NEET SS 2024 Diploma Radio Diagnosis Question Paper 2 with Solutions

Time Allowed :3 Hours	Maximum Marks :100	Total Questions :10

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 10 questions. The maximum marks are 100.
3. Each Question is of 10 marks.

Q1. a) Discuss the imaging features of pulmonary aspergillosis. [5]

Solution:

Step 1: Introduction to Pulmonary Aspergillosis.
Pulmonary aspergillosis refers to a range of pulmonary infections caused by the fungus Aspergillus, most commonly Aspergillus fumigatus. It can present as a colonization, allergic reaction, or invasive infection. The most common form of pulmonary aspergillosis is allergic bronchopulmonary aspergillosis (ABPA), followed by chronic pulmonary aspergillosis (CPA) and invasive pulmonary aspergillosis (IPA). The imaging features can vary based on the type and severity of the disease.

Step 2: Imaging Features of Pulmonary Aspergillosis.
(1) Chest X-ray:
- In ABPA, chest X-ray may show central bronchiectasis and airway changes. There may also be parenchymal infiltrates or nodules. However, chest X-ray is usually less sensitive than CT scan in detecting early changes.
- CPA may show cavitary lesions or fungal balls (also called aspergillomas), which are often seen in pre-existing lung cavities.
- In IPA, chest X-ray may reveal consolidation, cavitation, or multiple nodules. There may also be a ground-glass opacity pattern indicating infection or inflammation.

(2) High-Resolution CT (HRCT) Chest:
- ABPA: HRCT typically shows central bronchiectasis (which is often upper lobe predominant), tree-in-bud patterns, and mucus plugging. Parenchymal infiltrates may also be observed, particularly in the upper and middle lobes.
- CPA: HRCT is more sensitive for detecting aspergillomas within pre-existing cavities, and these typically appear as well-defined masses that move with the patient's position. The cavities may be surrounded by ground-glass opacities or nodular consolidations.
- IPA: Invasive aspergillosis often presents with nodular opacities that may coalesce to form consolidations or cavities. The lesions are often surrounded by a halo sign, which represents

a ground-glass opacity surrounding a nodule. This sign is particularly seen in immunocompromised patients. Air crescent sign may appear later in the disease as the tissue necrosis progresses, with the formation of a cavity containing air.
- CT findings may also show pleural effusions in severe cases of aspergillosis, particularly in IPA.

(3) MRI:
- MRI is not typically used in routine diagnosis but may be helpful in cases of cavitary lesions or aspergillomas to assess the extent of the lesion or its effect on surrounding tissues. In cases of cerebral aspergillosis (brain involvement), MRI is the imaging modality of choice.

Step 3: Key Diagnostic Features of Imaging in Pulmonary Aspergillosis.
- Cavitary lesions are typical in CPA and IPA.
- Fungal balls or aspergillomas are often found in pre-existing cavities.
- Central bronchiectasis and mucus plugging are suggestive of ABPA.
- Halo sign and air crescent sign on CT are strongly associated with invasive pulmonary aspergillosis.

> **Quick Tip**
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> HRCT chest is the most sensitive imaging modality for diagnosing pulmonary aspergillosis and is crucial for detecting early stages and complications of the disease.

Q1. b) Pulmonary nodules on HRCT chest. [5]

Solution:

Step 1: Introduction to Pulmonary Nodules.
Pulmonary nodules are defined as well-circumscribed lesions in the lungs that are smaller than 3 cm in diameter. They can be either benign or malignant, and it is essential to differentiate between the two using imaging and clinical findings. High-resolution CT (HRCT) is the gold standard for evaluating pulmonary nodules due to its high sensitivity in detecting small and subtle nodules, as well as providing detailed characteristics to assess the risk of malignancy.

Step 2: Imaging Features of Pulmonary Nodules on HRCT Chest.
(1) Benign Pulmonary Nodules: - Well-defined borders with smooth edges.
- Calcified nodules: These are typically benign and can be caused by granulomatous infections (e.g., tuberculosis, histoplasmosis) or hamartomas. The calcification pattern is often central or popcorn-like in hamartomas.
- Cavitary nodules: Nodules that are cavitary with thin walls and are associated with benign infections, abscesses, or sarcoidosis.
- Pneumoconiosis-related nodules: Nodules that appear in occupational diseases like silicosis or coal worker's pneumoconiosis. These nodules tend to be bilateral, small, and peripheral.

(2) Malignant Pulmonary Nodules: - Irregular borders with spiculated edges: These are highly suggestive of lung cancer. The spiculation indicates infiltration of the surrounding tissue, a feature of malignancy.
- Permanently growing: Malignant nodules tend to grow over time, and serial imaging is needed to monitor growth.
- CT features of metastasis: Metastatic nodules are typically multiple, round, and can be seen in both lungs. They may have a soft tissue density or may show necrotic areas.
- Ground-glass opacity (GGO): Some malignant nodules, particularly adenocarcinomas, present as partially solid lesions with ground-glass attenuation on CT. The presence of GGO is associated with early-stage lung cancer and can suggest invasive disease.
- Satellite nodules: The presence of small satellite nodules around a primary nodule is concerning for malignancy.
(3) Indeterminate Nodules: - Many nodules fall into an indeterminate category, where imaging features are not definitive. These nodules are generally small, with smooth borders but lack features specific enough to rule out malignancy. In such cases, further evaluation through serial imaging (usually at 3 months, 6 months, and 12 months) is often recommended to monitor growth.
- PET scan or biopsy may be indicated for indeterminate nodules that increase in size or show suspicious features over time.

Step 3: Key Factors in Assessing Pulmonary Nodules.
- Size: Nodules ¡6 mm in size have a low risk of malignancy, while those ¿8 mm are more likely to be malignant.
- Shape and edges: Smooth, well-defined nodules are more likely benign, while spiculated or irregular nodules are concerning for malignancy.
- Growth rate: Rapid growth of a nodule on serial imaging suggests malignancy.
- Calcification pattern: Central or laminated calcification is typically benign, while eccentric calcification may raise concern.

> **Quick Tip**
>
> HRCT is crucial for evaluating pulmonary nodules, and size, borders, and growth rate are essential factors in determining the risk of malignancy.

