

X-RAYS

Radiation symbols

International Radiation Symbol
"The Trefoil"



X-ray Radiation Hazard

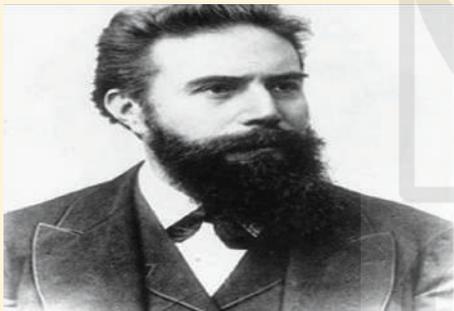


High-Level Sealed Source Ionizing Radiation Symbol
IAEA and ISO—2007



X-ray basics

Wilhelm Conrad Röntgen—Founding Father of Radiology



Discovered X-rays on 8th Nov 1895
Celebrated as
International Radiology Day



1st X-ray Image
Hand of Mrs. Bertha Rontgen

X-rays are a part of
Electromagnetic spectrum^Q

- Electromagnetic spectrum^Q:
- All energy components are part of this spectrum.
- In increasing order of frequencies/energies this spectrum includes—radio waves (least frequency and energy),^Q microwaves, infra-red, visible light, ultraviolet, X-rays and gamma rays (Maximum frequency and energy).^Q

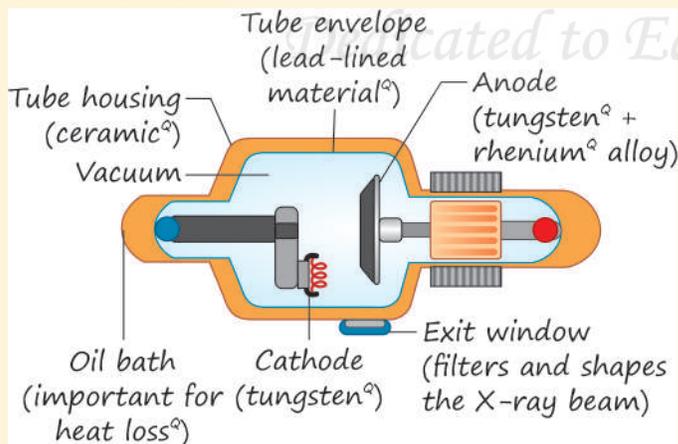
- All have the same speed^Q—speed of light— 3×10^8 m/s
 - All have the same type of wave^Q
- X-ray specifics:

- Have relatively high frequency and high energy
- Wavelength = 0.01–10 nm
- Energy 100 eV – 100 keV

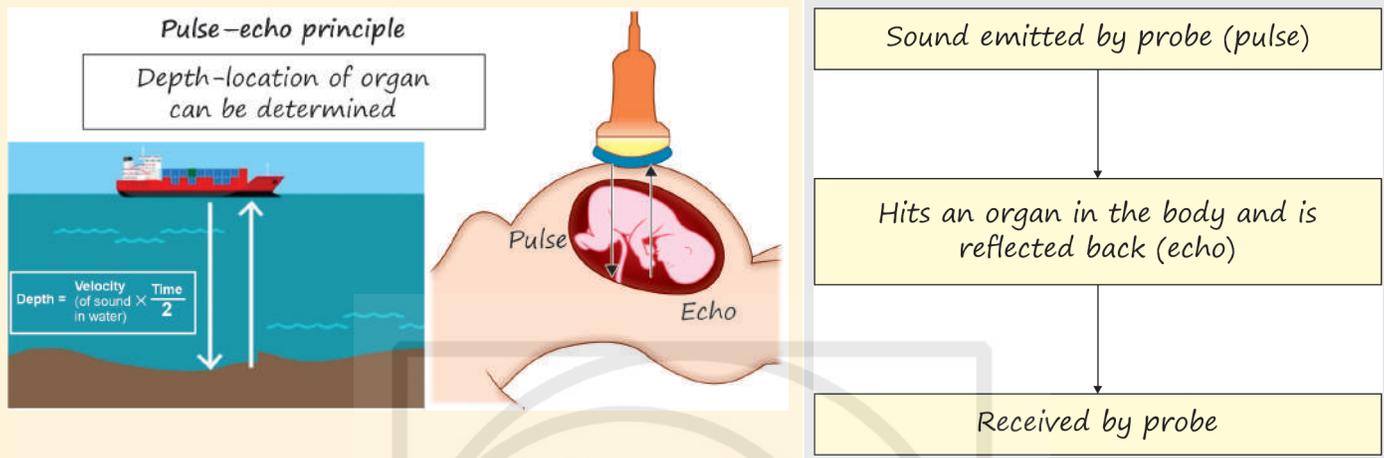
Tungsten:

- It is an important component of X-ray tube (Cathode filament)
- Symbol—W^Q
- Atomic number—74^Q
- Atomic mass number—184^Q
- Classified as transition metal^Q in the periodic table

X-ray Tube—Structure



Pulse-echo principle



Methods of display of ultrasound

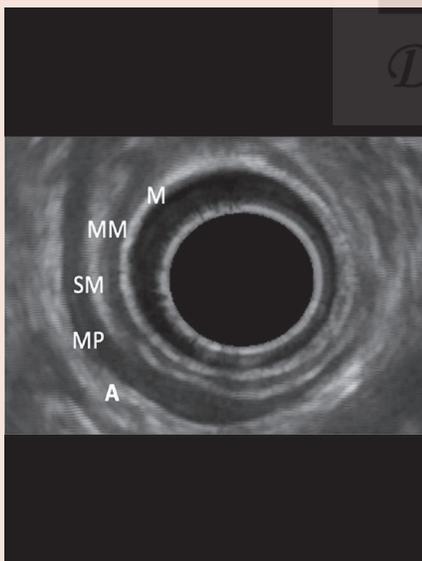
A-mode
A-SCAN
OPHTHALMIC USG

B-mode
Most Common Method of Display

M-mode
MOTION - VS - TIME GRAPH
Used in Echo cardiography: for cardiac evaluation

Endoscopic Ultrasound (EUS)

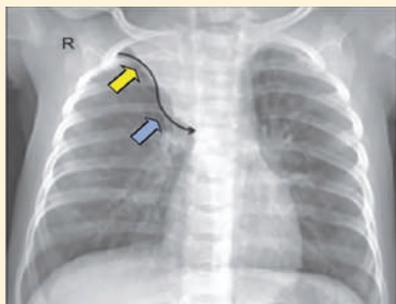
PYQ ALERT "FMGE JAN 2025 PATTERN"



Endoscopic ultrasound (EUS) is a procedure combining the range of endoscopy with the diagnostic abilities of ultrasound. EUS is used in the imaging of the upper GI tract and surrounding structures as well as the respiratory tract (where it is referred to as endobronchial ultrasound [EBUS]). A high-frequency transducer crystal is used, typically in the range of 12–20 MHz.

