🦴 Orthopedics Final

🔊 **Podcast Style Review (Experimental Feature) - Need to be on Wi-Fi not 4G to work properly!**

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- Topics are arranged in order of most to least commonly tested
- Check the table of contents below for easier navigation
- Good luck 🍀

1. Fractures (General Principles & Specific Types)

Fracture Healing

- **Determinants: Stability is the major determinant** of healing type (primary vs. secondary). **Blood supply is the most important factor overall**.
- **Healing Types:**

    - **Primary (Direct):** Requires **absolute stability** (e.g., compression plates, lag screws) and minimal gap (<1mm). No callus formation.
    - **Secondary (Indirect):** Occurs with **relative stability** (e.g., casts, IM nails, K-wires). Involves callus formation (inflammation → repair → remodeling).
- **Factors Affecting Healing:** Blood supply, stability, patient factors (age, nutrition, smoking, diabetes), fracture pattern (segmental worse), infection, medications (NSAIDs/steroids can impair).
- **Complications:**
    - **Nonunion/Delayed Union:** Common in **distal tibia**, scaphoid. Causes include poor blood supply, instability, infection, large gap, severe soft tissue injury.
    - **Malunion:** Healing in a non-anatomical position. Most common complication of **clavicle fracture**.
    - **Avascular Necrosis (AVN):** Risk highest with fractures disrupting blood supply (e.g., **femoral neck - anatomical**, scaphoid proximal pole, Kienbock's - lunate).
    - **Post-traumatic Arthritis:** Common after **intra-articular fractures**.
    - **Infection:** Especially with open fractures.
    - **Compartment Syndrome:** (See Section 9).
    - **Fat Embolism/ARDS:** High risk with **femur shaft** and pelvic fractures.
    - **Hemorrhage/Hypovolemic Shock:** Significant risk with **pelvic** and **femur shaft** fractures.
    - **Joint Stiffness:** Prevented by early motion when possible.
    - **Growth Disturbance:** In pediatric physeal injuries.

Open Fractures

- **Gustilo Classification:** Grades severity based on wound size, contamination, and soft tissue damage (Type I, II, IIIA, IIIB, IIIC). **Higher grades require more extensive surgery/antibiotics**.
- **Management Priorities: Life > Limb > Wound > Fracture (ATLS)**.
- **Initial Management:** Sterile dressing, splinting, **IV antibiotics (e.g., Augmentin; add Gentamicin for Grade III)**, tetanus prophylaxis, adequate irrigation (3L for Type I, 6L for Type II, 9L for Type III), debridement.
- **Most Common Site:** Tibia.

Specific Fractures

- **Femoral Neck:**
    - Common in **elderly with osteoporosis**.
    - High risk of **AVN (30% displaced)** and nonunion due to precarious blood supply.
    - Complication increasing mortality: **Dementia, Alzheimer's**.
    - Treatment: Young → Urgent ORIF; Elderly → Hemiarthroplasty or Total Hip Arthroplasty (THA).
- **Intertrochanteric:**
    - **Extracapsular**, common in **elderly with osteoporosis**.
    - **Good blood supply**, heals well with low AVN/nonunion risk.
    - Treatment: **ORIF (e.g., dynamic hip screw)**.
- **Femoral Shaft:**
    - **High-energy trauma** (young) or pathological (elderly).
    - Significant **blood loss**, risk of **fat embolism/ARDS**, compartment syndrome.
    - Proximal fragment often abducted/flexed.
    - Treatment: **Intramedullary nailing** is standard. **Needs operative fixation in children** (unlike many other pediatric fractures).
- **Subtrochanteric:**
    - High energy (young) or low energy/bisphosphonate-related (elderly).

