Radiology Final

🔊 **Podcast Style Review (Experimental Feature)**

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- **NOTE:** Highlighted in **bold** are the important key info!
- Topics are arranged in order of most to least commonly tested
- Check the table of contents below for easier navigation
- Good luck 🍀

General Radiology Principles

Computed Tomography (CT)

- **Hyperdense Lesions on CT:**
  - **Metallic clips**
  - **Intravenous contrast**
  - **Acute hemorrhage**
  - **Calcifications**
  - *Note: Lipoma is hypodense.*
- **CT is the best modality for detecting calcification.**
- CT uses **ionizing radiation**.

Magnetic Resonance Imaging (MRI)

- **MRI Properties:**
  - **Does NOT use ionizing radiation.**
  - MRI contrast (Gadolinium) is **relatively safe**.
  - **Takes more time** to perform than CT.
  - **Contraindicated with ferromagnetic substances** (e.g., certain implants, pacemakers - check compatibility).
- **MRI Uses & Sequences:**
  - **DWI (Diffusion Weighted Imaging): Gold standard for acute infarct (shows hyperintensity).**
  - **T1 + Contrast (Gadolinium): Excellent for intra-axial tumors** and assessing enhancement.
  - **MRV (MR Venography): Best for diagnosing cavernous sinus thrombosis.**
  - FLAIR: Good for periventricular white matter disease; **NOT specifically for calcification.**
  - STIR: A fat suppression sequence (T2 based).

- **MRI vs CT:**
  - MRI generally less sensitive than CT for **acute hemorrhage** (CT is faster and better).
  - CT is better for detecting **calcification** and **acute bone trauma**.
  - MRI **contraindicated** for definite localization of **intraorbital metallic foreign bodies** (CT preferred).

Contrast Media

- **Iodinated Contrast (CT/Angio):**
  - Relative Contraindications: **Asthma, Atopy (general allergies), specific food/penicillin allergies.**
  - **Strong Contraindication: Previous severe contrast allergy.**
  - Preparation for at-risk patients (e.g., asthma): **Oral prednisolone**.
- **Gadolinium Contrast (MRI):**
  - **Relatively safe** compared to iodinated contrast.
  - **Contraindicated in severe renal failure (e.g., Grade III or dialysis)** due to risk of NSF.
  - **Generally contraindicated in the first trimester of pregnancy.**

Ultrasound (US)

- **Properties:**
  - **No ionizing radiation.**
  - Can visualize vessels (with Doppler).
  - Operator dependent.
  - **Less accurate in obese patients.**
- **Optimal Conditions:** Thin patient, children, **full bladder** (for pelvic US).
- **Suboptimal Conditions:** Obese patient, **recent endoscopy** (air artifact), excessive bowel gas.

Radiographic Density & Attenuation

- **Highest Attenuation (most radiopaque/white): Metal, Bone, Contrast.**
- **Intermediate Attenuation:** Soft tissues, water/fluid.
- **Low Attenuation (most radiolucent/black): Fat, Air.**
- **Lung parenchyma:** Has **low attenuation** and high penetration due to air content.

Chest X-ray Interpretation

Technique & Views

- Standard Views: **PA (Posterior-Anterior) and Lateral.**
- **PA View:** Taken on **full inspiration**. Standard distance (1.8m or 6ft) minimizes heart magnification.
- **AP View (Anterior-Posterior):** Often portable, **exaggerates heart size**. Supine position alters fluid/air appearances.
- **Lateral View:** Helps localize lesions, view retrosternal/retrocardiac spaces. **Left hemidiaphragm often obscured anteriorly** by the heart.

Anatomy & Signs

- **Hilum:** Contains pulmonary arteries/veins, bronchi, lymph nodes. **Left hilum is normally slightly higher than the right.** Prominent hila can indicate adenopathy or pulmonary hypertension.
- **Heart Borders:**
  - **Right border = Right Atrium (adjacent to Middle Lobe).**
  - **Left border = Left Ventricle / Left Atrial Appendage (adjacent to Lingula/Upper Lobe).**
- **Silhouette Sign: Loss of a normal interface (border) indicates pathology in the adjacent lung.**
  - **Right heart border loss = RML pathology.**

- **Left heart border loss = Lingula (LUL) pathology.**
- Diaphragm loss = Lower lobe pathology.