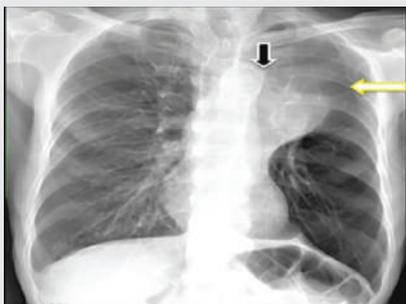
Applications:

- It is the best technique for visualizing the walls of bowel. It is the method of choice for TNM staging of bowel cancers.
- For aspiration (fine-needle aspiration [FNA]) of both solid and cystic pancreatic masses.
- Most sensitivity imaging modality in the detection of small functional pancreatic neuroendocrine tumors.
- EUS-guided biliary drainage has been shown to be an alternative to percutaneous transhepatic biliary drainage when conventional transpapillary endoscopic (ERCP) drainage has failed.



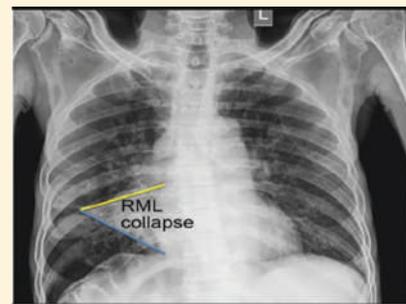
Golden S sign^Q

(Right upper lobe collapse due to a central mass lesion)



Luftsichel sign^Q

(Left upper lobe collapse with resultant overinflation of LLL)



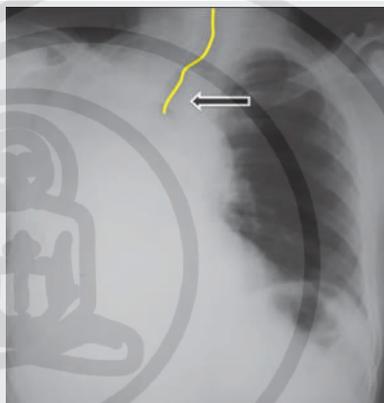
RML collapse

(Lordotic AP view - is better for diagnosis)



LLL collapse

(Triangular paraspinal wedge-shaped opacity)



Complete lung collapse

(Right opaque hemithorax with ipsilateral mediastinal shift)

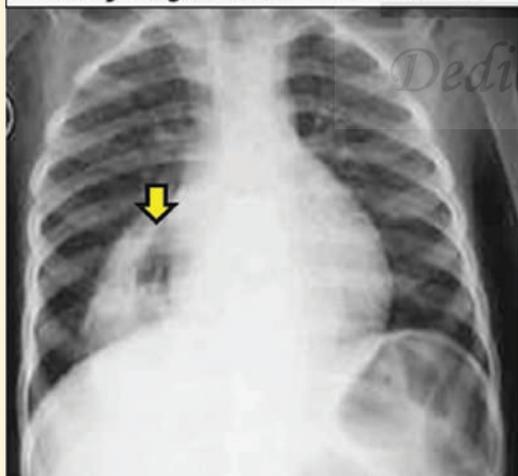
Round Atelectasis/Folded Lung/Blesovsky Syndrome

- Unusual form of collapse related to asbestos exposure with infolding of redundant pleura, often misdiagnosed as a mass lesion.
- IOC-CT^Q
- On CXR appears as a homogenous mass, up to 5 cm diameter, with ill-defined edges. It is always pleural based and is associated with pleural thickening.
- Comet tail sign^Q and Crow feet sign^Q: Vascular shadows radiating from the opacity

Diaphragmatic hernia

PYQ ALERT (NEET-PG 2025 PATTERN)

MORGAGNI HERNIA
Always Right sided - Less common



BOCHDALEK HERNIA
Always Left sided - Most common type



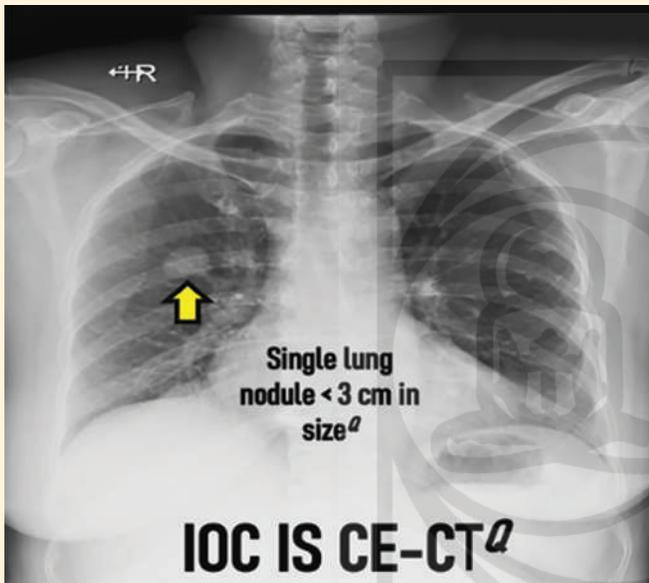
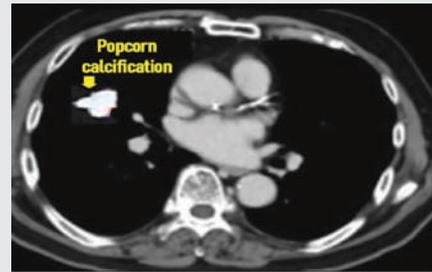
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Miscellaneous lung tumors

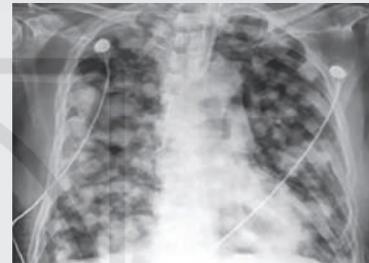
Lung hamartoma

Carney's Triad^Q—Seen in cases of Pulmonary hamartomas/chondromas. Consists of:

- Multiple pulmonary chondromas^Q
- Gastric epithelioid leiomyosarcoma/GISTs^Q
- Functioning extra-adrenal paragangliomas^Q



Solitary pulmonary nodule (SPN)



Cannon-ball lung metastases

Multiple large round well-defined lesions in both lungs—as the rich vascular bed of the lungs is hospitable to tumor emboli.

Causes:

- Renal cell carcinoma—most common^Q
- Choriocarcinoma
- Endometrial carcinoma
- Germ cell tumors
- Synovial sarcoma
- Prostate carcinoma

Mediastinal Abnormalities

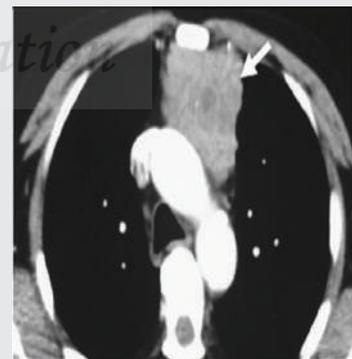
Mediastinal tumors

CLINICAL CLINCHER

Most common in mediastinal lesions:

- Overall most common mediastinal mass—Thymoma^Q
- Most common anterior mediastinal mass—Thymoma^Q
- Most common middle mediastinal mass—Lymph nodal mass^Q
- Most common middle mediastinal mass in children—Duplication cysts^Q
- Most common posterior mediastinal mass—Neurogenic tumors^Q

PYQ ALERT (NEET PG 2024 PATTERN)



Thymoma

- MC mediastinal tumor overall^Q
- MC anterior mediastinal tumor^Q
- MC tumor of thymus in adults^Q
- Associated with Myasthenia gravis^Q/hypogammaglobulinemia^Q/Good's syndrome^Q

Contd...

