DNB JUNE 2020 RADIODIAGNOSIS PAPER – I

Q1. Discuss in brief, the salient CT and MRI features in an acute ischemic stroke patient arriving to the hospital within 6 hours of onset. Suggest an algorithm-based approach for confirmation of diagnosis and guiding the management of such a patient.

Answer

ACUTE ISCHAEMIC STROKE

CT (Computed Tomography)

1. Non-contrast CT (NCCT):

- Hyperdense MCA Sign: A bright (hyperdense) middle cerebral artery (MCA) can indicate a thrombus (clot) within the artery.

- Loss of Grey-White Matter Differentiation: Early ischemia can cause the blurring of the normally distinct boundary between the grey matter (cortex) and white matter.

- Sulcal Effacement: Swelling of the brain tissue can cause the sulci (grooves on the brain surface) to become less visible.

- Insular Ribbon Sign: The insular cortex, which is highly susceptible to ischemia, can lose its normal definition.

- Hypoattenuation: Areas of the brain affected by ischemia may appear darker (hypoattenuated) due to decreased blood flow and early infarction.

2. CT Angiography (CTA):

- Vessel Occlusion: Direct visualization of occluded vessels, most commonly the MCA or other major arteries, indicating the location of the thrombus.

- Collateral Circulation: Assessment of alternative pathways of blood flow that may be supplying the ischemic area, which can influence treatment decisions.

3. CT Perfusion (CTP)

- Perfusion Maps: These maps help differentiate between the ischemic core (irreversibly damaged tissue) and the penumbra (potentially salvageable tissue).

- Cerebral Blood Flow (CBF), Cerebral Blood Volume (CBV), and Mean Transit Time (MTT) Areas with reduced CBF and prolonged

MTT but relatively preserved CBV often represent the penumbra, while significantly reduced CBV suggests the ischemic core.

Magnetic Resonance Imaging

1. Diffusion-Weighted Imaging (DWI):

- Restricted Diffusion: Areas of acute ischemia show up as bright (hyperintense) regions on DWI, indicating cytotoxic ooedema and cell death.

- Apparent Diffusion Coefficient (ADC) Maps: Corresponding dark (hypointense) areas on ADC maps confirm restricted diffusion and are indicative of acute infarction.

2. Fluid-Attenuated Inversion Recovery (FLAIR):

- Hyperintensity: FLAIR sequences can show hyperintense signals in the affected regions. In the very early stages (within 6 hours), these changes might be subtle or absent.

3. Magnetic Resonance Angiography (MRA)

- Vessel Occlusion: MRA can visualize the occluded arteries, similar to CTA, providing a non-invasive way to identify the location of the thrombus.

4. Perfusion-Weighted Imaging (PWI)

- Perfusion Deficits: PWI can identify areas with reduced perfusion, helping to distinguish between the ischemic core and the penumbra.

- Mismatch between DWI and PWI: A larger PWI lesion compared to the DWI lesion indicates a significant penumbra, suggesting that the tissue is at risk but potentially salvageable with timely reperfusion therapy.

MANAGEMENT

Step 1: Initial Assessment and Stabilization

- Assess Airway, Breathing, Circulation (ABCs): Ensure patient is stable.

- Neurological Examination: Perform a rapid neurological assessment,.

Step 2: Immediate Imaging

- Non-Contrast CT (NCCT) of the Head:

- Purpose: Rule out haemorrhage and identify early signs of ischemia.

- Findings: Look for hyperdense MCA sign, loss of grey-white matter differentiation, sulcal effacement, insular ribbon sign, and hypoattenuation.

Step 3: Advanced Imaging

If NCCT shows no haemorrhage:

- CT Angiography (CTA) of Head and Neck:

  - Purpose: Identify occlusion sites and assess collateral circulation.

  - Findings: Presence of vessel occlusion.

- CT Perfusion (CTP):

  - Purpose: Differentiate between ischemic core and penumbra.

  - Findings: Perfusion maps indicating areas of reduced CBF, CBV, and prolonged MTT.

Step 4: MRI (if available and feasible)

- MRI with DWI, ADC, and PWI:

  - Purpose: Confirm ischemic areas with high sensitivity and assess tissue viability.

  - Findings: DWI hyperintensity and ADC hypointensity for ischemic core; PWI showing perfusion deficits.

Step 5: Determine Eligibility for Reperfusion Therapy

- Intravenous Thrombolysis (IV tPA):

  - Eligibility: Confirm ischemic stroke, symptom onset within 4.5 hours, and no contraindications for tPA.

- Mechanical Thrombectomy:

  - Eligibility: Large vessel occlusion (LVO) identified on CTA or MRA, symptom onset within 6 hours (extendable up to 24 hours in select cases with favorable perfusion imaging).

Step 6: Treatment Decision Based on Imaging

- If CT/CTA/CTP or MRI confirms ischemic stroke with significant penumbra and small core:

  - Administer IV tPA if within 4.5 hours and no contraindications.

- Consider Mechanical Thrombectomy if LVO is present and within time window.

Step 7: Post-Reperfusion Therapy Management

- Monitor for Complications: Regularly assess for signs of hemorrhage and neurological improvement or deterioration.

- Supportive Care: Maintain blood pressure, glucose levels, and other supportive measures.

- Secondary Prevention: Initiate antiplatelet or anticoagulant therapy, control risk factors, and plan for rehabilitation.

Q2. A young adult patient has presented with unilateral pulsatile proptosis and chemosis after a road traffic accident. What is the probable aetiology and how will you confirm the diagnosis by imaging? Discuss the role of radiologic Interventions in managing such a condition.

Answer

The presentation of unilateral pulsatile proptosis and chemosis following a road traffic accident suggests a probable carotid-cavernous fistula (CCF), which is an fistula formation between the carotid arterial system and the cavernous sinus, often seen post trauma.

Imaging to Confirm the Diagnosis

1. CT Angiography (CTA):

- Initial Modality: Non-invasive and widely available.
- Findings:
  - Enlarged and tortuous superior ophthalmic vein.
  - Engorged cavernous sinus.
  - Abnormal communication between the carotid artery and the cavernous sinus.
  - Orbital congestion and proptosis.

2. MRI and MR Angiography (MRA):

- Detailed Soft Tissue and Vascular Imaging: Provides superior soft tissue contrast and better delineation of the vascular structures.
- Findings:
  - Enlarged cavernous sinus with flow voids indicating high-velocity blood flow.
  - Dilated superior ophthalmic vein.
  - Proptosis and orbital ooedema.
  - Enhancement and enlargement of extraocular muscles due to venous congestion.

3. Digital Subtraction Angiography (DSA):

- Gold Standard: Offers precise anatomical detail and can be used for both diagnosis and therapeutic intervention.

- Findings:

  - Direct visualization of the fistula between the carotid artery and the cavernous sinus.

  - Abnormal arterialization of the venous structures in the cavernous sinus and orbit.

  - Delineation of the exact location and size of the fistula.

- Procedure: Catheter is inserted into a femoral artery and guided to the carotid arteries; contrast is injected, and real-time X-ray images are captured to show the blood flow dynamics.

