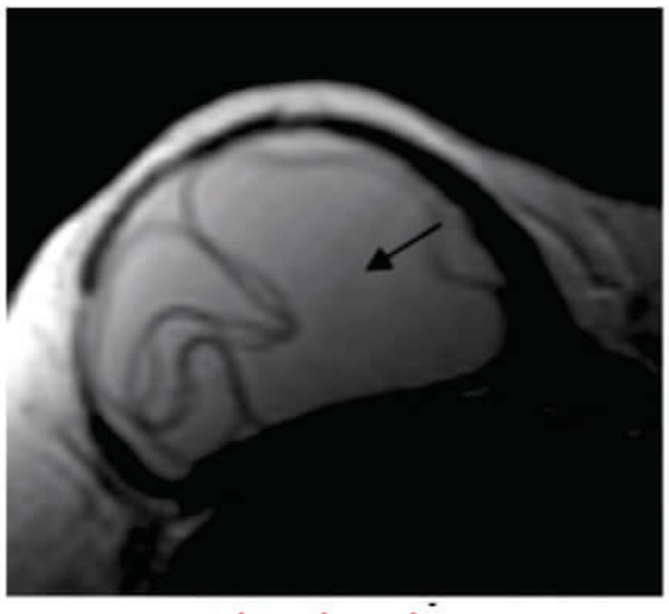
- Post mastectomy patient (or)
- Poland syndrome



Post mastectomy Chest X-ray

Intracapsular breast implant rupture:

→ Linguine sign will be present in MRI

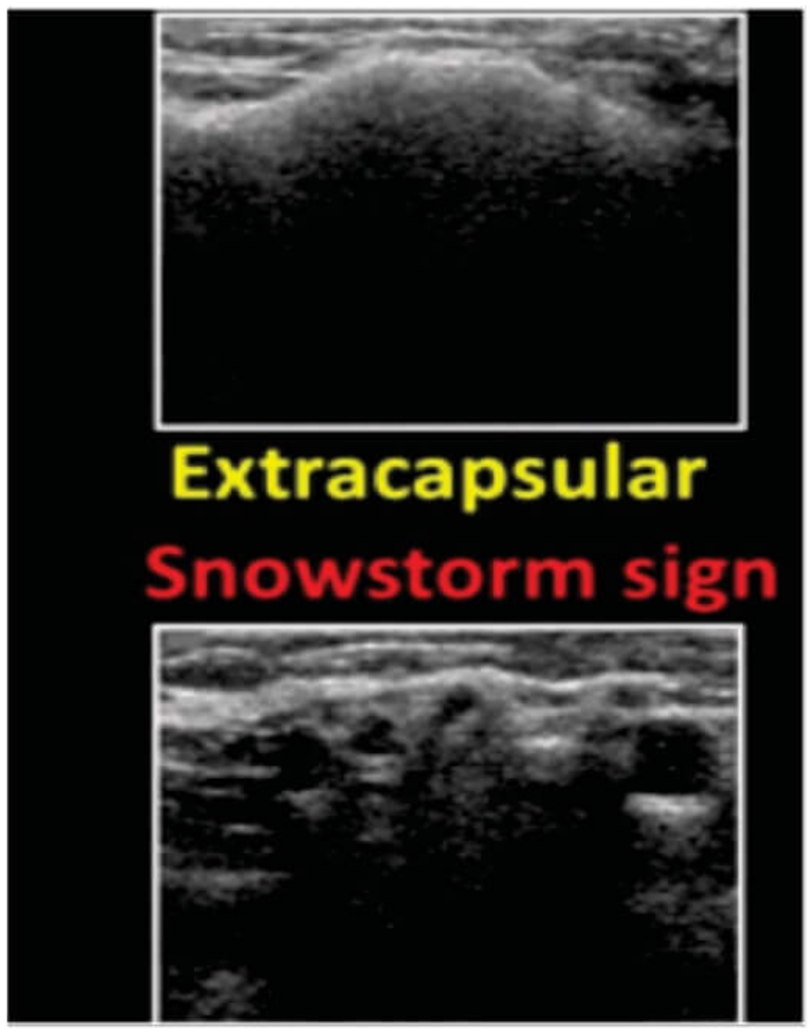


Linguine sign

→ Stepladder sign will be present in USG

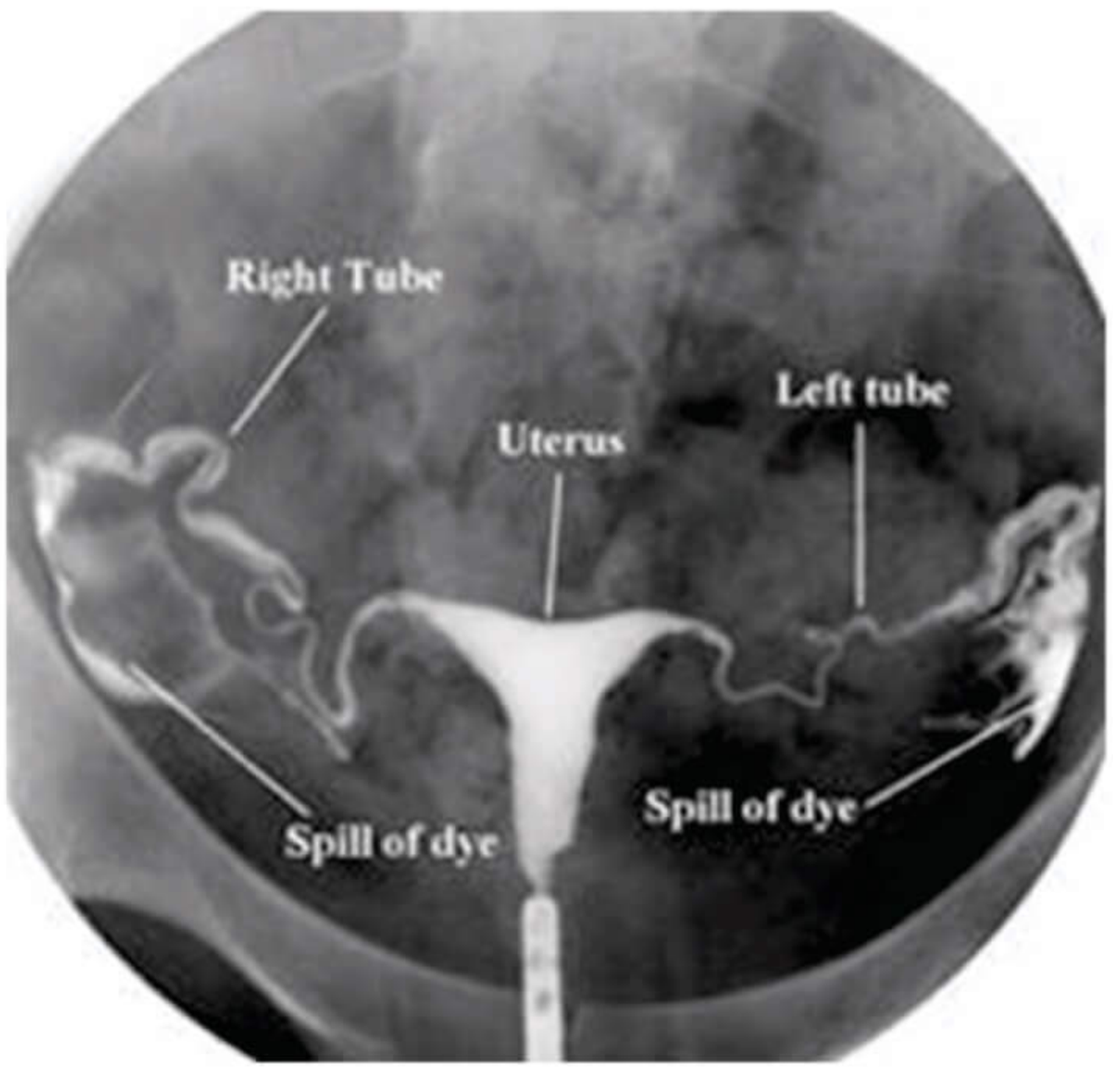
Extracapsular breast implant rupture:

→ Snowstorm appearance is seen in USG



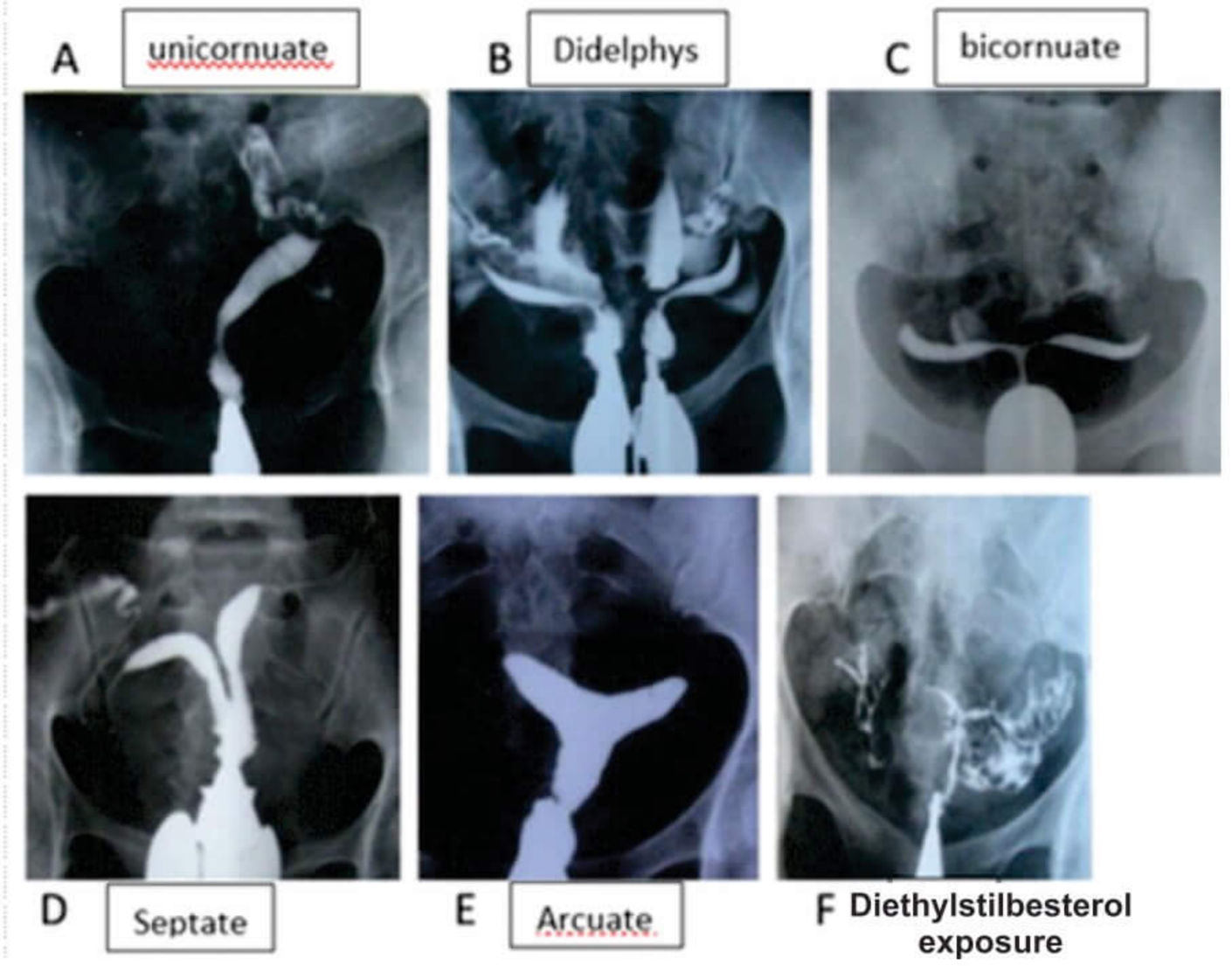
Hysterosalpingography:

→ Best time to do is 6th -10th day of menstrual cycle (to avoid damage to undiagnosed pregnancy)



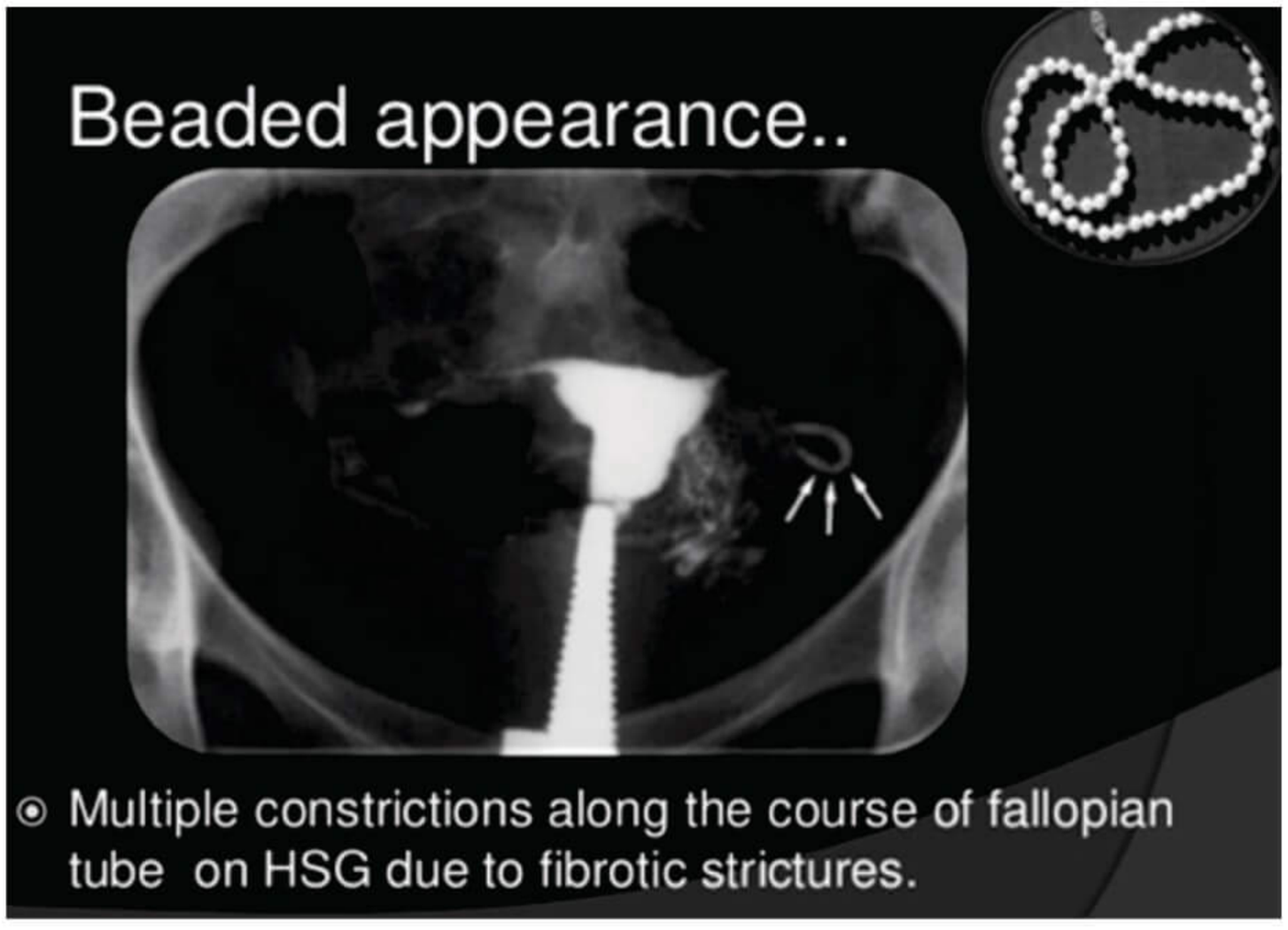
Normal HSG

Uterine anomalies:



Genital TB:

→ gives beaded appearance of fallopian tube



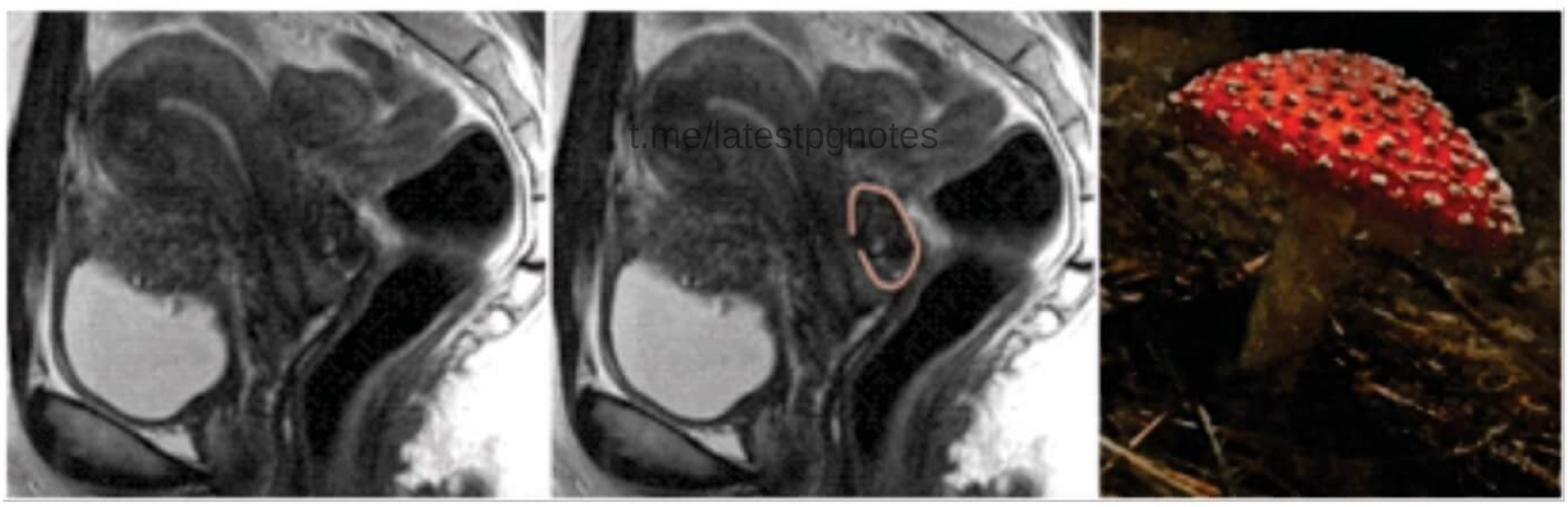
Hydrosalpinx:

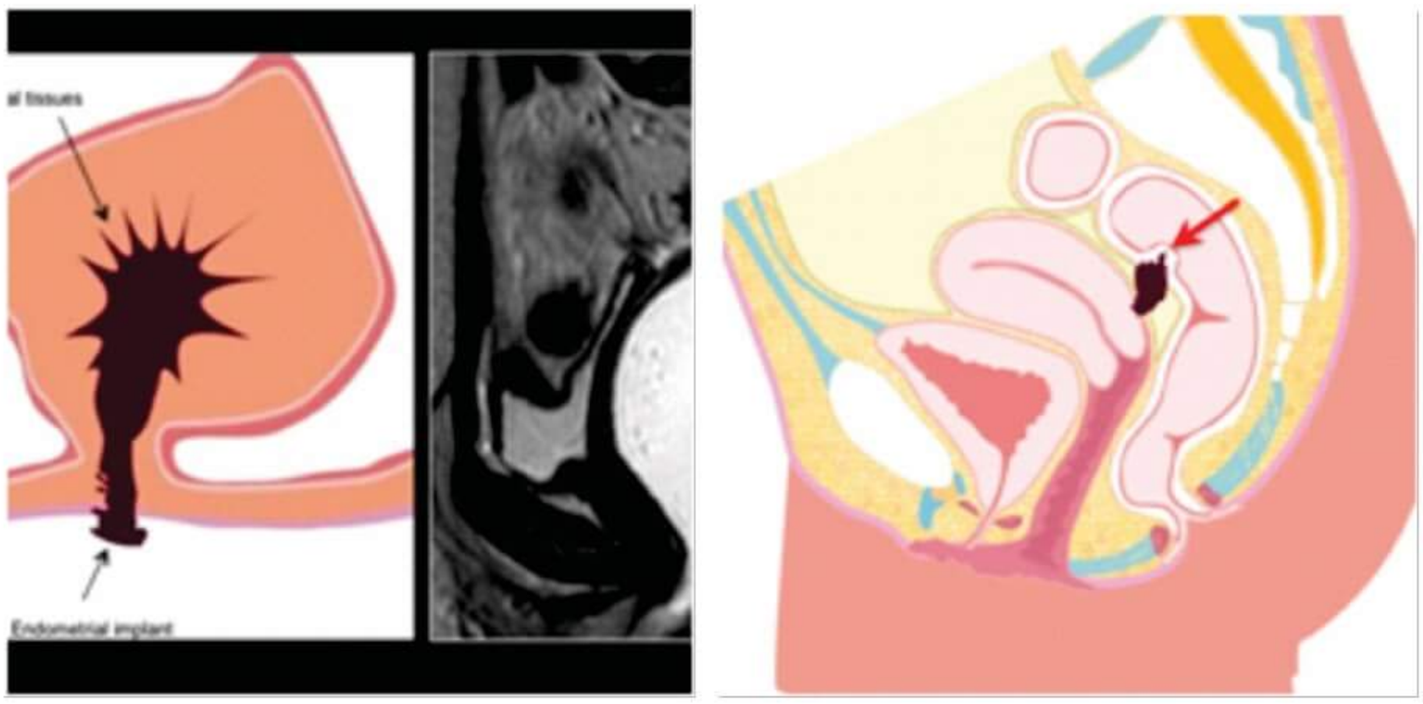
→ Shows bilaterally distended fallopian tube

BILATERAL HYDROSALPINX

Rectosigmoid endometriosis:

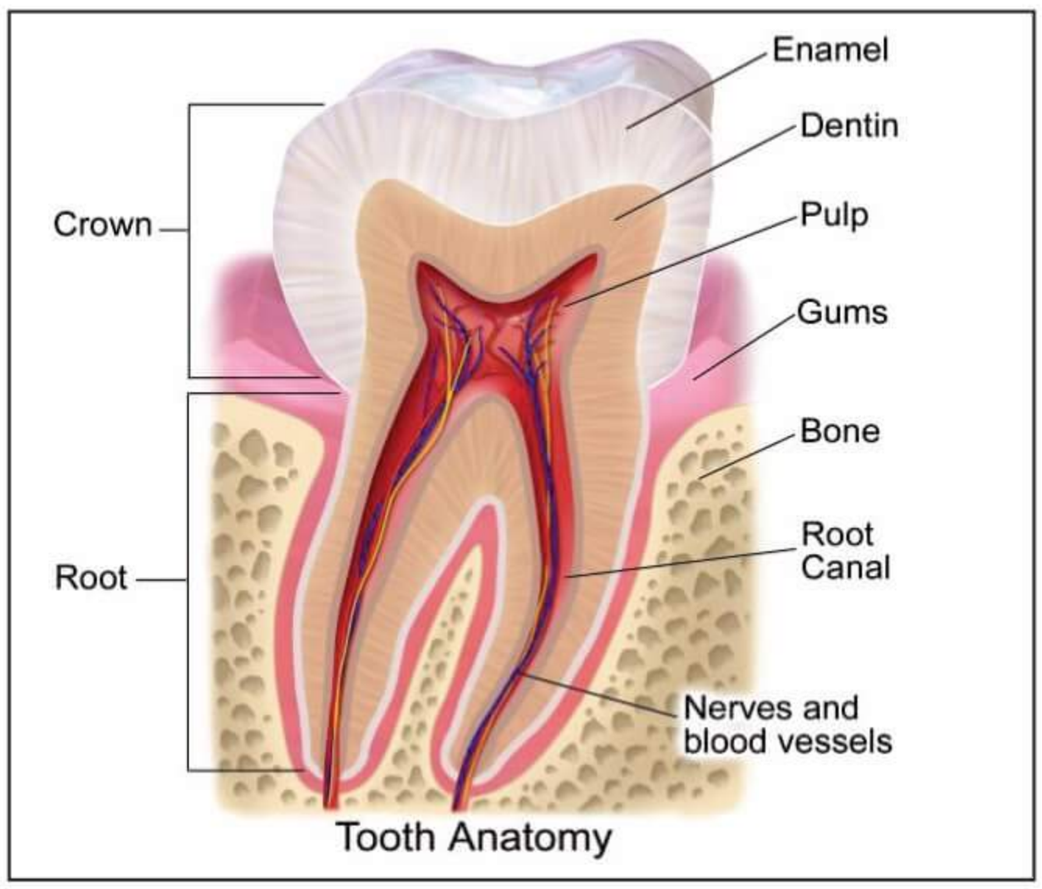
→ Proliferation of rectal muscle around the endometrial growth gives- **Mushroom Cap sign**





Dental Radiology

Tooth Anatomy



Tooth Anatomy

On Evaluation of the teeth, we have variant radiographs

- Intra Oral radiographs
- Extra Oral radiographs
- Orthopantomography

Intra Oral Radiographs:

→ These have a very good depiction of the tooth with its Peri apical region.

→ It has a small film size, so it is not useful to evaluate a very large Lesions.

→ But they give very good detail about few teeth with good clarity (2-4 teeth)