Pulmonary Embolism:

CXR—Poor sensitivity: Normal in early cases

CT Pulmonary Angiography: Investigation of Choice^Q

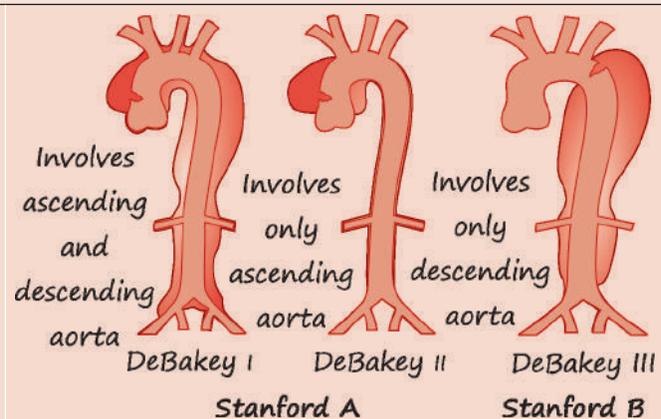
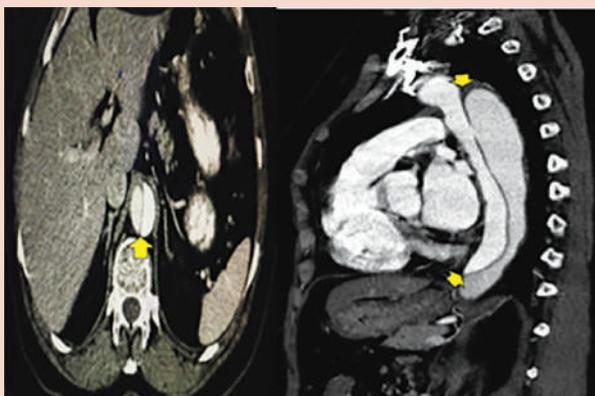
PULMONARY EMBOLISM CLINCHERS

- **Acute emboli:** Shows Polo mint sign^Q—Central nonenhancing filling defect due to thrombus with the contrast flowing peripherally.
- **Chronic emboli:** The thrombus forms an obtuse angle (c/f acute angle in acute emboli) with vessel walls and calcification.
- **Ultrasound/echocardiography:** Right ventricular hypokinesia (McConnell sign^Q), right ventricular dilatation and pulmonary arterial hypertension can be identified.
- **Nuclear/radionuclide scans:** Second-line Test for PTE, also known as Ventilation–Perfusion (V/Q) scan.
- **Mismatched defects^Q on V/Q scan**—suggestive of pulmonary embolism—present ventilation with absent perfusion in the same lung segment.
- **Invasive pulmonary angiography:** Gold Standard/Most Accurate Method—Invasive; hence, CT angiography is preferred for diagnosis.

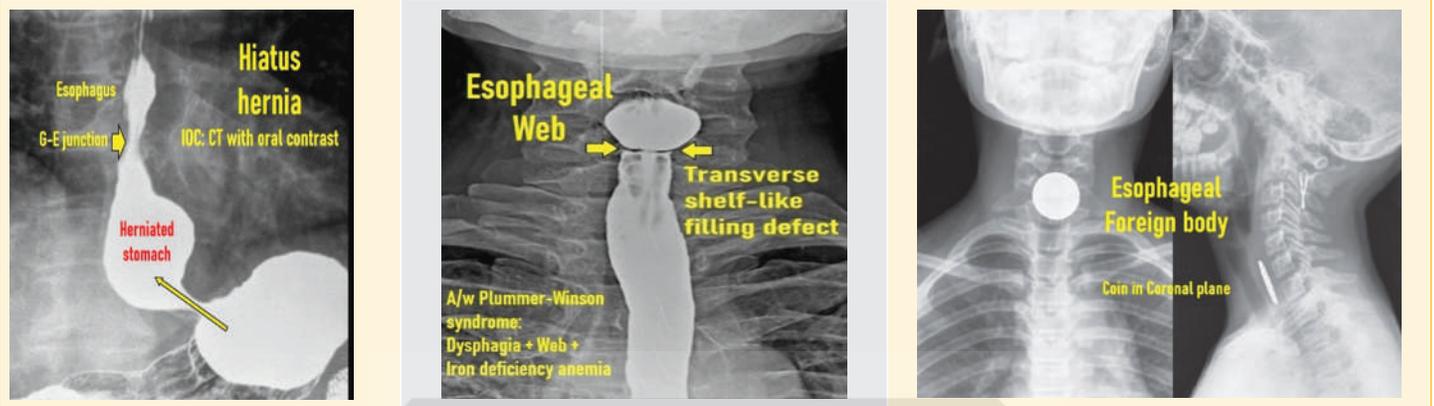
CONCEPT—GOLD STANDARD FOR VASCULAR ABNORMALITIES

Vascular abnormalities are an absolute favorite topic of your examiners! Remember, whenever, you are asked about the gold standard investigation for any vascular abnormality, the answer is invasive catheter angiography^Q. See the following table.

Conditions	Gold standard investigation
Berry aneurysm	Cerebral digital subtraction angiography (DSA)
Brain AV malformation	Cerebral digital subtraction angiography (DSA)
Renal artery stenosis	Invasive catheter angiography
Varicose veins/DVT	Invasive catheter venography
Aortic dissection	Invasive catheter venography
Pulmonary embolism	Invasive pulmonary angiography
Mesenteric artery thrombosis	Invasive abdominal or mesenteric angiography

Aortic dissection**PYQ ALERT “FMGE JAN 2023 PATTERN”**

Contd...