- **Air Bronchogram:** Visible air-filled bronchi surrounded by consolidated lung (e.g., pneumonia, edema). **CT is more sensitive** for detection. **Not normally visible** in peripheral lung.

Common Pathologies

- **Atelectasis/Collapse:** Loss of lung volume.
  - Signs: **Opacification, fissure displacement, hilar displacement, volume loss, mediastinal shift (towards collapse).**
  - **RUL Collapse: Elevates right hilum** and minor fissure.
  - **LUL Collapse:** Opacity obscuring left heart border, elevates left hilum.
- **Pneumonia:** Consolidation (opacity). **Lobar pneumonia respects fissures.**
  - **RML pneumonia silhouettes right heart border.**
  - **LLL pneumonia silhouettes left hemidiaphragm.**
- **Pleural Effusion:** Fluid in pleural space.
  - Signs: **Blunting of costophrenic angles**, meniscus sign, opacification. Supine: layers posteriorly, causing diffuse increased density.
- **Pneumothorax:** Air in pleural space.
  - Signs: **Visible pleural line**, absent lung markings peripherally.
  - **Tension Pneumothorax: Mediastinal shift *away* from pneumothorax**, ipsilateral hemidiaphragm depression. A medical emergency.
  - Supine: Air collects anteriorly, may be subtle (deep sulcus sign). **CT is most sensitive** for small pneumothorax.
- **Pulmonary Embolism (PE): Spiral CT Angiography is the imaging modality of choice.** CXR often normal or shows non-specific signs (atelectasis, small effusion).
- **Lung Nodules:** CXR insensitive for nodules **<5mm**. **Peripheral calcified nodule usually benign**. Signs favouring malignancy include size >8-10mm, irregular/spiculated border, growth.
- **Pneumoperitoneum:** Free air under diaphragm on erect CXR. **Best modality is often standing upright CXR/abdomen X-ray.** Most common cause: **perforated viscus (e.g., peptic ulcer).**

Brain CT & MRI

Hemorrhage

- **Acute Hemorrhage: Hyperdense (bright) on non-contrast CT.**
- **Epidural Hematoma (EDH):**
  - **Biconvex (lens) shape.**
  - Often associated with **skull fracture** (temporal bone common).
  - **Does NOT cross sutures.** Arterial source common (middle meningeal artery).
- **Subdural Hematoma (SDH):**
  - **Crescent shape.**
  - **Crosses sutures,** but not dural reflections (falx, tentorium). Venous source common.
  - Density varies with age: **Acute = hyperdense, Subacute = isodense, Chronic = hypodense.** Common in elderly and infants.
- **Intraventricular Hemorrhage:** Blood within ventricles. **Associated with poor prognosis.**

Ischemia / Infarct

- **Acute Infarct: MRI with DWI is the most sensitive modality**, shows restricted diffusion (hyperintense) within minutes to hours.

- CT may be normal initially, later shows **hypodensity** in a vascular territory.

Edema

- **Cytotoxic Edema:** Intracellular swelling (e.g., acute ischemia). **Causes restricted diffusion on DWI.**
- **Vasogenic Edema:** Extracellular fluid leakage (e.g., around tumors, inflammation). Appears as **hypodensity on CT** / T2 hyperintensity on MRI, often respecting white matter tracts.
- **Diffuse Brain Edema Signs on CT:**
  - **Effacement of sulci and basal cisterns.**
  - **Small ventricles.**
  - **Loss of grey-white matter differentiation.**
  - Diffuse brain **hypodensity.**

Tumors

- **Intra-axial Tumors:** Arise within brain parenchyma. Often enhance with **T1+Contrast MRI.**
- **Extra-axial Tumors:** Arise from meninges, nerves, etc. (outside brain).
  - **Meningioma:** Commonest extra-axial tumor, **broad dural attachment (dural tail)**, usually enhances avidly.
- Failure to enhance makes intra-axial tumor less likely but does not exclude it.