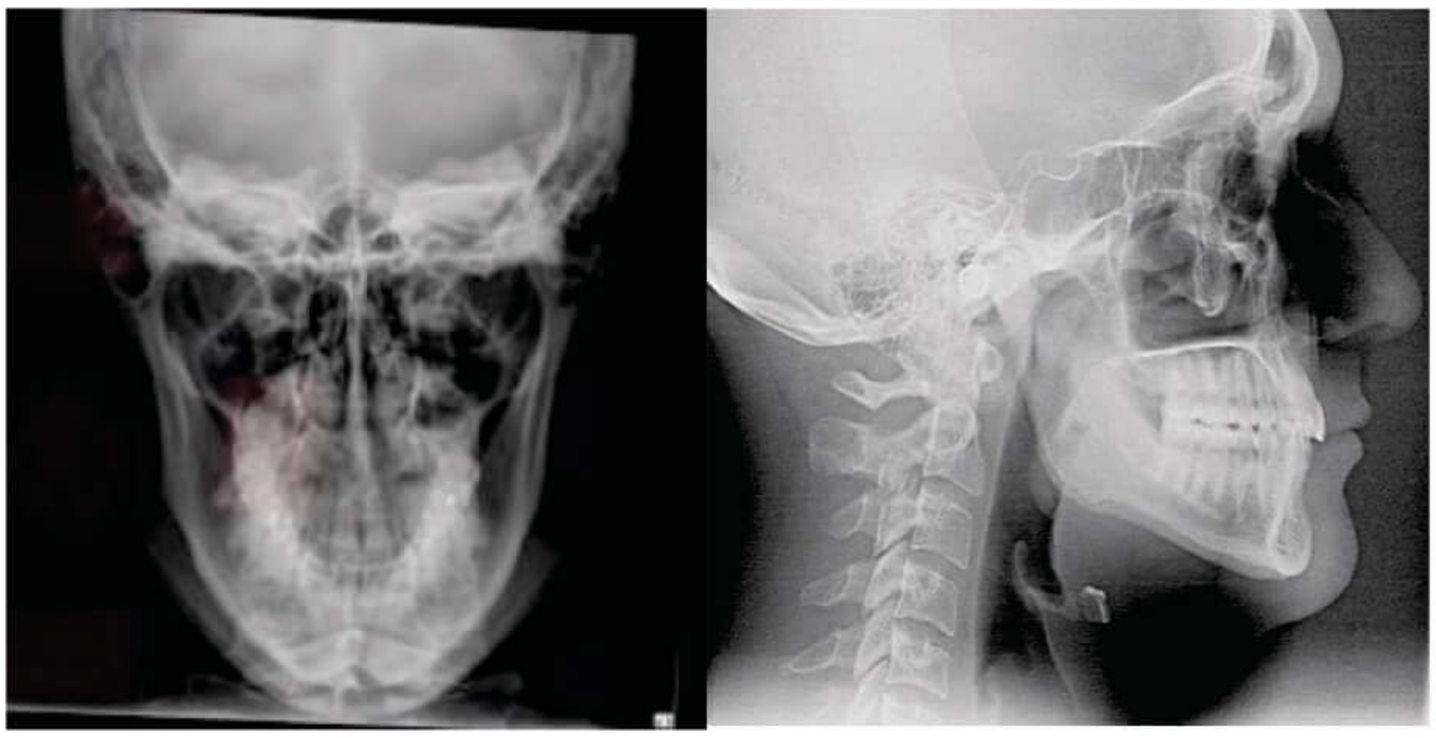

Intra oral radiographs

Extra Oral Radiographs:

→ Used to evaluate larger Lesion

→ Can take lateral radiograph, frontal radiograph to evaluate lesion in the maxilla, mandible and the skull region.

→ There is a good amount of superimposition of the skull base with the maxilla, so we generally prefer water's view to see the lesions better.



Extraoral radiographs

Orthopantomography: -

→ It is the radiographic technique which evaluate both the upper and lower jaw in a single film.

→ It is a Sectional radiology, which evaluates a broad area by moving the equipment across.

→ It is associated with low radiation dose.

→ Clarity is not as good as intra Oral.

orthopantomography

Odontogenic cyst

→ Arise from epithelial residues of tooth forming tissues, develop during or after Formation of teeth.

→ This can be inflammatory Cyst:

- Radicular and residual Cyst

→ And developmental:

- Dentigerous Cyst
- Odontogenic Keratocyst (OKC)

Radicular (Residual Cyst)

→ Most Common Odontogenic Cyst

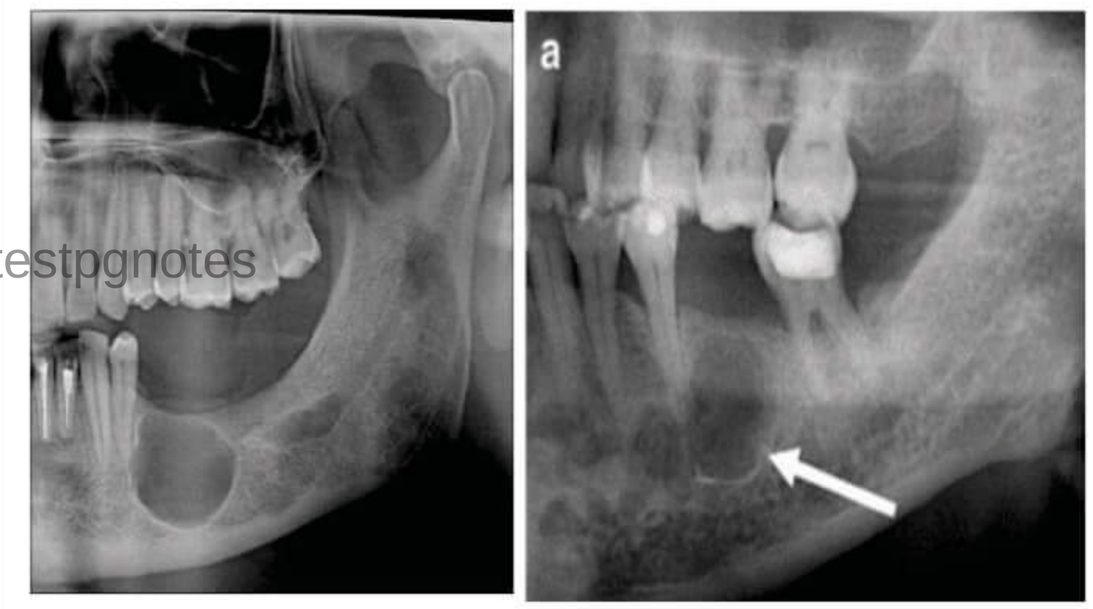
→ Inflammatory Cyst, develops at the **root apex** of a caries teeth due to Proliferation of epithelial cell rests of Malassez.

→ Develops at apex of Non-Vital teeth, Mainly **upper lateral incisors** or 1st Molar.

→ Extraction causes resolution, if it does not resolve then called **residual Cyst**.

→ Aka Peri apical Cyst.

radicular cyst



residual cyst

Dentigerous Cyst (Follicular Cyst)

→ Forms **within the lining of dental follicle** with fluid accumulation between enamel epithelium and Crown of a unerupted developing teeth.

