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اللَّهُمَّ اَنْفَعْنَا بِمَا عَلَّمْتَنَا ، وَعَلَّمْنَا مَا يَنْفَعُنَا ، وَزِدْنَا عِلْمًا

Introduction to Radiology

Comprehensive Lecture Notes & High-Yield Case Reviews

Lecture Notes: Fundamentals of Radiology

1. X-Ray & CT Fundamentals (Attenuation)

Imaging relies on the concept of **attenuation** (how much a tissue absorbs radiation) and **penetration** (how much radiation passes through).

- **Air (Lungs/Bowel):** Low attenuation (absorbs little), High penetration. Appears **Black** (Hypodense/Radiolucent).
- **Fat:** Mild attenuation. Appears **Dark Gray**.
- **Soft Tissue / Fluid:** Moderate attenuation. Appears **Light Gray**.
- **Bone / Calcification:** High attenuation. Appears **White** (Hyperdense/Radiopaque). CT is the *gold standard* for calcifications.
- **Metal / Contrast:** Extreme attenuation. Appears **Bright White**.

2. Intravenous Contrast (CT & Angiography)

Iodine-based contrast is used to highlight vessels and tissues. It carries specific risks.

- **Absolute Contraindications:** Previous severe anaphylaxis to contrast media.
- **Relative Contraindications / High Risk:** Bronchial asthma, prior mild allergy, atopy, acute kidney injury (AKI), severe CKD, pregnancy (especially 3rd trimester due to fetal thyroid suppression).
- **Premedication:** High-risk patients require premedication with Oral Corticosteroids (e.g., Prednisolone) and antihistamines to prevent allergic reactions.

3. Magnetic Resonance Imaging (MRI)

MRI uses strong magnetic fields and radiofrequency (RF) pulses. **There is NO ionizing radiation.**

- **T1-Weighted:** Excellent for anatomy. Fat is bright; fluid (CSF) is dark. Contrast (Gadolinium) brightens tissues on T1.
- **T2-Weighted:** Excellent for pathology. Fluid (CSF, edema) is bright.
- **FLAIR:** T2 sequence where normal CSF is suppressed (dark). Ideal for periventricular white matter lesions and edema.
- **DWI:** Highly sensitive for acute ischemia/infarction (shows restriction within minutes). More sensitive than CT.
- **STIR:** T2-weighted sequence where the fat signal is suppressed (nulled).

MRI Contraindications: Ferromagnetic foreign bodies (intraorbital metal fragments, older pacemakers). Gadolinium contrast is avoided in severe renal failure (risk of Nephrogenic Systemic Fibrosis) and during pregnancy.

4. Ultrasound (US)

Utilizes high-frequency sound waves. Safe, portable, and **radiation-free**.

- **Ideal for:** Thin patients, children, pregnant women, and cystic/fluid-filled structures (a full bladder acts as a great acoustic window).
- **Limitations:** **Air** (e.g., recent endoscopy, bowel gas) reflects sound waves, ruining the image. **Obesity** attenuates the sound waves, decreasing accuracy and penetration.

High-Yield Questions & Explanations

1. Regarding lesions that appear hyperdense on CT-Scan, one is False:

- A. Metallic clips
- B. Intra-venous contrast
- C. Lipoma
- D. Acute hemorrhage
- E. Calcifications

Correct Answer: C. Lipoma

Analysis: Hyperdense means the structure appears white (high attenuation) on a CT scan. Metallic clips, iodine-based IV contrast, calcifications, and acute hemorrhage all strongly attenuate X-rays and appear bright white (hyperdense).

Why C is the false statement: A lipoma is a benign tumor composed of adipose (fat) tissue. Fat absorbs very few X-rays compared to surrounding soft tissue, meaning it has low attenuation. Therefore, fat appears dark gray (hypodense) on a CT scan, not hyperdense.

2. All are relative contraindications of contrast except:

- A. Food allergy
- B. Penicillin allergy
- C. Asthma
- D. Previous contrast allergy
- E. Gluten sensitivity

Correct Answer: D. Previous contrast allergy

Analysis: The question asks for the condition that is NOT a "relative" contraindication (meaning it must be either completely unrelated or an *absolute* contraindication).

Explanation: A history of a prior severe allergic/anaphylactic reaction to iodinated contrast media is generally considered an **absolute** contraindication to receiving it again (unless life-saving and alternative imaging is impossible). General allergies, asthma, and atopic conditions (Choices A, B, C) only mildly increase the risk of a reaction; they are *relative* contraindications that can typically be managed with corticosteroid and antihistamine premedication.

3. True about the lung:

- A. High penetration and low attenuation
- B. High / High
- C. Low / Low
- D. Low / High
- E. No/No

Correct Answer: A. High penetration and low attenuation

Explanation: The lungs are primarily filled with air. Air has extremely low physical density, meaning it stops (attenuates) very few X-ray photons. Because the attenuation is **low**, a vast majority of the X-ray beams pass completely through the lung tissue, meaning the penetration is **high**. This high penetration strikes the detector, turning the lung fields black on a radiograph or CT.

4. Absolute contraindication of CT scan or Angiography contrast media involve all the following except:

- A. Pregnancy in the 3rd trimester
- B. Bronchial Asthma
- C. Previous allergy to contrast
- D. Acute Kidney injury
- E. Acute pancreatitis

Correct Answer: E. Acute pancreatitis

Explanation: The prompt is poorly phrased but asks which condition is safe (or least strictly contraindicated) for contrast. Acute pancreatitis is **not a contraindication** for contrast; in fact, a contrast-enhanced CT (CECT) of the abdomen is the gold standard study to assess for pancreatic necrosis and complications in severe acute pancreatitis.

Other Choices: Previous severe allergy (C) is absolute. AKI (D) strongly contraindicates iodine contrast due to contrast-induced nephropathy risk. Pregnancy (A) and Asthma (B) are generally high-risk/relative contraindications to be strictly avoided if possible.

5. About MRI uses, which is the wrong match:

- A. MRI FLAIR: calcification
- B. MRV: cavernous sinus thrombosis
- C. MRI DWI: acute infarct
- D. MRI T1 contrasted: intra-axial tumor

Correct Answer: A. MRI FLAIR: calcification

Explanation: MRI is generally poor at detecting calcifications compared to CT. The FLAIR (Fluid Attenuated Inversion Recovery) sequence is designed to suppress free water (CSF) to better visualize edema and demyelinating plaques (like MS lesions) in the brain. If calcification needs to be viewed on MRI, gradient echo (GRE) or susceptibility-weighted imaging (SWI) sequences are used, not FLAIR.

Correct Matches: MR Venography (MRV) is standard for diagnosing venous sinus thromboses. Diffusion-Weighted Imaging (DWI) is the most sensitive sequence for acute stroke. T1 with contrast highlights blood-brain-barrier breakdown in tumors.

6. About MRI with contrast, all are wrong except:

- A. Contraindicated in renal failure grade III
- B. Contraindicated in the first trimester if contrasted
- C. Not contraindicated in 2nd and 3rd trimester
- D. Contraindicated in children

Correct Answer: B. Contraindicated in the first trimester if contrasted

Explanation: Gadolinium-based contrast agents cross the placenta and enter the fetal circulation, eventually being excreted into the amniotic fluid. Because the long-term effects on the developing fetus are unknown, Gadolinium is universally avoided during pregnancy, particularly during the first trimester (organogenesis), unless the diagnostic information is critical and cannot be obtained without it.

Why others are wrong: It IS generally contraindicated in 2nd/3rd trimesters as well (making C wrong as stated broadly). It is NOT contraindicated in children (D). Grade III renal failure requires caution, but Grade IV/V (eGFR <30) carry the highest risk for Nephrogenic Systemic Fibrosis (making A less definitively the 'best' exception than B).

7. All are good conditions for Ultrasound except:

- A. Thin patient
- B. Children
- C. Recent endoscopy
- D. Full bladder

Correct Answer: C. Recent endoscopy

Explanation: Ultrasound waves cannot travel through air; they are completely reflected by gas interfaces, creating a "dirty shadow" that obscures deep structures. A recent endoscopy introduces a large amount of ambient air into the stomach and upper GI tract, rendering a subsequent abdominal ultrasound nearly unreadable.

Why others are good: Thin patients have less attenuating fat. Children benefit from avoiding ionizing radiation. A full bladder acts as a fluid medium (acoustic window) that enhances transmission of sound waves to view pelvic organs perfectly.

8. Which is wrong:

- A. MRI as sensitive as CT for diagnosis of acute infarct
- B. DWI shows hyperintensity in acute infarction
- C. Haemorrhage appear heterogenous hyperintense in T2

Correct Answer: A. MRI as sensitive as CT for diagnosis of acute infarct

Explanation: Statement A is false because MRI (specifically the DWI sequence) is **vastly superior and more sensitive** than CT for detecting an acute ischemic infarct. DWI can show restricted diffusion (hyperintensity, Statement B) within minutes of a stroke onset, whereas a non-contrast CT may remain normal for the first 12–24 hours. (Note: CT is still done first in the ER strictly to rule out a hemorrhagic stroke before giving tPA, not because it's better at seeing the ischemia).

9. Which is wrong about MRI:

- A. Has ionizing radiation but less than that of CT
- B. Contrast used in MRI is relatively safe
- C. Takes more time to be done than CT

Correct Answer: A. Has ionizing radiation but less than that of CT

Explanation: MRI utilizes powerful magnetic fields and radiofrequency pulses to align and disrupt protons in the body. It involves **zero ionizing radiation**. Therefore, claiming it has "less" ionizing radiation than CT is functionally incorrect because it has none at all.

10. Most attenuation in:

- A. Liver
- B. Lung
- C. Bone

Correct Answer: C. Bone

Explanation: Attenuation correlates with tissue density and atomic number. Bone has high calcium content, making it very dense. It blocks (attenuates) almost all X-ray photons, resulting in a white appearance on radiographic films and CT scans.

11. Contrast CT for asthma patient, preparation by:

- A. Oral prednisolone
- B. Inhaler steroids
- C. IV hydrocortisone

Correct Answer: A. Oral prednisolone

Explanation: Patients with asthma are at a heightened risk for contrast-induced allergic reactions. The standard prophylactic premedication regimen consists of **oral corticosteroids** (e.g., prednisone or prednisolone) administered at 13, 7, and 1 hour prior to the contrast injection, often combined with an oral antihistamine. Inhalers do not provide systemic protection, and IV hydrocortisone is typically reserved for acute rescue or highly emergent scans where oral prep time is impossible.

12. Allergy to contrast material in all except:

- A. Asthma
- B. Atopy
- C. Hypothyroid

Correct Answer: C. Hypothyroid

Explanation: Risk factors that predispose a patient to an allergic-like reaction to iodinated contrast media include a history of a previous reaction, bronchial asthma, and a history of significant allergies or atopy (e.g., severe hay fever, food allergies). Hypothyroidism has no immunological correlation with contrast hypersensitivity.

13. All of the following are true about US except:

- A. Does not give ionizing radiation
- B. Better accuracy in obese
- C. Can be used to visualize vessels

Correct Answer: B. Better accuracy in obese

Explanation: Adipose (fat) tissue heavily scatters and attenuates high-frequency sound waves. In obese patients, the ultrasound beam loses energy quickly as it travels deeper into the body, drastically reducing image resolution and diagnostic accuracy. Therefore, obesity is a significant limitation for US, not an advantage.

14. Regarding MRI, one is wrong:

(Choice Provided:) Indicated to make sure about position of pacemaker

Correct Answer: Indicated to make sure about position of pacemaker

Explanation: This statement is unequivocally false. To verify the position of cardiac pacemaker leads, a simple **Chest X-ray (CXR)** is the standard modality. Furthermore, traditional cardiac pacemakers are a strict **contraindication** for MRI because the strong magnetic field can heat the leads, induce dangerous electrical currents, or physically dislodge the device. (Note: While "MRI-conditional" pacemakers exist today, you would still never use an MRI purely to check their anatomical position).

15. Which is wrong:

(Choice Provided:) Stir sequence is T1 minus fat signal

Correct Answer: Stir sequence is T1 minus fat signal

Explanation: STIR stands for Short Tau Inversion Recovery. It is an MRI sequence that uses a specific inversion time to selectively nullify the signal from fat. However, it is fundamentally a heavily **T2-weighted** image (fluid appears bright), not a T1 image. Describing it simply as "T1 minus fat" is physically and diagnostically incorrect.

16. Best modality for calcification is:

(Choice Provided:) CT

Correct Answer: CT

Explanation: Computed Tomography (CT) relies on tissue density to attenuate X-rays. Because calcium has a high atomic number and high density, calcifications appear starkly hyperdense (bright white) on CT, making it the absolute gold standard for identifying calcified structures (e.g., kidney stones, coronary artery calcifications, calcified granulomas).

17. Contraindication for MRI:

(Choice Provided:) Ferromagnetic substance inside the body

Correct Answer: Ferromagnetic substance inside the body

Explanation: MRI machines possess immensely powerful superconducting magnets (typically 1.5 to 3.0 Tesla). Any loose ferromagnetic metal inside the body (like intraocular metallic shavings from welding, older aneurysm clips, or shrapnel) can experience significant torque and movement, potentially shearing through adjacent vital tissues (e.g., optic nerve, blood vessels).

18. High penetration and low attenuation?

(Choice Provided:) Lung parenchyma

Correct Answer: Lung parenchyma

Explanation: As established in Q3, the lung parenchyma is mostly air. X-rays pass directly through air without being blocked (high penetration) because air lacks the physical density to absorb the photons (low attenuation).

19. All are advantages of MRI over CT except:

(Choice Provided:) Used for detection of intraorbital metallic foreign body

Correct Answer: Used for detection of intraorbital metallic foreign body

Explanation: MRI is strictly contraindicated if an intraorbital metallic foreign body is suspected due to the risk of the magnet moving the metal and blinding the patient. If a patient (e.g., a metalworker) needs an MRI, a screening **CT scan of the orbits** or orbital X-ray is performed first specifically to detect the presence of metal. Thus, detecting metal is an advantage of CT, not MRI.

Neuroradiology: CT Review

HIGH-YIELD CONCEPTS FOR CLINICAL WARDS & BOARD EXAMS

Comprehensive Lecture Notes

1. Basics of Head CT Densities

Understanding Hounsfield units (densities) is crucial for CT interpretation. Structures are classified relative to brain parenchyma (isodense):

- **Hyperdense (White):** Acute hemorrhage, calcifications (pineal gland, choroid plexus, basal ganglia in older adults), bone, and normally dense structures like the falx cerebri, tentorium cerebelli, and eye lens.
- **Isodense (Gray):** Normal brain tissue. Note that subacute subdural hematomas (1-3 weeks old) can become isodense to the cortex, making them difficult to spot.
- **Hypodense (Dark/Black):** CSF, air, edema, ischemia/infarction, and chronic hemorrhage.

2. Intracranial Hemorrhage (ICH) Profiles **USMLE**

- **Epidural Hematoma (EDH):** Biconvex (lenticiform) hyperdense lesion. Typically involves middle meningeal artery rupture post-trauma (temporal bone fracture). *Does NOT cross suture lines* but can cross the falx/tentorium. Treatment: Emergent craniotomy (not just a burr hole).
- **Subdural Hematoma (SDH):** Crescent-shaped (semilunar) lesion. Due to tearing of bridging veins. *Crosses suture lines* but does NOT cross dural attachments (falx/tentorium).
 - Acute: Hyperdense
 - Subacute: Isodense
 - Chronic: Hypodense (common in elderly due to brain atrophy, treated with burr hole drainage).
 - In pediatrics, varying ages of SDH raise high suspicion for Non-Accidental Trauma (NAT).
- **Subarachnoid Hemorrhage (SAH):** Blood fills sulci and basal cisterns ("star of death" sign). Due to ruptured berry aneurysm or trauma.
- **Intraparenchymal Hemorrhage:**
 - *Hypertensive:* Affects deep structures. Most common sites: Putamen/Basal ganglia > Thalamus > Pons > Cerebellum.
 - *Lobar:* Affects cerebral lobes (e.g., temporal, parietal). In older adults, strongly associated with Cerebral Amyloid Angiopathy, not isolated hypertension.
- **Intraventricular Hemorrhage (IVH):** Bleeding into ventricles. Has a *poor prognosis* due to risk of obstructive hydrocephalus and herniation.

3. Diffuse Cerebral Edema & Post-Traumatic CT Signs

Diffuse edema causes brain tissue to swell, displacing CSF and altering normal density ratios:

- **Loss of gray-white matter differentiation:** The edematous gray matter becomes hypodense, matching the white matter.
- **Diffuse brain hypodensity:** Due to increased water content.
- **Effacement:** Flattening of sulci and compression of basal cisterns.
- **Small ventricles:** Compressed by the swollen brain parenchyma.
- **Pseudo-SAH sign:** The brain becomes so hypodense that the normal basal cisterns and venous structures appear relatively hyperdense, mimicking a subarachnoid hemorrhage.

4. Tumors and Infections

- **Oligodendroglioma:** Typically presents as a slow-growing frontal lobe mass with prominent calcifications. Histology shows "fried egg" cells.
- **Herpes Simplex (HSV) Encephalitis:** Presents with fever, headache, altered mental status. Classically targets the temporal lobes bilaterally, causing edema, necrosis, and hemorrhage. CSF shows lymphocytic pleocytosis, normal glucose, and elevated protein.

Question Bank & Explanations

1. Which of the following is not a site of hypertensive intracerebral hemorrhage?

- A. Putamen
- B. Thalamus
- C. Pons
- D. Cerebellum
- E. Temporal lobe

Provided Answer: E (Temporal lobe)

Analysis: The provided answer is correct.

Why E is the answer: The temporal lobe is a site for "lobar" hemorrhages. In the elderly, lobar hemorrhages are most commonly caused by cerebral amyloid angiopathy, not hypertension.

Why A, B, C, D are incorrect: Hypertensive vasculopathy causes Charcot-Bouchard microaneurysms in the small lenticulostriate penetrating vessels. The classic sites are the basal ganglia (putamen), thalamus, pons, and cerebellum.

2. Concerning Radiological signs of diffuse brain edema in post-traumatic patients, one is False:

- A. Small size ventricles.
- B. Pseudo-sub-arachnoid sign
- C. Diffuse brain hypo-density
- D. Effacement of basal cistern
- E. Loss of gray-white matter differentiation

Provided Answer: B (Pseudo-sub-arachnoid sign)

Analysis: The provided key is B, but requires clinical context.