    - Proximal fragment abducted/flexed. Better healing than femoral neck but higher implant failure rate.
- **Tibial Shaft:**
    - **Most common long bone fracture**, **most common site for open fracture**.
    - High risk of **compartment syndrome**.
    - Treatment: Casting (undisplaced), **IM nailing** (displaced).
- **Tibial Plateau:**
    - Often axial load + valgus/varus force (e.g., **pedestrian vs bumper**).
    - Intra-articular; requires CT scan. Assess for ligamentous/meniscal injury.
- **Ankle:**
    - **Syndesmosis integrity is key for stability**.
    - **Weber classification** based on fibula fracture level relative to syndesmosis (A-below, B-at, C-above).
    - Treatment: ORIF for unstable fractures (e.g., Weber C, displaced Weber B, bimalleolar).
- **Scaphoid:**
    - **Most common carpal fracture**, typically fall on outstretched hand (FOOSH).
    - Pain in **anatomical snuffbox**.
    - **X-ray may be initially negative**. Treat based on clinical suspicion (cast) and repeat X-ray/MRI/CT if needed.
    - High risk of **AVN/nonunion**, especially **proximal pole**.
- **Proximal Humerus:**
    - Common in elderly (osteoporosis). Fall on shoulder/direct blow.
    - Risk of **axillary nerve injury** (check deltoid function/sensation).
    - Neer classification based on displaced parts.
    - Treatment: Sling (one-part), ORIF/replacement (multi-part).
    - **Anatomical neck fracture** has higher AVN risk than surgical neck.
- **Humeral Shaft:**
    - Risk of **radial nerve injury** (wrist drop). Mechanism: Direct blow → transverse; Twisting → spiral.
- **Clavicle:**
    - Most common fracture in **middle third**.
    - Treatment: Usually non-operative (sling).
    - Most common complication: **Malunion**.
- **Pelvis:**
    - High-energy trauma often.
    - Risk of **massive hemorrhage (most dangerous immediate complication)**, urogenital injuries (esp. urethral), neurological injury.
    - Early cause of death: **Hypovolemia**.
- **Vertebral:**
    - Most common site affected by **osteoporosis**.
    - **Chance fracture:** Flexion-distraction (seatbelt) injury, unstable.
    - Primary survey priority: **Careful transportation/immobilization**.

2. Osteoarthritis (OA)

- **Pathophysiology: Degenerative**, "wear and tear," loss of articular cartilage.
- **Risk Factors: Age (>55)**, **Obesity**, Female, Genetics, Previous joint injury. **NOT Osteoporosis**.

- **Clinical Features:** Joint pain **worse with activity/end of day**, improves with rest. Morning stiffness **< 1 hour**. Asymmetrical involvement. Crepitus.
- **X-ray Findings: Asymmetrical joint space narrowing**, **Subchondral sclerosis**, **Osteophytes**, Subchondral cysts. **Periarticular osteopenia is NOT a feature**.
- **Common Sites:** Knee (medial compartment common), Hip, Hands (DIP - Heberden's nodes, PIP - Bouchard's nodes), Spine.
- **Treatment:**
  - Conservative: **Weight loss**, patient education, physiotherapy, analgesics (**Paracetamol**, NSAIDs), walking aids, intra-articular steroids.
  - Surgical: **Arthroplasty (joint replacement)** for severe pain/functional limitation unresponsive to conservative measures. Arthrodesis (fusion) an option for some joints (e.g., ankle, wrist).

3. Pediatric Orthopedics (General & Specific Conditions)

General Principles

- **Bone Differences:** Thicker periosteum (aids healing, limits displacement), presence of **physis (growth plate)**, more porous/less dense bone, increased plasticity (bowing, greenstick fractures).
- **Healing:** Generally **faster and better** than adults due to thick periosteum and robust blood supply.
- **Remodeling: Excellent capacity**, especially in younger children and for deformities near the physis and in the plane of joint motion (sagittal > frontal > transverse). **Rotation remodels poorly**. **Proximal humerus/distal radius remodel better** than elbow/proximal forearm.
- **Physeal Injuries (Salter-Harris Classification):**
  - **Type I:** Straight across physis. Good prognosis.
  - **Type II:** Above physis (into metaphysis). **Most common**. Good prognosis.
  - **Type III:** Lower (through epiphysis to physis). Intra-articular. Poorer prognosis.
  - **Type IV:** Through epiphysis, physis, and metaphysis. Intra-articular. Poorer prognosis (risk of growth arrest).
  - **Type V:** Rammed/Crushed physis. **Worst prognosis** (high risk of growth arrest).
- **Child Abuse:** Suspect with multiple fractures at **different stages of healing**, specific patterns (e.g., **spiral fractures** of long bones in non-ambulatory infants, posterior rib fractures, metaphyseal corner fractures). **Femur fracture** in child <1yr highly suspicious. **Humerus** is common site.