Q2. Enumerate the structures forming the right and left heart border on a plain chest radiograph (PA view). Discuss the features of enlargement of various cardiac chambers on a plain radiograph. [2+8]

Solution:

Step 1: Structures Forming the Right and Left Heart Border on a Plain Chest Radiograph (PA View).

(1) Right Heart Border: - The right heart border is formed by the right atrium on a PA chest radiograph. The right atrium is visible on the right side of the heart silhouette, extending from the right border of the chest and merging with the right ventricle.

(2) Left Heart Border: - The left heart border is formed by the following structures from superior to inferior:
- Left atrium (forming the upper part of the left heart border, adjacent to the pulmonary veins).
- Left ventricle (forming the lower and largest portion of the left heart border).
- Aortic arch (forming the uppermost portion of the left heart border, just behind the left clavicle).

Step 2: Features of Enlargement of Various Cardiac Chambers on a Plain Chest Radiograph.

(1) Right Atrium Enlargement: - Enlargement of the right atrium will cause an increase in the right heart border width, particularly at the right atrial appendage area. On a PA chest radiograph, this leads to a bulge at the right middle of the heart border.
- This enlargement is often seen in right-sided heart failure, pulmonary hypertension, or tricuspid valve disease.
- Associated features: A rightward shift of the heart, prominent superior vena cava, and dilated azygous vein.

(2) Right Ventricle Enlargement: - Right ventricular enlargement leads to a bulging of the right heart border in the right lower quadrant. This can cause the cardiac silhouette to become more rounded in the region below the right atrium.
- This enlargement is seen in conditions like chronic obstructive pulmonary disease (COPD), pulmonary embolism, pulmonary hypertension, and tricuspid regurgitation.
- Associated features: A widened costophrenic angle, pulmonary artery enlargement, and possible right-sided heart failure signs.

(3) Left Atrium Enlargement: - Left atrial enlargement results in the posterior bulging of the left heart border, especially seen on a lateral chest radiograph. On a PA view, it may lead to a prominent or elevated left atrial appendage, visible near the pulmonary veins.
- This is often associated with mitral valve disease (e.g., mitral stenosis), aortic stenosis, or left-sided heart failure.
- Associated features: A double density sign at the right upper side of the heart silhouette, representing the enlarged left atrium. The left atrial appendage may appear as a bulge on the left heart border.

(4) Left Ventricle Enlargement: - Left ventricular enlargement causes an increase in the size of the left heart border, especially in the lower part of the heart. This can result in a widened cardiac silhouette with a flattened or straightened left border.
- The apex of the heart may shift downwards and laterally. Left ventricular hypertrophy (LVH) often leads to a longer and more vertical left heart border.
- Associated features: The cardiac apex may be displaced laterally, and pulmonary venous congestion may be seen, along with interstitial edema or Kerley B lines.
- This enlargement is often seen in conditions like hypertension, aortic regurgitation, or valvular

heart disease.

(5) Overall Heart Enlargement (Cardiomegaly): - If the heart as a whole is enlarged, the cardiothoracic ratio (the ratio of the heart width to the chest width) will increase. This is a sign of heart failure or other diseases causing generalized enlargement of multiple chambers.
- Associated features: A widened cardiac silhouette and pulmonary congestion, often with pleural effusions and signs of left-sided heart failure.

> **Quick Tip**
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> Enlargement of the cardiac chambers can lead to changes in the heart borders on a chest radiograph. The right heart border is predominantly formed by the right atrium, and the left heart border by the left atrium and left ventricle. Enlargement of any chamber causes specific border changes.

Q3. Discuss placental evaluation by ultrasound. Discuss the imaging findings in placenta accreta spectrum disorders. [5+5]

Solution:

Step 1: Placental Evaluation by Ultrasound.

Placental evaluation by ultrasound is essential during pregnancy to assess the position, structure, and any abnormalities of the placenta. Ultrasound is the primary imaging tool used in the antenatal period for placental assessment because it is non-invasive, safe, and provides real-time imaging.
(1) Indications for Placental Ultrasound: - Placenta previa: When the placenta is abnormally located near or covering the cervical os, leading to a risk of bleeding. - Placental abruption: In cases of premature separation of the placenta from the uterine wall. - Placenta accreta, increta, percreta: To assess placental invasion into the uterine wall. - Intrauterine growth restriction (IUGR): To assess placental blood flow and structure. - Multiple pregnancies: To assess placental position and function in twin or triplet pregnancies.
(2) Techniques for Placental Ultrasound: - Transabdominal ultrasound: The most common method, useful for routine assessments of placental location and morphology. - Transvaginal ultrasound: Provides better resolution for assessing placental location, especially in cases of placenta previa or low-lying placenta. It is also valuable in identifying placenta accreta.
(3) Ultrasound Findings in Normal Pregnancy: - Placental location: The placenta is typically attached to the upper posterior or anterior uterine wall and should not extend over the cervix. The placental thickness is generally 2-4 cm. - Placental grade: Grading the placenta from Grade 0 (smooth, homogeneous) to Grade 3 (with calcifications, lobulations, and cystic spaces) depending on gestational age. - Placental blood flow: Doppler ultrasound may be used to assess blood flow in the umbilical artery and uterine arteries, helping to evaluate placental function and fetal well-being.

Step 2: Imaging Findings in Placenta Accreta Spectrum Disorders.
Placenta accreta spectrum (PAS) refers to a group of conditions where the placenta abnormally attaches to the uterine wall and invades deeper layers. This spectrum includes placenta accreta, placenta increta, and placenta percreta. Early diagnosis of PAS is critical to manage complications such as massive bleeding and the need for hysterectomy. Ultrasound imaging is the key diagnostic tool for PAS.
(1) Placenta Accreta: - Definition: The placenta adheres to the uterine wall but does not invade deeply into the myometrium. - Ultrasound Findings: - Loss of normal hypoechoic zone between the placenta and myometrium. - Placental lacunae or vascular spaces that appear as hypoechoic areas within the placenta. - Irregularities or thinning of the uterine wall may be visible. - Increased blood flow in the placental bed as seen on Doppler ultrasound.
- The myometrial thickness may appear decreased at the site of placenta accreta.
(2) Placenta Increta: - Definition: The placenta invades into the myometrium (muscular layer of the uterus). - Ultrasound Findings: - Deep placental lacunae with irregular vascular spaces that may extend into the myometrium. - Thinning or absence of the myometrium in the area of invasion. - Color Doppler may show high-velocity blood flow around the invading vessels, which could suggest the presence of an abnormal placenta. - Loss of the normal interface between the placenta and the uterus.