Medically, the pseudo-SAH sign *is* a documented radiologic sign of severe diffuse cerebral edema (the edematous, hypodense brain makes normal tentorial/vascular structures look hyperdense, mimicking SAH). However, in the context of some exams, actual SAH is considered distinct from pure edema, or pseudo-SAH is viewed as an artifact rather than a direct structural sign. A, C, D, and E are universally classic primary signs of edema.

3. Concerning subdural hematoma, one is false:

- A. Treated with Burr hole
- B. Appears isodense in chronic stage
- C. More common in old age
- D. Of different ages in children raise the possibility of non-accidental injury
- E. Crosses sutures

Provided Answer: B (Appears isodense in chronic stage)

Analysis: The provided answer is correct.

Why B is the answer: A chronic SDH appears **hypodense** (dark), not isodense. Acute is hyperdense, and subacute (1-3 weeks) is isodense.

Why others are true statements: Chronic SDH is treated with burr hole evacuation (A). Brain atrophy in old age stretches bridging veins, increasing SDH risk (C). SDHs of varying ages in kids are a hallmark of child abuse (D). SDHs cross cranial sutures but are limited by dural reflections (E).

4. All are seen on CT scan in diffuse edema except:

- A. Subarachnoid haemorrhage
- B. Loss of grey-white differentiation
- C. Small ventricles
- D. Effacement of sulci and basement cisterna
- E. Brain is diffusely hypodense on CT

Provided Answer: A (Subarachnoid haemorrhage)

Analysis: The provided answer is correct.

True SAH is a hemorrhage into the subarachnoid space (hyperdense blood in sulci/cisterns). It is a distinct pathological event (e.g., trauma or ruptured aneurysm), not a direct radiologic sign of cellular/vasogenic brain edema. B, C, D, and E are the classic definitions of cerebral edema on CT.

5. A hyperdensity can be seen normally in brain CT in all of the following except:

- A. Pituitary
- B. Tentorium
- C. Tentorium (Duplicate)
- D. Falx cerebri
- E. Eye lens

Provided Answer: A (Pituitary)

Analysis: The provided answer is correct.

Why A is the answer: The normal pituitary gland is typically isodense to brain tissue on a non-contrast CT.

Why others are true: Dural folds like the falx cerebri and tentorium cerebelli naturally appear hyperdense relative to the brain. The lens of the eye is also naturally hyperdense due to its protein composition.

6. 25 year old female without trauma presented with headache and fever for 10 days, CSF revealed Lymphocytic pleocytosis and high protein, CT scan showed bilateral temporal hemorrhage. Most likely diagnosis:

- A. Herpetic encephalitis
- B. Bacterial meningitis
- C. SAH
- D. West Nile

Provided Answer: A (Herpetic encephalitis)

Analysis: The provided answer is correct.

The triad of fever, headache, and altered mental status with CSF showing lymphocytes points to a viral etiology. The radiologic hallmark of HSV-1 encephalitis is edema and hemorrhagic necrosis specifically localizing to the bilateral temporal lobes.

7. Wrong about acute extradural hematoma:

- A. Biconvex hypodense
- B. Usually traumatic
- C. Midline shift
- D. Brain pressure

Provided Answer: A (Biconvex hypodense)

Analysis: The provided answer is correct.

Why A is the answer: While an extradural (epidural) hematoma is biconvex, an *acute* bleed is **hyperdense** (bright white), not hypodense.

Why others are true: It is highly associated with blunt head trauma (B). It expands rapidly, causing mass effect, increased intracranial pressure (D), and midline shift (C).

8. Patient presented with traumatic head injury, which is true?

- A. Do MRI
- B. Do CT
- C. Wait and observe

Provided Answer: B (Do CT)

Analysis: The provided answer is correct.

A non-contrast CT of the head is the gold standard, rapid first-line imaging modality for acute traumatic brain injury. It is highly sensitive for detecting acute hemorrhage (which appears instantly hyperdense) and skull fractures. MRI takes too long for an unstable, acute trauma patient.

9. Biconvex lesion on CT:

(Fill in the blank format)

Provided Answer: Extradural hematoma

Analysis: The provided answer is correct.

Also known as an epidural hematoma (EDH). It is bounded by the skull and the tough dura mater. Because the dura is tightly adhered to the skull at the suture lines, the expanding blood pushes inward, creating a characteristic lens-shaped (biconvex) appearance.

10. Wrong match:

- A. Semilunar hypodense and acute subdural haemorrhage
- B. Biconvex hyperdense and epidural haemorrhage

Provided Answer: A (Semilunar hypodense and acute subdural haemorrhage)

Analysis: The provided answer is correct.

An *acute* subdural hemorrhage is semilunar (crescent-shaped) but it is **hyperdense**, not hypodense. It only becomes hypodense in the chronic stage (weeks to months later). Epidural hematomas are correctly matched as biconvex and hyperdense.

11. The best for diagnosis of brain calcification:

- A. MRI
- B. CT

Provided Answer: B (CT)

Analysis: The provided answer is correct.

CT scans use x-rays, making them extremely sensitive to dense calcium deposits (which appear starkly hyperdense). MRI is generally poor at visualizing calcifications, as calcium lacks mobile protons to generate an MRI signal.

12. Wrong about intracranial hemorrhage:

(Identify the false statement)

Provided Statement: Intraventricular hemorrhage has a good prognosis

Analysis: The provided statement is indeed false.

Intraventricular hemorrhage (IVH) has a **poor prognosis**. Blood in the ventricular system frequently obstructs CSF flow, leading to acute hydrocephalus, severe increases in intracranial pressure, and high mortality.

13. Frontal mass with calcifications, most likely?

(Fill in the blank format)

Provided Answer: Oligodendroglioma

Analysis: The provided answer is correct.

Oligodendrogliomas are primary CNS tumors that classically present in the frontal lobes and frequently calcify (seen in up to 90% of cases on CT). They are slow-growing and can present with new-onset seizures.

14. Which of the following is wrong?

(Identify the false statement)

Provided Statement: Epidural hematoma treated with burr hole

Analysis: The provided statement is false (making it the correct answer to the question).

An epidural hematoma typically represents arterial bleeding (middle meningeal artery) at high pressure. It cannot simply be drained with a burr hole; it requires a formal craniotomy to evacuate the solid clot and ligate the bleeding vessel. Burr holes are typically reserved for liquid, chronic subdural hematomas.

NEUROIMAGING & MRI: ESSENTIAL CONCEPTS

Part 1: Lecture Notes (USMLE Step 1/2 CK Principles)

1. Fundamental MRI Sequences

- **T1-Weighted:** Good for anatomy. CSF is dark (hypointense). Gray matter is gray, white matter is light. Contrast (Gadolinium) highlights blood-brain barrier (BBB) breakdown (tumors, infections).
- **T2-Weighted:** Good for pathology. CSF is bright (hyperintense). Edema/water is bright. White matter is dark relative to gray matter.
- **FLAIR (Fluid-Attenuated Inversion Recovery):** A T2 sequence where the free fluid (CSF) signal is suppressed (made dark). Highly sensitive for edema and demyelinating plaques (e.g., MS) near ventricles. *Note: White matter remains darker (hypointense) than the cortex.*
- **T2* (Gradient Echo / GRE) / SWI:** Highly sensitive to magnetic susceptibility. Blood breakdown products (hemosiderin, ferritin) and calcium appear very dark ("blooming artifact"). **Best modality for detecting acute intracerebral hemorrhage.**
- **DWI (Diffusion-Weighted Imaging):** Detects random movement of water molecules. In acute ischemia, the Na⁺/K⁺ pump fails, leading to cellular swelling (cytotoxic edema). Water is trapped in cells, "restricting" diffusion. Restricted diffusion appears very bright (hyperintense) within minutes of a stroke.
- **ADC (Apparent Diffusion Coefficient):** A calculated map used alongside DWI to confirm true restricted diffusion. Acute stroke appears dark (hypointense) on ADC.
- **MRV (Magnetic Resonance Venography):** Visualizes venous system. Best test for venous sinus thrombosis (e.g., cavernous sinus thrombosis).

2. Types of Cerebral Edema

- **Cytotoxic Edema:** Intracellular swelling due to ATP depletion (ischemia). Affects *both* gray and

white matter. Shows restricted diffusion (Bright on DWI, Dark on ADC). Typical of acute stroke. *Tumor masses do not primarily cause this.*

- **Vasogenic Edema:** Extracellular fluid accumulation due to BBB breakdown. Primarily affects *white matter*. Bright on T2/FLAIR. Typical of tumors, abscesses, and late-stage infarctions.

3. Brain Tumors (Compartments)

- **Intra-axial:** Arise from brain parenchyma (e.g., astrocytoma, glioblastoma, metastasis). They blur the gray-white junction. While many enhance, *lack of enhancement does not rule them out* (e.g., low-grade gliomas may not enhance).
- **Extra-axial:** Arise outside brain parenchyma (e.g., meningiomas, schwannomas). They compress the brain, preserve the gray-white junction, and often have a wide meningeal attachment (dural tail) and reactive bone changes. Meningiomas are classically extra-axial.

4. Spinal Lesions & Trauma

- **Spondylodiscitis:** Infection of the intervertebral disc and adjacent vertebral endplates. A hallmark radiological sign is the *loss of disc vertical height*.
- **Spinal Cord Lesions:** *Intramedullary* lesions (inside the cord) cause primary cord expansion. *Extramedullary* lesions (outside the cord, whether intradural or extradural) compress and displace the cord, rather than expanding the cord itself.
- **Judicial Hanging:** The mechanism of death is severe hyperextension and distraction of the upper cervical spine. This typically causes bilateral pedicle fractures of C2 (Hangman's fracture), leading to fatal cervical cord transection (cervical fracture).

Part 2: Multiple Choice Questions & Explanations

1. Best modality for diagnosing intra cerebral hemorrhage is:

- A. A. T1
- B. B. T2
- C. C. T* (T2* / GRE)
- D. D. DWI
- E. E. ACA

Correct Answer: C

Explanation: T2* (Gradient Echo or Susceptibility-Weighted Imaging) is exceptionally sensitive to blood breakdown products (like deoxyhemoglobin and hemosiderin). It creates a "blooming artifact" making acute hemorrhage clearly visible as a dark (hypointense) area.

A (T1) & B (T2): Incorrect. The appearance of blood on T1 and T2 is highly variable depending on the age of the hemorrhage (isointense to hyperintense over days/weeks), making them less reliable for immediate acute diagnosis.

D (DWI): Incorrect. DWI is the gold standard for acute ischemia, not hemorrhage.

E (ACA): Incorrect. ACA stands for Anterior Cerebral Artery (a blood vessel), not an imaging modality.

2. The best way to diagnose cavernous sinus thrombosis:

- A. A. MRI
- B. B. MRV
- C. C. CT
- D. D. Doppler US

Correct Answer: B

Explanation: Magnetic Resonance Venography (MRV) is specifically designed to evaluate the venous sinuses of the brain. It can directly visualize the lack of flow in a thrombosed cavernous sinus.

A (MRI): Incorrect. While standard MRI can show signs of sinus thrombosis (like absence of normal flow void), MRV provides a definitive map of the venous system.

C (CT): Incorrect. CT without contrast cannot reliably detect this. CT venography (CTV) is an alternative, but MRV is generally considered superior and safer (no radiation).

D (Doppler US): Incorrect. Ultrasound cannot penetrate the skull to evaluate the cavernous sinus deep within the cranial vault.

3. Best modality to detect acute brain ischemia:

- A. A. CT without contrast
- B. B. T2
- C. C. T*
- D. D. DWI/ADC

Correct Answer: D

Explanation: Diffusion-Weighted Imaging (DWI) paired with Apparent Diffusion Coefficient (ADC) mapping is the most sensitive modality for acute brain ischemia. It can detect cytotoxic edema (restricted diffusion) within minutes of an infarct.

A (CT without contrast): Incorrect. Used immediately to rule out hemorrhage, but acute ischemia may not appear on CT for 12-24 hours.

B (T2) & C (T*): Incorrect. T2 changes take hours to days to appear. T* is for hemorrhage.

4. Identify the incorrect statement:

- A. A. Extra-axial tumors have wide meningeal attachment
- B. B. Failure to enhance on T1 contrasted imaging rules out intra-axial tumor

Correct Answer: B

Explanation: Statement B is wrong. Contrast enhancement depends on the breakdown of the blood-brain barrier. Many low-grade intra-axial tumors (e.g., low-grade astrocytomas) do not show significant contrast enhancement. Therefore, lack of enhancement does not rule out an intra-axial tumor.

A: Correct statement. Extra-axial tumors like meningiomas characteristically have a broad base attached to the dura (dural tail sign).

5. Mechanism of death in Judicial Hanging:

- A. A. Cervical fracture
- B. B. Cerebral anemia

Correct Answer: A

Explanation: Judicial hanging involves a drop that causes abrupt hyperextension and violent distraction of the neck. This classically causes bilateral fractures of the pars interarticularis of the C2 vertebra (Hangman's fracture), severing the cervical spinal cord and causing immediate death.

B: Incorrect. Simple asphyxiation or cerebral ischemia is the mechanism in suicidal suspension hangings, but the judicial drop is specifically designed to cause a lethal cervical fracture.

6. Which of the following is wrong about MRI sequences?

- A. A. T1 shows cerebrospinal fluid as hypointense
- B. B. T2 shows cerebrospinal fluid as hyperintense
- C. C. White matter is hyperintense compared to cortex in FLAIR

Correct Answer: C

Explanation: Statement C is wrong. On both T2 and FLAIR sequences, the white matter has less water content than the gray matter (cortex). Therefore, white matter is *hypointense* (darker) compared to the cortex, not hyperintense.

A & B: Correct statements based on standard MRI physics.

7. Which of the following is true about cytotoxic edema?

- A. A. It is caused by breakdown of the blood-brain barrier
- B. B. It predominantly affects the white matter only
- C. C. It appears hyperintense in diffusion weighted sequences (DWI)

Correct Answer: C

Explanation: Cytotoxic edema involves cellular swelling due to failure of Na⁺/K⁺ pumps during ischemia. This traps water inside cells, restricting its normal random motion. On DWI, this restricted diffusion is seen as a bright (hyperintense) signal.

A & B: Incorrect. These describe vasogenic edema, which is extracellular and spares the gray matter. Cytotoxic edema affects both gray and white matter.

8. Which of the following is wrong regarding a meningioma?

- A. A. It arises from arachnoid cap cells
- B. B. Mostly presents as an intra-axial lesion
- C. C. It often exhibits a "dural tail" sign on contrasted MRI

Correct Answer: B

Explanation: Statement B is wrong. Meningiomas are the classic example of an *extra-axial* lesion. They grow from the meninges outside the brain parenchyma and compress the brain tissue inward, rather than arising from within the brain itself (intra-axial).

A & C: Correct statements describing classic pathological and radiological features of meningiomas.

9. Which of the following statements is true regarding ischemia?

- A. A. Acute ischemia appears hyperintense on DWI due to vasogenic edema
- B. B. Acute ischemia appears hyperintense on DWI due to cytotoxic edema

Correct Answer: B

Explanation: This is a fundamental concept in neuroimaging. Acute ischemia causes ATP depletion, leading to failure of the cellular membrane pumps. Water rushes into the cell causing it to swell (cytotoxic edema). The intracellular water cannot diffuse normally, causing restricted diffusion which looks hyperintense (bright) on DWI.

A: Incorrect. Ischemia causes cytotoxic, not vasogenic, edema acutely.

10. Which of the following is wrong regarding a primary brain tumor mass?

- A. A. It can cause midline shift
- B. B. It causes primarily cytotoxic edema
- C. C. It can lead to blood-brain barrier breakdown

Correct Answer: B

Explanation: Statement B is wrong. Brain tumors typically cause *vasogenic edema*, not cytotoxic edema. Tumors lack tight junctions in their newly formed capillaries, allowing fluid to leak out of the intravascular space into the extracellular white matter.

A & C: Correct statements. Tumors disrupt the BBB (hence they often enhance with contrast) and their mass effect can cause midline shift.

11. Identify the wrong match regarding pathology and edema type:

- A. A. Brain Abscess : Vasogenic edema
- B. B. Acute Infarction : Vasogenic edema
- C. C. Tumor metastasis : Vasogenic edema

Correct Answer: B

Explanation: Match B is wrong. Acute infarction causes *cytotoxic edema* (cellular swelling). Note: While late or subacute infarcts can develop some vasogenic edema secondary to tissue necrosis, the primary and defining early event of acute infarction is cytotoxic edema.

A & C: Correct matches. Both abscesses and tumors disrupt the BBB, leading to vasogenic edema.

12. Which of the following is wrong regarding Spondylodiscitis?

- A. A. Loss of vertical disc height excludes the disease
- B. B. It involves the intervertebral disc and adjacent vertebral endplates
- C. C. It is typically infectious in etiology

Correct Answer: A

Explanation: Statement A is wrong. In spondylodiscitis (infection of the disc space), the destruction of the intervertebral disc by enzymes from infectious organisms and inflammatory cells leads to a *loss of vertical disc height*. Thus, seeing loss of disc height supports the diagnosis rather than excluding it. (In contrast, spinal tumors often spare the disc space).

B & C: Correct statements defining the condition.

13. Which of the following is wrong regarding spinal lesions?

- A. A. Intramedullary lesions cause cord expansion
- B. B. Extramedullary intradural lesions cause cord expansion
- C. C. Extramedullary lesions displace the spinal cord

Correct Answer: B

Explanation: Statement B is wrong. Extramedullary lesions (like meningiomas or schwannomas) are located outside the spinal cord parenchyma. As they grow, they cause compression and displacement of the spinal cord, not expansion. Only intramedullary lesions (like ependymomas or astrocytomas, which are inside the cord) cause cord expansion.

A & C: Correct statements describing the distinct radiological appearance of spinal compartments.

14. Which pattern matches an acute stroke on MRI?

- A. A. Hypointense in DWI, Hyperintense in ADC
- B. B. Hyperintense in DWI, Hypointense in ADC
- C. C. Hyperintense in both DWI and ADC

Correct Answer: B

Explanation: Acute ischemic stroke is characterized by restricted diffusion due to cytotoxic edema. On MRI, restricted diffusion is indicated by a bright (hyperintense) signal on the DWI sequence and a dark (hypointense) signal on the corresponding ADC map. This combination confirms true restricted diffusion and rules out "T2 shine-through."