Specific Pediatric Conditions

- **Osgood-Schlatter Disease: Traction apophysitis** of the **tibial tubercle**. Pain/swelling over tubercle exacerbated by activity (running, jumping). Common in adolescents after growth spurt. Treatment: Rest, activity modification, NSAIDs, stretching. Resolves with skeletal maturity.
- **Nursemaid's Elbow: Radial head subluxation** under the annular ligament. Typically occurs when arm is pulled. Child presents with arm extended and pronated, refuses to use it. Reduction: Supination + Flexion.
- **Clubfoot (Talipes Equinovarus):** Congenital deformity involving **CAVE** (**C**avus, Forefoot **A**dduction, Hindfoot **V**arus, **E**quinus). Treatment: **Ponseti serial casting** is gold standard, started soon after birth. Often requires **Achilles tenotomy**. Bracing needed afterwards to prevent recurrence.
- **Congenital Vertical Talus:** Rigid flatfoot deformity, often associated with neuromuscular conditions. **Rocker-bottom foot** appearance. Worse prognosis than clubfoot.
- **Metatarsus Adductus:** Forefoot adduction only, hindfoot normal. Usually flexible and resolves spontaneously.
- **In-toeing Causes:** Femoral anteversion (excessive internal rotation of hip), Internal tibial torsion, Metatarsus adductus. **Pes planus (flat foot) is NOT a cause**.
- **Flat Foot (Pes Planus):** Loss of medial longitudinal arch.
  - **Flexible:** Arch reappears on tip-toeing or great toe extension (Jack test). Common, usually asymptomatic, often resolves with age. Reassurance usually sufficient.

    - **Rigid:** Arch does not reform. Painful. Causes include **tarsal coalition (e.g., calcaneonavicular)**, congenital vertical talus, arthritis. Requires further investigation (X-ray, CT).
- **Kyphosis:**
    - **Postural:** Flexible, corrects with posture change. Common in adolescents.
    - **Scheuermann's: Rigid** thoracic hyperkyphosis (>45 deg) with vertebral **wedging (>5 deg over 3 vertebrae)**. Presents in adolescence, M>F. Can be painful.
    - **Congenital:** e.g., **Hemivertebra** (most common cause in 0-10 yrs).
    - **Angular kyphosis causes:** Congenital, fracture, infection (TB), tumor. **NOT Ankylosing Spondylitis** (causes generalized sweeping kyphosis).

4. Developmental Dysplasia of the Hip (DDH)

- **Definition:** Spectrum of abnormalities in hip development, from shallow acetabulum (dysplasia) to subluxation or dislocation.
- **Risk Factors: Breech presentation**, **Female**, **Family history**, Firstborn, Oligohydramnios. Mode of delivery itself is less important than presentation.
- **Clinical Examination:**
    - **Neonate (<6 months): Ortolani** (relocates dislocated hip - 'clunk'), **Barlow** (dislocates unstable hip - provocative). **Asymmetric skin folds**, **limited abduction (<60 deg)** is most reliable sign after neonatal period.
    - **Older Infant/Toddler (>6 months): Limited abduction**, **Apparent limb shortening** (Galeazzi sign), **Wide perineum** (bilateral), **Trendelenburg gait/sign**, Limping, Lumbar lordosis (bilateral).
- **Diagnosis:**
    - **Ultrasound:** Preferred method **< 4-6 months** (femoral head not ossified).
    - **X-ray:** Used **> 4-6 months**. Key lines/indices: **Acetabular index (>30 deg abnormal in infant)**, Perkin's line, Hilgenreiner's line, Shenton's line. Ossific nucleus position relative to quadrants formed by Perkin/Hilgenreiner lines indicates subluxation/dislocation. **Acetabular index is most important index**.
- **Late Findings (Neglected DDH):** Dysplastic acetabulum, femoral anteversion, femoral head/neck valgus, delayed ossification of femoral head, fibrofatty tissue in acetabulum.
- **Management:** Goal is early diagnosis and concentric reduction. Pavlik harness (newborns/early infants), closed reduction + spica cast, open reduction (older children/failed closed reduction).