RADIOLOGICAL INTERVENTION

1. Balloon Occlusion:

- Procedure: A catheter with an inflatable balloon is navigated through the vascular system to the site of the fistula.

  - The balloon is inflated within the cavernous sinus to block the abnormal flow.

- Advantages:

  - Direct occlusion of the fistula.

  - Immediate relief of symptoms.

- Limitations:

  - Risk of balloon migration or deflation.

  - Potential to cause thromboembolic events.

  - Needs expertise.

2. Coil Embolization:

- Procedure:

  - Coils are delivered via a microcatheter into the cavernous sinus or directly into the fistula.

  - The coils induce clot formation, leading to occlusion of the abnormal connection.

- Advantages:

  - Effective in achieving permanent occlusion.

- Can be used in conjunction with other materials (e.g., stents, liquid embolic agents).

- Limitations:

  - Risk of incomplete occlusion or recanalization.

  - Requires precise placement to avoid compromising normal arterial flow.

3. Stent-Assisted Coil Embolization:

- Procedure:

  - A stent is deployed across the fistula site within the carotid artery to maintain patency.

  - Coils are then placed through the stent into the cavernous sinus to occlude the fistula.

- Advantages:

  - Protects the parent artery while allowing targeted occlusion of the fistula.

  - Reduces risk of coil migration.

- Limitations:

  - More technically demanding.

  - Requires careful post-procedural management to ensure stent patency.

4. Liquid Embolic Agents:

- Procedure:

  - Liquid agents (e.g., Onyx, cyanoacrylate glue) are injected into the cavernous sinus to occlude the fistula.

- Advantages:

  - Can effectively penetrate complex vascular structures.

  - Useful in fistulas with multiple feeding vessels.

- Limitations:

  - Risk of unintended embolization to other vascular territories.

  - Requires precise control during injection.

Q3. Discuss in brief, various types of hyperparathyroidism. Describe imaging features of various types of hyperparathyroidism.

Answer

HYPERPARATHYROIDISM

PRIMARY

Aetiology

- Parathyroid Adenoma: Most common cause (about 85% of cases); a benign tumor in one of the parathyroid glands.

- Parathyroid Hyperplasia: Enlargement of all four glands, less common (10-15%).

- Parathyroid Carcinoma: Very rare cause (<1%).

Pathophysiology:

- The overproduction of PTH leads to increased calcium reabsorption from bones, kidneys, and intestines.

- Results in hypercalcemia and hypophosphatemia.

Clinical Features:

- Often asymptomatic and discovered incidentally.

- Symptoms, if present, may include:

  - Skeletal: Bone pain, osteoporosis, fractures.

  - Renal: Kidney stones, polyuria, nephrocalcinosis.

SECONDARY

Aetiology

- Chronic Kidney Disease (CKD): Most common cause, due to impaired phosphate excretion and reduced production of active vitamin D.

- Vitamin D Deficiency: Leads to decreased calcium absorption.

- Malabsorption Syndromes: Conditions like celiac disease, chronic pancreatitis.

Pathophysiology:

- Compensatory overproduction of PTH in response to hypocalcemia or hyperphosphatemia.

- Persistent stimulation leads to parathyroid gland hyperplasia.

Clinical Features:

- Symptoms are primarily related to the underlying cause (e.g., CKD).

- Bone pain and skeletal deformities (renal osteodystrophy) in severe cases.

- Calciphylaxis (calcification of blood vessels) in advanced CKD.

TERTIARY

after kidney transplantation.

Pathophysiology:

- Autonomous parathyroid hyperplasia and overproduction of PTH despite normalization of calcium and phosphate levels.

- Hypercalcemia due to autonomous functioning of the hyperplastic glands.

Clinical Features:

- Similar to primary hyperparathyroidism with symptoms of hypercalcemia.

- Bone pain, renal complications, gastrointestinal and neuropsychiatric symptoms.

Diagnosis:

- Elevated serum calcium and PTH levels, often after kidney transplantation.

- History of prolonged secondary hyperparathyroidism.

Management:

- Surgical: Parathyroidectomy is often required due to the autonomous nature of the hyperplasia.

- Gastrointestinal: Nausea, vomiting, abdominal pain, constipation, peptic ulcers.

- Neuropsychiatric: Fatigue, depression, cognitive dysfunction, muscle weakness.

Diagnosis:

- Elevated serum calcium and PTH levels.

- Low or normal serum phosphate levels.

- Imaging (e.g., ultrasound, Sestamibi scan) to localize adenoma or hyperplasia.

Management:

- Surgical: Parathyroidectomy is the definitive treatment.

- Medical: For non-surgical candidates or mild cases, options include monitoring, bisphosphonates, and calcimimetics.

Diagnosis:

- Elevated PTH levels with low or normal serum calcium and high serum phosphate levels (in CKD).

- Low serum 25(OH) vitamin D levels.

Management:

- Treat Underlying Cause: Address vitamin D deficiency, malabsorption, and phosphate retention.

- Phosphate Binders: To reduce serum phosphate levels.

- Vitamin D Analogues: To enhance calcium absorption and suppress PTH.

- Calcimimetics: To reduce PTH secretion.

- Dialysis: In patients with advanced CKD.

Management:

- Surgical: Parathyroidectomy is often required due to the autonomous nature of the hyperplasia.

- Medical: In some cases, calcimimetics can be used to manage calcium and PTH levels pre-operatively or when surgery is not an option.

IMAGING FEATURES OF HYPERPARATHYROIDSM

PRIMARY	SECONDARY	TERTIARY
Common Imaging Modalities - Ultrasound: - Parathyroid Adenoma: Hypoechoic, oval or bean-shaped mass near the thyroid gland. Doppler ultrasound may show increased vascularity.	**Common Imaging Modalities** - Ultrasound: - Parathyroid Glands: Multiple, diffusely enlarged parathyroid glands with a heterogeneous appearance.	**Common Imaging Modalities** - Ultrasound: - Parathyroid Glands: Multiple enlarged glands, similar to secondary hyperparathyroidism, often with nodular hyperplasia.

challenging.

- 99mTc-Sestamibi Scan:

- Adenoma: Shows increased uptake in the parathyroid gland due to its higher metabolic activity. Early images may show uptake in both thyroid and parathyroid tissue, but delayed images often show persistent uptake in adenomas.

- Hyperplasia: Multiple areas of increased uptake, though the pattern can be similar to adenomas.

- CT and MRI:

- CT Scan: Non-contrast and contrast-enhanced CT can identify adenomas as enhancing soft tissue masses.

- 4D-CT: Combines three-dimensional imaging with contrast enhancement phases, providing detailed anatomic and functional information. Adenomas typically show rapid uptake and washout of contrast.

- MRI: Adenomas appear as well-defined, T2 hyperintense and T1 hypointense lesions, enhancing with gadolinium.

- DXA (Dual-energy X-ray Absorptiometry:

- Bone Mineral Density: Often reduced in cortical bone (e.g., forearm) due to increased bone resorption

decreased corticomedullary differentiation.

- 99mTc-Sestamibi Scan:

- Hyperplasia: Multiple areas of increased uptake in the neck, reflecting hyperplastic glands.

- Delayed Imaging: Can help differentiate hyperplastic glands from thyroid tissue.