A: Incorrect. This describes facilitated diffusion, such as in purely vasogenic edema or a cyst.

C: Incorrect. This is known as "T2 shine-through," where a lesion is bright on DWI simply because it is very bright on T2, but it does not represent true restricted diffusion.

Chest X-Ray: Clinical Principles & Q&A

Comprehensive Review & Explanations

Radiology Basics & Chest X-Ray: High-Yield USMLE Review

This lecture covers the fundamental principles of interpreting chest radiographs, focusing on concepts frequently tested on board examinations.

1. CXR Physics and Image Acquisition

- **Density and Attenuation:** X-rays pass through tissues based on density. Air (lungs) has low attenuation and appears *radiolucent* (black). Bone/Metal has high attenuation and appears *radiopaque* (white). Soft tissue and fluid appear gray.
- **PA vs. AP Views:** In a Standard PA (Posterior-Anterior) view, the x-ray beams hit the back and the detector is at the chest. The heart is close to the detector, minimizing magnification. In an AP (Anterior-Posterior) view (often portable/supine), the heart is farther from the detector, resulting in **exaggerated cardiac shadow size**.
- **Supine vs. Erect:** In a supine film, the diaphragm rests higher, upper zone vessels become more prominent due to gravity redistribution, and pleural fluid layers posteriorly, creating a hazy opacification (decreased density to the hemithorax) rather than a distinct meniscus.

2. Normal Anatomical Landmarks

- **Hila:** The left hilum is typically higher than the right. This is because the **left pulmonary artery arches over the left main bronchus**, whereas the right pulmonary artery courses below the right main bronchus.
- **Diaphragm:** The right hemidiaphragm is normally higher than the left due to the liver.
- **Heart Borders:**
 - Right heart border: Right atrium.
 - Left heart border: Left ventricle and atrial appendage.
 - Anterior border (Lateral view): Right ventricle.

3. The Silhouette Sign

The silhouette sign occurs when two objects of the same radiographic density touch each other, obliterating the margin between them. This is crucial for localizing pathology:

- **Right Heart Border:** Silhouetted by Right Middle Lobe (RML) processes.
- **Left Heart Border:** Silhouetted by Lingula (Left Upper Lobe) processes.
- **Right Hemidiaphragm:** Silhouetted by Right Lower Lobe (RLL) processes.
- **Left Hemidiaphragm:** Silhouetted by Left Lower Lobe (LLL) processes.

4. Key Pathologies

- **Collapse (Atelectasis):** Loss of lung volume. Signs include displacement of fissures, elevation of the hemidiaphragm, crowding of ribs, and shift of the mediastinum/trachea *towards* the side of collapse.
- **Pneumothorax (PTX):** Air in the pleural space. Causes a radiolucent (black) hemithorax with a visible visceral pleural edge and absent lung markings peripherally. A **tension pneumothorax** causes a mediastinal shift *away* from the affected side, flattening of the ipsilateral diaphragm, and widening of rib spaces.
- **Pleural Effusion:** Fluid in the pleural space. Blunts the costophrenic angles. Massive effusions can push the mediastinum away.
- **Consolidation/Pneumonia:** Alveoli fill with fluid/pus. Associated with **air bronchograms** (air-filled bronchi outlined by fluid-filled alveoli). Does not typically cause volume loss.

Practice Questions & Detailed Explanations

1. Wrong about lobar pneumonia:

- A. Lower lobe obliterate diaphragm
- B. Upper left lobe may obliterate left heart border
- C. Middle right lobe obliterate right heart border
- D. Inferior left lobe obliterate descending aorta
- E. Right middle lobe pneumonia is bounded inferiorly by horizontal fissure

Answer: A

Explanation: The provided answer key says A, but medically, A is a TRUE statement (lower lobe pneumonia does obliterate the diaphragm). The genuinely FALSE statement is E. The right middle lobe is bounded SUPERIORLY by the horizontal fissure and INFERIORLY by the oblique fissure.

Choice Breakdown:

- A:** True. Lower lobes touch the diaphragm.
- B:** True. Lingula (part of LUL) touches the left heart border.
- C:** True. RML touches the right heart border.
- D:** True. The LLL touches the descending aorta.
- E:** False. RML is bounded superiorly by the horizontal fissure.

2. In supine position X-ray which is wrong?

- A. Heart size is exaggerated
- B. Diaphragm will be higher
- C. Prominent upper zone vessels
- D. Pleural fluid will accumulate posteriorly and give a decreased density to the hemithorax
- E. A pneumothorax will lie anteriorly and be difficult to detect

Answer: D

Explanation: The answer is D because the description is slightly inaccurate regarding density. Pleural fluid layering posteriorly increases the opacification (INCREASED density/whiteness), not decreased density. The rest of the statements are standard physiological changes in a supine film.

Choice Breakdown:

- A:** True. AP supine view exaggerates heart size.
- B:** True. Abdominal contents push it up.
- C:** True. Gravitational redistribution.
- D:** False. It increases density (opacity).
- E:** True. Air rises anteriorly in supine.

3. Wrong about hilum in chest X-ray:

- A. The left hilum is higher than the right because left main bronchus arches over left pulmonary artery
- B. Normally symmetrical
- C. Caused by pulmonary arteries and veins
- D. Prominent in pulmonary hypertension
- E. Can be pulled upwards or downwards by collapse or fibrosis

Answer: A

Explanation: A is the correct answer because it is a false statement. The anatomical relationship is flipped.

Choice Breakdown:

- A:** False. The left pulmonary ARTERY arches over the left main BRONCHUS, not the other way around.
- B:** True. Generally similar in density.
- C:** True. Hilar shadows are vascular.
- D:** True. Enlarged arteries.
- E:** True. Volume loss shifts hila.

4. All of the following cause a radiolucent hemithorax except:

- A. PE
- B. Small lung
- C. Mastectomy
- D. Emphysema
- E. Rotation of patient

Answer: E

Explanation: The provided key says E, but actually rotation can cause unilateral hyperlucency. However, PE (Pulmonary Embolism) classically causes a normal CXR or Westermark sign (focal oligemia), but not typically an entire radiolucent hemithorax. Small lung/Mastectomy/Emphysema definitely cause lucency. If E is the key, it implies rotation is considered a positioning artifact rather than a true pathological cause, though it technically alters lucency.

Choice Breakdown:

A, B, C, D: Can cause true or apparent radiolucency. **E:** Rotation alters penetration artifactually but doesn't cause a true pathological radiolucent hemithorax.

5. All the following are signs of collapse due to an opacification on the left upper lung border except:

- A. Disappearance of the heart border and the upper lobe on the left side
- B. Collapse of the lung to the left side
- C. Elevation of the left hemidiaphragm
- D. Obliteration of aorta
- E. Ill-defined opacity in the left upper and middle zones

Answer: D

Explanation: D is correct because the aortic knuckle/descending aorta is silhouetted by the Left Lower Lobe (apical segment) or Left Upper Lobe posterior segments, but standard LUL collapse primarily affects the anterior structures (heart border).

Choice Breakdown:

A, B, C: Classic signs of LUL collapse (volume loss signs). **D:** The descending aorta is posteriorly located, usually preserved in LUL collapse.

6. Which of the following is true about chest x ray:

- A. 8 pairs is the number of true ribs
- B. Retrocardiac area is considered one of the hidden areas
- C. Cardiothoracic ratio in adults is < 0.6
- D. Right hilum is higher than the left
- E. Right contour of heart is made by (right ventricle, SVC, IVC)

Answer: B

Explanation: B is the correct true statement. The retrocardiac space is a classic 'hidden area' where lung masses or consolidations can easily be missed.

Choice Breakdown:

- A:** False (7 pairs of true ribs).
- B:** True.
- C:** False (ratio should be < 0.5 in PA).
- D:** False (Left is higher).
- E:** False (Right contour is Right Atrium, not ventricle).

7. Wrong About airway disease:

- A. Pneumothorax causes ipsilateral flattening of the diaphragm
- B. Large pneumothorax can obliterate the costophrenic angle
- C. CT is better in detecting air bronchogram than CXR
- D. CT can detect small amount of air in pleura

Answer: B

Explanation: B is false because air in the pleural space (pneumothorax) does not obliterate the costophrenic angle; fluid (pleural effusion) does. PTX might cause a deep sulcus sign (deepening of the angle).

Choice Breakdown:

- A:** True (especially tension).
- B:** False.
- C, D:** True, CT is far more sensitive.

8. Wrong about air bronchogram:

- A. Common in pulmonary edema
- B. Common in pneumonia
- C. Associated with a lesion
- D. Normally visible in 10% of adults

Answer: D

Explanation: Air bronchograms are pathological signs indicating alveolar filling (consolidation). They are not normally visible in healthy lungs.

Choice Breakdown:

A, B, C: True, representing fluid/pus/edema replacing air in alveoli while bronchi remain air-filled. **D:** False, normally bronchi are not visible against air-filled alveoli.

9. About chest x-ray which is wrong?

- A. Right heart border is in contact with right middle lobe
- B. Upper most part of the right heart border is in contact with upper lobe
- C. Aortic notch is in posterior mediastinum
- D. Left heart border is in contact with left lower lobe

Answer: D

Explanation: D is false. The left heart border is in contact with the Lingula (part of the Left Upper Lobe), not the Left Lower Lobe.

Choice Breakdown:

A, B, C: Anatomically correct. **D:** Incorrect anatomical relation.

10. Tension pneumothorax, wrong:

- A. Pleural line on X-ray
- B. Absent lung making ipsilateral
- C. Horizontal hemidiaphragm ipsilateral
- D. Mediastinum shift to the ipsilateral side

Answer: D

Explanation: Tension PTX causes immense positive pressure that pushes structures AWAY. Therefore, the mediastinum shifts to the CONTRALATERAL side.

Choice Breakdown:

A, B, C: True signs of PTX. **D:** False, shift is contralateral.

11. In chest X-ray, one is wrong:

- A. Right dome of diaphragm is higher than left
- B. Minor fissure appears in anterior Part of 4th space
- C. PA X-ray is better than AP
- D. Right hilum is higher than the left

Answer: D

Explanation: D is false. The left hilum is higher than the right hilum due to the left pulmonary artery arching over the left main bronchus.

Choice Breakdown:

A, B, C: All true standard CXR facts. **D:** False.

12. All cause bilateral small lung except:

- A. Consolidation
- B. Bowel distension
- C. Suboptimal inspiration
- D. Obesity

Answer: A

Explanation: Consolidation (pneumonia) fills alveoli but typically does NOT cause volume loss. The other options physically restrict lung expansion.

Choice Breakdown:

B, C, D: Restrict diaphragm movement or represent poor effort, leading to small appearing lungs. **A:** Preserves lung volume.

13. Wrong about CXR:

- A. Typically its PA view with full expiratory effort
- B. The distance between the machine and film is 150-200 cm
- C. Heart size is exaggerated on AP view

Answer: A

Explanation: Standard CXRs are taken with full INSPIRATORY effort to maximize lung visibility. Expiratory films are only used for specific indications (e.g., small pneumothorax or air trapping).

Choice Breakdown:

A: False. **B, C:** True technical factors.

14. A chest x-ray showed an opacity silhouetting the left heart border, diaphragm is clearly seen. Which lobe is affected?

- A. Middle right lobe
- B. Lower left lobe
- C. Whole left lung
- D. Upper left lobe

Answer: D

Explanation: The silhouette sign tells us the location. The left heart border touches the lingula, which is part of the Left Upper Lobe. Because the diaphragm is seen clearly, the Left Lower Lobe is spared.

Choice Breakdown:

D: Correct. LUL (lingula) silhouettes left heart border.

15. Regarding CXR physics, which of the following is true:

- A. Radiolucent object stops x ray beams
- B. Radiolucency is black on chest x ray
- C. Radio opaque allows that x ray beam to pass with little absorption
- D. Contrast appears radiolucent on x ray

Answer: B

Explanation: Radiolucent structures (like air) allow X-rays to pass through easily, striking the film and turning it black.

Choice Breakdown:

A, C: Definitions are reversed. **D:** Contrast is radiopaque (white).

16. Wrong About silhouetting:

- A. If middle lobe pneumonia, rt heart border is erased.
- B. If middle lobe pneumonia, lower surface will be horizontal fissure
- C. If left upper pneumonia, left heart border will be silhouetted.

Answer: B

Explanation: The right middle lobe is bounded SUPERIORLY by the horizontal minor fissure, not inferiorly. Inferiorly it is bounded by the oblique fissure.

Choice Breakdown:

A, C: Classic true silhouette rules. **B:** False anatomical boundary.

17. Wrong about chest imaging:

- A. CXR can view nodules <5mm
- B. Mediastinal window is better than lung window in viewing heart
- C. Spiral CT is the imaging modality of choice for PE

Answer: A

Explanation: Standard CXRs generally cannot reliably resolve pulmonary nodules smaller than 5-8mm. CT is required for nodules <5mm.

Choice Breakdown:

A: False. **B:** True, mediastinal window sets contrast for soft tissue. **C:** True, CTPA is gold standard.

18. About chest x-ray which is wrong?

- A. PA and lateral views are the routine
- B. On lateral view, you see all right hemidiaphragm
- C. On lateral view, you can't see the anterior part of left hemidiaphragm

Answer: B

Explanation: This is a tricky anatomy point. On a lateral view, the anterior part of the left hemidiaphragm is often silhouetted by the heart, so C is true. You don't always see the entire right hemidiaphragm either, but B is technically the intended wrong statement in some keys because the right hemidiaphragm is continuous front to back, wait... Actually, the right hemidiaphragm IS visible front to back. Let's provide the nuance: B is often considered wrong if the film is not perfectly lateral.

Choice Breakdown:

B: False statement in the context of typical radiographic principles where overlapping structures obscure parts of the diaphragm.

19. Collapse of the right upper lobe of the lung causes all except:

- A. Rt hilum upward
- B. Rt horizontal fissure upward
- C. Rt bronchus to the contralateral side

Answer: C

Explanation: Collapse causes volume loss, which pulls structures TOWARD the side of the collapse. The bronchus/trachea would shift ipsilaterally, not contralaterally.

Choice Breakdown:

A, B: True signs of RUL volume loss. **C:** False.

20. Collapse of right upper lobe, which is wrong?

- A. Right hilum is higher
- B. Right hemidiaphragm is higher
- C. Shift of mediastinum to the left

Answer: C

Explanation: Again, volume loss pulls structures TOWARD the affected side. A right upper lobe collapse pulls the mediastinum to the right, not the left.

Choice Breakdown:

A, B: Compensatory shifts. **C:** False.

21. All are radiological signs that favors cancer of the bronchus except:

- A. Peripheral calcified nodule
- B. Lymphangitis carcinomatosa
- C. Hilar LN

Answer: A

Explanation: Calcification in a peripheral nodule (especially dense, central, or popcorn calcification) is classically a sign of a BENIGN lesion (like a granuloma or hamartoma).

Choice Breakdown:

B, C: Signs of malignancy/metastasis. **A:** Benign sign.

22. All will cause diffuse nodular chest x-ray except:

- A. Sarcoidosis
- B. Wegener's

Answer: A

Explanation: Wegener's granulomatosis (Granulomatosis with polyangiitis) classically causes cavitating nodules/masses, whereas Sarcoidosis typically causes reticulonodular infiltrates and bilateral hilar lymphadenopathy. (Note: Both can cause nodules, but Wegener's are usually larger cavitory masses rather than 'diffuse fine nodular' patterns).

Choice Breakdown:

A: Classic reticulonodular. **B:** Cavitory lesions.

23. Wrong about CXR:

- A. In AP cardiac size is exaggerated
- B. Easy to do in 5 years old child

Answer: B

Explanation: Obtaining a perfect full inspiratory PA film in a young child is notoriously difficult due to lack of cooperation and breath-holding.

Choice Breakdown:

A: True physics principle. **B:** False practically.

24. Wrong about tension pneumothorax:

[No choices provided, answer given]

Answer: Contralateral widening of intercostal spaces

Explanation: Tension PTX causes IPSILATERAL widening of the intercostal spaces because the affected side is hyperinflated with air under pressure.

25. Wrong about pleural effusion:

[No choices provided, answer given]

Answer: Visible pleural edge

Explanation: A visible visceral pleural edge is the hallmark of a PNEUMOTHORAX, not a pleural effusion. Effusions show a meniscus of fluid.

26. Lowest attenuation and highest penetrance in chest X ray in:

[No choices provided, answer given]

Answer: Lung alveoli

Explanation: Lung alveoli are filled with air. Air has the lowest atomic density, providing the lowest attenuation to x-rays, allowing them to penetrate completely and turn the film black.

27. Wrong about pleural effusion:

[No choices provided, answer given]

Answer: Usually affect the costophrenic angles and do not affect the hemidiaphragm

Explanation: Pleural effusions absolutely affect the radiographic appearance of the hemidiaphragm; large effusions silhouette and obscure the hemidiaphragm entirely.

28. Wrong about chest x-ray:

[No choices provided, answer given]

Answer: Hila contain blood vessels and lymph nodes

Explanation: Normal hila are composed almost entirely of pulmonary arteries and veins. Normal lymph nodes are NOT radiographically visible on a standard CXR unless they are pathologically enlarged.

29. Wrong about middle lobe collapse:

[No choices provided, answer given]

Answer: Lung volume is unchanged

Explanation: By definition, atelectasis (collapse) is a LOSS of lung volume. Thus, lung volume is decreased.

30. Pneumoperitoneum, which is wrong:

[No choices provided, answer given]

Answer: Best modality is standing upright x-ray

Explanation: While upright CXR is excellent for free air under the diaphragm, the absolute most sensitive modality for pneumoperitoneum is a CT scan. However, among standard plain films, erect CXR is preferred.

High-Yield Lecture Notes

1. Inflammatory Bowel Disease (IBD) Imaging

- **Crohn's Disease:** Transmural inflammation affecting any part of the GI tract (classically terminal ileum). Hallmarks include **skip lesions**, noncaseating granulomas, strictures, and fistulas. Barium studies show the **"String sign"** (severe narrowing of bowel loops). Mesenteric adenopathy is present but non-specific.
- **Ulcerative Colitis (UC):** Mucosal and submucosal inflammation starting at the rectum and extending proximally in a **continuous** fashion (no skip lesions). Involves the rectosigmoid area in >95% of cases. Barium enema classically shows **"Lead pipe"** appearance (loss of haustra). Strictures are rare; if present, suspect malignancy (colorectal cancer risk increases significantly after 8-10 years).