5. Slipped Capital Femoral Epiphysis (SCFE)

- **Definition:** Fracture through the proximal femoral **physis** (Salter-Harris Type I) causing posterior and inferior slippage of the epiphysis relative to the metaphysis.
- **Epidemiology: Most common hip disorder in adolescents** (boys avg 13, girls avg 12). **More common in males**, **obese children**, Black ethnicity. Bilateral in 20-40%.
- **Clinical Features:** Presents with insidious onset **groin, thigh, or knee pain** (referred pain common!). Limp (**antalgic gait**, toes pointing out). **Limited internal rotation**, abduction, and flexion. **Obligatory external rotation** during passive hip flexion (Drehmann sign).
- **Diagnosis: Requires AP and frog-leg lateral X-rays of BOTH hips**. Klein's line (line along superior femoral neck) should intersect epiphysis on AP view; failure to do so indicates slip. Lateral view crucial for assessing slip severity. **X-ray is necessary**.
- **Stability:** Stable (able to bear weight) vs. Unstable (unable to bear weight - higher AVN risk).
- **Treatment: Surgical emergency** to prevent further slippage. **In situ fixation** with screws is standard. **Closed reduction is dangerous** and generally avoided. Osteotomy may be needed for severe deformity.
- **Complications: Avascular necrosis (AVN)**, **Chondrolysis** (cartilage death).

6. Scoliosis

- **Definition:** Lateral curvature of the spine > 10 degrees, often with rotation (**3D deformity**).

- **Types:**
  - **Idiopathic: Most common type** (80%). Subtypes: infantile, juvenile, **adolescent (most frequent)**. Typically **painless**. **Right thoracic curve** is most common pattern. F > M.
  - **Congenital:** Vertebral anomalies (e.g., hemivertebra).
  - **Neuromuscular:** e.g., Cerebral Palsy, Duchenne Muscular Dystrophy.
  - **Syndromic:** Associated with various syndromes.
  - **Functional/Postural:** Non-structural curve due to external factor (e.g., leg length discrepancy, muscle spasm). **Corrects with position change** (e.g., sitting, forward bending). Not a true 3D deformity.
- **Clinical Features:** Shoulder asymmetry, scapular prominence (**rib hump** on forward bending - Adam's test), waistline asymmetry, apparent leg length discrepancy. **Pain suggests underlying cause** (e.g., tumor like **osteoid osteoma**, infection) in idiopathic type. Neurological exam important. **Asymmetric abdominal reflex is NOT a typical sign**.
- **Diagnosis:** Standing full-length spine X-rays (PA and lateral). **Cobb angle** measures curve magnitude. **Risser sign** (iliac crest apophysis ossification) assesses skeletal maturity.
- **Management:**
  - Observation: Curves < 20-25 degrees.
  - **Bracing:** For **skeletally immature** patients with curves **25-45 degrees** to prevent progression.
  - **Surgery (Spinal Fusion):** Curves **> 45-50 degrees** (risk of progression in adulthood), significant cosmetic concern, pulmonary compromise. **Main goal is often cosmetic** and preventing progression.
- **Progression Risk:** Highest during **adolescent growth spurt** (between breast budding and menarche in girls). Curve magnitude and skeletal immaturity are key factors.