- CT and MRI:

- CT Scan: Similar to primary hyperparathyroidism, though the glands are often more numerous and symmetrical.

- 4D-CT: Useful for detailed localization and functional assessment.

- MRI: Enlarged glands with characteristics similar to those seen in primary hyperparathyroidism.

- Bone Imaging:

- X-rays: Can show subperiosteal resorption, especially in the phalanges, “salt-and-pepper” skull, and osteosclerosis in the spine and pelvis.

- DXA: Often reveals low bone mineral density, especially in the cortical bone, with signs of renal osteodystrophy.

- 99mTc-Sestamibi Scan:

- Adenoma/Hyperplasia: Persistent uptake in hyperplastic glands or adenomas. The pattern is often similar to secondary hyperparathyroidism but can be more pronounced due to long-standing disease.

- CT and MRI:

- CT Scan: Enlarged parathyroid glands, potentially with features indicating adenoma development within the hyperplastic glands.

- 4D-CT: Provides detailed localization and functional imaging, helping to distinguish between residual hyperplasia and adenomas.

- MRI: Enlarged, T2 hyperintense and T1 hypointense glands, enhancing with gadolinium.

- Bone Imaging:

- X-rays: Can show severe bone changes, similar to those seen in secondary hyperparathyroidism but more pronounced.

- DXA: May show significant reductions in bone mineral density with evidence of osteitis fibrosa cystica and other bone remodeling

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Q4. Discuss various indications, techniques, advantages and limitations of MRI in imaging of breast cancer.

Answer

MRI IN BREAST CANCER

Indications for Breast MRI

1. Screening High-Risk Patients:

- BRCA Mutation Carriers: Women with BRCA1 or BRCA2 mutations.
- Strong Family History: Those with a strong family history of breast cancer.
- Previous Radiation Therapy: Women who had chest radiation therapy between the ages of 10 and 30.

2. Further Evaluation of Mammographic Findings:

- Inconclusive Mammography or Ultrasound: To further assess abnormalities that are difficult to characterize on mammography or ultrasound.

3. Preoperative Staging:

- Extent of Disease: Assessing the extent of cancer, including tumor size and multifocality/multicentricity.
- Contralateral Breast Evaluation: Screening the opposite breast for occult disease.

4. Assessment of Neoadjuvant Chemotherapy Response:

- Treatment Monitoring: Evaluating tumor response to chemotherapy before surgery.

5. Implant Integrity Assessment:

- Silicone and Saline Implants: Evaluating for implant rupture and other complications.

6. Problem-Solving Tool:

- Dense Breast Tissue: When mammography is limited due to high breast density.

- Scarring vs. Recurrence: Differentiating scar tissue from recurrent tumor.

MRI Techniques for Breast Cancer Imaging

1. Patient Preparation:

- Timing: Ideally performed in the second week of the menstrual cycle for premenopausal women to reduce background parenchymal enhancement.

- Patient Positioning: Prone position with the breasts hanging into a dedicated breast coil.

2. Contrast Administration:

- Gadolinium-Based Contrast Agents: Used to enhance the imaging of breast tissue and highlight tumors.

3. Imaging Protocol:

- T1-Weighted Images: Pre-contrast images to assess the anatomy and detect calcifications.

- Dynamic Contrast-Enhanced (DCE) MRI: Serial imaging post-contrast to evaluate the enhancement kinetics of lesions.

- T2-Weighted Images: To differentiate between cystic and solid masses and to evaluate ooedema and haemorrhage.

- Diffusion-Weighted Imaging (DWI): Assessing the cellular density and distinguishing benign from malignant lesions.

4. Image Analysis:

- Morphologic Assessment: Shape, margin, and internal characteristics of the lesion.

- Kinetic Assessment: Enhancement patterns over time (wash-in and wash-out curves).

Advantages of Breast MRI

1. High Sensitivity:

- Detection of Cancer Particularly useful for detecting invasive lobular carcinoma and other lesions that may be occult on mammography and ultrasound.

2. Multiplanar Imaging:

- Detailed Anatomy: Provides high-resolution images in multiple planes, aiding in accurate lesion localization.

3. Functional Imaging:

- DCE and DWI: Allows assessment of tumor vascularity and cellular density, which can help differentiate benign from malignant lesions.

4. No Ionizing Radiation:

- Safe for Repeated Use: Unlike mammography, MRI does not use ionizing radiation, making it safer for high-risk populations requiring frequent imaging.

Limitations of Breast MRI

1. High Cost:

- Expensive Modality: More costly compared to other imaging techniques like mammography and ultrasound.

2. Limited Specificity:

- False Positives: High sensitivity can lead to false-positive findings, resulting in unnecessary biopsies and anxiety.

3. Accessibility and Availability:

- Limited Access: Not available in all medical centers, particularly in resource-limited settings.

4. Contrast Agent Risks:

- Gadolinium-Based Contrast: Potential risks include allergic reactions and, in rare cases, nephrogenic systemic fibrosis in patients with severe renal impairment.

5. Technical Challenges:

- Motion Artifacts: Patient motion can degrade image quality.

- Timing and Patient Preparation: Requires optimal timing in premenopausal women and proper positioning for accurate results.

6. Interpretation Expertise:

- Specialized Training: Requires radiologists with specialized training in breast MRI to accurately interpret findings.

Q5. Describe various morphological patterns of vertebral body injuries in thoraco-lumbar spine. Discuss role of MRI in the diagnosis and management of such vertebral body injuries.

Answer

Classification of Thoraco-Lumbar Spine Injuries

Compression Fractures	Burst Fractures	Chance Fractures	Fracture-Dislocations	Minor Vertebral Fractures
Mechanism Typically result from axial loading, often combined with flexion. **Imaging Features** 1. Wedge Compression: Anterior height loss with intact posterior wall, resulting in a wedge-shaped vertebral body. 2.Stable Fracture: No involvement of the posterior vertebral elements; spinal canal remains intact. **Clinical Implications:** Often stable; pain management and bracing are common treatments. Surgery is rarely required.	**Mechanism** High-energy axial loading causes the vertebral body to shatter, with retropulsion of bony fragments into the spinal canal. **Imaging Features** 1. Comminuted Fracture 2. Loss of Vertebral Height: Both anterior and posterior. 3.Spinal Canal Compromise 4. CT: Best modality to assess bony fragments. **Clinical Implications:** Potentially unstable; risk of neurological injury necessitates surgical intervention in many cases.	**Mechanism** Hyperflexion with distraction, often seen in seatbelt injuries in motor vehicle accidents. **Imaging Feature** 1. Horizontal Fracture Line: Extends through the vertebral body, pedicles, and spinous process. 2. CT: Clearly shows the fracture line through the posterior elements. 3. MRI: Useful for assessing ligamentous injury. **Clinical Implications:** Unstable injury; often requires surgical stabilization.	**Mechanism** High-energy trauma resulting in severe flexion, extension, rotation, or shear forces. **Imaging Features** 1. Vertebral Displacement 2. Facet Joint Disruption: Facet dislocations or perched facets. 3. Spinal Canal Compromise 4. CT and MRI: Essential for detailed assessment of bony and soft tissue damage. **Clinical Implications:** Highly unstable; immediate surgical intervention is typically required.	**Mechanism** Low-energy trauma, often in osteoporotic bones. **Imaging Features** 1. Endplate Fractures: Fractures confined to the superior or inferior endplates. 2. Compression: Minor height loss without significant displacement. **Clinical Implications:** Generally stable; managed conservatively with pain management and physical therapy.