CLINICAL CLINCHER— Ca ESOPHAGUS

Ca Esophagus

Abrupt irregular narrowing of esophagus
Rat tail appearance

- Elderly patient with weight loss and dysphagia—equal for solids and liquids^Q
- Barium swallow—Abrupt irregular narrowing—Rat tail appearance^Q
- Overall IOC—Endoscopy + Biopsy^Q
- Imaging IOC for staging—PET-CT^Q
- Imaging IOC for TN staging—Endoscopic USG^Q

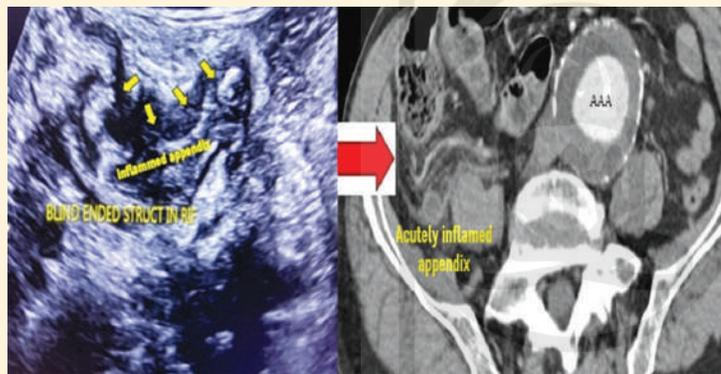
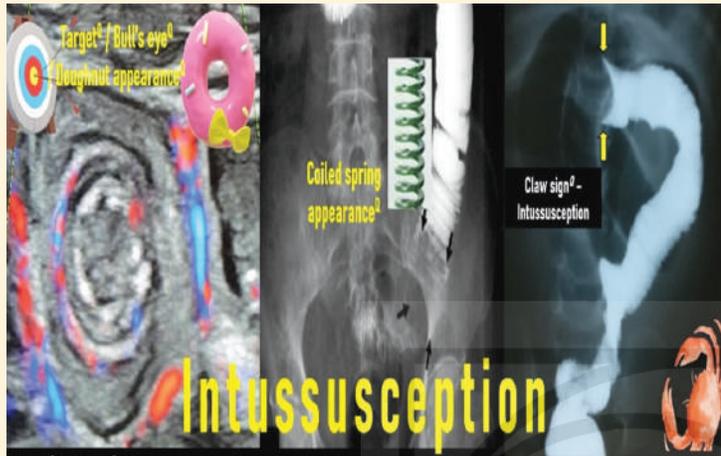
Achalasia Cardia versus Ca Esophagus

	Achalasia cardia	Ca Esophagus
Pathology	Motility disorder	Malignant growth
Dysphagia	Liquids > Solids	Solids > Liquids
IOC	Manometry	Esophagoscopy + Biopsy
Ba swallow findings	Bird beak sign—smooth elongated tapering	Rat tail sign—Abrupt narrowing with mucosal irregularity

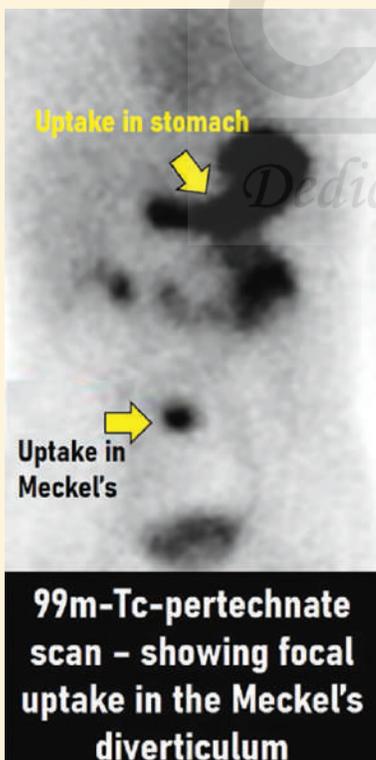
Dedicated to Education

Small bowel obstruction	Large bowel obstruction
<p>Multiple dilated small bowel loops—centrally located loops with multiple air-fluid levels and valvulae conniventes—Herringbone appearance/Concertina effect—suggests SBO</p>	<p>Dilated large bowel loops—Predominantly peripheral bowel loops with haustrations and few long air-fluid levels—suggests LBO</p>

Small Bowel Spotters



Acute appendicitis



99m-Tc-pertechnetate scan – showing focal uptake in the Meckel's diverticulum

Intussusception:

CLINICAL CLINCHER

- Child 2 months – 2 years of age
- Pain in abdomen
- Red currant jelly stools
- Most common site in children—Ileocolic^Q
- Most common site in adults—Colocolic^Q
- IOC in pediatric age group—USG^Q
- IOC in adults—CE-CT^Q

Acute Appendicitis:

CLINICAL CLINCHER

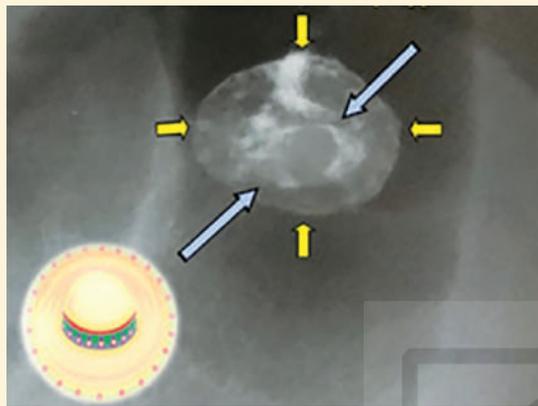
- Child with fever
- Pain in abdomen, vomiting
- Pain at tenderness in RIF at McBurney's point
- IOC in children—USG^Q
- IOC in adults—CE-CT^Q
- Named signs on CE-CT
 - Cecal bar sign^Q
 - Arrowhead sign^Q
- Appendicular mucocele—Appendix distended with mucinous contents. Associated with mucinous cystadenoma of appendix^Q

Meckel's Diverticulitis:

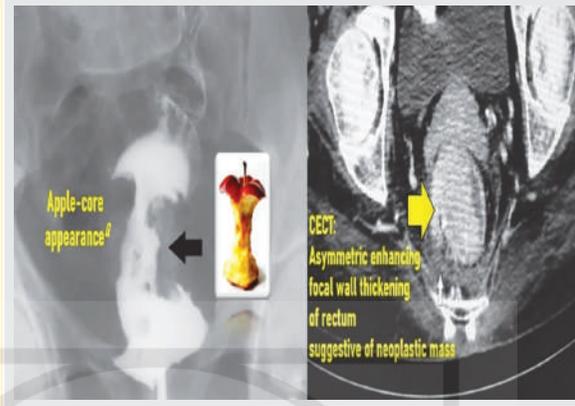
CLINICAL CLINCHER

- Meckel's Diverticulum Specifics.
- Rule of 2^Q:
- 2 inches long
 - 2 feet from ileocecal junction
 - 2% population affected
 - 20% ectopic mucosa (gastric mucosa > pancreatic)
 - GI bleeding—MC presentation in adults
 - Littre's hernia^Q—Meckel's diverticulum in the hernia sac
- Meckel's diverticulum has ectopic gastric mucosa, which secretes acid and presents clinically as GI bleeding.
 - IOC—99mTc-pertechnetate scan. The radionuclide is concentrated in the gastric mucosa—both in the stomach and Meckel's diverticulum—thus helping localize it.