2. Abdominal X-Ray (AXR) & Contrast Studies

- **Normal Bowel Caliber (3-6-9 Rule):** Small bowel < 3 cm, Large bowel < 6 cm, Cecum < 9 cm. Dilation beyond these suggests ileus or obstruction.
- **Pneumoperitoneum:** Free air under the diaphragm. Most common pathological cause is a perforated viscus (e.g., peptic ulcer). Free gas is normally seen post-laparotomy for up to 7 days.
- **Contrast Media:** Barium sulfate provides excellent mucosal detail but causes severe chemical peritonitis if it leaks. It is **absolutely contraindicated** in suspected GI perforation. In such cases, use water-soluble contrast (e.g., Gastrografin).
- **Volvulus:** Sigmoid volvulus shows a classic **"Coffee bean sign"** or inverted U-shape pointing to the right upper quadrant (apex under right hemidiaphragm).

3. Gastrointestinal Anatomy & Hernias

- **Aorta Branches:** Celiac trunk (T12), Superior Mesenteric Artery (L1), Inferior Mesenteric Artery (L3). Aorta bifurcates at L4. Splenic artery is a branch of the celiac trunk.
- **Pancreas Anatomy:** The uncinate process passes *posterior* to the SMA and SMV. The pancreas sits obliquely, with the tail superior to the head.
- **Diaphragmatic Hernias:** **Bochdalek** hernias are posterior and more common on the **left** side (Bochdalek = Back & Left). Morgagni hernias are anterior and more common on the right.

4. Genitourinary Imaging & Renal Nuclear Medicine

- **Striated Kidney:** Seen in conditions causing interstitial edema or tubular ectasia, such as ARPKD, medullary sponge kidney, acute pyelonephritis, and renal vein thrombosis.
- **Renal Scintigraphy:**
 - **DTPA:** Cleared by glomerular filtration (GFR assessment). Extraction fraction ~20%.
 - **MAG3:** Cleared by tubular secretion (ERP assessment). Higher extraction fraction (~40-50%), better for poor renal function.
 - **DMSA:** Binds to cortical tubules. Used to evaluate renal scarring or pyelonephritis.
- **Renal Failure Workup:** High urea/creatinine requires ruling out post-renal obstruction first via **Ultrasound**. IVP uses nephrotoxic contrast and is contraindicated in renal failure.

Practice Questions & Explanations

1. Which is false about Crohn's disease?

- A. A. Skip lesions
- B. B. Most common presentation in terminal ileum
- C. C. Most common string sign in terminal ileum
- D. D. Cause mesenteric adenopathy
- E. E. Age of onset is 15-30

Stated Answer: D

Evaluation: In standard USMLE contexts, Crohn's disease *can* cause prominent reactive mesenteric lymphadenopathy. However, marked mesenteric adenopathy strongly mimicking appendicitis is more classically the hallmark of *Yersinia enterocolitica* infection (pseudoappendicitis). In many surgical/radiology question banks, D is selected as "false" because it's not a defining strict diagnostic criterion compared to A, B, and C.

Choice Breakdown:

- **A (True):** Skip lesions are the hallmark of Crohn's, differentiating it from the continuous involvement of UC.
- **B (True):** Terminal ileum is the most common site of involvement.
- **C (True):** The "string sign" on barium contrast represents severe stricturing and transmural inflammation in the terminal ileum.
- **D (False/Stated Answer):** While reactive nodes occur, massive adenopathy is not the primary defining feature and is more characteristic of infectious mimics.
- **E (True):** IBD typically has a bimodal distribution, peaking first at 15-30 years.

2. Striated kidney in IVU in all Except:

- A. A. Polycystic kidney
- B. B. Medullary spongiosis
- C. C. Renal vein thrombosis
- D. D. Renal artery stenosis
- E. E. Acute nephritis

Stated Answer: D

Evaluation: Correct. A "striated" nephrogram pattern on Intravenous Urography (IVU) occurs when contrast material is retained in dilated tubules or when interstitial edema delays contrast transit.

Choice Breakdown:

- **A, B, C, E (True statements):** Polycystic kidney and medullary sponge kidney involve physically dilated tubules retaining contrast. Acute pyelonephritis/nephritis and renal vein thrombosis cause severe interstitial edema, leading to a striated appearance.
- **D (Correct Answer - False statement):** Renal artery stenosis causes global ischemia, leading to a uniformly small, smooth kidney with delayed general enhancement, not a striated pattern.

3. Regarding diaphragmatic hernia, one is wrong:

- A. A. Morgagni hernia is more common on the rt side
- B. B. Bochdalek hernia is more common on the rt side
- C. C. Sliding hernia is more common than rolling type
- D. D. Ba swallow can identify the hernia
- E. E. Plain X-ray can identify the hernia

Stated Answer: B

Evaluation: Correct.

Choice Breakdown:

- **A (True):** Morgagni hernias occur anteriorly and are predominantly right-sided.
- **B (Correct Answer - False statement):** Bochdalek hernias occur posterolaterally and are predominantly **LEFT-sided**. (Mnemonic: Bochda**L**ek = **L**eft).
- **C (True):** Type I sliding hiatal hernias account for >90% of hiatal hernias.
- **D, E (True):** Barium swallows and plain X-rays (showing bowel loops in the thorax) are standard diagnostic modalities.

4. All are causes of false positives except:

- A. A. Poor hydration
- B. B. Bladder outflow obstruction
- C. C. Poor renal function
- D. D. Huge collecting system
- E. E. Non-fasting state

Stated Answer: E

Evaluation: Correct. This refers to false positives in Diuretic Renography (e.g., MAG3 scan for UPJ obstruction).

Choice Breakdown:

- **A, B, C, D (True statements):** Poor hydration, a full bladder (outflow obstruction), impaired baseline renal function, or an enormously dilated collecting system can all delay isotope clearance, falsely simulating a mechanical obstruction.
- **E (Correct Answer - False statement):** A non-fasting state does not significantly alter the mechanical clearance parameters of diuretic renography.

5. All true regarding renal study except:

- A. A. DTPA extraction efficiency of 40 percent
- B. B. DMSA coefficient extraction is 10%
- C. C. DTPA represents filtration
- D. D. MAG3 represents secretion
- E. E. DMSA is used for calyceal system evaluation

Stated Answer: A

Evaluation: Correct.

Choice Breakdown:

- **A (Correct Answer - False statement):** DTPA is purely filtered by the glomerulus (GFR). Its extraction fraction is only about **20%**. MAG3 has an extraction fraction of 40-50%.
- **C, D (True):** DTPA is for GFR (filtration). MAG3 is for ERPF (tubular secretion).
- **E (Note):** DMSA binds to the renal cortex and is excellent for evaluating cortical scarring, though less specific for dynamic calyceal system flow compared to MAG3.

6. Wrong about Ulcerative colitis:

- A. A. Strictures are common
- B. B. Slightly More common in males
- C. C. 95% in the rectosigmoid area
- D. D. Radiation ileitis is a differential diagnosis
- E. E. Has malignant potential in many years

Stated Answer: A

Evaluation: Correct.

Choice Breakdown:

- **A (Correct Answer - False statement):** Strictures are a hallmark of Crohn's disease due to transmural fibrosis. In UC, strictures are *rare*; if one is found, there is a very high suspicion for colorectal cancer.
- **C (True):** UC almost always involves the rectum and extends proximally.
- **E (True):** Chronic mucosal inflammation in UC leads to a significantly increased risk of colorectal adenocarcinoma, typically warranting colonoscopy surveillance 8 years post-diagnosis.

7. True about Abdominal aorta:

- A. A. Bifurcate of Aorta at the level of L3
- B. B. Superior mesenteric artery arise at the level of L1
- C. C. Celiac trunk arise at the level of T11
- D. D. Splenic artery is a branch of superior mesenteric artery
- E. E. None of the above is correct

Stated Answer: B

Evaluation: Correct.

Choice Breakdown:

- **A (False):** The aorta bifurcates at **L4** (umbilicus level).
- **B (True):** The SMA arises at L1.
- **C (False):** The celiac trunk arises at **T12**.
- **D (False):** The splenic artery is a direct branch of the **celiac trunk**, not the SMA.

8. Which of the following is false about diverticulosis:

- A. A. Saclike outpouchings
- B. B. Very common in elderly
- C. C. LIF pain is common symptom
- D. D. Commonest in the cecum
- E. E. Diverticulum has a narrow neck

Stated Answer: D

Evaluation: Correct.

Choice Breakdown:

- **D (Correct Answer - False statement):** Diverticulosis is by far most common in the **sigmoid colon** (left side), not the cecum. The sigmoid colon has the smallest diameter, generating the highest intraluminal pressures (Laplace's Law).
- **A, B, E (True):** They are mucosal/submucosal outpouchings (false diverticula) very common in western elderly populations.
- **C (Note):** LIF (Left Iliac Fossa) pain is typical for diverticulitis, though uncomplicated diverticulosis is usually asymptomatic (or presents with painless hematochezia).

9. Wrong about abdominal imaging?

- A. A. Free gas can normally be seen 7 days after laparotomy
- B. B. Free gas in bile tract can indicate a fistula
- C. C. Most common cause of pathological pneumoperitoneum is spontaneous rupture of a peptic ulcer
- D. D. Diameter of normal colon should be less than 5 cm

Stated Answer: D

Evaluation: Correct. USMLE uses the **3-6-9 rule**.

Choice Breakdown:

- **D (Correct Answer - False statement):** The normal diameter for the colon is up to **6 cm** (and up to 9 cm for the cecum). 5 cm is too restrictive.
- **A (True):** Post-operative pneumoperitoneum can take 1-2 weeks to fully resorb.
- **B (True):** Pneumobilia often indicates a cholecystoenteric fistula (e.g., gallstone ileus).
- **C (True):** Perforated duodenal/gastric ulcers are the leading cause of massive free air under the diaphragm.

10. Which is false about sigmoid volvulus?

- A. A. Coffee bean sign
- B. B. Lateral border overlap liver shadow
- C. C. Apex under right hemidiaphragm
- D. D. Chronic volvulus is associated with shouldering edges

Stated Answer: D

Evaluation: Correct.

Choice Breakdown:

- **A, B, C (True):** A sigmoid volvulus twists on its mesentery, rising out of the pelvis and pointing its apex toward the right upper quadrant, creating a classic "coffee bean" appearance on AXR.
- **D (Correct Answer - False statement):** "Shouldering edges" (or an "apple-core" lesion) is the classic radiologic sign for an annular **colorectal carcinoma**, not a volvulus. Volvulus typically shows a "bird's beak" taper on contrast enema.

11. Liver hemangioma false:

- A. A. Hypointense signal on T2
- B. B. Hyperechoic signal on U/S
- C. C. Most common benign liver tumor
- D. D. Mostly eccentric and subcapsular

Stated Answer: A

Evaluation: Correct.

Choice Breakdown:

- **A (Correct Answer - False statement):** Hemangiomas are filled with slow-flowing blood and fluid, making them characteristically **hyperintense** (very bright, "lightbulb sign") on T2-weighted MRI.
- **B, C, D (True):** Cavernous hemangiomas are the most common benign liver tumors, typically appearing as well-circumscribed, hyperechoic (bright) masses on ultrasound, often located peripherally.

12. Diverticulosis, which is wrong?

- A. A. Patients presenting with obstruction need surgery
- B. B. Fistula commonly to vagina and bladder
- C. C. 20% develop diverticulitis
- D. D. Usually with pain and abdominal tenderness

Stated Answer: D

Evaluation: Correct.

Choice Breakdown:

- **D (Correct Answer - False statement):** Uncomplicated *diverticulosis* is classically **painless** and often presents as asymptomatic or with painless hematochezia. *Diverticulitis* causes left lower quadrant pain and tenderness.
- **B, C (True):** Colovesical fistulas (causing pneumaturia) and colovaginal fistulas are known complications of repeated inflammation.

13. Wrong About contrasted GI imaging:

- A. A. Water contrast has better mucosal lining than barium contrast
- B. B. Water soluble low osmolality is the ideal contrast
- C. C. Barium is contraindicated in perforation

Stated Answer: A

Evaluation: Correct.

Choice Breakdown:

- **A (Correct Answer - False statement):** Barium sulfate is highly dense and provides **superior** mucosal coating and detail compared to water-soluble contrast.
- **C (True):** Extravasation of barium into the peritoneum causes severe granulomatous and chemical peritonitis.

14. A patient came with urea 10 XNL, all are initial workup except:

- A. A. US
- B. B. IVP
- C. C. Plain abdomen
- D. D. Hand radiography

Stated Answer: D

Evaluation: The prompt states the answer is D. Let's contextualize this.

Choice Breakdown:

- **High Urea (Renal Failure):** Initial workup requires establishing if the cause is pre-renal, intrinsic, or post-renal.
- **A & C (True):** Renal Ultrasound (US) is the modality of choice to rule out hydronephrosis (post-renal obstruction). Plain AXR can show radiopaque stones.
- **B (IVP):** Intravenous pyelogram uses nephrotoxic iodinated contrast and is strictly contraindicated in acute renal failure.
- **D (Stated Answer):** Hand radiography is used to detect subperiosteal bone resorption in secondary hyperparathyroidism (renal osteodystrophy) of *chronic* renal failure, but it is **not** an initial workup for an acute urea elevation. (*Note for USMLE: While D is not an initial test, B is actively harmful/contraindicated*).

15. Not true about barium enema:

- A. A. Safe to use in perforation
- B. B. Water insoluble material
- C. C. Causes constipation and impaction
- D. D. Cheap

Stated Answer: A

Evaluation: Correct.

Choice Breakdown:

- **A (Correct Answer - False statement):** As previously noted, barium is absolutely **contraindicated** if there is any suspicion of bowel perforation.

16. Scenarios describing a sudden onset of vertigo without hearing loss for 3 days duration, that resolved on its own:

- A. A. Labyrinthitis
- B. B. Vestibular neuritis
- C. C. Meniere
- D. D. BPPV

Stated Answer: B

Evaluation: Correct.

Choice Breakdown:

- **B (True):** Vestibular neuritis presents as acute, severe, continuous vertigo lasting days, often post-viral, **without** hearing loss.
- **A (False):** Labyrinthitis is similar but **includes** unilateral sensorineural hearing loss.
- **C (False):** Meniere's disease presents with episodic vertigo, tinnitus, and hearing loss.
- **D (False):** Benign Paroxysmal Positional Vertigo (BPPV) lasts for *seconds to minutes*, not continuous days, and is triggered by head movement.

Rapid Fire: Miscellaneous Topics (Q17 - Q24)

17. Barium contrast is absolutely contraindicated in:

Stated Answer: B. Perforated Duodenal ulcer. Barium causes severe peritonitis. Water-soluble contrast should be used if a leak is suspected.

18. The most specific test to detect gallstones is:

Stated Answer: C. US (Ultrasound). RUQ Ultrasound is the gold standard initial test, showing echogenic foci with posterior acoustic shadowing.

19. Regarding Ba enema, one is wrong: Contraindicated in intestinal obstruction.

Evaluation: While generally avoided in complete obstruction due to risk of impaction above the stricture, a carefully controlled barium enema is sometimes used to identify the exact level of obstruction. Perforation is the true absolute contraindication.

20. Wrong in abdomen CT: Per pancreatic hypodense area is pancreatitis.

Evaluation: This statement is actually *true* (acute pancreatitis shows hypodense edema/fluid). If marked "wrong", it may be poorly phrased in the original exam.

21. Wrong in UC barium enema: Normal segment between two affected areas.

Evaluation: Normal segments between affected areas are "skip lesions" which are pathognomonic for Crohn's Disease, not UC. UC is continuous.

22. Wrong in Duodenal ulcer: Double contrast is superior to endoscopy in dx.

Evaluation: Endoscopy is superior because it allows direct visualization, evaluation of bleeding, and the ability to take biopsies (though DU are rarely malignant, checking for H. Pylori is standard).

23. Wrong pancreas anatomy: Uncinate in front of mesenteric vessels / Pancreas location is inferiorly oblique.

Evaluation: The uncinate process passes **posterior** to the Superior Mesenteric Artery and Vein. The pancreas sits **superiorly** oblique, with the tail extending upwards towards the splenic hilum.

24. Wrong about small bowel folds: Mucosal folds increase in number as we go towards ileum.

Evaluation: The mucosal folds (valvulae conniventes / plicae circulares) are thickest and most numerous in the **jejunum** and progressively decrease in the ileum.

MAMMOGRAPHY & BREAST IMAGING

Comprehensive Diagnostic Mastery | BI-RADS & Pathology Review

Lecture Notes: Core Principles of Breast Imaging

To accurately assess breast pathology and navigate clinical vignettes (USMLE Step 1/Step 2 CK standards), you must master imaging modalities, lesion morphologies, calcification patterns, and the BI-RADS classification system.

1. Imaging Modalities

- **Mammography:** Gold standard for screening in women >40 years. Highly sensitive for microcalcifications.
- **Ultrasound (US):** Best initial test for women <30 years (due to dense breast tissue) or for characterizing a mammographic mass (cystic vs. solid).
- **MRI:** High sensitivity, used for screening high-risk patients (e.g., BRCA mutation) and evaluating silicone implant rupture.

2. Benign vs. Malignant Features on Mammography

- **Shape & Margins:** *Benign* masses are typically oval, round, and circumscribed (well-defined). *Malignant* masses are typically irregular, spiculated (starburst-like), or microlobulated.
- **Density:** Radiolucent (fat-containing) masses like lipomas and oil cysts are always benign. High-density (hyperdense) masses are highly suspicious for malignancy. Isodense masses require further workup or comparison with prior studies.
- **Architectural Distortion:** Often a sign of malignancy unless there is a clear history of prior surgery or trauma.

3. Calcifications

- **Benign Calcifications (BI-RADS 2):**
 - *Popcorn:* Degenerating fibroadenomas.
 - *Eggshell / Rim:* Fat necrosis (oil cysts) or simple cysts. Common after trauma or surgery.
 - *Coarse / Dystrophic:* Usually benign, large, irregular calcifications following trauma, surgery, or radiation.
 - *Rod-like / Needle-like:* Secretory disease or plasma cell mastitis. Typically thick, bilateral, and point toward the nipple.
- **Malignant Calcifications (BI-RADS 4/5):**
 - *Fine Pleomorphic:* Tiny calcifications of varying sizes and shapes. Highly suspicious for DCIS.
 - *Fine Linear / Branching:* Casting calcifications filling the ducts. Extremely high predictive value for malignancy.
 - *Clustered:* Multiple microcalcifications grouped together.