Morphological Patterns

A. Wedge Compression Fractures:

- Anterior Height Loss: Typically involves the anterior third of the vertebral body.
- Posterior Wall Intact: No posterior displacement of bone fragments.
- MRI: May show bone marrow ooedema indicating acute fracture.

B. Burst Fractures

- Comminution: Multiple fracture fragments within the vertebral body.
- Interpedicular Widening: Indicates lateral displacement of the vertebral body fragments.
- Retropulsed Fragments: May compromise the spinal canal; evaluated by CT.
- CT and MRI: Combination is used for detailed assessment of bony and soft tissue injury.

C. Flexion-Distraction (Chance) Fractures:

- Horizontal Fracture: Extends through the vertebral body and posterior elements.
- Posterior Ligamentous Complex Injury: MRI is essential to evaluate soft tissue damage.
- CT: Provides detailed fracture visualization and extent.

D. Fracture-Dislocations:

- Displacement: Significant anteroposterior or lateral displacement of the vertebra.
- Facet Joint Involvement: Dislocation or subluxation of facet joints.
- Neurological Compromise: High risk; detailed by MRI.

E. Minor Vertebral Fractures:

- Endplate Fractures: Disruption confined to the superior or inferior endplates.
- Non-Displaced Fractures: Stable with minimal height loss.

ROLE OF MRI

1. Soft Tissue Injury Assessment:

- Ligamentous Damage: MRI is the gold standard for evaluating the posterior ligamentous complex (PLC), which includes the supraspinous ligament, interspinous ligament, ligamentum flavum, and posterior longitudinal ligament. Integrity of these structures is crucial for determining spinal stability.

- Intervertebral Discs: MRI provides excellent visualization of disc herniation, bulging, or disruption associated with vertebral fractures.

- Muscle and Tendon Injury: MRI can identify associated injuries to the paraspinal muscles and tendons, which may influence the management plan.

2. Bone Marrow Oedema:

- Acute Fractures: MRI can detect bone marrow oedema, which is indicative of acute fractures. This is particularly useful in cases where X-rays or CT scans do not clearly show the fracture line.

- Chronicity: Helps in distinguishing between acute, subacute, and chronic fractures based on the presence and pattern of oedema.

3. Spinal Cord and Nerve Root Involvement:

- Spinal Cord Compression: MRI is essential for evaluating the degree of spinal cord compression due to retropulsed bone fragments, hematomas, or disc material.

- Myelopathy: MRI can identify changes in the spinal cord itself, such as myelomalacia or contusion, which are critical for predicting neurological outcomes.

- Nerve Root Compression: High-resolution images of the nerve roots help in identifying impingement or damage, influencing both surgical and conservative treatment plans.

4. Infection and Tumor Evaluation:

- Differential Diagnosis: MRI can help differentiate vertebral fractures caused by trauma from those due to pathological processes such as infections (osteomyelitis) or metastatic disease.

Management Role of MRI

1. Surgical Planning:

- Extent of Injury: Detailed images of all affected structures, including bones, ligaments, discs, and neural elements, are critical for surgical planning.

- Approach Selection: Helps in choosing the most appropriate surgical approach (e.g., anterior, posterior, or combined) by providing a comprehensive view of the injury.

- Stability Assessment: MRI findings on ligamentous injury and vertebral body involvement guide decisions regarding the need for stabilization procedures such as spinal fusion.

2. Non-Surgical Management:

- Treatment Decisions: MRI findings of intact PLC and absence of significant spinal canal compromise may support conservative management with bracing and physical therapy.

- Monitoring Healing: Follow-up MRIs can be used to monitor the healing process, detect complications (e.g., non-union or progressive kyphosis), and adjust treatment plans accordingly.

3. Prognostication:

- Neurological Recovery: The degree of spinal cord and nerve root involvement on MRI can provide prognostic information regarding potential recovery of neurological function.

- Risk of Progression: MRI can help predict the risk of progressive deformity or instability, guiding long-term management strategies.

Q6. Enumerate various causes for unilateral painful hip in a 10-year-old child. Discuss the role of imaging in any two pathologies.

Answer

UNILATERAL PAINFUL LIMP IN A CHILD <10

1. Transient Synovitis – Common in this age group often self-limiting inflammation of the hip joint.

- Aetiology: Often follows a viral infection or minor trauma.
- Symptoms: Sudden onset of hip pain and limping, often without fever.
- Diagnosis: Clinical diagnosis supported by ultrasound showing joint effusion.

2. Legg-Calvé-Perthes Disease

- Description: Avascular necrosis of the femoral head.
- Aetiology: Unknown, possibly related to vascular interruption.
- Symptoms: Gradual onset of limp and hip pain, sometimes referred to the knee, with limited hip movement.
- Diagnosis: X-ray shows increased density of the femoral head followed by fragmentation and reossification.

3. Slipped Capital Femoral Epiphysis (SCFE

- Description: Displacement of the femoral head relative to the neck at the growth plate.
- Etiology: Often occurs during rapid growth spurts, associated with obesity or hormonal imbalances.
- Symptoms: Gradual onset of hip, thigh, or knee pain, with a limp and restricted hip movement.
- Diagnosis: X-ray showing the femoral head displaced posteriorly and inferiorly relative to the femoral neck.

4. Septic Arthritis

- Description: Infection of the hip joint.

- Etiology Bacterial infection, commonly Staphylococcus aureus.

- Symptoms: Acute onset of severe hip pain, fever, and inability to bear weight.

- Diagnosis: Elevated white blood cell count, ESR, CRP, and ultrasound showing joint effusion. Joint aspiration confirms the diagnosis.

5. Osteomyelitis

- Description Infection of the bone, commonly affecting the proximal femur.

- Etiology: Bacterial infection, often hematogenous spread.

- Symptoms: Gradual onset of localized bone pain, fever, and swelling.

- Diagnosis: Elevated inflammatory markers, MRI showing bone marrow oedema, and possible bone biopsy.

6. Juvenile Idiopathic Arthritis (JIA

- Description: Chronic arthritis in children under 16, affecting one or more joints.

- Etiology: Autoimmune disease.

- Symptoms: Chronic joint pain and swelling, morning stiffness, and decreased range of motion.

- Diagnosis: Clinical diagnosis supported by elevated inflammatory markers and imaging showing joint effusion or synovitis.

7. Trauma

- Description: Fractures or soft tissue injuries to the hip or proximal femur.

- Etiology: Falls, sports injuries, or accidents.

- Symptoms: Acute onset of pain, inability to bear weight, and localized tenderness.

- Diagnosis: X-rays to detect fractures or dislocations; MRI may be needed for soft tissue injuries.

8. Developmental Dysplasia of the Hip (DDH)

- Description: Abnormal development of the hip joint.

- Etiology: Congenital or developmental factors.

- Symptoms: Limping, pain, or decreased hip movement.