Colonic Spotters



Mexican hat sign^Q
Pedunculated colonic polyp



Ca Colon/Rectum

Ca Colon specifics:

- IOC for diagnosis— colonoscopy with guided biopsy
- Overall IOC for staging—PET-CT
- Most common site for metastases— Liver



Colonic diverticulosis

Colonic diverticulosis:

- Most common site—Sigmoid colon^Q
- Least common site—Rectum^Q
- Saw-tooth appearance of diverticulosis
- Bowler hat appearance^Q is seen when viewed en-face
- CE-CT: IOC for diverticular disease



Coffee-bean sign – Sigmoid volvulus

Sigmoid Volvulus—MC site of volvulus of bowel^Q

CLINICAL CLINCHER PYQ ALERT (FMGE JAN 2025 PATTERN)

- Elderly female
- Known case of mental handicap/institutionalization
- Massive gaseous distension of abdomen

Named signs:

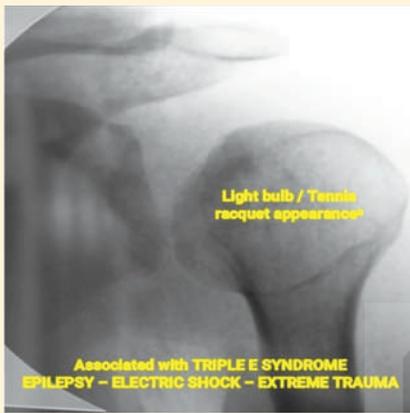
- Inverted U-shaped loop^Q
- Kidney bean sign^Q
- Omega sign^Q
- Left flank overlap sign^Q
- Frimann-Dahl sign^Q
- Coffee bean sign^Q
- Bent inner tube sign^Q
- Liver overlap sign^Q
- Pelvis overlap sign^Q



Perianal fistula/Fistula-in-ano

- IOC—MRI Fistulography
- Initial investigation—Conventional sinogram/fistulogram

Posterior shoulder dislocation (fluoroscopic spot film)



CLINICAL CLINCHER

Recurrent anterior shoulder dislocation—associated injuries

Recurrent anterior dislocation is associated with:

- Hill-Sachs defect^Q/Hatchet defect^Q—Impaction injury on posterolateral aspect of humeral head
- Bankart lesion^Q—Avulsion injury of anteroinferior glenoid rim
- Greater tuberosity fracture
- HAGL lesion^Q—Humeral avulsion of glenohumeral ligament

Humeral fractures
Neer classification^Q



Neer Classification
Based on—Number of fracture parts and fragment displacement

Supracondylar fracture of humerus MC fracture around elbow in children



- MC type—Extension type^Q
- MC nerve injured—AIN^Q
- MC artery injured—Brachial artery^Q
- MC long-term complication—Malunion^Q (Gunstock deformity^Q)

Scaphoid fracture MC carpal fracture^Q

PYQ ALERT “NEET-PG 2019 PATTERN”



MC Carpal Fracture^Q

- Tenderness at anatomical snuff box^Q
- MC site—Waist of scaphoid^Q
- Avascular necrosis^Q—More proximal the fracture, greater the risk of AVN^Q
- Herbert screw technique used for Rx^Q

Colles' fractures



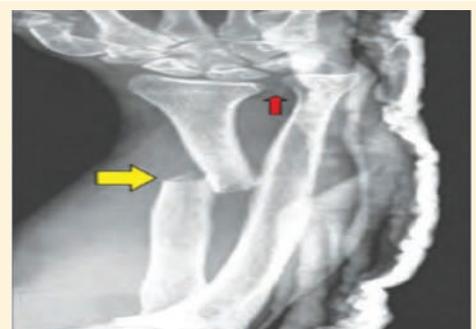
Distal Radius Fracture with Dorsal Tilt and Impaction

Monteggia fracture dislocation



Fracture Ulna + Dislocation of Radius

Galeazzi fracture dislocation

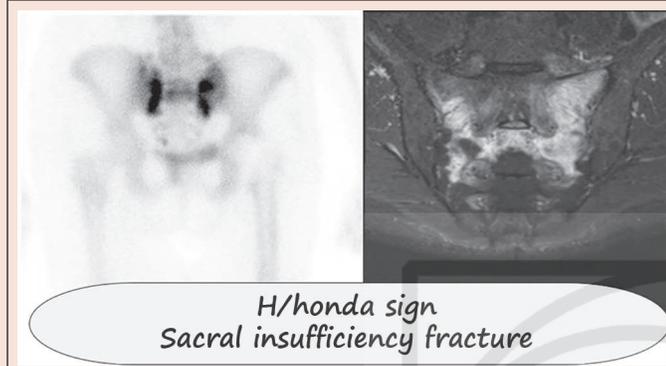


Fracture Radius + Dislocation of Ulna

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H-sign–Sacral Insufficiency Fracture

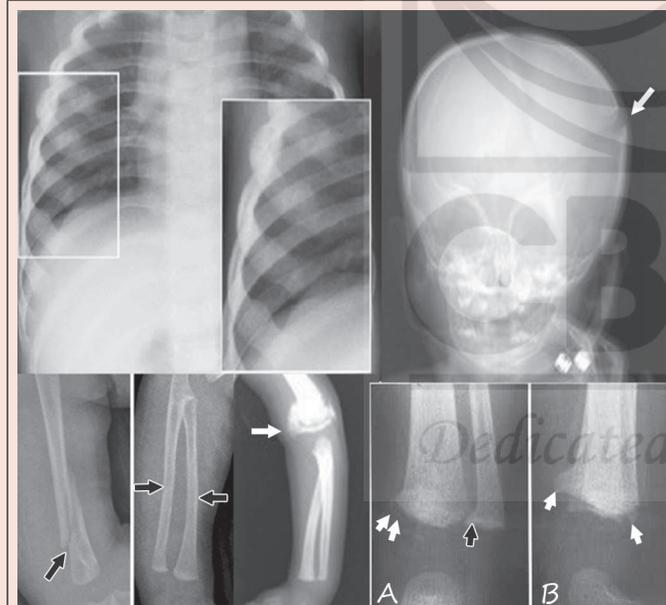
PYQ ALERT “INI-CET MAY 2025 PATTERN”



- **Sacral insufficiency fractures** are a subtype of stress fractures, which are the result of normal stresses on abnormal bone, most frequently seen in the setting of osteoporosis. They fall under the broader group of pelvic insufficiency fractures.
- **Associated with osteoporosis as well as other abnormal bone conditions, including rheumatoid arthritis, Paget disease, Osteomalacia, DM, history of radiation therapy**
- Typically seen in elderly females who present with low back pain without any history of significant trauma.
- Tc99m-MDP bone scan and MRI are the best modalities for imaging