(3) Placenta Percreta: - Definition: The placenta perforates through the entire myometrium and may extend into the serosa or other surrounding structures such as the bladder or rectum.
- Ultrasound Findings: - Full-thickness invasion of the placenta through the uterine wall. - Absence of myometrium between the placenta and the surrounding structures (e.g., bladder).
- Vascular spaces or lacunae that penetrate the myometrium and may even be seen extending outside the uterine wall. - Color Doppler may show abnormal blood vessels that appear to cross into the bladder or other structures.
- The presence of placental bulging or bladder wall involvement may suggest percreta.

(4) Differential Diagnosis: - PAS must be distinguished from other conditions that can cause similar ultrasound findings, such as placenta previa or fibroids, which can have overlapping features like vascularity or lacunae. A careful assessment of placental location, myometrial thickness, and Doppler patterns is necessary for accurate diagnosis.

> **Quick Tip**
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> Ultrasound is the key tool for diagnosing placenta accreta spectrum. Key signs include loss of the hypoechoic zone between the placenta and myometrium, placental lacunae, and abnormal blood flow patterns on Doppler ultrasound.

Q4. a) Discuss the imaging features of scurvy on a plain radiograph. [5]

Solution:

Step 1: Introduction to Scurvy.
Scurvy is a disease caused by vitamin C deficiency, which leads to collagen synthesis defects,

resulting in symptoms like bleeding gums, fatigue, muscle weakness, and skin changes. The condition also affects bone health, which can be evaluated through plain radiographs.
Plain radiographs are often used to detect the bone abnormalities associated with scurvy, particularly in children. Scurvy can lead to subperiosteal hemorrhages, bone resorption, and fractures, which are visible on X-ray imaging.

Step 2: Imaging Features of Scurvy on Plain Radiographs.
(1) Widening of the Growth Plates: - One of the early findings in scurvy, particularly in children, is widening of the growth plates due to failure of cartilage maturation. The metaphyseal regions of the bones appear widened or flared, especially in long bones such as the femur and tibia.
(2) Subperiosteal Hemorrhage: - Subperiosteal hemorrhage is a hallmark of scurvy and appears as fluffy, soft tissue opacities adjacent to the bone. This occurs due to the fragility of blood vessels around the bones in the absence of adequate collagen. It typically affects the distal femur, tibia, and radius.
(3) Pelkin's Fractures (Cortical Fractures): - In scurvy, subperiosteal hemorrhages may lead to cortical fractures known as Pelkin's fractures. These appear as transverse fractures involving the cortex of the long bones, often without much displacement. These fractures are commonly found in the tibia, femur, and humerus.
(4) Scorbutic Rosary: - The scorbutic rosary is a term used to describe the prominent costochondral junctions visible on X-ray, particularly in the ribs. This occurs due to osteoid accumulation at the costochondral junction, which is caused by impaired collagen formation.
(5) Ground Glass Appearance: - The ground-glass appearance of the metaphysis, especially in the distal femur and proximal tibia, is another feature of scurvy. This is indicative of osteopenia or bone density loss due to impaired bone mineralization.
(6) Fractures and Osteopenia: - Bone resorption and osteopenia (reduced bone density) may lead to spontaneous fractures, especially in weight-bearing bones. These fractures are typically non-traumatic and occur more easily in the context of scurvy.

Quick Tip

In scurvy, widening of growth plates, subperiosteal hemorrhage, and the scorbutic rosary are characteristic radiographic findings that indicate vitamin C deficiency.

Q4. b) Avascular necrosis (AVN) of hip on X-ray and MRI. [5]

Solution:

Step 1: Introduction to Avascular Necrosis (AVN) of the Hip.
Avascular necrosis (AVN), also known as osteonecrosis, is a condition characterized by the death of bone tissue due to lack of blood supply. The hip is one of the most commonly affected joints, and AVN typically involves the femoral head. It can result from various causes such as trauma, steroid use, alcoholism, sickle cell disease, or autoimmune diseases.
Imaging plays a crucial role in diagnosing AVN, and both X-ray and MRI are commonly used to assess the extent and stage of the disease.

Step 2: Imaging Features of AVN of the Hip on X-ray.

(1) Early Stage (Normal X-ray or Subtle Changes): - In the early stages of AVN, X-ray may be normal or show only minor changes such as mild joint space narrowing or bone sclerosis. In some cases, there may be soft tissue swelling around the joint. Early detection is challenging on X-ray.
(2) Late Stage (Classic Findings): - Crescent sign: This is one of the classic features of AVN on X-ray, representing subchondral bone collapse. The crescent sign is seen as a radiolucent line or defect beneath the articular surface, indicating collapse and fracture of the subchondral bone. - Joint space narrowing: As the bone necrosis progresses, the affected hip joint may show narrowing of the joint space due to cartilage loss. - Sclerosis: Bone sclerosis may develop in the affected femoral head as the necrotic bone heals or compensates for the loss of blood supply. - Femoral head collapse: In advanced stages, the femoral head may collapse, leading to deformity of the femoral head and acetabulum, which can cause osteoarthritis.
(3) Secondary Degenerative Changes: - In advanced AVN, degenerative changes such as osteoarthritis can develop, with osteophyte formation, subchondral cysts, and joint deformity being seen on X-ray.

Step 3: Imaging Features of AVN of the Hip on MRI.