- Diagnosis: Clinical examination with Ortolani and Barlow tests, confirmed by ultrasound or X-ray.

Role of Imaging

1. Slipped Capital Femoral Epiphysis (SCFE)

Imaging Modalities

1. X-ray:

- Role: Primary diagnostic tool for SCFE.

- Views: Anteroposterior (AP) and frog-leg lateral views are typically obtained.

- Findings:

a. AP View: Widening and irregularity of the growth plate, decreased height of the epiphysis, and alignment changes.

b. Frog-Leg Lateral View: Best for visualizing the degree of slippage. The "ice cream slipping off the cone" sign is characteristic.

2. MRI:

- Role: Used when X-rays are inconclusive or to assess early, pre-slip SCFE, and complications.

- Findings:

a. Oedema: Increased signal in the metaphysis and growth plate on T2-weighted images, indicating early slip before it becomes apparent on X-ray.

b. Physeal Abnormalities: Detailed view of the growth plate showing irregularity and widening.

c. Associated Changes: Assessment of surrounding soft tissues and detection of concurrent conditions like synovitis.

3. CT Scan:

- Role: Less commonly used but can be helpful for preoperative planning and in complex cases where 3D reconstruction of the hip is beneficial.

- Findings: Precise delineation of the extent of slippage and any associated deformities of the femoral head and neck.

4. Ultrasound:

- Role: Rarely used for diagnosis but can be helpful in very early cases or in patients who cannot undergo MRI.

- Findings: May show joint effusion and subtle changes in the epiphyseal plate.

Clinical Utility:

- Diagnosis: X-rays are crucial for initial diagnosis and classification of the slip severity (mild, moderate, or severe).

- Monitoring: Serial imaging is important to monitor the progression of the slip and the response to treatment.

- Preoperative Planning: Detailed assessment of the slip and femoral head position to guide surgical intervention.

- Postoperative Follow-Up: Imaging, particularly X-ray and sometimes MRI, is used to assess the success of surgical treatment and detect complications such as avascular necrosis.

2. Developmental dysplasia of hip

Imaging Modalities

1. Ultrasound (US)

- Role: Primary imaging modality for newborns and infants under six months of age.

- Techniques:

a. Static Ultrasound: Measures key angles and assesses the position of the femoral head within the acetabulum.

b. Dynamic Ultrasound: Evaluates the stability of the hip using stress maneuvers (e.g., Barlow and Ortolani tests).

- Findings:

a. Graf Classification: Uses measurements like the alpha and beta angles to classify hip maturity and dysplasia.

b. Hip Subluxation or Dislocation

c. Acetabular Development

2. X-ray

- Role: Preferred imaging modality for children over six months when the femoral head begins to ossify.

- Views:

  - Anteroposterior (AP) Pelvis: Standard view for assessing hip development.

  - Frog-Leg Lateral View: Sometimes used to provide additional information about hip positioning.

- Findings:

  a. Acetabular Index: Angle measurement to assess acetabular slope and depth.

  b. Hilgenreiner's Line: A horizontal line through the triradiate cartilages; used as a reference for other measurements.

  c. Perkin's Line: A vertical line from the lateral aspect of the acetabulum; used to assess femoral head positioning.

  d. Shenton's Line: A continuous curve formed by the superior margin of the obturator foramen and the inferior border of the femoral neck; interruption suggests dislocation.

  e. Delayed Ossification: Indicates developmental delays in the femoral head ossification.

3. Magnetic Resonance Imaging (MRI)

- Role: Used in complex cases, preoperative planning, and postoperative follow-up.

- Findings:

  a. Cartilage Anatomy: Detailed view of the acetabular cartilage, labrum, and the femoral head.

  b. Reduction Assessment: Useful in evaluating the success of closed or open reduction procedures.

  c. Associated Pathologies: Identifies concurrent abnormalities like labral tears or synovitis.

4. Computed Tomography (CT)

- Role: Less commonly used due to radiation exposure but valuable in specific scenarios.

- Applications:

  - Preoperative Planning: Detailed bony anatomy and alignment, particularly in complex or recurrent cases.

- Postoperative Assessment: Evaluates the position of the femoral head and the quality of the reduction.

- Findings:

a. 3D Reconstructions: Provides detailed anatomical views of the hip joint, aiding in surgical planning.

b. Bony Alignment: Accurate assessment of the acetabulum and femoral head relationship.

Clinical Utility

Diagnosis

- Screening: Ultrasound is the preferred method for early screening in at-risk infants (e.g., breech presentation, family history of DDH).

- Confirmation: Ultrasound can confirm instability or dysplasia seen in physical examinations using dynamic techniques.

Q7. a) Describe briefly various neurocutaneous syndrome.

b) Describe imaging features of von Hippel Lindau syndrome.

Answer

NEUROCUTANEOUS SYNDROMES

1. Neurofibromatosis Type 1 (NF1)

- Genetics: Autosomal dominant; mutation in the NF1 gene on chromosome 17.

- Clinical Features:

- Café-au-lait Spots: Light brown skin patches.
- Neurofibromas: Benign nerve sheath tumors that can occur anywhere in the body.
- Lisch: Iris hamartomas visible on slit-lamp examination
- Axillary/Groin Freckling: Small freckle-like spots in these areas.
- Skeletal Abnormalities: Scoliosis, pseudoarthrosis, tibial dysplasia.
- Learning Disabilities: Common, with variable severity
- Neurological Complications: Optic gliomas, seizures, and higher risk of certain cancers.

2. Neurofibromatosis Type 2 (NF2)

- Genetics: Autosomal dominant; mutation in the NF2 gene on chromosome 22.

- Clinical Features:

- Bilateral Vestibular Schwannomas: Tumors on the nerves responsible for hearing and balance.
- Meningiomas: Tumors of the meninges (brain and spinal cord covering).
- Ependymomas: Tumors of the ependymal cells lining the ventricles of the brain and the central canal of the spinal cord.
- Cataracts: Early onset posterior subcapsular cataracts.
- Skin Tumors: Less common and fewer than in NF1.

3. Tuberous Sclerosis Complex (TSC)

- Genetics: Autosomal dominant; mutations in TSC1 or TSC2 genes.

- Clinical Features:

- Skin Lesions: Facial angiofibromas, hypomelanotic macules (ash leaf spots), Shagreen patches, periungual fibromas.

- Neurological: Cortical tubers, subependymal nodules, subependymal giant cell astrocytomas (SEGA).
- Seizures: Common and often difficult to control.
- Cognitive Impairments: Ranging from learning disabilities to severe intellectual disability.
- Renal: Angiomyolipomas, cysts, and risk of renal cell carcinoma.
- Cardiac: Rhabdomyomas, which may regress with age.
- Pulmonary: Lymphangioleiomyomatosis (LAM), mainly in women.

4. Sturge-Weber Syndrome

- Genetics: Typically sporadic; associated with somatic mutation in the GNAQ gene.

- Clinical Features:

- Port-Wine Stain: Facial nevus flammeus typically following the distribution of the trigeminal nerve.
- Leptomeningeal Angiomatosis: Vascular malformations affecting the leptomeninges, often unilateral.
- Seizures: Often focal and can be difficult to control.
- Neurological: Hemiparesis, developmental delays, intellectual disability.
- Ocular: Glaucoma, choroidal hemangiomas.