Battered Child Syndrome/Suspected Physical Abuse/Inflicted Injury

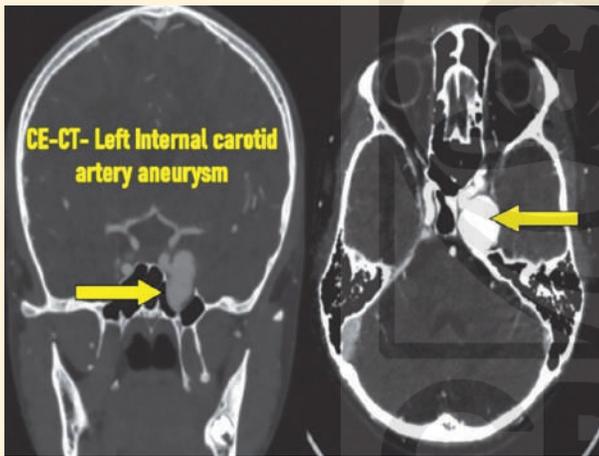
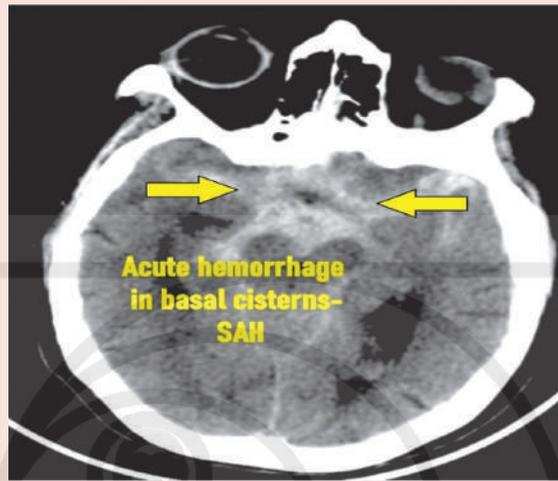
PYQ ALERT “FMGE JULY 2025 PATTERN”



- Suspicious features include:
 - Injury in the nonambulatory/totally dependent child
 - Injury and the provided history are inconsistent, especially when accompanied by delayed medical attention
 - Multiple fractures with trivial trauma/single fall
 - Retinal hemorrhage
 - Torn frenulum
- Metaphyseal fractures/Bucket handle fractures/Corner fractures—are pathognomonic—see bottom right X-rays here
- Multiple fractures seen simultaneously in variable stages of healing—Skull fractures + Rib fractures in top row here and long bone fractures in lower row here in the X-ray.

Subarachnoid Hemorrhage (SAH)

PYQ ALERT "FMGE DEC 2021 PATTERN"/FMGE JULY 2025 AND NEET PG 2024



MC cause of SAH—Trauma^Q

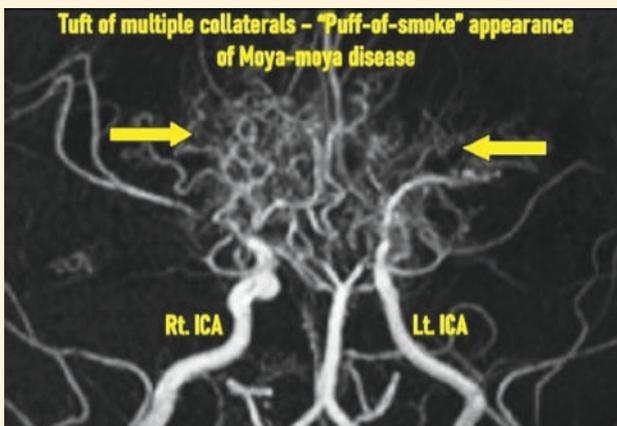
- MC cause of nontraumatic SAH—rupture of berry aneurysm^Q
- MC site of berry aneurysm—anterior communicating artery (ACoM)^Q

CLINICAL CLINCHER

History:

- Middle-aged patient
- Thunderclap headache^Q/worst headache of my life^Q
- Altered sensorium
 - Hunt-Hess grading system^Q is used—predicts outcome
 - IOC for acute SAH—CT
 - IOC for subacute SAH—MRI
 - Best MRI sequences—Gradient Echo (GRE) and Susceptibility Weighted Imaging (SWI)

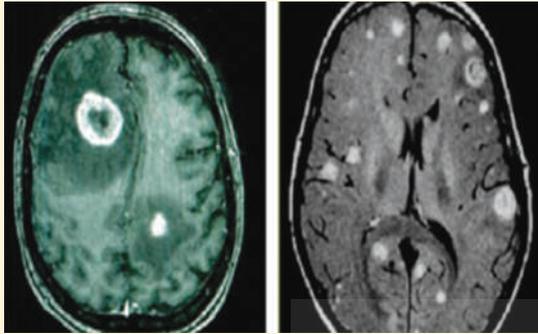
Stroke specifics



Moyamoya disease:

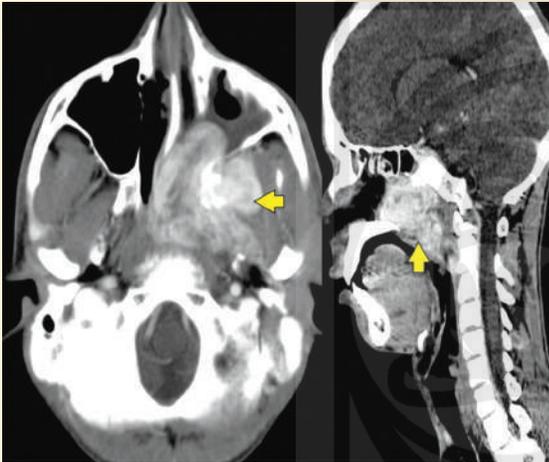
- Idiopathic arteriopathy is common in Japan. It is characterized by progressive narrowing of supraclinoid internal carotid artery.
- Gradual ICA narrowing leads to multiple small abnormal net-like collaterals seen on Digital Subtraction Angiography (DSA)—as if a "Puff-of-smoke"^Q is rising up—hence, the name.

Miscellaneous tumors



Brain metastases:

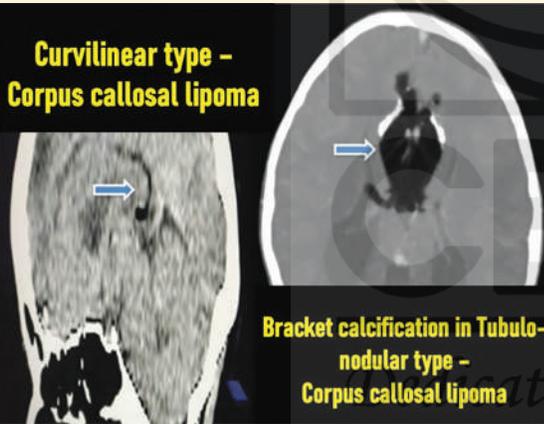
- Most common brain tumor in adults^Q
- Most common Primary tumors—Lung^Q > Breast > Melanoma
- Melanoma metastases—appear T1 hyperintense^Q



CLINICAL CLINCHER

Juvenile Nasopharyngeal Angiofibroma (JNAF)

- Adolescent male
- C/o epistaxis
- Intensely enhancing mass at Sphenopalatine foramen
- Seen exclusively in adolescent males^Q
- Hollman-Miller sign^Q Mass pushes the posterior wall of the maxillary sinus anteriorly
- MRI—salt and pepper appearance^Q due to flow voids of blood vessels