Other

- **Calcification: CT is the best modality.** Common sites: pineal gland, choroid plexus, falx, basal ganglia (age-related/pathologic).
- **Cavernous Sinus Thrombosis: MRV (MR Venography) is the investigation of choice.**
- **Normal Hyperdensities on CT:** Acute blood, IV contrast, calcification (physiologic/pathologic), bone. **Pituitary gland is normally isodense.**

Gastrointestinal System (GIS) Radiology

Contrast Studies

- **Barium:**
  - **Contraindicated in suspected perforation.**
  - Excellent mucosal detail. Water insoluble.
  - Used for swallows, meals, follow-throughs, enemas.
- **Water-Soluble Contrast:**
  - Used if **perforation is suspected.**
  - **Low osmolality agents preferred.** Less mucosal detail than barium.

Specific Conditions

- **Pneumoperitoneum:** Free intraperitoneal air. **Most common cause: perforated peptic ulcer.** Best seen on erect CXR or left lateral decubitus abdomen X-ray.
- **Bowel Obstruction:** Dilated loops of bowel proximal to obstruction, collapsed distally.
- **Crohn's Disease: Skip lesions**, often affects **terminal ileum** (string sign), transmural inflammation, fistulas, abscesses. **Strictures are common.**
- **Ulcerative Colitis:** Continuous mucosal inflammation starting in rectum. Loss of haustra (lead pipe colon). **Strictures are uncommon.** Increased cancer risk. **No skip lesions.**
- **Sigmoid Volvulus:** Twisting of sigmoid colon. **Coffee bean sign** on AXR. Apex points to RUQ.
- **Liver Hemangioma: Most common benign liver tumor.** Typically **hyperechoic on US** and **T2 hyperintense on MRI.**
- **Diverticulosis/Diverticulitis:** Outpouchings (diverticulosis). Inflammation = diverticulitis, often LLQ pain. Complications: abscess, perforation, fistula (esp. colo-vesical).

- **Gallstones: Ultrasound is the primary imaging modality.** Stones appear as echogenic foci with posterior acoustic shadowing.
- **Diaphragmatic Hernia:** Bochdalek (posterior) more common on **left**. Morgagni (anterior) more common on right.
- **Pancreatitis:** CT may show enlarged pancreas, peripancreatic inflammation (**hypodense** fluid/stranding), necrosis (non-enhancing areas).

Renal Imaging

- **Ultrasound:** Initial investigation for hydronephrosis, renal masses, size.
- **CT:** Best for stones (non-contrast), masses (contrast-enhanced), trauma.
- **Nuclear Renography:** Assesses function and drainage.
  - **DTPA:** Measures GFR (filtration). Low extraction.
  - **MAG3:** Measures effective renal plasma flow (secretion). High extraction. Preferred for assessing obstruction.
  - **DMSA:** Binds to cortex. Best for **detecting scars** and assessing differential renal function.

Mammography

BI-RADS Classification

- **BI-RADS 0:** Incomplete assessment, needs further imaging.
- **BI-RADS 1:** Negative.
- **BI-RADS 2: Benign finding(s).** (e.g., stable mass >2yrs, typical benign calcifications, simple cyst, fat-containing lesion).
- **BI-RADS 3: Probably Benign (<2% risk of malignancy).** Needs short-interval follow-up (usually 6 months).
- **BI-RADS 4: Suspicious abnormality.** Needs biopsy (4a=low, 4b=moderate, 4c=high suspicion).
- **BI-RADS 5: Highly suggestive of malignancy (>95% risk).** Needs biopsy.
- **BI-RADS 6: Known biopsy-proven malignancy.**

Benign Features

- **Mass Shape/Margin: Round, oval, well-circumscribed/defined margins.**
- **Calcifications:**
  - **Coarse / "Popcorn" (degenerating fibroadenoma).**
  - **Large rod-like (secretory disease).**
  - **Round/Punctate.**
  - **"Eggshell" / Rim (cyst, fat necrosis).**
  - Lucent-centered.
- **Associated Features: Fat containing (lipoma, hamartoma, galactocele, oil cyst).** Simple cyst on US. Stable appearance over time.