5. Von Hippel-Lindau Disease (VHL)

- Genetics: Autosomal dominant; mutation in the VHL gene on chromosome 3.

- Clinical Features:

- Hemangioblastomas: Highly vascular tumors in the central nervous system, especially the cerebellum, spinal cord, and retina.
- Renal Cell Carcinoma: Increased risk.
- Pheochromocytomas: Tumors of the adrenal glands.
- Pancreatic Cysts and Tumors: Including neuroendocrine tumors.
- Endolymphatic Sac Tumors: Affecting hearing.

6. Ataxia-Telangiectasia (A-T)

- Genetics: Autosomal recessive; mutation in the ATM gene.

- Clinical Features:

- Neurological: Progressive cerebellar ataxia, oculomotor apraxia.
- Telangiectasias: Dilated blood vessels, especially in the eyes and skin.
- Immunodeficiency: Recurrent infections due to low levels of immunoglobulins.
- Increased Cancer Risk: Particularly lymphomas and leukemias.
- Endocrine: Premature aging, insulin resistance.

IMAGINE FEATURES OF VON HIPPE LINDAU SYNDROME

Central Nervous System (CNS)

1. Hemangioblastomas:

- Location: Commonly found in the cerebellum, brainstem, spinal cord, and retina.

- MRI:

  - T1-Weighted Images: Typically iso- to hypointense.
  - T2-Weighted Images: Hyperintense.
  - Post-Contrast: Strong, homogeneous enhancement of the solid component, often with an associated cystic component.

- CT Scan:

  - Without Contrast: Hypodense or isodense.
  - With Contrast: Marked enhancement.
  - Angiography: Highly vascular tumors with prominent feeding vessels.

Retina

1. Retinal Hemangioblastomas:

- Fluorescein Angiography: Early hyperfluorescence and late leakage.

- OCT (Optical Coherence Tomography: Demonstrates the presence of retinal tumors and associated macular oedema.

Abdominal Organs

Kidneys

- Renal Cell Carcinoma (RCC:

  - CT Scan:

    - Without Contrast: Hypodense or isodense mass.
    - With Contrast: Enhancing mass with possible necrotic or cystic areas.

  - MRI:

    - T1-Weighted Images: Hypointense.
    - T2-Weighted Images: Hyperintense.
    - Post-Contrast: Strong enhancement.

  - Ultrasound: Hypoechoic or mixed echogenicity masses.

- Renal Cysts:

  - CT Scan: Well-defined, non-enhancing, water-density lesions.

- MRI: Hyperintense on T2-weighted images and hypointense on T1-weighted images, with no enhancement post-contrast.

Pancreas

- Pancreatic Cysts:

  - CT Scan: Well-defined, low-attenuation lesions without enhancement.

  - MRI: Hyperintense on T2-weighted images, hypointense on T1-weighted images.

- Pancreatic Neuroendocrine Tumors:

  - CT Scan:

    - Without Contrast: Hypodense or isodense.
    - With Contrast: Hyperenhancing during the arterial phase.

  - MRI:

    - T1-Weighted Images: Hypointense.
    - T2-Weighted Images: Hyperintense.
    - Post-Contrast: Early arterial phase enhancement.

Adrenal Glands

1. Pheochromocytomas:

- CT Scan:

  - Without Contrast: Well-circumscribed, homogeneous or heterogeneous lesions, often hypodense.
  - With Contrast: Intense enhancement.

- MRI:

  - T1-Weighted Images: Hypointense or isointense.
  - T2-Weighted Images: Hyperintense ("light bulb sign").
  - Post-Contrast: Intense enhancement.

- MIBG Scan: Increased uptake in pheochromocytomas.

Liver

1. Liver Hemangiomas:

- CT Scan:

  - Without Contrast: Hypodense.
  - With Contrast: Peripheral nodular enhancement with centripetal fill-in.

- MRI:

- T1-Weighted Images: Hypointense.
- T2-Weighted Images: Hyperintense.
- Post-Contrast: Peripheral nodular enhancement with gradual fill-in.

Ear

1. Endolymphatic Sac Tumors:

- CT Scan: Bone erosion around the endolymphatic sac.

- MRI:

  - T1-Weighted Images: Isointense or slightly hyperintense.
  - T2-Weighted Images: Hyperintense.
  - Post-Contrast: Intense enhancement.

Q8. Discuss the role of HRCT and MRI in the evaluation of congenital sensorineural hearing loss.

Answer

ROLE OF HRCT IN SNHL

Role and Advantages:

- Bone Structure Visualization: HRCT is excellent for detailed imaging of the bony structures of the ear, including the temporal bone, cochlea, vestibular apparatus, and internal auditory canal (IAC).

- Resolution: HRCT provides high-resolution images that can detect minute bony anomalies.

Indications:

- Cochlear Anomalies: Evaluation of cochlear structure, including the presence of cochlear dysplasia or aplasia.

- Ossicular Chain: Assessment of the ossicular chain for any malformations or discontinuities.

- Bony Labyrinth: Detection of malformations of the bony labyrinth.

- Enlarged Vestibular Aqueduct: Identification of enlarged vestibular aqueduct (EVA), which is often associated with SNHL.

- Cochlear Implants: Preoperative assessment to evaluate cochlear patency and anatomy for implant planning.

HRCT Findings:

- Cochlear Dysplasia: Abnormal development of the cochlea, such as incomplete partition type II (Mondini deformity), characterized by a less coiled cochlea.

- Enlarged Vestibular Aqueduct: Vestibular aqueduct larger than 1.5 mm in diameter.

- Common Cavity: A single cystic cavity replacing the cochlea and vestibule.

- Stapes Fixation: Detection of fixation of the stapes footplate, which may affect hearing function.

Techniques:

- Thin-Section Scanning: Use of thin slices (0.5 to 1.0 mm) to obtain high-resolution images.

- Multiplanar Reconstructions: Coronal and sagittal reconstructions for detailed anatomical visualization.

Role of Magnetic Resonance Imaging (MRI) in SNHL

MRI Role and Advantages:

- Soft Tissue Contrast: Superior contrast resolution for soft tissues, allowing detailed evaluation of the inner ear, auditory nerve, and brainstem pathways.

- Multiplanar Imaging: Ability to obtain images in multiple planes without moving the patient, useful for comprehensive assessment.

- No Radiation: Safer for repeated use, especially important in pediatric populations.

Indications:

- Cochlear Nerve: Assessment of the cochlear nerve, including the presence and size of the nerve within the internal auditory canal (IAC).

- Inner Ear Structures: Evaluation of membranous labyrinth abnormalities, such as cochlear nerve aplasia or hypoplasia.

- Brainstem and Central Auditory Pathway: Identification of pathologies involving the brainstem and higher auditory pathways.

- Cochlear Implant Planning: Complementary to HRCT in assessing the soft tissue structures for cochlear implant candidacy.

MRI Findings:

- Cochlear Nerve Aplasia/Hypoplasia: Absence or small size of the cochlear nerve in the IAC.