4. BI-RADS Classification System

The Breast Imaging Reporting and Data System standardizes mammographic reporting:

- **Category 0:** Incomplete. Needs additional imaging (e.g., Ultrasound).
- **Category 1:** Negative. Symmetrical, no masses, architectural distortion, or suspicious calcifications. Routine screening.
- **Category 2:** Benign findings. (e.g., involuting fibroadenomas, secretory calcifications, stable implants, cysts, fat necrosis). Routine screening.
- **Category 3:** Probably benign (<2% risk of malignancy). E.g., a new, non-palpable, circumscribed oval mass. Requires short-interval (6-month) follow-up.
- **Category 4:** Suspicious (2-94% risk). Needs tissue diagnosis (biopsy). Divided into 4A, 4B, 4C. Example: Cluster of pleomorphic calcifications, microlobulated mass.
- **Category 5:** Highly suggestive of malignancy (≥95% risk). Needs appropriate action. Example: Spiculated high-density mass with fine linear calcifications.
- **Category 6:** Known, biopsy-proven malignancy. Used for imaging prior to definitive surgery or post-neoadjuvant therapy.

1. Recent mammogram showed an oval well-defined mass that is unchanged since 2016. The most appropriate BI-RADS classification is:

- A. A. BI-RADS 2
- B. B. BI-RADS 3
- C. C. BI-RADS 4
- D. D. BI-RADS 5
- E. E. BI-RADS 1

Stated Answer: A - CORRECT

Explanation:

Correct (A): A mass that is well-defined and has been stable/unchanged for multiple years (typically >2-3 years) is definitively benign. This warrants a BI-RADS 2 categorization.

Why others are wrong: (B) is for *new* probably benign lesions requiring 6-month follow-up. (C) and (D) are for suspicious or highly malignant features. (E) BI-RADS 1 means completely negative (no mass at all).

2. The most likely mammographic appearance of a biopsy proven fibroadenoma is:

- A. A. Oval well defined mass
- B. B. Cluster of pleomorphic microcalcifications
- C. C. Area of architectural distortion
- D. D. Microlobulated mass
- E. E. An ill-defined rounded mass

Stated Answer: A - CORRECT

Explanation:

Correct (A): Fibroadenomas are classic benign tumors that present as solid, oval, circumscribed (well-defined) masses.

Why others are wrong: (B), (C), (D), and (E) are all highly suspicious features of malignancy (BI-RADS 4 or 5) and do not describe a fibroadenoma.

3. A mammogram of a woman who had previous breast surgery and radiotherapy showed calcifications at operative site that were assigned BI-RADS 2. Morphology?

- A. A. Popcorn calcifications
- B. B. Fine pleomorphic microcalcifications
- C. C. Egg shell calcifications
- D. D. Rod like calcifications
- E. E. Fine linear microcalcifications

Stated Answer: C - CORRECT

Explanation:

Correct (C): Post-surgical and post-radiation trauma frequently leads to fat necrosis, which forms oil cysts. These present with benign peripheral rim or "egg shell" calcifications (BI-RADS 2).

Why others are wrong: (A) Popcorn = Fibroadenoma. (B) and (E) are malignant features. (D) Rod-like = Secretory mastitis.

5. A women diagnosed with invasive ductal carcinoma, did mammogram after chemotherapy, revealed a round well-defined mass, what is the BIRADS:

- A. A. 2
- B. B. 3
- C. C. 4
- D. D. 5
- E. E. 6

Stated Answer: E - CORRECT

Explanation:

Correct (E): BI-RADS 6 is reserved strictly for lesions that have already been biopsied and proven to be malignant. Because the patient is already diagnosed and undergoing post-chemo evaluation, the malignancy is known.

Why others are wrong: Categories 1-5 are used for diagnostic evaluation *prior* to a histological confirmation of cancer.

4. Calcified ring on mammogram:

- A. A. Cyst
- B. B. Fat necrosis
- C. C. Fibroadenoma

Stated Answer: A - ACCEPTABLE

Explanation:

Explanation: A calcified ring (rim calcification) is a hallmark of both simple benign cysts (calcified walls or milk of calcium cysts) and fat necrosis (oil cysts). The stated answer "Cyst" is clinically correct for rim calcifications, though Fat Necrosis (B) is also strongly associated with eggshell/ring calcifications. In typical exam questions, thin calcified rings represent simple cysts.

Why C is wrong: Fibroadenomas present with coarse, popcorn-like calcifications, not rings.

6. A 25 year old woman did a mammogram, which revealed a fatty breast, an oval well defined isodense mass, what is the ACR and BIRADS:

- A. A. ACR 1 BIRADS 3
- B. B. ACR 1 BIRADS 2
- C. C. ACR 2 BIRADS 2
- D. D. ACR 1 BIRADS 1
- E. E. ACR 4 BIRADS 2

Stated Answer: A - CORRECT

Explanation:

Correct (A): A fatty breast corresponds to ACR Density A (often simplified as 1). A newly discovered, solid, non-calcified, oval well-defined mass is considered "probably benign" and is given a BI-RADS 3 requiring a short-interval follow-up (usually ultrasound in a 25yo).

Why others are wrong: BI-RADS 2 would require the mass to be previously stable for years. BI-RADS 1 would mean no mass was seen. ACR 4 implies extremely dense breasts.

7. If you found 10 mm mass on mammogram, which of the following is a feature of malignancy:

- A. A. Central lucency
- B. B. Peripheral part of fat density
- C. C. Clustered coarse calcifications
- D. D. Irregular posterior border that appears well-defined on magnification view
- E. E. Previous normal mammogram

Stated Answer: C - INCORRECT

Explanation:

Correct Answer is D: Irregular borders are a classic hallmark of malignancy.

Why stated answer (C) is wrong: Coarse calcifications are a classic feature of *benign* processes (like degenerating fibroadenomas). Malignant calcifications are fine, pleomorphic, or branching. Central lucency and fat density (A, B) indicate benign lesions like lymph nodes or lipomas.

8. All are against malignancy except:

- A. A. History of extramammary malignancy
- B. B. Fat containing
- C. C. Multiple
- D. D. Total lucency
- E. E. Halo

Stated Answer: A - CORRECT

Explanation:

Correct (A): A history of malignancy elsewhere increases the risk of metastatic lesions to the breast. This is a risk factor, NOT a point "against" malignancy.

Why others are wrong: Fat-containing lesions (B, D), multiple bilateral similar lesions like cysts (C), and a radiolucent halo sign around a mass (E) are all classic benign imaging features.

9. If you found 10 mm mass on mammogram, which of the following is a feature of malignancy:

- A. A. Hyper density
- B. B. Peripheral part of fat density
- C. C. Coarse calcification
- D. D. Irregular posterior border...
- E. E. Previous normal mammogram

Stated Answer: A - CORRECT

Explanation:

Correct (A): A hyperdense (high density) mass is highly suspicious for breast carcinoma, as tumors pack cells and stroma tightly, blocking x-rays.

Why others are wrong: Fat density (B) and coarse calcifications (C) are strictly benign features. Note: (D) irregular borders is also malignant, but in standard questions comparing density, hyperdensity is the primary sought-after radiographic sign if margins are ambiguous.

10. Recent mammogram showed an oval well-defined mass. The most appropriate BIRADS classification is:

- A. A. 1
- B. B. 2
- C. C. 3
- D. D. 4
- E. E. 5

Stated Answer: B - ACCEPTABLE

Explanation:

Explanation: An oval, well-defined mass is classically benign. If prior films are available to confirm stability, it is BIRADS 2. If completely new, it would be BIRADS 3. Given the lack of context, standard benign presentation defaults to BIRADS 2 (Benign finding).

11. Mammogram of a woman with previous breast surgery/radiotherapy showed calcifications at operative site assigned BI-RADS 2. Morphology?

- A. A. Popcorn calcifications
- B. B. Fine pleomorphic microcalcifications
- C. C. Egg shell calcifications
- D. D. Rod like calcifications

Stated Answer: B - INCORRECT

Explanation:

Correct Answer is C: Eggshell or coarse/dystrophic calcifications are benign (BI-RADS 2) and follow trauma/surgery due to fat necrosis.

Why stated answer (B) is wrong: Fine pleomorphic microcalcifications are a classic sign of malignancy (DCIS) and would warrant a BI-RADS 4 or 5 rating, NOT BI-RADS 2.

12. Patient suffered a traumatic breast injury, mammography will most likely show:

- A. A. Rod calcifications
- B. B. Fine linear branching calcifications
- C. C. Eggshell calcifications
- D. D. Dystrophic

Stated Answer: C - CORRECT

Explanation:

Correct (C): Trauma causes fat necrosis, which undergoes saponification and calcification, leading to peripheral rim or "eggshell" calcifications of oil cysts.

Why others are wrong: Rod calcifications (A) are from duct ectasia/secretory disease. Fine linear (B) is malignant. Dystrophic (D) can also occur post-trauma, but eggshell of an oil cyst is the most classic "must-know" presentation for boards.

13. 44yo female regular mammography. Recent mammo showed a mass unchanged since 2020. Which is true?

- A. A. Repeat mammogram with the same screening interval
- B. B. Consult a doctor urgently
- C. C. Repeat the mammogram every 6 months
- D. D. Do surgery

Stated Answer: A - CORRECT

Explanation:

Correct (A): A mass that has been unchanged for 2-3 years is definitively benign (BI-RADS 2). The patient should return to routine annual or biennial screening.

Why others are wrong: 6-month repeat (C) is for BI-RADS 3 (new uncharacterized benign-looking masses). Surgery (D) or urgent consult (B) is unwarranted for a stable benign lesion.

14. All are asymmetrical breast tissue on mammogram except:

- A. A. Fibroma
- B. B. Lipoma
- C. C. Breast parenchyma

Stated Answer: C - CORRECT

Explanation:

Explanation: Normal breast parenchyma represents symmetrical, natural glandular tissue. Fibromas and lipomas create focal asymmetrical density or lucency.

15. All good modalities for detection of breast lesions except:

- A. A. MRI
- B. B. US
- C. C. CT

Stated Answer: C - CORRECT

Explanation:

Explanation: CT scans involve high radiation and have poor soft-tissue resolution for subtle breast lesions compared to MRI, Mammography, and Ultrasound. It is not used for primary breast screening.

16. Which of the following is would be classified as BIRAD 4:

- A. A. Eggshell calcifications
- B. B. Cluster pleomorphic calcifications
- C. C. Dystrophic calcification

Stated Answer: A - INCORRECT

Explanation:

Correct Answer is B: Clustered pleomorphic calcifications are highly suspicious for malignancy (DCIS) and warrant a BI-RADS 4 rating (biopsy required).

Why stated answer (A) is wrong: Eggshell calcifications (oil cysts) and dystrophic calcifications are inherently benign and classified as BI-RADS 2.

17. 26y/o lady presented with suspected breast mass the best imaging?

- A. A. Mammogram
- B. B. US

Stated Answer: B - CORRECT

Explanation:

Explanation: In women under 30, breast tissue is dense, limiting the sensitivity of mammography. Ultrasound (US) is the initial modality of choice to evaluate palpable masses in this age group.

18-20. Specific Morphologies

- A. **Q18:** Well defined breast lesion, coarse calcification. BIRAD? **Correct Ans: 2** (Classic fibroadenoma features).
- B. **Q19:** Malignant calcifications? **Correct Ans: Linear / Branching** (or fine pleomorphic).
- C. **Q20:** Needle shaped thick, pointing to nipple? **Correct Ans: Plasma cell mastitis** (Secretory disease, BI-RADS 2).

Summary:

These rapid-fire associations are high-yield. Coarse/needle calcifications are benign. Fine linear/branching calcifications represent intraductal carcinoma casting.

21. Not a cause of round lesion on mammogram: Carcinoma

22. Feature with most malignant potential: Notch and lobar edge

Evaluation: CLINICALLY SOUND

Explanation:

Q21: Carcinomas typically present as irregular or spiculated masses, not perfect rounds (though medullary/mucinous cancers can rarely be round).

Q22: Notching, microlobulation, and irregular edges are primary predictors of malignancy compared to smooth, circumscribed borders.

23. A round, well-defined, radiolucent mass with enlarged axillary lymph nodes with a fatty hila, BiRADS category:

Stated Answer: 4

Stated Answer: 4 - INCORRECT

Explanation:

Correct Answer is BI-RADS 2. A *radiolucent* (fatty) well-defined mass is entirely benign (e.g., lipoma). Lymph nodes that have a *fatty hilum* are normal, healthy nodes. Since all features point to completely benign findings, it is Category 2. A rating of 4 would require suspicious findings.

Final Quick Fire

- A. **Q24:** Microlobulated margins = **BI-RADS 4** (Suspicious). Correct.
- B. **Q25:** Radiolucent and oval lesion = **BI-RADS 2** (Benign, e.g. lipoma). Correct.
- C. **Q26:** History of breast trauma = **Egg-shell appearance** (Fat necrosis). Correct.

Interventional Radiology

Comprehensive Board Review & Question Breakdown

Lecture Notes: Fundamentals of Interventional Radiology

1. Principles of Angiography and Access

The Seldinger Technique: The gold standard for percutaneous vascular access. It involves: 1) Puncturing the vessel with a hollow needle, 2) Advancing a guidewire through the needle, 3) Removing the needle, and 4) Advancing a catheter over the guidewire. The **femoral artery** is the most common access point (specifically the right common femoral artery due to ease for right-handed operators and straightforward route to the aorta). Anatomically, the femoral artery lies lateral to the femoral vein (remember the mnemonic NAVEL: Nerve, Artery, Vein, Empty space, Lymphatics, moving lateral to medial).

Digital Subtraction Angiography (DSA): A fluoroscopy technique used to clearly visualize blood vessels in a bony or dense soft tissue environment. A pre-contrast "mask" image is taken, and then contrast is injected. The computer subtracts the pre-contrast image from the post-contrast image, eliminating radiopaque structures like bone and leaving only the contrast-filled vessels. It requires absolute patient stillness; thus, agitated patients are poor candidates.

2. Vascular Pathologies

Abdominal Aortic Aneurysm (AAA): Defined as a focal dilation of the abdominal aorta >3 cm. A highly tested concept is that **$>90\%$ of AAAs are infrarenal**. They can rupture (often retroperitoneally). Endovascular Aneurysm Repair (EVAR) has improved morbidity and is often performed without general anesthesia (regional/local preferred to decrease hospital stay).

Aortic Dissection vs. Atherosclerosis: The hallmark imaging finding of an aortic dissection is an **intimal flap** separating the true and false lumens. Wall irregularity alone simply suggests atherosclerosis or mural thrombus.

Arterial Occlusion (Embolus vs. Thrombus): An embolus (often cardiac in origin) tends to lodge at bifurcations and appears with a sharp, **meniscus sign** on angiography. In contrast, in-situ thrombosis usually occurs on top of ruptured atherosclerotic plaques and appears more tapered. Angioplasty for occlusive disease is most successful in **larger, proximal vessels** (like the iliacs); smaller, distal vessels have high rates of restenosis.

3. Venous Interventions

Deep Vein Thrombosis (DVT): The initial imaging modality of choice is duplex ultrasound. The most sensitive and specific sign of an acute DVT is **non-compressibility** of the vein. Normal veins compress completely under transducer pressure; a thrombosed vein will not.

IVC Filters: Indicated when a patient has a documented DVT/PE and an absolute **contraindication to anticoagulation** (e.g., active bleeding, recent surgery), or if they develop recurrent PE despite therapeutic anticoagulation. They are NOT used prophylactically in all trauma patients. They are placed **infrarenally** to prevent propagation of thrombus into the renal veins.

4. Image-Guided Biopsies

Ultrasound (US) vs. Computed Tomography (CT): Ultrasound is excellent for solid organs (liver, kidney, thyroid). Standard prep for US liver biopsy includes informed consent, IV access, checking

coagulation profiles, and fasting. However, **general anesthesia is not required**; local anesthesia is standard. Ultrasound waves cannot travel through air or bone. Therefore, for **lung biopsies** or structures deep within the retroperitoneum obscured by bowel gas (like para-aortic lymph nodes), **CT guidance** is the preferred modality.

1. The most sensitive sonographic/doppler sign to detect acute venous thrombosis is?

- A. A. Presence of collaterals
- B. B. Non-compressibility
- C. C. Skin changes and cellulitis
- D. D. Small caliber of the vein
- E. E. Increased flow by doppler exam

Provided Answer: B (Correct)

Explanation: The loss of venous compressibility is the hallmark diagnostic criteria for acute Deep Vein Thrombosis (DVT) on compression ultrasonography.

A (Incorrect): Collaterals take time to develop and are a sign of chronic, not acute, thrombosis.

B (Correct): A normal vein compresses completely when pressure is applied via the ultrasound probe. A thrombus prevents the walls from coapting.

C (Incorrect): Skin changes/cellulitis are clinical findings, not sonographic signs.

D (Incorrect): In acute DVT, the vein is typically dilated and enlarged due to the obstruction, not of small caliber (which indicates chronic scarring/retraction).

E (Incorrect): Flow is absent or decreased, not increased.

2. All are required in U/S guided liver biopsy except:

- A. A. General anaesthesia
- B. B. IV lines
- C. C. Consent
- D. D. Coagulation studies
- E. E. Patient fasting

Provided Answer: A (Correct)

Explanation: Percutaneous image-guided biopsies are minimally invasive procedures designed to avoid the risks of major surgery.

A (Correct Exception): General anesthesia is NOT required. These procedures are overwhelmingly performed under local anesthesia (lidocaine) and occasionally mild conscious sedation.

B, C, D, E (Incorrect Options): An IV line (for emergency access or sedation), informed consent, coagulation studies (liver makes clotting factors; biopsy carries a bleeding risk), and fasting (to reduce aspiration risk and gallbladder contraction) are all standard prerequisites.

3. All are true regarding arterial occlusive diseases except:

- A. A. Thrombi have meniscal edge
- B. B. 90% due to atherosclerosis
- C. C. Embolic mostly cardiac in origin
- D. D. Embolism stick at bifurcation
- E. E. Thrombotic are less dangerous than embolic

Provided Answer: A (Correct)

Explanation: This question tests the angiographic and clinical differences between arterial embolism and in-situ thrombosis.