(1) Early Detection (MRI as the Gold Standard): - MRI is the most sensitive imaging modality for detecting early AVN, especially before any changes are visible on X-ray. It can detect bone marrow edema (a hallmark of early AVN) as high signal intensity on T2-weighted images.
- MRI findings include: - Bone marrow edema: High signal intensity on T2-weighted images at the femoral head, indicating inflammation or early ischemia. - Low signal intensity on T1-weighted images in the affected area, indicating necrosis.
(2) Characteristic MRI Findings in Established AVN: - Necrotic bone: On T1-weighted MRI, the necrotic femoral head may appear as a low signal area. The subchondral region is often involved. - Double line sign: A double line sign is another classic feature seen on T2-weighted MRI. It represents a dark inner line of necrotic bone surrounded by a bright outer line of reparative tissue (fibrous tissue and new bone formation). - Femoral head collapse: MRI can show structural collapse of the femoral head in later stages of AVN. - Joint effusion: An increase in synovial fluid or joint effusion is commonly seen as a secondary feature in later stages of AVN.
Step 4: Role of MRI in Staging AVN.
- MRI plays a crucial role in staging AVN using classification systems like the Ficat and Arlet classification, which is based on MRI findings and guides treatment decisions. The stages range from early bone edema (stage I) to femoral head collapse (stage IV).

Quick Tip

MRI is the most sensitive imaging modality for early detection of AVN, showing bone marrow edema and the double line sign. X-rays are useful for assessing late-stage findings like the crescent sign and femoral head collapse.

Q5. Discuss the neuro-imaging features of hypoxic ischemic encephalopathy (HIE) in term and preterm births. [5+5]

Solution:

Step 1: Introduction to Hypoxic Ischemic Encephalopathy (HIE).
Hypoxic ischemic encephalopathy (HIE) is a neurological condition that results from insufficient oxygen and blood flow to the brain, typically occurring during labor and delivery. HIE can lead to cerebral injury and neurological impairments ranging from mild developmental delays to severe disabilities or death. The degree of injury and its effects vary depending on the timing, severity, and duration of the hypoxic event.
Neuro-imaging plays a crucial role in identifying and assessing the extent of brain injury caused by hypoxia-ischemia, especially in neonates who present with clinical signs of neurological dysfunction after birth. The most common imaging modalities used in HIE are cranial ultrasound, magnetic resonance imaging (MRI), and computed tomography (CT).

Step 2: Neuro-imaging Features of HIE in Term Infants.

(1) MRI Features in Term Infants: - Timing and Extent of Injury: MRI is the most sensitive imaging modality for assessing hypoxic-ischemic injury in term infants. The timing of the injury relative to birth is critical in determining the pattern and distribution of brain injury. MRI findings in term infants with HIE can include: - Basal ganglia and thalamic lesions: These areas are the most commonly affected due to their vulnerability to hypoxic-ischemic injury. MRI shows bilateral symmetric lesions in the putamen, globus pallidus, and thalamus, which are hyperintense on T1-weighted images and hypointense on T2-weighted images. - Cortex and white matter injury: In more severe cases, the cerebral cortex and white matter can also be affected. MRI may reveal cortical laminar necrosis (loss of neurons in the cortical layers), white matter edema, or necrosis. - Posterior limb of the internal capsule: Lesions in this area, especially the posterior limb, are often associated with severe injury and are seen as low signal intensity on T2-weighted MRI, indicating axonal injury. - Pattern of injury: The watershed areas of the brain, which lie between the main vascular territories, are especially susceptible to hypoxic-ischemic injury. These areas are typically located cortically, leading to cortical infarctions visible on MRI. - Cerebellum: In severe cases of HIE, the cerebellum may also show evidence of neurodegeneration, appearing hypointense on T2-weighted imaging.

(2) CT Scan Features in Term Infants: - CT scan is not as sensitive as MRI for detecting early HIE but can still show increased density in the affected brain regions, especially if there is acute hemorrhage or infarction. - Edema in the periventricular or subcortical areas may also be seen, and in later stages, ventricular dilation may develop as a result of brain atrophy.

Step 3: Neuro-imaging Features of HIE in Preterm Infants.

(1) MRI Features in Preterm Infants: - Injury in Preterm Infants: The neuro-imaging features of HIE in preterm infants often differ from those seen in term infants. Preterm infants are more vulnerable to intraventricular hemorrhage (IVH) and periventricular leukomalacia (PVL) due to their underdeveloped brain structure. - Intraventricular Hemorrhage (IVH): IVH is a common manifestation of HIE in preterm infants, especially those born before 32 weeks ges-

tation. MRI shows hypointense areas in the ventricles, indicating blood or clot formation. More severe cases may lead to ventricular dilatation or post-hemorrhagic hydrocephalus. - Periventricular Leukomalacia (PVL): PVL is another common finding in preterm infants and is a form of white matter injury. MRI shows cystic lesions in the periventricular white matter that appear hyperintense on T2-weighted images. PVL is associated with necrosis of the white matter around the ventricles and is often linked with motor impairments such as cerebral palsy. - Cerebellar Injury: In preterm infants, the cerebellum may also be affected by HIE, showing shrinkage or hypoplasia on MRI due to impaired development and ischemia. - Basal Ganglia and Thalamus: As in term infants, the basal ganglia and thalamus may show injury, but this is less common in preterm infants than in term infants, who have more mature brain structures.

(2) CT Scan Features in Preterm Infants: - CT scan in preterm infants often shows intraventricular hemorrhage or parenchymal hemorrhage in periventricular or subcortical regions. As with term infants, ventricular dilatation and brain atrophy may be noted in later stages, indicating progressive damage.

Step 4: Differences in Imaging Findings Between Term and Preterm Infants.

- In term infants, HIE predominantly affects the basal ganglia, thalamus, and cortex, with watershed areas and white matter being more involved. - In preterm infants, the most common findings are intraventricular hemorrhage and periventricular leukomalacia, with less involvement of the basal ganglia and thalamus.

> **Quick Tip**
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> In term infants, MRI typically reveals basal ganglia, thalamic, and cortical injuries in HIE, while preterm infants often exhibit intraventricular hemorrhage (IVH) and periventricular leukomalacia (PVL) due to their immature vascular and brain structures.