- Labyrinthine Anomalies: Identification of anomalies in the membranous labyrinth, such as cochlear nerve deficiency.

- Inflammatory/Infectious Conditions: Detection of labyrinthitis or other inflammatory conditions affecting the inner ear.

- Auditory Brainstem Pathologies: Visualization of brainstem tumors, demyelination, or other pathologies affecting the auditory pathways.

Techniques:

- High-Resolution T2-Weighted Imaging: For detailed visualization of the inner ear fluid spaces (cisterns, cochlea, vestibule).

- 3D Constructive Interference in Steady State (CISS): Provides detailed images of small structures like the cranial nerves and inner ear.

- Post-Contrast T1-Weighted Imaging: Useful for identifying enhancing lesions, such as tumors or inflammation.

- Diffusion-Weighted Imaging (DWI): Helpful in detecting acute ischemic lesions that may affect auditory pathways.

Clinical Utility

1. Diagnosis:

- HRCT: Initial assessment to identify bony anomalies such as EVA, cochlear dysplasia, or ossicular malformations.

- MRI: Confirming the presence and integrity of the cochlear nerve, evaluating the membranous labyrinth, and detecting central causes of hearing loss.

2. Treatment Planning:

- Cochlear Implants: Both HRCT and MRI are used preoperatively to assess the cochlear anatomy and the status of the auditory nerve.

- Surgical Interventions: Detailed anatomical information aids in planning surgical corrections of any identified malformations.

3. Prognosis and Follow-Up:

- HRCT and MRI: Monitor the progression of identified anomalies and assess the outcomes of surgical or medical interventions.

Q9. Discuss basic principles of MR Spectroscopy. Discuss in brief, role of MR Spectroscopy in the evaluation of various brain pathologies.

Answer

Fundamentals of MR Spectroscopy

- Nuclear Magnetic Resonance (NMR) Principles: MRS is based on the principles of NMR. When placed in a magnetic field, certain nuclei (such as hydrogen, carbon, phosphorus) resonate at specific frequencies. This resonance frequency depends on the magnetic field strength and the chemical environment of the nucleus.

- Chemical Shift: The resonance frequency of a nucleus is influenced by the electronic environment surrounding it. Different chemical compounds will shift the resonance frequency slightly, a phenomenon known as the chemical shift. This shift is measured in parts per million (ppm).

Basic Components of an MRS System

- Magnet: Provides a strong and uniform magnetic field, typically measured in Tesla (T). Higher field strengths improve the resolution and sensitivity of the spectroscopy.

- Radiofrequency (RF) Coils: Used to transmit and receive RF pulses. These coils are similar to those used in standard MRI but are often specialized for MRS.

- Gradient Coils: Create small variations in the magnetic field to encode spatial information.

- Spectrometer: Analyzes the signals received from the RF coils and converts them into a spectrum.

Data Acquisition

- Voxel Selection: MRS focuses on a small volume of interest (VOI) within the tissue. This is achieved using techniques like single-voxel spectroscopy (SVS) or multi-voxel spectroscopy (MVS).

  - Single-Voxel Spectroscopy (SVS): Acquires data from a single, predefined region.

  - Multi-Voxel Spectroscopy (MVS): Also known as Chemical Shift Imaging (CSI), acquires data from multiple voxels simultaneously, allowing for the creation of metabolic maps.

- Pulse Sequences: Specific pulse sequences are used to manipulate the spins and acquire the spectra. Common sequences include Point-Resolved Spectroscopy (PRESS) and Stimulated Echo Acquisition Mode (STEAM).

  - PRESS: Uses three RF pulses to select the voxel and acquire the spectrum.

- STEAM: Uses three 90-degree pulses and is less sensitive to magnetic field inhomogeneities.

Spectrum Analysis

- Frequency Domain: The acquired data is initially in the time domain and is converted to the frequency domain using Fourier Transform (FT).

- Peaks and Chemical Shifts: Each metabolite produces a peak at a specific chemical shift in the spectrum. The area under each peak is proportional to the concentration of the metabolite.

- Common Metabolites:

- N-Acetyl Aspartate (NAA): Typically seen at 2.0 ppm, associated with neuronal health.

- Choline (Cho): Seen at 3.2 ppm, associated with cell membrane turnover.

- Creatine (Cr): Seen at 3.0 ppm, serves as a reference due to its relatively stable concentration.

- Lactate (Lac): Seen at 1.3 ppm, indicates anaerobic metabolism.

- Myoinositol (mI): Seen at 3.5 ppm, associated with glial cells.

- Glutamate and Glutamine (Glx): Seen at 2.1-2.5 ppm, important in neurotransmission.

ROLE OF MR SPECTROSCOPY IN VARIOUS PATHOLOGIES

1. Brain Tumors

- Metabolite Changes: Tumors often show increased choline (Cho) due to high cell membrane turnover, decreased N-acetyl aspartate (NAA) indicating neuronal loss or dysfunction, and increased lactate (Lac) due to anaerobic metabolism.

- Tumor Grading: Higher-grade tumors show more pronounced metabolic changes, such as elevated Cho and the presence of lactate and lipids.

- Differentiation: MRS helps differentiate between tumor types (e.g., gliomas vs. metastases) and between tumor recurrence and radiation necrosis.

- Preoperative Planning: Provides metabolic information to aid in surgical planning and biopsy targeting.

Key Metabolites:

- Choline (Cho): Elevated in most tumors due to increased membrane turnover.

- N-acetyl aspartate (NAA): Decreased in tumor regions reflecting neuronal loss.

- Creatine (Cr): Often used as an internal reference.

- Lactate (Lac): Increased in high-grade tumors and necrosis.

- Lipid: Elevated in high-grade tumors and necrosis.

2. Multiple Sclerosis (MS)

Role of MRS:

- Metabolite Changes: MS lesions typically show reduced NAA reflecting axonal loss or dysfunction, elevated myo-inositol (mI) indicating gliosis, and sometimes increased Cho due to active demyelination.

- Disease Monitoring: MRS can be used to monitor disease progression and response to therapy by tracking metabolite levels over time.

- Distinguishing Lesions: Helps differentiate active inflammatory lesions from chronic inactive plaques.

Key Metabolites:

- N-acetyl aspartate (NAA): Reduced in demyelinated regions.

- Myo-inositol (mI): Elevated indicating gliosis.

- Choline (Cho): May be increased during active demyelination.

3. Epilepsy

Role of MRS:

- Focus Identification: Helps identify epileptogenic foci by detecting metabolic abnormalities such as decreased NAA in regions of neuronal loss.

- Assessment of Metabolic Dysfunction: Provides information on metabolic dysfunction in the epileptogenic zone.

- Pre-surgical Evaluation: Assists in the pre-surgical evaluation of patients with intractable epilepsy by pinpointing metabolic abnormalities.

Key Metabolites:

- N-acetyl aspartate (NAA): Decreased in epileptogenic zones.

- Lactate (Lac): May be elevated during seizures due to anaerobic metabolism.

4. Stroke

Role of MRS:

- Acute Stroke: In acute ischemic stroke, MRS can show elevated lactate due to anaerobic metabolism and decreased NAA reflecting neuronal injury.