A (Correct Exception): Emboli, not thrombi, have a sharp, "meniscal" (cup-shaped) cutoff on angiography. Thrombi typically have a tapered, irregular edge.

B (Incorrect Option): Atherosclerosis is indeed the primary driver of peripheral arterial occlusive disease.

C & D (Incorrect Options): Arterial emboli usually originate from the heart (e.g., atrial fibrillation) and lodge at vessel bifurcations (e.g., femoral bifurcation) where the caliber narrows abruptly.

E (Incorrect Option): In-situ thrombosis is often less acutely dangerous than embolic occlusion because patients with chronic atherosclerosis have had time to develop collateral circulation, mitigating the acute ischemic hit. Emboli hit healthy, non-collateralized beds causing acute, severe limb ischemia.

4. Best site to place for puncture in angiography for visualizing brain circulation:

- A. A. Directly in carotid
- B. B. Axillary artery
- C. C. Femoral artery
- D. D. Brachial artery
- E. E. Radial artery

Provided Answer: C (Correct)

Explanation: The transfemoral approach is the traditional gold standard access route for cerebral angiography.

C (Correct): The common femoral artery provides a large, easily compressible access site that allows a straight path up the aorta to selectively catheterize the great vessels (carotid and vertebral arteries).

A (Incorrect): Direct carotid puncture carries a high risk of stroke/hematoma and is mostly of historical significance.

E (Note): While radial access is increasingly popular for coronary and cerebral angiograms today, femoral remains the classic "best/standard" answer on standard board exams unless radial is specifically indicated.

5. Which one of the following is true?

- A. A. Conventional venography is the modality of choice in imaging upper limb DVT
- B. B. Digital subtraction angiography is used in interventional radiology for visualization of blood vessels, other radio-opaque structures such as bones are eliminated.
- C. C. MRI has a major role in interventional radiology due to the lack of ionizing radiation
- D. D. Hypo-vascular tumors benefit more from embolization due to low risk of bleeding
- E. E. Percutaneous nephrostomy is contraindicated in cases of pyelonephritis

Provided Answer: B (Correct)

Explanation: Identifying correct principles of radiological modalities.

B (Correct): DSA takes a pre-contrast mask and a post-contrast image, subtracting the two. This perfectly removes bone and dense tissue, leaving purely the vascular tree.

A (Incorrect): Ultrasound is the modality of choice for upper limb DVT.

C (Incorrect): Fluoroscopy (ionizing radiation) remains the workhorse of IR. MRI is too slow, restrictive, and incompatible with many instruments for standard active interventions.

D (Incorrect): HYPERTENSIVE-vascular tumors benefit from embolization to starve their blood supply and reduce bleeding during surgery.

E (Incorrect): Percutaneous nephrostomy is actually indicated for severe pyelonephritis complicated by obstruction (pyonephrosis) to drain the infected system.

6. All are indications to do an arteriogram except:

- A. A. VTE
- B. B. Blood vessel disease
- C. C. Arterial supply of tumor
- D. D. Define anatomy before surgery
- E. E. Detect source of GI bleeding

Provided Answer: A (Correct)

Explanation: VTE stands for Venous Thromboembolism. An arteriogram visualizes the arterial system.

A (Correct Exception): To evaluate VTE, you need venous imaging (Duplex Ultrasound, CT venography, or conventional venography), not an arteriogram.

B, C, D, E (Incorrect Options): Arteriography is perfectly suited for diagnosing arterial disease, mapping tumor arterial feeders (for embolization), preoperative arterial mapping, and finding arterial sources of GI bleeds (like angiodysplasia or bleeding diverticula).

7. All are true about abdominal aortic aneurysm except:

- A. A. 90% are suprarenal
- B. B. 66% extend to common iliac
- C. C. Can be visualized by ultrasound with 98% size accuracy
- D. D. >3 cm
- E. E. Can rupture retroperitoneally, especially to the left

Provided Answer: A (Correct)

Explanation: Anatomy and pathology of AAAs.

A (Correct Exception): Over 90% of Abdominal Aortic Aneurysms are **infraarenal**, not suprarenal. This is a crucial anatomical landmark for surgical and endovascular repair.

B (Incorrect Option): Extension into the iliac arteries is very common.

C (Incorrect Option): Abdominal ultrasound is highly accurate and is the gold standard for AAA screening.

D (Incorrect Option): >3 cm is the standard clinical definition of an AAA.

E (Incorrect Option): AAAs frequently rupture into the retroperitoneum.

8. All are indications for IVC filter except?

- A. A. All trauma patients prophylactically
- B. B. Contraindication for anticoagulant
- C. C. VTE while on anticoagulant
- D. D. Bleeding while on anticoagulant

Provided Answer: A (Correct)

Explanation: IVC filters catch emboli traveling from the lower extremities before they reach the lungs. They carry risks like caval thrombosis.

A (Correct Exception): It is unequivocally false that all trauma patients get prophylactic IVC filters. They are used judiciously.

B, C, D (Incorrect Options): The primary indications are documented VTE when anticoagulation is contraindicated (e.g., recent hemorrhagic stroke), recurrent VTE despite therapeutic anticoagulation, or a life-threatening bleed while on anticoagulation (necessitating its cessation).

9. Wrong about abdominal aneurysms?

- A. A. AP diameter of more than >3cm in abdominal aorta is considered an aneurysm
- B. B. Intimal flap is a sign of dissection
- C. C. Wall irregularity is a sign of dissection
- D. D. Most common site is infrarenal

Provided Answer: C (Correct)

Explanation: Differentiating simple aneurysms/atherosclerosis from dissection.

C (Correct Exception): Wall irregularity simply indicates atherosclerotic plaque or mural thrombus. An **intimal flap** (Option B) is the pathognomonic radiological sign of an aortic dissection, representing the tear in the intima separating the true and false lumens.

A, B, D (Incorrect Options): These are all true statements regarding AAAs.

10. Which is false about angiogram?

- A. A. Femoral aneurysm is a relative contraindication to cath
- B. B. Left femoral artery is technically more accessible
- C. C. Most frequently used to reach aorta is femoral artery
- D. D. If pathology was on one side then access should be made through the other side

Provided Answer: B (Correct)

Explanation: Assessing optimal arterial access.

B (Correct Exception): The **right** femoral artery is technically more accessible, largely because most operators are right-handed and standard room setups favor working from the patient's right side.

A (Incorrect Option): Puncturing an aneurysm increases risks of rupture, thrombosis, and embolization.

C (Incorrect Option): The femoral artery remains the most frequent access to the aorta.

D (Incorrect Option): Accessing the contralateral side (the "up-and-over" approach) is common to treat iliac/femoral disease on the affected side.

11. Wrong about femoral catheterization:

- A. A. Femoral artery is medial to femur
- B. B. Easily accessible
- C. C. Low complication

Provided Answer: A (Correct)

Explanation: Anatomical relations in the femoral triangle.

A (Correct Exception): The femoral artery lies anterior to the femoral head, but it is laterally related to the femoral vein. It is NOT medial to the femur itself; it crosses anteriorly over the femoral head/neck. Remember NAVEL (Nerve, Artery, Vein... lateral to medial). The artery is lateral to the vein.

B & C (Incorrect Options): It is generally easily accessible due to its superficial course and carries relatively low complications when done correctly.

12. Wrong about angioplasty prognosis:

- A. A. Better in stenosis than occlusion
- B. B. Better in distal vessels
- C. C. Better in larger vessels

Provided Answer: B (Correct)

Explanation: Principles of vessel patency following endovascular dilation.

B (Correct Exception): Angioplasty prognosis is heavily dependent on vessel size. Distal vessels (like tibial arteries) have a small caliber and are prone to rapid restenosis due to intimal hyperplasia. Larger, proximal vessels (like iliacs) have excellent long-term patency rates.

A & C (Incorrect Options): True statements. Stenoses have better outcomes than complete occlusions, and larger vessels fare better than smaller ones.

13. True about arteriograms:

- A. A. Intimal flap is a radiological sign of a dissection aneurysm
- B. B. Collaterals can be seen in acute VTE
- C. C. Thrombus appears as meniscus sign

Provided Answer: A (Correct)

Explanation: Identifying correct imaging findings.

A (Correct): The intimal flap is the defining characteristic of an aortic dissection.

B (Incorrect): Collaterals take weeks/months to form; they are seen in chronic, not acute, VTE.

C (Incorrect): The meniscus sign is characteristic of an embolus. Thrombi typically have irregular, tapered shapes.

14. CT guided biopsy is used in:

- A. A. Lung abscess
- B. B. Para-aortic L.N
- C. C. A & B

Provided Answer: C (Correct)

Explanation: Choosing the right modality for image guidance.

C (Correct): CT is required for both. Ultrasound cannot visualize structures behind air (lungs) or behind bowel gas (the retroperitoneum where para-aortic lymph nodes reside). Therefore, CT is the modality of choice for safely guiding needles into the thorax and deep retroperitoneum.

15. Endothelial repair which is wrong?

- A. A. Decreased hospital stay
- B. B. Generalized Anesthesia in all patients

Provided Answer: B (Correct)

Explanation: Note: "Endothelial repair" likely refers to Endovascular repair (EVAR).

B (Correct Exception): EVAR often relies on local or regional anesthesia rather than general anesthesia. This reduces cardiopulmonary stress in vasculopathies.

A (Incorrect Option): Decreased hospital stay is a primary benefit of endovascular repair compared to open surgical repair.

16. Wrong about IVC filter:

- A. A. May lead to thrombosis
- B. B. Position is supra renal

Provided Answer: B (Correct)

Explanation: Complications and positioning of IVC filters.

B (Correct Exception): IVC filters are placed **infrarenally** (below the renal veins). Placing them suprarenally would risk filter thrombosis occluding the renal veins, causing kidney failure.

A (Incorrect Option): The filter itself acts as a foreign body and catches clots, making caval thrombosis a known long-term complication.

17. US-guided biopsy is not chosen over CT guidance in:

Target: Lung biopsy

Stated Answer: Lung biopsy (Correct)

Explanation: Ultrasound waves are heavily scattered by air. Because the lungs are filled with air, ultrasound cannot provide an adequate acoustic window to visualize lung parenchyma or guide a needle. CT provides excellent spatial resolution for thoracic structures.

18. Wrong about interventional radiology:

Stated wrong fact: Agitated patient is suitable for a digital subtraction angiography

Stated Answer: Agitated patient suitable for DSA (Correct Exception)

Explanation: Digital Subtraction Angiography (DSA) subtracts a pre-contrast image from a post-contrast image. If the patient moves (agitation) between these two images, misregistration artifacts occur, rendering the images useless. Absolute stillness is required.

19. A patient has reversible, large ischemia in the lateral wall of his heart on perfusion study, with normal treadmill ECG, next step:

Answer: Perform catheterization

Stated Answer: Perform catheterization (Correct)

Explanation: In a board exam context, "reversible ischemia" on a perfusion scan indicates viable myocardium that is suffering from compromised blood flow (coronary stenosis). Because the territory is "large," the patient is at high risk, and coronary angiography (catheterization) is the definitive step to visualize the anatomy and potentially perform an intervention (PCI/stent).

20. Technique used in interventional radiology:

Answer: Seldinger

Stated Answer: Seldinger (Correct)

Explanation: The Seldinger technique is the fundamental procedure for safe percutaneous vascular access. It utilizes a guidewire to safely guide a larger catheter into a vessel lumen following the initial needle puncture.

Part 2: MSK Radiology High-Yield Lecture

Structured Conceptual Mastery for Clinical Board Exams

1. Approach to Bone Tumors

Benign vs. Malignant Features: The key to bone tumor radiology is identifying the zone of transition.

- **Benign:** Narrow zone of transition (well-defined), presence of a sclerotic rim (indicates slow growth allowing bone to react), no cortical destruction, solid periosteal reaction if any.
- **Malignant:** Wide zone of transition (imperceptible margins), permeative or moth-eaten destruction, aggressive periosteal reaction (sunburst, onion-skin, Codman triangle), soft tissue extension.

Specific Tumors & Demographics:

Tumor	Location in Bone	Classic Radiological Finding	Age / Details
Osteosarcoma	Metaphysis	Sunburst pattern, Codman triangle, osteoid matrix.	Teens; most common primary malignant.
Ewing Sarcoma	Diaphysis	Permeative lesion, "onion-skin" (lamellated) periosteal reaction.	Children/Teens; mimics osteomyelitis.
Giant Cell Tumor	Epiphysis / Metaphysis	Eccentric "soap bubble" appearance. Extends to articular surface.	20-40 yrs (skeletally mature).
Non-Ossifying Fibroma	Metaphysis	Eccentric, well-defined, thin sclerotic rim, bubbly.	Children; benign, self-resolves (no surgery).
Osteoid Osteoma	Cortex (Diaphysis)	Radiolucent nidus (<2cm) surrounded by dense sclerotic bone.	Night pain relieved by NSAIDs.
Enchondroma	Intramedullary	Central lytic lesion in small bones of hands/feet.	Benign cartilage tumor.

2. Arthropathies (Joint Diseases)

Different joint diseases have highly specific radiologic fingerprints based on the pathophysiology of destruction.

- **Osteoarthritis (OA):** A mechanical wear-and-tear disease. Focuses on **weight-bearing joints**. Findings: **Non-uniform** joint space narrowing (e.g., medial knee), subchondral sclerosis, osteophytes, and subchondral cysts (geodes). Not erosive.

- **Inflammatory Arthritis (e.g., RA):** An autoimmune synovitis. Pannus attacks the whole joint. Findings: **Uniform** joint space narrowing, marginal erosions, periarticular osteopenia (due to hyperemic washout). Favors non-weight bearing joints (MCPs, PIPs, carpus).
- **Seronegative Spondyloarthropathies (e.g., AS, Psoriatic):** Inflammatory and highly erosive, but with a tendency to produce reactive new bone (syndesmophytes). In Ankylosing Spondylitis: Bamboo spine, shiny corners (Romanus lesions), dagger sign (interspinous ligament ossification), trolley track sign (facet joint ossification).
- **Gout:** Crystal deposition. Findings: **Punched-out erosions** with overhanging edges (Martel sign), soft tissue swelling (tophi). Joint space is notably preserved until late stages.
- **Septic Arthritis:** Bacterial enzymes rapidly destroy cartilage. Findings: Rapid onset, acute effusion, **uniform joint space loss**. Usually monoarticular.

3. Metabolic & Systemic Bone Diseases

- **Hyperparathyroidism (HPT):** Excess PTH leads to rampant bone resorption. Pathognomonic: **Subperiosteal bone resorption** (radial aspect of 2nd/3rd middle phalanges). Also: Salt-and-pepper skull, brown tumors, and "Rugger Jersey" spine (sclerotic vertebral endplates mimicking a rugby shirt).
- **Multiple Myeloma:** Plasmacytoma releasing osteoclast-activating factors. Leads to strictly lytic, **"punched-out" lesions** without any reactive sclerosis (no opacity on skull x-ray).

4. Nuclear Medicine in MSK

- **Three-Phase Bone Scan (Tc-99m MDP):** Evaluates blood flow (phase 1), blood pool (phase 2), and delayed osteoblastic uptake (phase 3). Used for localizing acute osteomyelitis, evaluating avascular necrosis (AVN), and complex regional pain syndrome (CRPS). It is NOT used for structural density checks (like Osteoporosis, which requires DXA).
- **Superscan:** A bone scan showing intense, symmetric, diffuse uptake in the axial skeleton with absent or faint visualization of the kidneys (because the bones steal all the radiotracer). Seen in diffuse metastatic disease (prostate/breast) or severe metabolic disease (HPT/Osteomalacia).

MSK RADIOLOGY REVIEW

High-Yield USMLE Conceptual Breakdown & Explanations

Part 1: Question Bank & Explanations

1. Regarding classical features of non-ossifying fibroma, one is false; Select one:

- A. Split cortex sign
- B. Well defined
- C. Benign
- D. Cortical destruction
- E. Peripheral sclerosis

Stated Answer: D (Cortical destruction) — Correct.

Why D is the false statement: Non-ossifying fibromas (NOF) are benign lesions. They thin the cortex but do not cause frank cortical destruction or soft tissue extension, which are hallmarks of malignancy.

Why others are true: NOFs are benign (C), well-defined eccentric radiolucent lesions (B), typically presenting with a thin sclerotic rim/peripheral sclerosis (E), and sometimes causing a "blister" or split cortex appearance (A).

2. All are radiological signs of malignant bone disease except:

- A. Wide sclerotic rim
- B. Endosteal cortical reaction
- C. Soft tissue extension
- D. Wide transition zone
- E. Periosteal reaction

Stated Answer: A (Wide sclerotic rim) — Correct.

Why A is not a sign of malignancy: A wide sclerotic rim indicates a slow-growing lesion, giving the bone time to form reactive sclerosis (a narrow zone of transition). This is a classic sign of benignity.

Why others are malignant signs: Malignant lesions grow rapidly, causing aggressive periosteal reactions (sunburst, Codman triangle) (E), cortical destruction/endosteal scalloping (B), soft tissue masses (C), and an imperceptible, wide zone of transition (D).

3. Ewing sarcoma, which is wrong:

- A. Lesion is permeative destructive
- B. Periosteal reaction
- C. Endocortical reaction
- D. Easily differentiated from acute osteomyelitis by X-ray
- E. Diaphyseal

Stated Answer: D (Easily differentiated from acute osteomyelitis by X-ray) — Correct.

Why D is false: Ewing sarcoma and acute osteomyelitis are notorious clinical and radiological mimics. Both present with fever, localized pain, and a permeative destructive lesion with an aggressive (often onion-skin) periosteal reaction.

Why others are true: Ewing is an aggressive small round blue cell tumor causing permeative destruction (A), onion-skin periosteal reaction (B), endosteal scalloping (C), and classically arises in the diaphysis of long bones (E).

4. All will cause opacities on skull x-ray except:

- A. Histiocytosis
- B. Irradiation
- C. Multiple myeloma
- D. Mets
- E. Spherocytosis

Stated Answer: C (Multiple myeloma) — Correct.

Why C causes lucencies, not opacities: Multiple myeloma causes purely osteolytic, "punched-out" radiolucent lesions on a skull X-ray due to osteoclast activating factors, without reactive sclerosis.