Q6. a) Ultrasound BI-RADS. [5]

Solution:

Step 1: Introduction to Ultrasound BI-RADS.
The Breast Imaging Reporting and Data System (BI-RADS) is a system developed by the American College of Radiology (ACR) for categorizing breast imaging findings, primarily in mammography and breast ultrasound. It helps standardize the interpretation of breast imaging studies and provides a way to communicate findings clearly and consistently. BI-RADS is used to assess the risk of malignancy and guide further management decisions.
Ultrasound BI-RADS is an extension of the BI-RADS system applied specifically to breast ultrasound. It categorizes findings based on features such as shape, margins, echo pattern, and vascularity. The system helps radiologists evaluate the likelihood of a lesion being benign or malignant and provides a framework for follow-up recommendations.

Step 2: Ultrasound BI-RADS Categories.

(1) BI-RADS 1: Negative - Description: No abnormalities are detected on the ultrasound. The breast tissue is normal with no lesions. - Management: Routine screening is advised based on age and risk factors.
(2) BI-RADS 2: Benign - Description: The lesion is benign with no suspicious features. Common benign findings include simple cysts, fibroadenomas, or adenomas. - Management: Routine follow-up or screening is typically recommended.
(3) BI-RADS 3: Probably Benign - Description: The lesion is likely benign, but further evaluation is recommended for reassurance. Features may include oval shape, smooth margins, and homogeneous echo texture. Lesions such as simple cysts and benign fibroadenomas are examples. - Management: Short-term follow-up imaging (usually 6 months) is recommended to monitor for any changes in the lesion's characteristics.
(4) BI-RADS 4: Suspicious Abnormality - Description: The lesion has characteristics that are suspicious for malignancy, such as irregular shape, microcalcifications, or ill-defined borders. - Management: Biopsy is recommended to confirm the diagnosis and rule out malignancy. - BI-RADS 4A: Low suspicion of malignancy (5-10% probability). - BI-RADS 4B: Moderate suspicion of malignancy (10-50% probability). - BI-RADS 4C: High suspicion of malignancy (50-95% probability).
(5) BI-RADS 5: Highly Suggestive of Malignancy - Description: The lesion has features highly suggestive of malignancy, such as irregular shape, spiculated margins, and hypoechoic appearance. - Management: Biopsy is essential, and surgery may be indicated if the lesion is confirmed to be malignant.
(6) BI-RADS 6: Known Biopsy-Proven Malignancy - Description: The lesion has been confirmed as malignant by previous biopsy. - Management: Treatment, such as surgery, chemotherapy, or radiation, is indicated based on the pathology results.

Step 3: Key Features Considered in Ultrasound BI-RADS.

- Shape: Oval (benign) vs. irregular (malignant). - Margins: Smooth (benign) vs. irregular or spiculated (malignant). - Echo pattern: Homogeneous (benign) vs. heterogeneous (malignant). - Vascularity: Low or absent vascularity (benign) vs. increased vascularity (malignant).

> **Quick Tip**
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> In ultrasound BI-RADS, BI-RADS 3 suggests a probably benign lesion, and BI-RADS 4 is suspicious for malignancy, indicating the need for biopsy.

Q6. b) Role of MR perfusion in evaluation of breast masses. [5]

Solution:

Step 1: Introduction to MR Perfusion.
Magnetic Resonance (MR) perfusion imaging is an advanced imaging technique used to eval-

uate blood flow to tissues, particularly useful in the assessment of breast masses. It provides functional information on vascularity within a lesion, which is crucial for differentiating benign from malignant lesions. MR perfusion can be performed with dynamic contrast-enhanced MRI (DCE-MRI), which tracks the movement of a contrast agent through the breast tissue over time.
Perfusion imaging assesses how well blood is flowing through the tumor and surrounding tissues. Malignant tumors tend to have abnormal blood vessels, which are more permeable, disorganized, and have higher blood flow compared to benign tumors, making MR perfusion a useful tool in the characterization of breast masses.

Step 2: Role of MR Perfusion in the Evaluation of Breast Masses.

(1) Differentiating Benign and Malignant Lesions: - Benign breast lesions such as fibroadenomas typically exhibit low vascularity and slow contrast uptake on MR perfusion. They show a gradual increase in contrast enhancement and typically plateau over time. - Malignant lesions, on the other hand, typically demonstrate rapid contrast uptake and a washout pattern on MR perfusion imaging. They have disorganized blood vessels, which lead to increased blood flow and increased permeability of the vessels, allowing the contrast agent to pass more freely.
(2) Quantifying Tumor Vascularity: - K-trans (volume transfer constant) and Ve (extravascular extracellular volume fraction) are perfusion parameters used to assess the vascular permeability and the blood volume in the tumor. These parameters help assess the aggressiveness of the tumor. - Higher K-trans values are associated with malignant lesions due to the increased vascular permeability and hypervascularity of malignant tumors.
(3) Preoperative Assessment: - MR perfusion can help assess the extent of the tumor and evaluate whether there is invasive spread to adjacent tissues. This is particularly useful in planning surgical resection or determining if neoadjuvant therapy is needed before surgery. - It can also aid in distinguishing between tumor recurrence and post-treatment changes, which can be challenging to differentiate with other imaging modalities.
(4) Monitoring Treatment Response: - MR perfusion can be used to monitor the response of breast tumors to neoadjuvant chemotherapy or radiation therapy. A decrease in perfusion parameters, such as K-trans, can indicate a reduction in tumor vascularity and is often associated with a positive treatment response.

(5) Limitations of MR Perfusion: - Although MR perfusion is a useful tool, it is not without limitations. It requires specialized equipment and expertise to interpret the results. Additionally, contrast agents used in MR perfusion carry a risk of allergic reactions or renal impairment in susceptible patients.
- Perfusion imaging is also influenced by technical factors, including the timing of contrast injection and the choice of imaging parameters, which can affect the accuracy of the findings.

Quick Tip

MR perfusion is a powerful tool for assessing the vascularity of breast masses, helping to distinguish benign from malignant lesions and aiding in treatment planning.

Q7. Classify Mullerian duct anomalies. Discuss the imaging approach in Mullerian duct anomalies, describing their imaging features briefly. [2+8]

Solution:

Step 1: Classification of Mullerian Duct Anomalies.