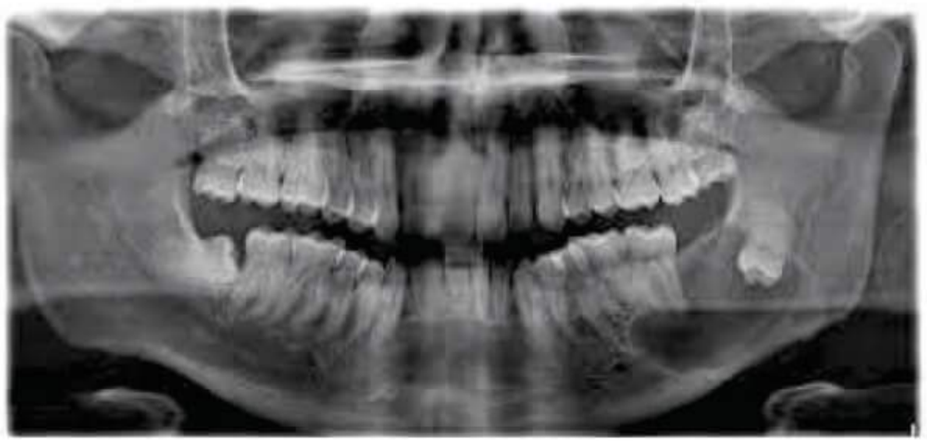
→ M/C type of Non inflammatory Odontogenic Cyst.

→ Arises from reduced **enamel epithelium surrounding the crown** of an **unerupted tooth.**

→ **Unilocular** radiolucency with impacted tooth with Pericoronal radiolucency, attached to the took at its neck with crown appearing to lie within the cyst.

→ 75% located in mandible, usually 3rd molar.

Denitgerous cyst (follicular cyst)



Dentigerous cyst (follicular cyst)

Odontogenic Keratocyst (OKC)

→ Development jaw cyst with aggressive behaviour and high recurrence rate.

→ Arises from **epithelial remnant of dental lamina.**

→ **Usually Unilocular** lucent lesion mostly at the **Posterior body and ramus of mandible, extending along the mandible length** with scalloped well-defined margins.

→ Cyst not associated with tooth Crown Or unerupted tooth.

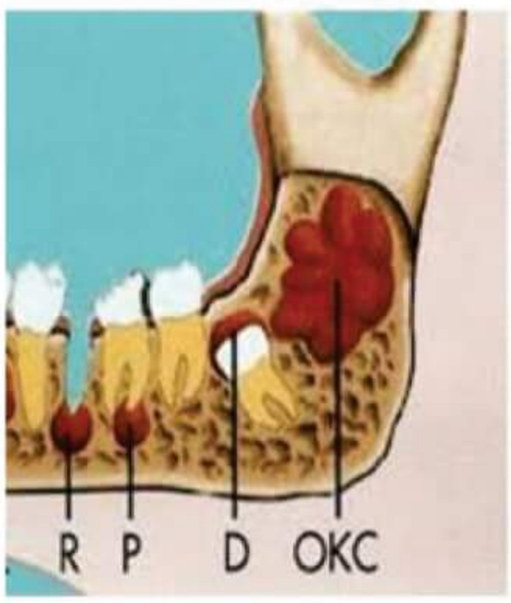
→ Multilocular OKC may resemble ameloblastoma

→ Contain cheery material within and shows diffusion restriction on MRI.

→ Preferred treatment is **surgical enucleation.** Curettage has high recurrence.

Odontogenic keratocyst (OKC)