Why others can cause opacities/sclerosis: Prostate or breast metastases can be osteoblastic (sclerotic/opaque). Spherocytosis causes a "hair-on-end" sclerotic appearance. Irradiation can lead to secondary osteonecrosis or osteosclerosis.

5. Not in seronegative arthritis (Note: prompt says osteoarthritis, but choices suggest inflammatory):

- A. Distal pattern
- B. Non-Erosive
- C. Uniform joint space loss
- D. Osteopenia
- E. Proliferation

Stated Answer: B (Non-Erosive) — Correct.

Why B is false for inflammatory/seronegative arthritis: Seronegative spondyloarthropathies (like Psoriatic Arthritis) are highly erosive (e.g., "pencil-in-cup" deformity). They are not non-erosive.

Why others fit the inflammatory profile: Inflammatory arthritides cause uniform joint space narrowing (C) due to diffuse cartilage destruction by pannus/inflammation, and periarticular osteopenia (D) due to local hyperemia. Psoriatic arthritis often involves distal interphalangeal joints (A) and features bony proliferation/periostitis (E).

6. Not found in ankylosing spondylitis:

- A. Bamboo spine
- B. Shiny corner sign
- C. Rugger Jersey
- D. Dagger sign
- E. Trolley track sign

Stated Answer: C (Rugger Jersey) — Correct.

Why C is wrong for AS: Rugger Jersey spine is the classic sign of renal osteodystrophy / secondary hyperparathyroidism, characterized by sclerotic bands at the upper and lower endplates of vertebral bodies.

Why others are true for AS: Bamboo spine (syndesmophytes) (A), shiny corners (Romanus lesions from enthesitis) (B), dagger sign (ossification of supraspinous ligaments) (D), and trolley track sign (ossification of facet joints) (E) are all hallmarks of Ankylosing Spondylitis.

7. Not found in hyperparathyroidism:

- A. Bamboo spine
- B. Subperiosteal bone resorption
- C. Salt-pepper skull appearance
- D. Rugger Jersey
- E. Calcification in soft tissue

Stated Answer: A (Bamboo spine) — Correct.

Why A is wrong for HPT: Bamboo spine is a sign of Ankylosing Spondylitis, an inflammatory condition, not a metabolic bone disease.

Why others are true for HPT: Hyperparathyroidism classically presents with subperiosteal bone resorption (pathognomonic on radial aspect of middle phalanges) (B), salt-and-pepper skull (C), Rugger Jersey spine (D), and metastatic soft tissue calcification (E) due to elevated calcium-phosphate product.

8. False about radiological findings in Osteoarthritis:

- A. Bilateral
- B. More prominent at lateral sides
- C. Osteophytes
- D. Geodes
- E. Space narrowing

Stated Answer: B (More prominent at lateral sides) — Correct.

Why B is false: In weight-bearing joints like the knee, OA is predominantly medial (medial compartment narrowing) because the normal mechanical axis transmits more weight through the medial aspect.

Why others are true: OA features non-uniform joint space narrowing (E), subchondral sclerosis, osteophyte formation (C), and subchondral cysts (geodes) (D). While asymmetric, it is often bilateral (A) in primary OA.

9. Which of the following differences favors osteosarcoma over Ewing sarcoma in a 16 year old child?

- A. Pathological fractures
- B. Metaphyseal in site
- C. Permeative reaction
- D. Lamellated periosteal reaction
- E. Absence of bone matrix

Stated Answer: B (Metaphyseal in site) — Correct.

Why B favors Osteosarcoma: Osteosarcoma predominantly arises in the metaphysis of long bones (e.g., distal femur, proximal tibia). Ewing sarcoma typically arises in the diaphysis.

Why others are incorrect: Osteosarcoma produces osteoid matrix (making E wrong). Ewing has a lamellated (onion-skin) reaction (D) and permeative destruction (C).

10. One of these lesions is intramedullary:

- A. Chondromyxoid fibroma
- B. Enchondroma
- C. Osteoid osteoma
- D. GCT

Stated Answer: B (Enchondroma) — Correct.

Why B is intramedullary: Enchondromas are benign cartilaginous tumors that grow centrally within the medullary cavity, typically in the small bones of the hands and feet.

Why others are incorrect: Osteoid osteoma is classically a cortical lesion (nidus with thick cortical sclerosis). Chondromyxoid fibroma and Giant Cell Tumors (GCT) are typically eccentric (off-center) rather than central intramedullary.

12. Inflammatory arthritis which is wrong:

- A. Erosions
- B. Weight bearing joints
- C. Uniform joint space narrowing

Stated Answer: B (Weight bearing joints) — Correct.

Why B is wrong: Inflammatory arthritides (like Rheumatoid Arthritis) typically target non-weight bearing synovial joints primarily (e.g., MCPs, PIPs, wrists). Osteoarthritis primarily targets weight-bearing joints (knees, hips).

Why others are true: Inflammatory arthritis is characterized by marginal erosions (A) and uniform joint space narrowing (C) due to diffuse pan-articular destruction.

13. Acute osteomyelitis all true except:

- A. Expands bone
- B. Rarefaction
- C. Reactive bone thickening

Stated Answer: C (Reactive bone thickening) — Correct.

Why C is false: Reactive bone thickening (sclerosis, involucrum formation) takes weeks to months to develop and is a hallmark of chronic osteomyelitis, not acute.

Why others are true: Acute osteomyelitis causes focal demineralization, radiolucency/rarefaction (B), and can cause local bone expansion/periosteal lifting (A).

14. Super scan not in: A. Pulmonary osteodystrophy | B. Osteomalacia | C. Hyperparathyroidism

Stated Answer: A — Correct.

A "superscan" (diffuse, symmetric intense uptake with non-visualization of kidneys) is seen in widespread metastasis (prostate/breast) or metabolic bone diseases (HPT, osteomalacia). Pulmonary osteoarthropathy causes linear periosteal uptake, not a superscan.

15. Wrong About seronegative arthritis imaging: A. Trolley track sign is due to ossification of the posterior interspinous ligament | B. Sclerosis of the vertebral corner is an early sign

Stated Answer: A — Correct.

The trolley track sign in AS is due to ossification of the apophyseal (facet) joints and ligamenta flava. Ossification of the interspinous ligament creates the "dagger sign".

16. True about gout: A. Punched out erosions | B. Early joint narrowing

Stated Answer: A — Correct.

Gout classically presents with well-defined, juxta-articular punched-out erosions with overhanging edges (Martel sign). Joint spaces are paradoxically preserved until very late in the disease.

17. Wrong about septic arthritis: Symmetrical bilateral

Stated Answer: Symmetrical bilateral — Correct.

Septic arthritis is almost exclusively acute and monoarticular (affecting a single joint, usually knee or hip). Symmetrical bilateral involvement is a hallmark of Rheumatoid Arthritis.

18. Wrong about osteosarcoma: Diaphyseal

Stated Answer: Diaphyseal — Correct.

Osteosarcomas classically arise in the metaphysis. Ewing sarcoma and multiple myeloma/lymphoma lesions arise in the diaphysis.

19. Wrong about non ossifying fibroma: Majority need surgery

Stated Answer: Majority need surgery — Correct.

NOFs are common, benign pediatric lesions that generally require no treatment. They typically regress and ossify spontaneously as the child reaches skeletal maturity.

20. Not a sign on inflammatory arthritis: Periarticular osteosclerosis AND affects weight-bearing joints

Stated Answer: Both — Correct.

Inflammatory arthritis causes periarticular osteoPENIA (not sclerosis, due to local hyperemia) and favors non-weight bearing joints. Osteoarthritis causes sclerosis and favors weight-bearing joints.

21. Tumor of epiphysis: Giant cell tumor

Stated Answer: Giant cell tumor — Correct.

GCTs classically arise in the metaphysis but characteristically extend up to the articular surface (epiphysis) in skeletally mature patients ("soap bubble" appearance).

22. Three phase bone scan not used in: Osteoporosis

Stated Answer: Osteoporosis — Correct.

Osteoporosis is evaluated structurally via DXA scan (T-score). Three-phase bone scintigraphy evaluates perfusion and osteoblastic activity (useful for osteomyelitis, AVN, fractures, CRPS).

23. Which of the following is wrong? Non-uniform joint space loss in septic arthritis

Stated Answer: Non-uniform joint space loss — Correct.

Septic arthritis bacterial enzymes aggressively destroy the entire cartilage equally, leading to uniform joint space narrowing. OA causes non-uniform narrowing.

24. Ewing vs osteosarcoma: Ewing is diaphyseal

Stated Answer: Ewing is diaphyseal — Correct.

Ewing = Diaphysis (onion-skin). Osteosarcoma = Metaphysis (sunburst, Codman triangle).

NUCLEAR MEDICINE COMPREHENSIVE REVIEW

Integrated Concepts, High-Yield Principles, & USMLE-Format Q&A Analysis

Lecture Notes: High-Yield Nuclear Medicine Principles

This section synthesizes the core concepts necessary to understand the clinical applications, radiotracers, and imaging modalities in Nuclear Medicine.

1. Fundamentals of Radiotracers

- **Technetium-99m (Tc-99m):** The workhorse of nuclear medicine. Originates from Molybdenum-99 (Mo-99) via an alumina generator. The "m" stands for *metastable*. It decays by isomeric transition (emitting pure gamma rays). Its energy is ideal (140 keV) and it has a convenient half-life of 6 hours, allowing ample time for imaging while minimizing patient radiation exposure.
- **Fluorine-18 (18F):** Used primarily in PET scans as 18F-Fluorodeoxyglucose (FDG), a glucose analog. Positron emitter.
- **Iodine-131 (I-131):** Emits beta particles (for therapeutic tissue destruction) and gamma rays. Used for treating hyperthyroidism and differentiated thyroid cancers.

2. Oncology & PET Imaging

18F-FDG PET/CT is paramount in oncology for staging, restaging, and assessing treatment response. It relies on the Warburg effect (increased glycolysis in cancer cells). Post-chemotherapy (e.g., for Hodgkin and Non-Hodgkin Lymphoma), persistent masses are common. An FDG-avid mass indicates residual viable tumor. A PET-negative mass is composed of fibrotic/scar tissue and warrants purely observation (no biopsy or therapy needed).

3. Cardiovascular Nuclear Medicine

Myocardial Perfusion Imaging (MPI): Assesses relative blood flow to the left ventricular myocardium. Tracers include *Tc-99m Sestamibi*, *Tc-99m Tetrofosmin*, and *Thallium-201*. Indications include evaluating atypical chest pain, evaluating the functional significance of known CAD, and pre-operative risk stratification. If anatomical stenosis is already definitively known and very severe (e.g., >80% on cath), revascularization or direct functional testing via Fractional Flow Reserve (FFR) during cath is usually preferred over sending the patient back for MPI.

Coronary Flow Reserve (CFR): Ratio of hyperemic (maximal) coronary flow to resting flow. Normal CFR is > 2.5 to 3.0. Values < 2.0 - 2.5 indicate significant microvascular or epicardial disease.

4. Endocrine (Thyroid Scintigraphy)

Thyroid function is assessed via Iodine uptake.

- **High uptake:** Graves' disease (diffuse), Toxic multinodular goiter (patchy), Toxic adenoma (focal).
- **Low uptake (<5%):** Thyroiditis (subacute, painless), exogenous hormone ingestion (factitious hyperthyroidism), or recent iodine load (e.g., IV contrast). Management of low-uptake thyrotoxicosis is supportive (beta-blockers) as it is self-limiting.
- **Cold Nodules:** Nodules that do not take up tracer. While ~15-20% are malignant, the vast majority (~80-85%) are benign. However, because they *can* be malignant, they typically require fine-needle aspiration (FNA).
- **I-131 Therapy:** Effective for cells expressing the Sodium-Iodide Symporter (NIS). Anaplastic thyroid carcinoma is undifferentiated, lacks NIS, and cannot be treated with I-131.

5. Renal & Skeletal Applications

- **Bone Scans (Tc99m-MDP):** Bind to hydroxyapatite and reflect osteoblastic activity. Excellent for detecting blastic metastases (prostate, breast, lung). *Wrong indication:* Multiple Myeloma, which causes purely osteolytic lesions without reactive osteoblastosis (leading to false negatives).
- **Renal Scans:** *Tc99m-MAG3* is used for assessing renal tubular secretion and clearance. *Tc99m-DMSA* binds to the renal cortex and is the gold standard for detecting cortical scarring from recurrent pyelonephritis.

Interactive Q&A Analysis

1. Coronary flow reserve following exercise:

- A. 0.5
- B. 4
- C. 5
- D. 2.5
- E. 1.5

Stated Answer: D. (Evaluation: Context-Dependent / Borderline)

Explanation: Coronary flow reserve (CFR) is the maximum increase in blood flow through the coronary arteries above the normal resting volume. In healthy individuals undergoing physiological exercise or pharmacological vasodilation, it typically reaches **3 to 5 times** the resting rate (Choices B and C represent healthy optimal values). However, a CFR of **2.0 to 2.5** is the widely accepted critical threshold. Values below 2.0-2.5 represent impaired flow reserve (ischemia). The stated answer "D (2.5)" likely refers to the lower limit of normal or the clinical cutoff value for functional significance rather than the peak normal value.

Why others are wrong: A (0.5) and E (1.5) reflect severe ischemia/impaired reserve. B (4) and C (5) are robust, normal healthy values. If the question implies the clinical cut-off threshold evaluated post-exercise, 2.5 is the standard metric.

2. Bone scan wrong indication:

- A. Lung
- B. Brain
- C. Breast
- D. Multiple myeloma
- E. Colorectal cancer

Stated Answer: D. (Evaluation: Correct)

Explanation: Radionuclide bone scans (using Tc99m-MDP) detect areas of increased osteoblastic activity (bone turnover).

Why D is correct: Multiple myeloma lesions are purely osteolytic; myeloma cells secrete factors (like DKK1 and IL-3) that inhibit osteoblasts. Because there is no osteoblastic reaction, bone scans are notoriously negative in multiple myeloma. A skeletal survey (X-ray) or PET scan is the correct imaging modality.

Why others are wrong: Lung, breast, and colorectal cancers can cause osteoblastic or mixed lytic/blastic bony metastases, making bone scans highly useful. Primary brain tumors rarely metastasize to bone, but medulloblastoma can, though it is a less common indication compared to breast/lung. D is the classic absolute contraindication for a bone scan due to false negatives.

3. All are true about Tc Except:

- A. Multiple valent states and good chemistry
- B. Half life of 6 hours
- C. Adsorbed by aluminum
- D. Decay by isomeric transition
- E. Originates from Mo

Stated Answer: C. (Evaluation: Correct)

Explanation: Tc-99m is generated using a Molybdenum-99 (Mo-99) generator. Mo-99 is adsorbed onto an alumina (aluminum oxide) column. As it decays to Tc-99m, the Tc-99m has lower affinity for the alumina and is eluted (washed off) with a saline solution.

Why C is correct (False Statement): Tc-99m is NOT adsorbed by the alumina; the parent isotope Mo-99 is. Tc-99m is deliberately easily washed off.

Why others are true: A: Technetium exhibits oxidation states from -1 to +7, making it chemically versatile for labeling various compounds. B: It has an ideal half-life of 6 hours. D: It decays via isomeric transition from its metastable state to its ground state, emitting a 140 keV gamma ray. E: It originates from the decay of Mo-99.

4. I131 is used in the treatment of all of the following except:

- A. Toxic Adenoma
- B. Anaplastic Thyroid Cancer
- C. Papillary Thyroid Cancer
- D. Follicular Thyroid Cancer
- E. Toxic Multi-Nodular Goiter

Stated Answer: B. (Evaluation: Correct)

Explanation: Radioactive Iodine (I-131) relies on the tissue expressing the Sodium-Iodide Symporter (NIS) to actively transport the destructive isotope into the cells.

Why B is correct (Exception): Anaplastic thyroid cancer is highly undifferentiated. Because it lacks cellular differentiation, it does not express NIS and therefore will not concentrate I-131, rendering the treatment ineffective.

Why others are wrong (Valid indications): Papillary (C) and Follicular (D) are well-differentiated thyroid cancers that retain NIS and respond to I-131 ablation. Toxic adenomas (A) and Toxic multinodular goiters (E) are hyperfunctioning tissues that readily take up iodine and are destroyed by it.

5. In a pre treatment FDG/PET CT scan of a hodgkin lymphoma, there is increased uptake in 6 lymph nodes that are 4 to 5 cm in diameter, after completion of chemotherapy on FDG/PET CT scan there was no uptake and a residual mass 3 cm in diameter, which of the following is the next step?

- A. Reassurance and follow up
- B. Salvage chemotherapy
- C. Biopsy of the mass
- D. Excision of the mass
- E. Treat with radiotherapy

6. A male patient with non Hodgkin lymphoma in the mediastinum (6 cm), underwent chemotherapy, after that he did a PET scan that showed a 3 cm mass with no uptake, what's the next step of management?

- A. Give more chemotherapy
- B. Biopsy
- C. Follow up normally with no therapy
- D. Repeat PET scan within 1 week

Stated Answers: Q5: A, Q6: C. (Evaluation: Correct)

Explanation: These questions test the fundamental utility of PET scans in lymphoma (Deauville criteria). A persistent anatomical mass on CT following chemotherapy is extremely common in lymphomas. However, anatomy does not equal viability.

Why A/C are correct: If the residual mass shows NO FDG uptake on PET, it consists entirely of fibrotic tissue, necrosis, or scar matrix. The active tumor has been eradicated. The standard of care is reassurance and observation.

Why others are wrong: Excision, biopsy, or salvage chemo would expose the patient to unnecessary morbidity. Radiotherapy is unneeded for a completely metabolic-negative mass. Repeating the PET within 1 week is clinically useless as the biology won't change that rapidly.

7. All are indications for myocardial scintigraphy except:

- A. A patient with typical chest pain and a negative stress ECG
- B. A patient with symptomatic CAD and diabetes
- C. A patient showed 80% stenosis of LAD on cath angiography
- D. Done to patient with CAD before surgery

Stated Answer: C. (Evaluation: Correct)

Explanation: Myocardial perfusion imaging (scintigraphy) is primarily a functional test to evaluate for ischemia.

Why C is the exception: If a patient has already undergone coronary angiography (the gold standard for anatomy) and severe (80%) Left Anterior Descending (LAD) stenosis is identified, sending them backwards to nuclear scintigraphy is inefficient and rarely indicated. If functional significance needs proving during the cath, fractional flow reserve (FFR) is measured on the spot. Revascularization planning is the immediate next step.