Müllerian duct anomalies (MDAs) result from abnormal development of the Müllerian ducts during embryogenesis. These anomalies lead to congenital uterine malformations, which can affect the uterus, cervix, and upper vagina. MDAs are classified into several categories based on the type of anomaly and the extent of the malformation.
The American Society for Reproductive Medicine (ASRM) classification system for Müllerian anomalies includes the following categories:
(1) Class I: Müllerian Agenesis/Hypoplasia (Mayer-Rokitansky-Küster-Hauser Syndrome) - Definition: Complete or partial agenesis or hypoplasia of the uterus and upper two-thirds of the vagina. The Müllerian ducts do not develop, leading to primary amenorrhea and an absent or underdeveloped uterus.
- Clinical Features: Amenorrhea with normal secondary sexual characteristics.
- Imaging: MRI shows absent uterus or small rudimentary uterine structures.
(2) Class II: Unicornuate Uterus - Definition: A single uterine horn develops, often with a rudimentary horn on the opposite side, which may be non-communicating. It can be associated with renal anomalies.
- Clinical Features: Unilateral pelvic pain, recurrent miscarriage, or ectopic pregnancy.
- Imaging: MRI or hysterosalpingography (HSG) reveals a single uterine horn, and the contralateral horn may show a non-communicating rudimentary structure.
(3) Class III: Uterus Didelphys - Definition: Complete duplication of the uterus, cervix, and sometimes the vagina, resulting in two separate uterine cavities.
- Clinical Features: Reproductive difficulties such as miscarriages or preterm labor.
- Imaging: MRI and ultrasound show two separate uterine horns and cervical duplication. The vagina may also be duplicated.
(4) Class IV: Bicornuate Uterus - Definition: Partial or complete duplication of the uterus, resulting in two uterine horns that may be separated by a dividing septum. The cervix may be single or double.
- Clinical Features: Reproductive challenges, such as miscarriages and preterm labor.
- Imaging: MRI and HSG show two uterine horns with a single cervix. MRI is particularly useful for assessing the degree of separation of the uterine horns.
(5) Class V: Septate Uterus - Definition: A single uterine cavity divided by a fibrous or muscular septum, which may vary in length and thickness. The external uterine contour is normal.
- Clinical Features: Recurrent miscarriage or preterm labor due to the abnormal uterine cavity.
- Imaging: HSG shows a normal external uterine contour with a septum dividing the uterine cavity. MRI provides better delineation of the septum and the uterine wall.
(6) Class VI: Arcuate Uterus - Definition: A mild form of septate uterus, with a slight indentation at the top of the uterine fundus.
- Clinical Features: Typically asymptomatic or associated with mild reproductive issues.
- Imaging: HSG and MRI show a normal uterine cavity with a slight indentation at the fundus.
(7) Class VII: Hypertrophic Uterus - Definition: This category involves uterine enlargement without a structural anomaly. It is usually due to fibroids or endometrial hyperplasia.

- Clinical Features: Symptoms of menorrhagia and pelvic discomfort.
- Imaging: Ultrasound and MRI show myometrial enlargement or fibroid masses.

Quick Tip

The ASRM classification of Müllerian anomalies is based on the degree of uterine duplication and presence of septum. MRI is the most accurate imaging modality for assessing these anomalies.

Q8. A patient presents with progressive painless proptosis of the left eye. Enumerate the various pathologies that can cause proptosis, with respect to different compartments of the orbit on imaging. Discuss the imaging features of pathologies affecting the intra-conal compartment of the orbit. [3+7]

Solution:

Step 1: Pathologies that Can Cause Proptosis and Their Relation to Different Compartments of the Orbit.

Proptosis (or exophthalmos) refers to the abnormal protrusion of the eye, which can be caused by various pathologies affecting different compartments of the orbit. The orbit is anatomically divided into the following compartments:
1. Preseptal Compartment (Anterior Compartment): - Infections such as cellulitis or abscess (e.g., orbital cellulitis). - Inflammatory conditions like thyroid eye disease (Graves' orbitopathy). - Trauma leading to orbital hematomas or fractures.
2. Postseptal Compartment (Posterior Compartment): - Tumors: Both benign (e.g., meningioma, optic nerve glioma) and malignant (e.g., lymphoma, metastatic tumors). - Vascular malformations: Carotid-cavernous fistula, vascular tumors. - Infections that spread from the paranasal sinuses into the orbit, causing orbital abscess.
3. Intra-conal Compartment (located within the muscle cone): - Benign tumors: Such as lymphangioma, hemangioma, optic nerve glioma. - Malignant tumors: Including lymphoma, metastases, and neuroblastoma. - Inflammatory conditions like orbital pseudotumor or granulomatous diseases (e.g., sarcoidosis). - Vascular lesions like vascular malformations (e.g., arteriovenous malformations).
4. Extra-conal Compartment (around the muscle cone): - Lacrimal gland masses: Such as lacrimal gland tumors (benign or malignant). - Infections and inflammatory diseases affecting the orbital fat or the muscles.

Step 2: Imaging Features of Pathologies Affecting the Intra-conal Compartment of the Orbit.

The intra-conal compartment is bounded by the ocular muscles, the optic nerve, and the bone of the orbit. Lesions in this area can result in significant proptosis, especially when they compress the optic nerve or displace the ocular muscles. Imaging modalities like CT and MRI are invaluable for assessing the intra-conal compartment.