Odontogenic keratocyst



R – Residual cyst

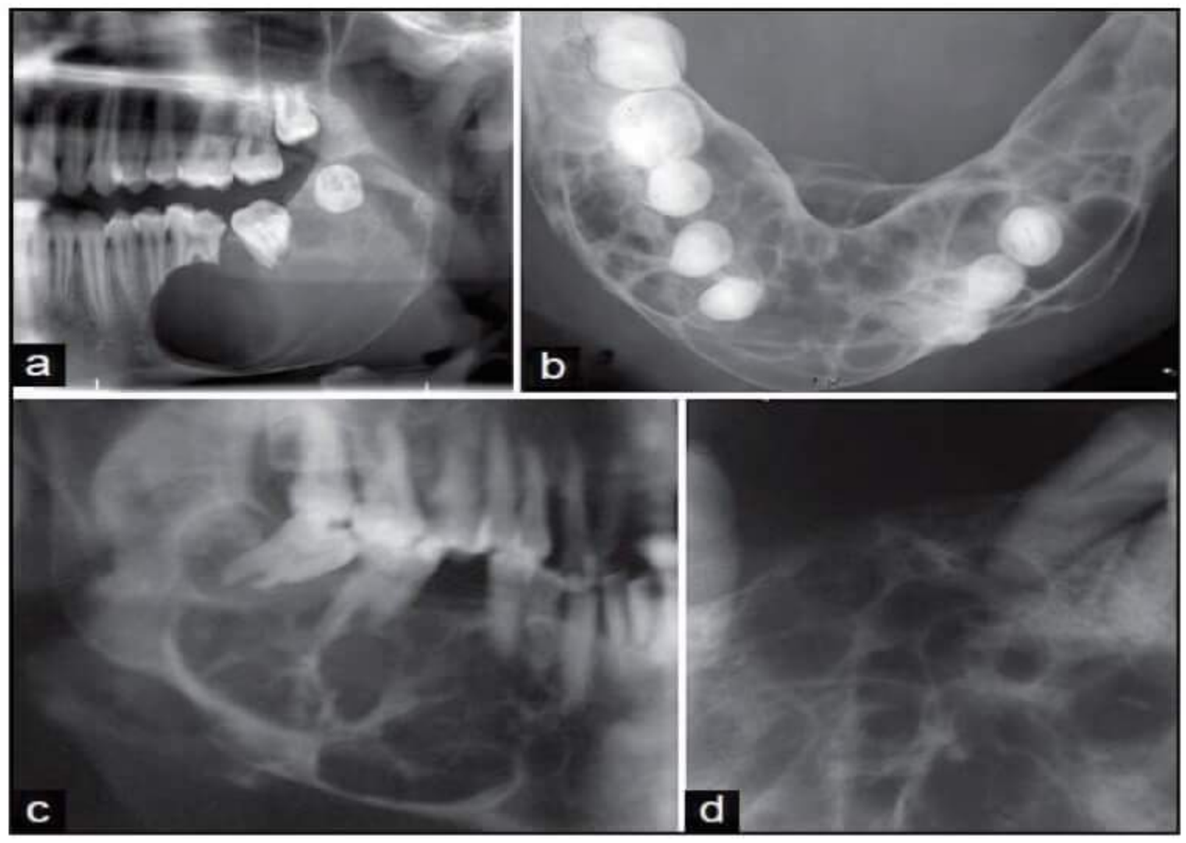
P – Periapical cyst

D – Dentigerous cyst

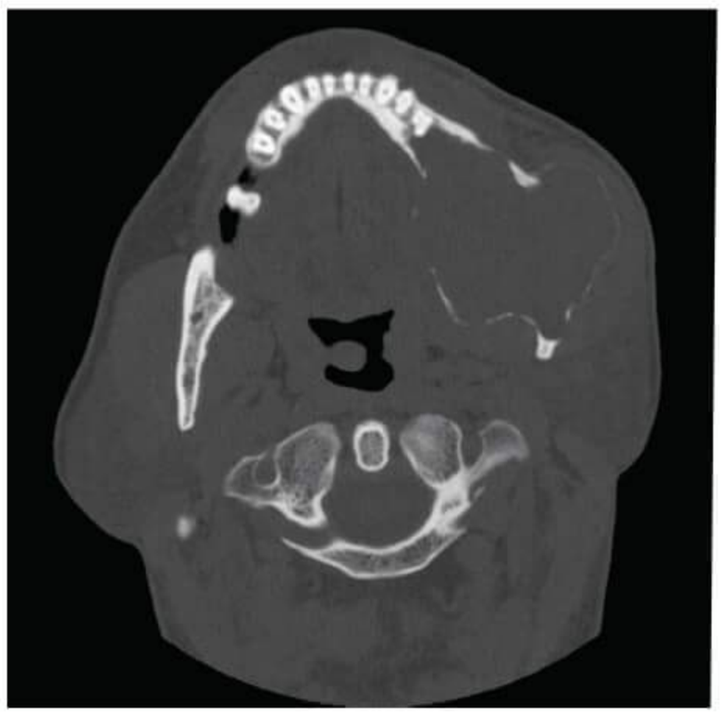
OKC – Odontogenic keratocyst

Ameloblastoma: -

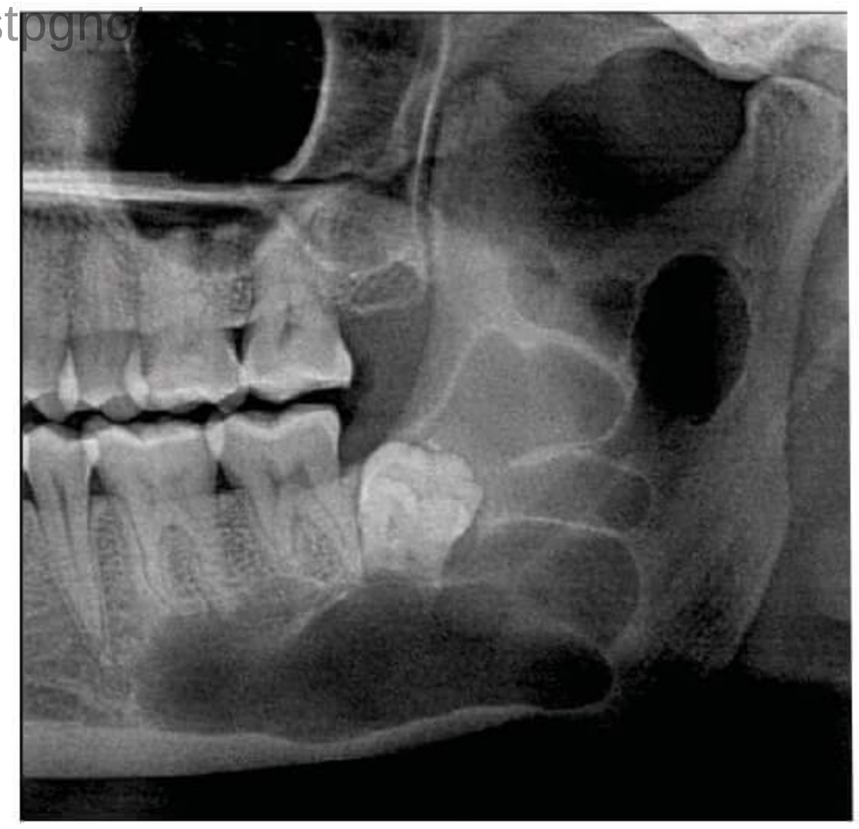
- → Locally invasive **benign neoplasm arising from Odontogenic epithelium.**
- → Bubbly **multilocular mixed cystic solid mass in Posterior body or ramus of mandible.**
- → Multilocular radiolucency containing **septa and locules** of variable size giving **honey comb, Soap bubbly appearance.**
- → Jaw expansion and resorption of adjacent tooth roots.



ameloblastoma



Thinning of cortex and cortical expansion – ameloblastoma (CT scan)



soap bubble / honey comb appearance – ameloblastoma