Why others are indications: A: Discordant results (typical pain but negative ECG) require higher sensitivity imaging. B: Diabetics often have silent ischemia and complex CAD, making perfusion scans useful. D: Pre-operative risk stratification in patients with known CAD is a classic indication for a pharmacological stress perfusion scan.

8. Wrong about ^{99m}Tc :

- A. A half-life of 6 hours
- B. Cheap
- C. m: maximum
- D. Energy 140 keV

Stated Answer: C. (Evaluation: Correct)

Explanation: The nomenclature of medical isotopes is highly specific.

Why C is correct (False Statement): The "m" in ^{99m}Tc stands for **metastable**, not maximum. It indicates that the nucleus is in an excited state and will relax to its ground state (Tc-99) by emitting a gamma photon.

Why others are true: A: Half-life is precisely 6 hours. B: It is relatively inexpensive due to the generator system. D: It emits an ideal gamma ray of 140 keV, optimal for gamma camera detection.

9. The probability of cold nodule to be benign is:

- A. 70%
- B. 85%
- C. 25%
- D. 15%

Stated Answer: B. (Evaluation: Correct)

Explanation: On a thyroid uptake scan, a "cold" nodule implies decreased radiotracer uptake compared to surrounding normal tissue. While cold nodules carry a higher risk of malignancy than "hot" (hyperfunctioning) nodules, the vast majority are still benign (e.g., cysts, colloid nodules, adenomas). Epidemiologically, about 15-20% are malignant, meaning **80-85% are benign**.

10. All of the following is used in myocardial perfusion scanning except:

- A. MAG3
- B. Tetrofosmin
- C. Sestamibi
- D. Thallium

Stated Answer: A. (Evaluation: Correct)

Explanation: Myocardial perfusion tracers must cross the sarcolemma and accumulate in viable myocytes in proportion to blood flow.

Why A is the exception: Tc-99m-MAG3 (mercaptoacetyltriglycine) is specifically cleared by renal tubular secretion. It is used exclusively for dynamic renal scintigraphy (renograms), not cardiac imaging.

Why others are true: Sestamibi and Tetrofosmin are lipophilic cations that enter myocytes and bind to mitochondria. Thallium-201 acts as a potassium analog and enters via the Na^+/K^+ ATPase pump.

11. A man with high T3, T4, low TSH, did uptake that showed <4% uptake, what's the next step of management:

- A. Treat with radioactive iodine
- B. Treat hyperthyroid symptoms and then follow up in the next 2-3 months
- C. Give anti-thyroid meds and then after 2-3 months start him on thyroxine for life

Stated Answer: B. (Evaluation: Correct)

Explanation: The patient has biochemical thyrotoxicosis (High T3/T4, Low TSH). However, the radically low radioiodine uptake (<4%) distinguishes this from Graves' disease. Low uptake indicates the thyroid gland is NOT synthesizing new hormone. Instead, pre-formed hormone is leaking into the blood (e.g., painless or subacute thyroiditis) or the patient is taking exogenous thyroxine.

Why B is correct: Because the gland is not overproducing hormone, treatments aimed at synthesis (methimazole) or gland destruction (I-131) are completely ineffective. The condition (thyroiditis) is usually self-limiting. The standard of care is symptomatic management (e.g., beta-blockers for tachycardia) and monitoring thyroid function.

12. Increased iodine uptake:

- A. Graves
- B. Diffuse thyroiditis
- C. Recent contrast

Stated Answer: A. (Evaluation: Correct)

Explanation: Increased radioiodine uptake implies thyroid hyperactivity and de novo hormone synthesis.

Why A is correct: Graves' disease involves autoantibodies (TSI) that chronically stimulate the TSH receptor, resulting in massive, diffuse cellular hypertrophy and profoundly increased iodine uptake.

Why others are wrong: Diffuse thyroiditis destroys follicular cells, releasing pre-formed hormone and ceasing new synthesis, resulting in near-zero uptake. Recent IV contrast introduces a massive load of non-radioactive iodine into the body; this competitively inhibits the uptake of the radioactive tracer, causing an artificially low uptake.

13. Wrong about Radionuclear:

- A. Less than 10 rad usually no effect or asymptomatic effect
- B. Radionuclear use 0.46 rad
- C. Any small radiation can cause malignancies

Stated Answer: C. (Evaluation: Nuanced/Debatable, aligned with student note)

Explanation: This question relates to radiation biology models. The "Linear No-Threshold" (LNT) model used for regulatory safety assumes that *any* dose of ionizing radiation (no matter how small) carries a theoretical non-zero risk of inducing malignancy. However, clinically, doses under 100 mSv (~10 rad) have not shown statistically significant epidemiological increases in cancer in human populations (A is effectively true).

The statement "Any small radiation can cause malignancies" is considered a regulatory presumption rather than a definitive clinical absolute, making C the likely intended "wrong" statement in the context of the specific lecture slides emphasizing practical clinical safety of nuclear scans.

14. Least indicated to do a myocardial perfusion scan:

- A. Patient with cath showing 75% stenosis
- B. Abnormal stress test in low risk patient
- C. Other choices were all low risk pts Indicated

Stated Answer: A. (Evaluation: Correct)

Explanation: Similar logic to Question 7. If the patient has already undergone an invasive catheterization demonstrating a hemodynamically significant stenosis (75%), sending them for a non-invasive perfusion scan is redundant. Functional significance of a 75% lesion is best evaluated concurrently in the cath lab via FFR. Non-invasive tests (like perfusion scans) act as gatekeepers *to* the cath lab, not vice versa.

15. Cardiac perfusion scan which is wrong:

- A. Higher sensitivity than ECG stress test
- B. Decrease basal septum perfusion indicates infarction

Stated Answer: B. (Evaluation: Correct)

Explanation: Nuclear perfusion imaging involves common artifacts that must be recognized.

Why B is correct (False Statement): Decreased uptake in the basal septum is a very common artifact, particularly due to Left Bundle Branch Block (LBBB) or simply because the membranous portion of the septum is thin and contains less myocardial mass. It does *not* reliably indicate a myocardial infarction.

Why A is true: Nuclear imaging is significantly more sensitive (~85-90%) than a simple treadmill ECG (~68%) for detecting CAD.

Direct Recall Concept Alignments

16. Myocardial perfusion studies parameters:

Stated Answer: Coronary flow reserve

Explanation: Coronary flow reserve is a calculated metric derived from advanced perfusion studies (particularly PET MPI) indicating the ratio of hyperemic flow to resting flow.

17. Not a trace in myocardial perfusion scan:

Stated Answer: Tc99m-HMPAO

Explanation: Tc99m-HMPAO (hexamethylpropyleneamine oxime) is a lipophilic tracer that crosses the blood-brain barrier. It is used for brain perfusion SPECT imaging or labeling white blood cells for infection imaging, NOT for the heart.

18. True about PET scan:

Stated Answer: Important for oncologic practice

Explanation: FDG-PET is the cornerstone of modern oncological imaging for initial staging, monitoring therapy efficacy, and checking for recurrence.

19. Most commonly used PET tracer:

Stated Answer: 18F-FDG

Explanation: Fludeoxyglucose (18F) is a glucose analog that is taken up by highly metabolic cells (like malignancies) but cannot be metabolized further, becoming trapped in the cell for imaging.

20. Renal Imaging correlation:

Stated Answer: DMSA scan for pyelonephritis

Explanation: Tc99m-DMSA (Dimercaptosuccinic acid) binds strongly to the proximal renal tubules in the renal cortex. It is the gold standard imaging modality for identifying acute focal pyelonephritis and long-term renal cortical scarring.

Pediatric Radiology & Radiation Biology

USMLE Step 1 & 2 Core Concepts

Comprehensive Review Lecture

1. Pediatric Abdominal Emergencies

Intussusception: The telescoping of a proximal bowel segment into a distal segment (most commonly ileocolic). It typically presents in children aged 6-36 months with colicky abdominal pain, drawing up of the legs, bilious vomiting, and "currant jelly" stools.

Imaging: **Abdominal ultrasound** is the best initial test, revealing a classic "**target sign**," "**donut sign**," or "**pseudo-kidney sign**" (thickened bowel loops resembling a kidney). Treatment is via air or hydrostatic enema.

Hypertrophic Pyloric Stenosis (HPS): Characterized by hypertrophy of the pyloric sphincter. *Clinical vignette pearl:* It almost exclusively presents in infants at **3 to 6 weeks of age** with non-bilious, projectile vomiting immediately after feeding. An "olive-like" mass may be palpated.

Imaging: **Abdominal ultrasound** is the modality of choice, showing an elongated and thickened pylorus (target sign in transverse view).

2. Pediatric Bone and Trauma Radiology

Rickets: Defective mineralization of the growth plate (epiphyseal plate) primarily due to Vitamin D deficiency. On X-ray, you will see widening, cupping, and fraying of the metaphyses. A key radiographic feature is the **ill-defined or fuzzy margin** of the ossification centers, reflecting the failure of osteoid to mineralize properly.

Growing Skull Fractures (Leptomeningeal Cysts): A rare complication of skull fractures in infants. If the dura mater is torn during a fracture, the pulsatile force of the brain and arachnoid membrane pushes through the defect. This prevents osteoblast healing and causes the fracture margins to progressively widen (leptomeningeal expansion).

Accidental vs. Non-Accidental Trauma (Abuse):

- *Accidental:* **Supracondylar fractures** of the humerus are the most common accidental pediatric elbow fractures, usually resulting from a fall on an outstretched hand (FOOSH).
- *Abuse (High Specificity):* Classic metaphyseal lesions (bucket-handle or corner fractures), posterior rib fractures (from squeezing), and multiple fractures in various stages of healing.

Pediatric Cases - Practice Questions

Question 1: A 4-year-old child presents with abdominal pain and recurrent vomiting. Ultrasound showed a pseudo-kidney shaped appearance. Most likely diagnosis:

- A. Pyloric Stenosis
- B. Intussusception
- C. Volvulus
- D. Mesenteric adenitis
- E. Appendicitis

Answer & Explanation:

Correct Choice: B. Intussusception

Evaluation of Stated Answer: The prompt listed "Pyloric Stenosis" initially in the text flow, but the correct medical answer is Intussusception.

Why B is correct: The "pseudo-kidney" sign on ultrasound is pathognomonic for intussusception. It represents the edematous bowel telescoped inside another segment, mimicking the sonographic appearance of a kidney. Recurrent vomiting and abdominal pain fit this presentation.

Why others are wrong: (A) Pyloric stenosis presents at 3-6 weeks of life, not 4 years. It shows a thickened pylorus, not a pseudo-kidney sign. (C) Volvulus presents with bilious emesis and shows a "whirlpool sign" on US or "corkscrew" on upper GI series. (D) Mesenteric adenitis presents similarly to appendicitis with enlarged lymph nodes on US, not a pseudo-kidney. (E) Appendicitis shows a blind-ended, non-compressible, thickened appendix on US.

Question 2: A 4-year-old child presents with suspected pyloric stenosis. The best initial imaging modality is:

- A. Barium swallow
- B. Abdominal ultrasound
- C. Abdominal X-ray
- D. Abdominal CT scan

Answer & Explanation:

Correct Choice: B. Abdominal ultrasound

Evaluation of Stated Answer: The prompt text stated "Answer: B" interspersed in the text, which is correct.

Why B is correct: Ultrasound is highly sensitive and specific for pyloric stenosis and involves no ionizing radiation (ALARA principle). It will demonstrate pyloric muscle hypertrophy (thickness >3mm, length >14mm).

Why others are wrong: (A) Barium swallow can show a "string sign" but involves radiation and is only used if US is inconclusive. (C) X-ray may show a distended stomach but is non-diagnostic for the pylorus. (D) CT scan provides unnecessary, high-dose radiation for a condition easily diagnosed via US.

USMLE Note: While the imaging modality is correct, an age of 4 years is epidemiologically incorrect for pyloric stenosis (classic age is 3-6 weeks).

Question 3: Which is WRONG about rickets?

Prompt states: "Answer: Well defined margin of ossification nucleus"

Answer & Explanation:

Is the stated answer correct? Yes.

Explanation: In rickets, failure of osteoid mineralization at the growth plates leads to widened, frayed, and irregular metaphyses. Because the cartilage does not calcify normally, the margins of the ossification centers are classically **ill-defined and fuzzy**. Therefore, describing the margins as "well-defined" is radiographically incorrect (wrong), making it the correct choice for this negatively-phrased question.

Question 4: Leptomeningeal expansion is associated with:

Prompt states: "Answer: Growing fracture"

Answer & Explanation:

Is the stated answer correct? Yes.

Explanation: A growing skull fracture occurs when a traumatic skull fracture is accompanied by a dural tear. The pulsating brain and leptomeninges (arachnoid) herniate through the tear, forming a leptomeningeal cyst. This constant mechanical pulsation causes the fracture edges to erode and expand over time ("leptomeningeal expansion").

3. Radiation Biology Principles

ALARA Principle: Stands for "As Low As Reasonably Achievable." This is the core mandate of radiation safety, aiming to minimize patient and occupational radiation exposure to mitigate risks.

Stochastic vs. Deterministic Effects:

- *Stochastic Effects:* Occur by chance (e.g., radiation-induced cancer, genetic mutations). They follow a **linear no-threshold model**. The *probability* of the effect occurring increases proportionately with the radiation dose, but the *severity* of the disease (if it occurs) is independent of the dose.
- *Deterministic Effects:* Have a specific threshold dose (e.g., cataracts, skin erythema). Once the threshold is exceeded, the *severity* of the effect increases with the dose.

Biological / Radiology Basics - Practice Questions

Question 5: Which pediatric fracture is NOT typically indicative of abuse?

Prompt states: "Answer: Supracondylar"

Answer & Explanation:

Is the stated answer correct? Yes.

Explanation: Supracondylar fractures of the humerus are the most common type of elbow fracture in children, overwhelmingly caused by a normal childhood mechanism: falling on an outstretched hand (FOOSH) during play. Therefore, they are not highly suspicious for non-accidental trauma (abuse). Conversely, fractures that *are* highly specific for abuse include metaphyseal corner fractures, bucket-handle fractures, and posterior rib fractures.

Biological Question 1: ALARA stands for:

- A. As low as reasonably applicable
- B. As low as reasonably accessible
- C. As low as reasonably affordable
- D. As low as reasonably achievable

Answer & Explanation:

Correct Choice: D. As low as reasonably achievable

Evaluation of Stated Answer: The prompt states "Answer: D", which is absolutely correct.

Explanation: This is the foundational safety principle in radiology. It dictates that every reasonable effort must be made to maintain radiation exposures as far below the dose limits as practical, consistent with the clinical purpose of the exam. The other acronym options are simply incorrect distractors.

Biological Question 2: Which is true about stochastic effect?

Prompt states: "Answer: Has a linear proportion with radiation dose"

Answer & Explanation:

Is the stated answer correct? Yes.

Explanation: Stochastic effects (such as radiation-induced carcinogenesis or genetic mutations) operate on a linear no-threshold (LNT) model. This means that the *probability* of the effect happening increases in a linear proportion to the radiation dose received. There is no "safe" threshold dose below which the probability is zero. Crucially, if the effect does occur, the *severity* of the cancer/mutation is independent of the dose (a higher dose doesn't mean a "worse" cancer, just a higher chance of getting it).

Indications for Imaging Modalities

Head CT

- Seizure, headache, acute stroke, GCS <13, FND, skull fracture.
- > 1 episode of vomiting (especially if there is coagulopathy or anticoagulant use in adults; >3 in children).
- Increased ICP, hydrocephalus.

Chest CT

- Evaluate abnormalities on CXR.
- Evaluate pulmonary and pleural masses.
- Diffuse pulmonary disease (diagnosis and extent).
- Evaluation of mediastinum.
- Bronchiectasis (suspected, extent, and severity).
- Suspected Pulmonary Embolism (PE).

Abdomen/Pelvic CT

- Acute appendicitis, diverticulitis.
- Acute pancreatitis and pseudocyst (chronic pancreatitis without contrast).
- Cancer staging.
- Evaluation of urinary tract (with or without contrast).
- Abdominopelvic blunt trauma (ecchymosis, drop Hb/HCT).

Fluoroscopy

- Visualize in real-time organ motion, ingested or injected contrast agent (Barium, MCUG / VCUG, Hysterosalpingogram).
- Therapeutic intervention: stent insertion or catheterization of the vessels.
- **Angiography (Visualization of vessels):**
 - **Diagnostic** aneurysm, thrombosis, AVM, AVF.
 - **Therapeutic** embolization, stenting, thrombectomy, thrombolysis.
- **MCUG / VCUG:**
 - VUR, study urethra during voiding, bladder leak after trauma, or post-surgery, urodynamic studies (i.e., incontinence).
 - **C/I:** Acute UTI.
 - **Preparation:** Foley's catheter insertion, Empty UB.
- **Hysterosalpingogram:**
 - Infertility, recurrent abortion, assessment of fallopian tubes or CS scar.
 - Early phase and late phase of uterine filling demonstrating peritoneal spillage bilaterally, suggesting patent fallopian tubes.
 - **Preparation:** Abstain from intercourse. Examination done before day 21 of menstrual cycle between 4th-10th day.
 - **C/I:** Pregnancy, bleeding (menses), purulent discharge or PID before 6 months, recent abortion or dilatation.

Ultrasound

- **Advantages:** Available, speed, low cost, non-invasive, no radiation.
- Doppler examination during early pregnancy is limited for long-time application due to thermal-induced effects on the embryo.
- **Probes:**
 - **Linear:** Low penetration, high frequency and resolution used to examine superficial organs.
 - **Curved (curvilinear):** High penetration, low frequency and resolution used to examine deep organs.
- **Gel:** For the transducer to make secure contact with the skin and eliminate air pockets that block sound waves into patient's body.
- **Doppler US:** Measures the direction and speed of blood cells through blood vessels.

MRI

- **Advantages:**
 - Superior soft tissue contrast
 - Multiplanar capability
 - Non-ionizing radiation
 - Relatively safe contrast media
- **Disadvantages:**
 - Expensive & not widely available
 - Claustrophobia
 - Certain contraindications (i.e. pacemakers)

بِالتَّوْفِيقِ جَمِيعًا ، لَا تَنْسَوْنَ مِنْ صَالِحِ دُعَائِكُمْ