Curvilinear type - Corpus callosal lipoma

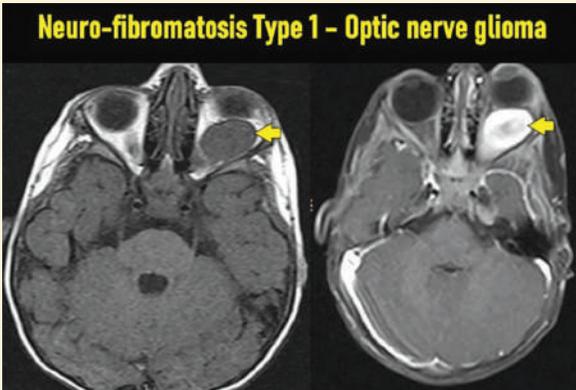
Bracket calcification in Tubulonodular type - Corpus callosal lipoma



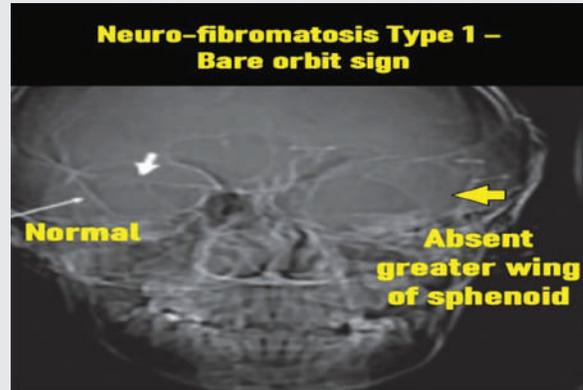
RETINOBLASTOMA

- Heterogenous retinal intraocular mass
- Clinically - Leucocoria
- IOC for staging - MRI

Familial brain tumor syndromes/phakomatoses



Neuro-fibromatosis Type 1 - Optic nerve glioma



Neuro-fibromatosis Type 1 - Bare orbit sign

Normal

Absent greater wing of sphenoid

Landmark findings in early pregnancy



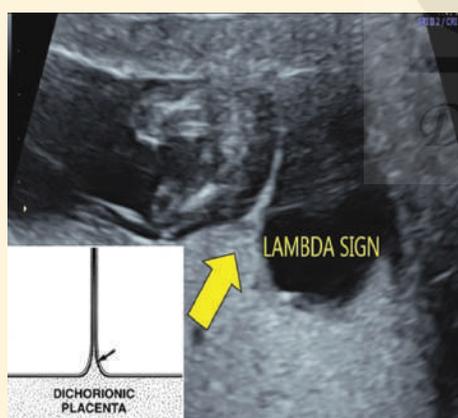
- To be done only when CRL is between 45 mm and 84 mm
- A translucency at nuchal region (back of neck) is measured
- Screening test for aneuploidies—trisomy 21/18/13
- If fetus has aneuploidy/turner syndrome/cardiac disease—NT is increased
- Combined test = NT scan + double marker blood test—has higher sensitivity

CLINICAL CLINCHER

Best parameter for Dating of gestation in 1st trimester	Crown rump length (CRL) ^Q
Best parameter for Dating of gestation in 2nd trimester	Biparietal diameter (BPD) ^Q > Head circumference (HC) ^Q
Best parameter for Dating of gestation in 3rd trimester	Femur length (FL) ^Q
Overall best time for dating of gestation	1st trimester ^Q
Overall best parameter for dating of gestation	Crown rump length (CRL) ^Q
Overall best parameter for estimation of birth weight (IUGR/macrosomia)	Abdominal circumference (AC) ^Q

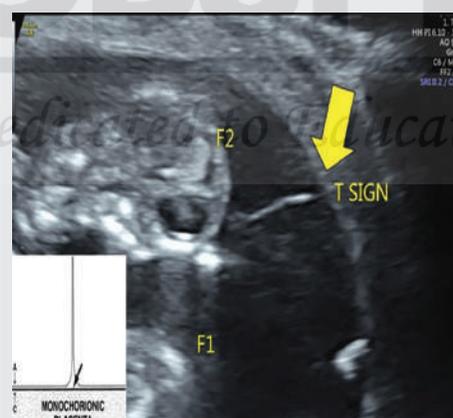
OBSTETRIC IMAGING SPECIFICS

Dichorionic pregnancy



Twin peak sign^Q/Lambda sign^Q

Monochorionic pregnancy



T sign^Q

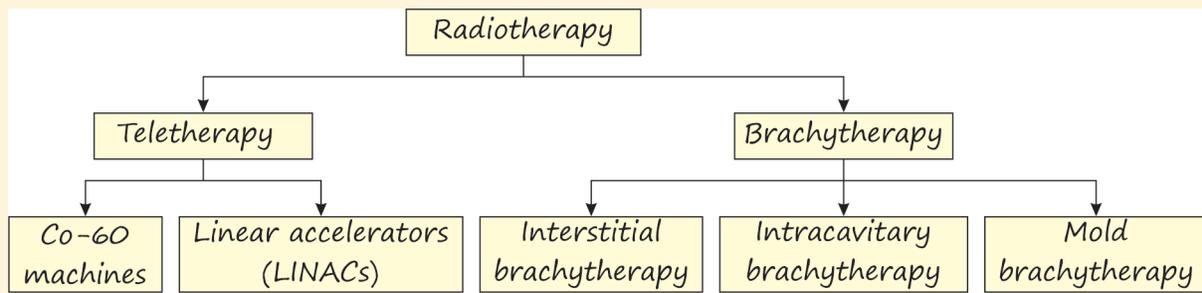
Anencephaly



Mickey mouse sign^Q/Frog eye appearance^Q

PYQ ALERT (NEET PG 2024 PATTERN)

Types of Radiotherapy: Based on method of administration

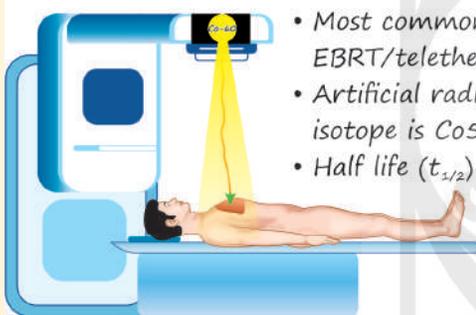


Types of Teletherapy:

External Beam Radiotherapy (EBRT)/Teletherapy

Disadvantages of Co-60 machines:
 1. Radiation exposure to department personnel^o

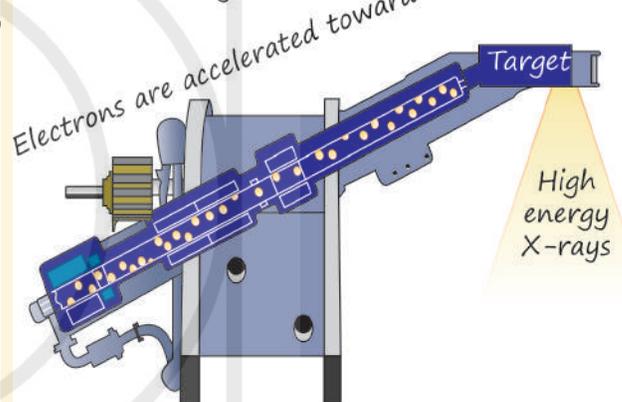
Cobalt 60 machines



2. Inefficient functioning^o
- Most common isotope used in EBRT/teletherapy^o
 - Artificial radioisotope^o (Natural isotope is Co59-Nonradioactive)
 - Half life ($t_{1/2}$) = 5.2 years^o