Malignant Features

- **Mass Shape/Margin: Irregular shape, spiculated margins, indistinct/obscured margins, microlobulated margins.**
- **Calcifications:**
  - **Fine linear / Fine linear branching (most suspicious).**
  - **Pleomorphic (varying shapes/sizes), clustered.**
  - Amorphous, clustered.
- **Associated Features: Architectural distortion,** asymmetric density, skin thickening/retraction, suspicious axillary lymph nodes (loss of fatty hilum, rounded, dense). **Notch and lobar edge** signs.

Specific Lesions / Scenarios

- **Fibroadenoma:** Common benign tumor, often oval, well-defined, may have popcorn calcification.
- **Fat Necrosis:** Can occur post-trauma/surgery. May present as oil cyst (lucent with eggshell calcification) or mimic malignancy.
- **Cyst:** Well-defined, round/oval. Appears as anechoic lesion with posterior acoustic enhancement on US. May have eggshell calcification if old.
- **Imaging in Young Women (<30-35): Ultrasound is the preferred initial imaging modality** for a palpable lump.

Musculoskeletal (MSK) Radiology

Bone Lesions - General Features

- **Benign Signs: Well-defined margin, narrow zone of transition, sclerotic rim,** geographic bone destruction, **no cortical destruction**, no aggressive periosteal reaction.
- **Malignant Signs: Ill-defined margin, wide zone of transition,** permeative or moth-eaten bone destruction, **cortical destruction, aggressive periosteal reaction** (Codman's triangle, sunburst, lamellated), **soft tissue extension.**

Specific Bone Lesions

- **Benign:**
  - **Non-ossifying fibroma (NOF):** Eccentric, metaphyseal, lytic, **sclerotic border,** bubbly appearance. Common in children/adolescents.
  - **Enchondroma:** Intramedullary cartilage tumor, often in hands/feet. May have calcification.
  - **Giant Cell Tumor (GCT): Epiphyseal**, lytic, geographic, abuts articular surface, usually no sclerotic rim. Can be locally aggressive.
- **Malignant:**
  - **Osteosarcoma: Metaphyseal**, destructive, **produces osteoid (bone matrix),** aggressive periosteal reaction. Most common primary malignant bone tumor in adolescents.
  - **Ewing Sarcoma: Diaphyseal**, permeative destruction, lamellated ("onion skin") periosteal reaction. Affects children/young adults. Mimics osteomyelitis.
  - **Multiple Myeloma:** Punched-out lytic lesions, diffuse osteopenia. Commonest primary malignant bone tumor in adults >40.
  - **Metastases:** Most common malignant bone tumor overall. Can be lytic, blastic, or mixed.

Arthritis

- **Osteoarthritis (OA):** Degenerative. **Non-uniform joint space narrowing, osteophytes, subchondral sclerosis, subchondral cysts.** Affects weight-bearing joints, DIPs, PIPs.
- **Inflammatory Arthritis (e.g., Rheumatoid Arthritis): Uniform joint space narrowing, marginal erosions,** periarticular osteopenia, soft tissue swelling. Affects small joints (MCPs, PIPs, wrists).
- **Seronegative Spondyloarthropathies (e.g., Ankylosing Spondylitis):** Affects axial skeleton (sacroiliac joints, spine). **Sacroiliitis** (erosions, sclerosis, fusion). **Syndesmophytes** (leading to **bamboo spine**). Enthesitis. **Shiny corner sign, dagger sign, trolley track sign** are specific features.
- **Gout:** Deposition of urate crystals. **Punched-out erosions with sclerotic borders and overhanging edges.** Tophi (soft tissue masses). Joint space preserved until late.
- **Septic Arthritis:** Joint infection. Rapid joint destruction, effusion. Usually **monoarticular.**

Metabolic Bone Disease

- **Hyperparathyroidism: Subperiosteal bone resorption** (classic sign, esp. radial aspect of phalanges), **salt-and-pepper skull,** brown tumors, **Rugger Jersey spine.**
- **Osteomalacia:** Defective mineralization. Decreased bone density, Looser zones (pseudofractures).

Bone Scan

- **"Super Scan":** Diffusely increased skeletal uptake with absent/faint kidney visualization. Seen in widespread **metastatic disease, severe hyperparathyroidism, osteomalacia.**

- **Three-Phase Bone Scan:** Useful for evaluating **osteomyelitis** and complex regional pain syndrome.