- Chronic Stroke: In chronic stages, there may be persistent decreases in NAA indicating permanent neuronal damage.

Key Metabolites:

- Lactate (Lac): Elevated in acute ischemia.

- N-acetyl aspartate (NAA): Decreased in affected regions.

- Choline (Cho): May be increased in regions of inflammation.

5. Infections and Inflammatory Diseases

Role of MRS:

- Differentiation: Helps differentiate between infectious and non-infectious inflammatory processes.

- Infections: Can show elevated lipids and lactate in abscesses due to bacterial metabolism and necrosis.

- Inflammatory Diseases: May show elevated choline and myo-inositol in diseases like encephalitis or demyelinating conditions.

Key Metabolites:

- Lactate (Lac): Elevated in abscesses and infected regions.

- Lipids: Elevated in necrotic tissue.

- Myo-inositol (mI): Elevated in inflammatory conditions.

6. Metabolic and Genetic Disorders

Role of MRS:

- Diagnosis: Can identify specific metabolic abnormalities in genetic metabolic disorders.

- Monitoring: Useful in monitoring the biochemical response to therapy.

Key Disorders:

- Leigh’s Disease: Elevated lactate in the brainstem and basal ganglia.

- Canavan Disease: Markedly elevated NAA levels.

- Mitochondrial Disorders: Elevated lactate and abnormal NAA levels.

7. Neurodegenerative Diseases

Role of MRS:

- Early Detection: Can detect metabolic changes before significant anatomical changes are visible on conventional MRI.

- Disease Progression: Tracks the progression of metabolic changes in diseases like Alzheimer's and Parkinson's.

Q 10. A 14-year-old male presented with fever, pain and swelling of right proximal arm.

a) What are the various differential diagnosis?

b) Discuss in brief, role of imaging in the evaluation of such a case.

Answer

1. Osteomyelitis

- Description: An infection and inflammation of the bone.

- Clinical Features: Fever, localized pain, swelling, warmth, and sometimes redness over the affected area.

- Diagnosis: Elevated white blood cell count, ESR, CRP, blood cultures, and imaging (X-ray, MRI, or bone scan).

2. Septic Arthritis

- Description: Infection within a joint, commonly bacterial.

- Clinical Features: Severe pain, fever, swelling, and limited range of motion in the affected joint.

- Diagnosis: Joint aspiration and analysis, blood cultures, elevated inflammatory markers, and imaging.

3. Cellulitis

- Description: A bacterial skin infection that can extend to deeper tissues.

- Clinical Features: Red, swollen, warm, and tender skin. Fever and lymphangitis (red streaks) may also be present.

- Diagnosis: Clinical examination, blood cultures, and possibly ultrasound to check for abscess formation.

4. Pyomyositis

- Description: A bacterial infection of the skeletal muscles, often caused by Staphylococcus aureus.

- Clinical Features: Localized muscle pain, swelling, tenderness, and fever.

- Diagnosis: MRI, ultrasound, blood cultures, and elevated inflammatory markers.

5. Ewing's Sarcoma

- Description: A malignant bone tumor commonly affecting adolescents.

- Clinical Features: Pain and swelling at the site of the tumor, fever, and sometimes a palpable mass.

- Diagnosis: Imaging (X-ray showing a characteristic "onion-skin" appearance, MRI, CT), biopsy, and bone scan.

6. Osteosarcoma

- Description: A primary malignant bone tumor typically occurring in children and adolescents.

- Clinical Features: Progressive pain, swelling, and sometimes a palpable mass. Fever is less common but may occur.

- Diagnosis: X-ray (showing a "sunburst" pattern), MRI, CT, biopsy, and bone scan.

7. Rhabdomyosarcoma

- Description: A malignant tumor of skeletal muscle origin, more common in children.

- Clinical Features: Pain, swelling, and sometimes fever, depending on the location.

- Diagnosis: Imaging (MRI or CT), biopsy, and possibly PET scan.

8. Leukemia

- Description: A malignancy of the blood and bone marrow.

- Clinical Features: Bone pain, fever, fatigue, pallor, and other signs of bone marrow suppression (anemia, thrombocytopenia).

- Diagnosis: Complete blood count (CBC), bone marrow biopsy, and imaging if localized pain is present.

9. Trauma/Fracture

- Description: Injury to the bone or surrounding tissues.

- Clinical Features: History of trauma, localized pain, swelling, and sometimes deformity.

- Diagnosis: X-ray, CT scan for complex fractures.

10. Juvenile Idiopathic Arthritis (JIA)

- Description: An autoimmune disorder causing inflammation of the joints.

- Clinical Features: Joint pain, swelling, stiffness, fever, and fatigue.

- Diagnosis: Clinical examination, blood tests (RF, ANA), and imaging (ultrasound, MRI)

11. Bursitis

- Description: Inflammation of a bursa (a small fluid-filled sac near joints).

- Clinical Features: Localized swelling, pain, and reduced movement in the affected area.

- Diagnosis: Clinical examination, ultrasound, and MRI if needed.

12. Reactive Arthritis

- Description: Arthritis that develops in response to an infection elsewhere in the body.

- Clinical Features: Joint pain and swelling, often accompanied by other systemic symptoms such as fever.

- Diagnosis: Clinical examination, blood tests, and imaging if necessary.

ROLE OF IMAGING

1. X-ray

- Purpose: The first-line imaging tool used to assess bone structure and integrity. X-rays can quickly identify fractures, bone lesions, or abnormal growths.

- Utility: Helps rule out or confirm fractures, detect bone tumors (like osteosarcoma and Ewing's sarcoma), or show signs of osteomyelitis (such as periosteal reactions and bone destruction).

2. Ultrasound

- Purpose: Utilized to evaluate soft tissues, muscles, and smaller structures not well visualized on X-rays.

- Utility: Useful for detecting soft tissue abnormalities such as cellulitis, abscesses, pyomyositis, or muscle tears. It can also guide diagnostic procedures like aspiration or biopsy.

3. Magnetic Resonance Imaging (MRI)

- Purpose: Provides detailed images of bone and soft tissue, including marrow.

- Utility: Excellent for diagnosing osteomyelitis, which might show bone marrow oedema before changes are visible on X-rays. MRI is invaluable for evaluating bone tumors, soft tissue tumors (like rhabdomyosarcoma), and differentiating between benign and malignant lesions. It also helps in assessing joint diseases such as septic arthritis or juvenile idiopathic arthritis.

4. Computed Tomography (CT) Scan

- Purpose: Offers detailed images of bone and can provide finer details than an X-ray.

- Utility: Particularly useful when complex bone structures are involved or when precise details about bone destruction or tumor extension are needed. CT can be superior for evaluating complex fractures or in surgical planning.

5. Bone Scan

- Purpose: A nuclear imaging method that helps detect bone metabolism and blood flow.

- Utility: Useful in detecting osteomyelitis, metastatic bone disease, or primary bone tumors over the whole body, indicating active bone processes that might not yet be visible on X-rays.

6. Positron Emission Tomography (PET) Scan

- Purpose: Combined with CT (PET/CT), this provides metabolic and anatomical details.

- Utility: Useful for identifying malignant tumors and their metastases, differentiating between benign and malignant lesions, and sometimes for infection.