(1) Orbital Hemangioma (Vascular Tumors): - MRI: These tumors are often well-circumscribed, hyperintense on T2-weighted images and hypointense on T1-weighted images. On contrast-enhanced MRI, these lesions show heterogeneous enhancement with areas of vascular flow voids. - CT: May show a well-defined mass that is hyperdense on non-contrast images with enhancement post-contrast.
(2) Optic Nerve Glioma: - MRI: Optic nerve gliomas are typically isointense or slightly hypointense on T1-weighted images and hyperintense on T2-weighted images. The tumor may cause fusiform enlargement of the optic nerve. Contrast-enhanced MRI shows enhancement of the tumor along the optic nerve. - CT: May show optic nerve enlargement but is less sensitive compared to MRI.
(3) Lymphangioma: - MRI: These lesions are usually multiloculated with cystic spaces and high signal intensity on T2-weighted images. The lesion often shows variable enhancement with contrast, and flow voids may be present within the cystic spaces due to vascular channels. - CT: Low attenuation on non-contrast images, with enhancement following contrast. It shows cystic structures.
(4) Orbital Pseudotumor (Idiopathic Orbital Inflammation): - MRI: It presents as a diffuse mass involving the muscles and orbital fat. The lesion shows uniform enhancement with contrast and is hypointense on T1-weighted images and hyperintense on T2-weighted images. - CT: There is orbital soft tissue swelling with no distinct margins and orbital fat stranding. There may be muscle enlargement with irregular contours.
(5) Metastatic Tumors: - MRI: Metastatic lesions in the intra-conal compartment are usually solid, with poorly defined borders and variable signal intensity. These tumors may show marked enhancement with contrast, and they can displace the muscles and the optic nerve. - CT: These lesions are hyperdense with contrast enhancement and may cause bony involvement or destruction in advanced stages.
(6) Neuroblastoma: - MRI: Neuroblastoma in the intra-conal compartment presents as a solid mass, often hyperintense on T2-weighted images and hypointense on T1-weighted images, with extensive enhancement following contrast administration. - CT: Appears as a well-defined or irregular mass with enhancement, and it may show calcifications.
(7) Lacrimal Gland Tumors (e.g., Adenoma, Adenocarcinoma): - MRI: Lacrimal gland tumors in the intra-conal space show well-defined masses that are isointense or hyperintense on T2-weighted images and hypointense on T1. They exhibit homogeneous enhancement after contrast administration. - CT: These tumors can cause enlargement of the lacrimal gland with variable density on non-contrast images.

Quick Tip

Imaging of intra-conal orbital pathologies often requires MRI for its superior soft tissue contrast and ability to delineate soft tissue lesions, vascular structures, and the relationship of masses to the optic nerve and ocular muscles.

Q9. How are Idiopathic Interstitial Pneumonias (IIPs) classified? Discuss the imaging approach in Idiopathic Interstitial Pneumonias (IIPs) including CT imaging protocol and salient imaging features. [2+(2+6)]

Solution:

Step 1: Classification of Idiopathic Interstitial Pneumonias (IIPs).

Idiopathic Interstitial Pneumonias (IIPs) are a group of interstitial lung diseases (ILDs) characterized by chronic inflammation and fibrosis of the lung interstitium. These diseases primarily involve the lung parenchyma and can lead to progressive pulmonary fibrosis and respiratory failure.

IIPs are classified into the following major categories:

(1) Idiopathic Pulmonary Fibrosis (IPF):
- The most common and well-known form of IIP, characterized by fibrotic changes and honeycombing of the lung tissue. It typically affects the lower lobes and is associated with a poor prognosis.

(2) Non-Specific Interstitial Pneumonia (NSIP):
- A less aggressive form of interstitial lung disease, with a better prognosis than IPF. It is characterized by uniform interstitial fibrosis without the honeycomb appearance.

(3) Desquamative Interstitial Pneumonia (DIP):
- This type of IIP is often associated with smoking and is characterized by alveolar macrophage accumulation and minimal fibrosis.

(4) Respiratory Bronchiolitis-Associated Interstitial Lung Disease (RB-ILD):
- Primarily affects smokers, with bronchiolar involvement and peripheral centrilobular nodules on imaging.

(5) Acute Interstitial Pneumonia (AIP):
- A rapidly progressive form of IIP, with a clinical course resembling acute respiratory distress syndrome (ARDS). It has a poor prognosis.

(6) Lymphocytic Interstitial Pneumonia (LIP):
- Often associated with autoimmune diseases or HIV infection, it shows a lymphocytic infiltrate in the interstitium.

(7) Cryptogenic Organizing Pneumonia (COP):
- Characterized by polyps of granulation tissue in the small airways and alveolar ducts. It may present with a patchy distribution and responds well to steroids.

Step 2: Imaging Approach in Idiopathic Interstitial Pneumonias (IIPs).

Imaging plays a critical role in the diagnosis, monitoring, and differentiation of the various forms of IIPs. High-resolution CT (HRCT) is the primary imaging modality used for evaluating IIPs, as it provides detailed information about lung parenchyma, fibrotic changes, and other characteristic features of these diseases.

CT Imaging Protocol:
The CT imaging protocol for evaluating IIPs typically involves the following parameters:
- High-resolution CT (HRCT) scans are acquired with thin slices (1-2 mm) to maximize the ability to detect subtle interstitial changes.
- Inspiratory scans are performed in the supine position to assess the parenchyma in full inspiration. In some cases, expiratory CT may also be done to evaluate air trapping or obstruction.
- Contrast is usually not required unless there is suspicion of an additional vascular or oncologic cause.
- Multi-slice CT (MSCT) technology is often used for better resolution and coverage of the lung fields.

Step 3: Imaging Features in IIPs on CT.

(1) Idiopathic Pulmonary Fibrosis (IPF):
- Honeycombing: Reticular opacities with cystic spaces (honeycombing) predominantly in the lower lobes and peripheral regions. This is the most characteristic feature of IPF.
- Ground-glass opacities: May be present in the early stages and often progress to fibrosis.
- Architectural distortion and traction bronchiectasis due to fibrosis.
- Subpleural and basal predominant involvement.

(2) Non-Specific Interstitial Pneumonia (NSIP):
- Ground-glass opacities: Often bilateral, homogeneous, and lower lobe predominant.
- Reticular opacities without the presence of honeycombing.
- Absence of honeycombing distinguishes NSIP from IPF.

(3) Desquamative Interstitial Pneumonia (DIP):
- Ground-glass opacities with patchy distribution predominantly in the lower lobes.
- Minimal fibrosis and no honeycombing.
- This pattern often improves with smoking cessation.

(4) Respiratory Bronchiolitis-Associated ILD (RB-ILD):
- Centrilobular nodules and peripheral ground-glass opacities.
- Hyperinflation and peripheral bronchial wall thickening are common features.
- Smoker's lung is typically seen in this subtype.