Linacs-Linear accelerators

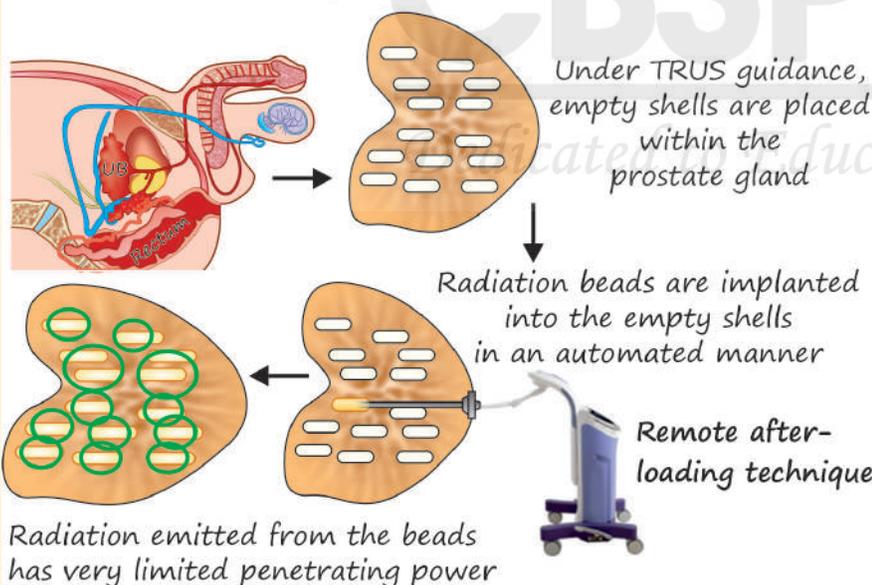
Linacs are modified, heavy duty X-ray tubes



PYQ ALERT (FMQE JULY 2025 PATTERN)

Types of Brachytherapy

Interstitial Brachytherapy:



Intracavitary Brachytherapy



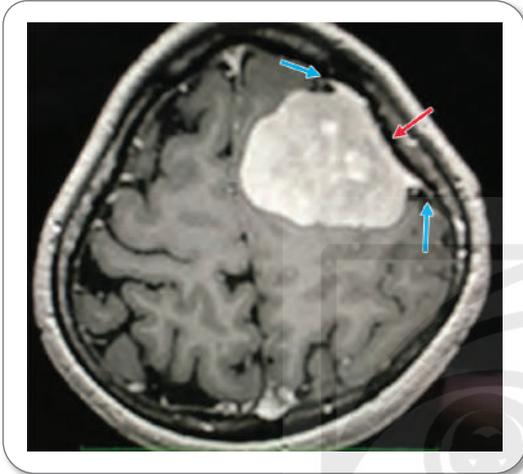
Contd...

LATEST QUESTION PAPERS

- NEET PG 2025 (MEMORY-BASED)
- NEET PG 2024 (MEMORY-BASED)
- NEET PG 2023 (MEMORY-BASED)
- NEET PG 2022 (MEMORY-BASED)
- NEET PG 2021 (MEMORY-BASED)
- NEET PG 2020 (MEMORY-BASED)
- INI-CET NOVEMBER 2025 (MEMORY-BASED)
- INI-CET MAY 2025 (MEMORY-BASED)
- INI-CET NOVEMBER 2024 (MEMORY-BASED)
- INI-CET MAY 2024 (MEMORY-BASED)
- INI-CET NOVEMBER 2023 (MEMORY-BASED)
- INI-CET MAY 2023 (MEMORY-BASED)
- INI-CET NOVEMBER 2022 (MEMORY-BASED)
- FMGE JULY 2025 (MEMORY-BASED)
- FMGE JANUARY 2025 (MEMORY-BASED)
- FMGE JULY 2024 (MEMORY-BASED)
- FMGE JANUARY 2024 (MEMORY-BASED)
- FMGE JANUARY 2023 (MEMORY-BASED)
- FMGE JULY 2023 (MEMORY-BASED)
- FMGE JUNE 2021 (MEMORY-BASED)
- FMGE DECEMBER 2021 (MEMORY-BASED)
- FMGE AUGUST 2020 (MEMORY-BASED)
- FMGE DECEMBER 2020 (MEMORY-BASED)

NEET PG 2025 (Memory-Based)

1. A woman presented with recurrent headaches. Identify the lesion in the given MRI.



- Glioma
- Ependymoma
- Pilocytic astrocytoma
- Meningioma

Ans. d. Meningioma

Ref: Grainger & Allison's Diagnostic Radiology 6th edition—Page no. 1278

Explanation The image shows an intensely enhancing extra-axial lesion with broad based toward dura and tapering dural tails; hence, it is suggestive of a meningioma.

Meningioma clinchers

- Dural-based intensely enhancing extra-axial mass lesion
- Hyperdense on NC-CT^Q
- Dural tails^Q: Tapered portion toward the dural surface—suggests a dural origin
- Mother-in-law sign on angiography^Q: Enhancement is like a mother-in-law—comes early in life and stays put for a long time....hope you get it!!
- Associated with hyperostosis of skull^Q
- Pneumosinus dilatans^Q: Associated with enlargement of paranasal sinuses
- Sunburst (spoke-wheel) pattern of vessels^Q on angiography
- Elevated alanine^Q on MR spectroscopy
- May be associated with NF2^Q: MISME syndrome^Q—multiple inherited schwannomas and meningiomas and ependymomas

2. What is the most appropriate statement regarding the given investigation?



- Invasive and can be therapeutic treatment for bladder calculi
- Noninvasive and used to diagnose ureteropelvic junction obstruction
- Noninvasive and gold standard for bladder cancer
- Requires percutaneous access to the renal pelvicalyceal system

Ans. b. Noninvasive and used to diagnose ureteropelvic junction obstruction

Ref: Radiological Procedures (A Guideline)—Dr Bhusan N. Lakhkar 3rd Edition—Page no. 27

Explanation The image shows an Intravenous urography (IVU) spot image. IVU is done by injecting iodinated contrast intravenously. As it travels in the systemic circulation into the arteries—it reaches the kidneys and gets filtered at the glomerulus—hence, highlights the kidneys, the renal calyces, ureters and the urinary bladder. Thus any cause of urinary tract obstruction such as calculi, pelviureteric junction obstruction can be diagnosed using IVU. It is a noninvasive technique and is not therapeutic for bladder calculi. It can help us seen a bladder mass or cancer as a filling defect in the UB however, is not the Gold standard for the same. It requires percutaneous access to the veins and not directly to the renal pelvicalyceal system per se.