Interventional Radiology

Vascular Procedures

- **Angiography:** Imaging of blood vessels using contrast.
  - **Digital Subtraction Angiography (DSA):** Subtracts bone/soft tissue for better vessel visualization.
  - **Femoral artery is the most common access site** for systemic/aortic/cerebral angiography.
  - **Femoral artery is MEDIAL to the femoral VEIN.**
- **Angioplasty/Stenting:** Opening narrowed/occluded vessels. **Better results in stenosis vs occlusion, and in larger vs smaller vessels.**
- **Embolization:** Blocking blood vessels (e.g., to treat bleeding, tumors, AVMs).
- **IVC Filter:** Placed in Inferior Vena Cava (usually **infrarenal**) to prevent pulmonary embolism.
  - Indications: **Contraindication to anticoagulation, failure of anticoagulation, complication (bleeding) on anticoagulation.**
  - Complication: **Can cause IVC thrombosis.**

Non-Vascular Procedures

- **Biopsy:** Image-guided (US or CT) tissue sampling.
  - **US Guidance:** Suitable for superficial/accessible lesions (liver, kidney, thyroid). **General anesthesia often not required.**
  - **CT Guidance:** Better for deep lesions (lung, retroperitoneum).
  - Pre-procedure checks: **Consent, coagulation studies, patient fasting.**
- **Percutaneous Nephrostomy:** Placing a drainage tube into the renal collecting system. Used to relieve obstruction.

Pathologies

- **Deep Vein Thrombosis (DVT): Non-compressibility of the vein on ultrasound is the most sensitive sign.**
- **Arterial Occlusive Disease:** Mostly due to **atherosclerosis.** Emboli often lodge at bifurcations (cardiac origin common). Thrombi form in situ.
- **Abdominal Aortic Aneurysm (AAA):** Aortic diameter **>3cm. Most common location is infrarenal.** Ultrasound is good for screening and size monitoring. **Intimal flap indicates dissection, not just aneurysm.** Rupture is major risk.

Nuclear Medicine

Radiopharmaceuticals & Principles

- **Technetium-99m (99mTc):** Workhorse isotope. **Half-life 6 hours, energy 140 keV.** Decays via **isomeric transition.** Produced from Molybdenum-99 generator.
- **18F-FDG:** Glucose analog used for **PET scanning.** Uptake reflects metabolic activity. **Most common PET tracer.**
- **Radiation Safety:** Minimize dose (ALARA principle). Stochastic effects (cancer risk) possible even at low doses. <10 rad unlikely to cause acute effects.

Common Scans

- **PET Scan (FDG):**
  - **Oncology:** Staging, restaging, treatment response assessment, detecting recurrence. **Important in lymphoma management** (negative scan after chemo = good prognosis, follow-up).
  - Also used for infection/inflammation, cardiology, neurology.
- **Myocardial Perfusion Imaging (MPI):**
  - Uses tracers like Thallium-201 or Tc-99m agents (Sestamibi, Tetrofosmin).

    - Compares stress vs rest images to detect **ischemia (reversible defect) or infarction (fixed defect).**
    - **Higher sensitivity than ECG stress test alone.**
    - Assesses **coronary flow reserve.**
    - *Note: Tc-99m HMPAO is a brain agent, not used for MPI.*
- **Bone Scan:**
    - Uses Tc-99m labeled bisphosphonates (MDP/HDP).
    - Highly sensitive for detecting **metastatic disease, osteomyelitis, fractures, arthritis.**
    - Non-specific uptake patterns require clinical correlation.
    - **Wrong indication: Primary lung/brain imaging** (unless looking for skull/spine mets).
- **Thyroid Scan:**
    - Uses Iodine-123, I-131, or Tc-99m pertechnetate.
    - Evaluates thyroid function and morphology (nodules).
    - **Increased uptake:** Graves' disease.
    - **Decreased uptake:** Thyroiditis, recent iodine exposure (contrast).
    - Low uptake in hyperthyroidism suggests **thyroiditis** (treat symptoms, follow up).
- **Renal Scan (Renography):** (See GIS section). Assesses function, drainage, scars.