(5) Acute Interstitial Pneumonia (AIP):
- Diffuse bilateral consolidation or ground-glass opacities.
- Rapid progression to fibrosis and fibrotic consolidation may occur in later stages.
- CT findings often resemble acute respiratory distress syndrome (ARDS).

(6) Lymphocytic Interstitial Pneumonia (LIP):
- Mild ground-glass opacities in the lower lobes.
- Nodules and cystic changes in some cases.
- May be associated with autoimmune conditions or HIV.

(7) Cryptogenic Organizing Pneumonia (COP):
- Patchy consolidations with a bronchocentric pattern.

- Air bronchograms within areas of consolidation.
- Peripheral and subpleural distribution.
- Often reversible with steroids.

Quick Tip

IIPs are primarily classified into fibrotic and non-fibrotic types, with IPF being the most common and poor prognosis disease. NSIP and DIP are less aggressive forms.
HRCT is essential for evaluating the pattern and distribution of lung disease in IIPs. The presence of honeycombing, ground-glass opacities, and traction bronchiectasis are key features in distinguishing between different types of IIPs.

Q10. Enumerate the various neck spaces in the infrahyoid compartment of neck and illustrate them with a well labelled diagram. Discuss the carotid space in detail, including the imaging features of pathologies in this space. [5+5]

Solution:

Step 1: Neck Spaces in the Infrahyoid Compartment of the Neck.

The infrahyoid compartment of the neck refers to the region located below the hyoid bone. This compartment contains several important anatomical spaces, which are bounded by muscles, fasciae, and other structures. The major neck spaces in the infrahyoid compartment include:

1. Anterior Triangle:
- Bounded by the midline of the neck, sternocleidomastoid muscle, and the lower border of the mandible.
- This space contains important structures such as the carotid arteries, internal jugular veins, and the vagus nerve.

2. Carotid Space:
- This space is located in the lateral neck and is bounded by the carotid sheath. It contains critical vascular and nervous structures such as the common carotid artery, internal jugular vein, vagus nerve, and sympathetic nerve fibers.

3. Muscular Space:
- This space lies between the sternohyoid and sternothyroid muscles. It is filled with muscles, fascia, and lymph nodes.

4. Visceral Space:
- This space contains structures such as the trachea, esophagus, and the thyroid gland. It lies between the sternothyroid and thyrohyoid muscles.

5. Pretracheal Space:
- The pretracheal space is a loose connective tissue space that surrounds the trachea and esophagus. It extends inferiorly to the mediastinum and contains lymph nodes.

6. Retropharyngeal Space:
- This space is located behind the pharynx and extends to the mediastinum. It allows for the free movement of the pharynx, larynx, and esophagus during swallowing and respiration.

Step 2: Carotid Space and Imaging Features of Pathologies.

The carotid space is located within the lateral neck, defined by the carotid sheath and its boundaries. It is a critical area due to the presence of the common carotid artery, internal jugular vein, vagus nerve, and sympathetic nerve fibers. The carotid space is involved in various pathologies, and imaging is essential for diagnosing conditions that affect this region.

(1) Anatomy of the Carotid Space:
- The carotid space is bounded by the following structures:
- Anteriorly: The posterior aspect of the sternocleidomastoid muscle.
- Posteriorly: The prevertebral fascia.
- Medially: The pharynx and larynx.
- Laterally: The sternocleidomastoid muscle.
- The carotid sheath is a connective tissue structure that encloses the common carotid artery, internal jugular vein, and vagus nerve. It also contains lymph nodes.

(2) Imaging Features of Pathologies in the Carotid Space:
(a) Carotid Artery Aneurysm:
- CT/MRI: Shows a saccular or fusiform dilation of the carotid artery. The aneurysm may be associated with displacement of surrounding structures.
- Ultrasound: Can reveal a pulsatile mass within the carotid artery. Doppler flow studies show turbulent blood flow within the aneurysm.

(b) Carotid Artery Dissection:
- CT Angiography (CTA): Reveals intimal flap or false lumen within the carotid artery. It can show narrowing of the true lumen and enlarged false lumen.
- MRI/MR Angiography (MRA): Can detect blood-filled space in the arterial wall and provide detailed information about the extent of dissection.

(c) Carotid Body Tumor (Paraganglioma):
- CT/MRI: The tumor appears as a well-defined, hypervascular mass at the carotid bifurcation. It may show enhancement after contrast injection and can cause displacement of the carotid artery.
- Ultrasound: Pulsatile, solid mass located at the bifurcation of the common carotid artery, with vascular flow in color Doppler.

(d) Lymphadenopathy:
- CT/MRI: Enlarged lymph nodes may be seen within the carotid space, often associated with primary or metastatic head and neck cancers. Lymph nodes are typically round or oval with

rim enhancement on contrast imaging.
- MRI: Cervical lymphadenopathy can be characterized by low signal intensity on T1-weighted images and high signal intensity on T2-weighted images. Contrast-enhanced MRI can show enhanced lymph nodes.

(e) Infections (e.g., Carotid Artery Infections, Abscesses):
- CT/MRI: Shows a walled-off collection or abscess with heterogeneous enhancement. The abscess may be adjacent to the carotid artery and show peripheral enhancement with central necrosis.
- Ultrasound: Can detect the presence of pulsatile masses or abscesses in the carotid space.

(3) Other Pathologies in the Carotid Space:
- Vascular Malformations: Rare vascular malformations such as arteriovenous fistulas may affect the carotid space. These can be seen on MRI as areas of turbulent flow.
- Tumors of the Vagus Nerve: Schwannomas or neurofibromas involving the vagus nerve can be visualized as well-defined masses in the carotid sheath on MRI. These are often hyperintense on T2-weighted images and enhance with contrast.

Quick Tip

The infrahyoid compartment of the neck contains various important spaces, with the carotid space being the most significant for vascular, neural, and lymphatic structures. The carotid space contains critical structures such as the common carotid artery, internal jugular vein, and vagus nerve. Imaging techniques such as CT, MRI, and ultrasound are essential for evaluating pathologies like aneurysms, dissections, tumors, and infections in this region.