7. Infections (Osteomyelitis & Septic Arthritis)

Osteomyelitis

- **Definition:** Inflammation/infection of bone.
- **Pathogenesis:** Hematogenous spread (common children), direct inoculation (trauma, surgery), contiguous spread. Increased intraosseous pressure causes pain and ischemia → necrosis → **sequestrum** (dead bone fragment, nidus for infection). **Involucrum** (new bone formation around sequestrum). Sinus tract (cloaca) may form.
- **Etiology: Staphylococcus aureus** is **most common cause overall**.
  - Neonates: **Group B Streptococcus**, E. coli, S. aureus.
  - Children: S. aureus, H. influenzae (less common now due to vaccine).
  - Sickle Cell Disease: **Salmonella**, S. aureus.
  - Adults: S. aureus.
- **Common Sites: Metaphysis of long bones** in children (rich blood supply, slow flow; e.g., **distal femur**, proximal tibia). **Vertebrae** in adults.
- **Clinical Features:** Local pain, swelling, warmth, redness, fever, malaise. Refusal to bear weight/use limb (children).
- **Diagnosis:**
  - Labs: **Elevated ESR and CRP** (CRP most sensitive for monitoring response). WBC may be elevated. Blood cultures positive in ~50%.
  - Imaging:
    - **X-ray:** Often **normal early** (<10-14 days). Later shows periosteal reaction, lytic lesions, sclerosis. **Sequestrum/involucrum** pathognomonic for **chronic osteomyelitis**.
    - **MRI: Most sensitive study** for early diagnosis and assessing extent.
    - Bone Scan: Sensitive but less specific than MRI. Useful for multifocal disease. "Cold" lesions indicate poor prognosis (necrosis).
- **Treatment: IV antibiotics** (empiric initially, then targeted based on cultures), surgical debridement (especially chronic OM or abscess), sequestrectomy.

Septic Arthritis

- **Definition:** Infection within a joint space. **Orthopedic emergency** (rapid cartilage destruction).
- **Etiology: S. aureus** most common. Others: Streptococcus, Neisseria gonorrhoeae (young adults), H. influenzae (young children).
- **Common Sites:** Knee (adults), **Hip (children)**.
- **Clinical Features:** Acute onset **single joint pain**, swelling, warmth, effusion, severely restricted range of motion. Fever, systemic illness. **Refusal to bear weight** (children).
- **Diagnosis: Joint aspiration** is crucial: High WBC (>50,000/mm^3), >90% neutrophils, positive Gram stain (~50%), positive culture (~70%). **Positive culture is pathognomonic**. Elevated ESR/CRP. Blood cultures.
- **Kocher Criteria (Pediatric Hip):** Differentiate SA from transient synovitis. 4 criteria: Fever (>38.5°C), **Inability to bear weight (most reliable sign)**, ESR > 40 mm/hr, WBC > 12,000/mm^3. Probability increases with # of criteria met.
- **Treatment: Emergent surgical drainage/irrigation** (arthrotomy or arthroscopy), **IV antibiotics**.

8. Peripheral Nerve Injuries & Syndromes

- **Axillary Nerve (C5, C6):**
  - Injury: **Anterior shoulder dislocation**, surgical neck of humerus fracture.
  - Motor: Deltoid (abduction > 15°), Teres minor (external rotation).
  - Sensory: Lateral shoulder (regimental badge area).
  - **Most common nerve injured in shoulder dislocation**.
- **Radial Nerve (C5-T1):**
  - Injury: Axilla (crutches - "Saturday night palsy"), **Humeral shaft fracture** (spiral groove), forearm (repetitive motion).
  - Motor: **Extensors** of wrist, fingers, thumb; Supinator; Triceps (if injury high).
  - Sensory: Posterior arm/forearm, **dorsal aspect of radial 3.5 fingers**, **first dorsal web space**.
  - Signs: **Wrist drop**, finger drop. Sensation loss in first web space indicates radial injury.
- **Median Nerve (C5-T1):**
  - Injury: Supracondylar humerus fracture, wrist laceration, **Carpal Tunnel Syndrome**.
  - Motor: Forearm pronators, wrist/finger flexors (radial side), **Thenar muscles (LOAF)** - Lumbricals 1&2, Opponens pollicis, Abductor pollicis brevis, Flexor pollicis brevis (superficial head).
  - Sensory: Palmar aspect radial 3.5 fingers, dorsal fingertips radial 3.5 fingers.
  - Signs: **Ape hand** (thenar atrophy, loss of opposition - low lesion), **Hand of Benediction** (when attempting fist - high lesion), **Pointing index sign**. Loss of fine touch/vibration often occurs before pain/temperature loss.
- **Ulnar Nerve (C8-T1):**
  - Injury: Medial epicondyle fracture (elbow), cubital tunnel, hook of hamate fracture (wrist), **Guyon canal compression (cyclists, ganglion cyst)**.
  - Motor: Intrinsic hand muscles (**interossei**, lumbricals 3&4, hypothenar muscles, adductor pollicis), Flexor carpi ulnaris, Flexor digitorum profundus (ulnar half).
  - Sensory: Ulnar 1.5 fingers (palmar and dorsal).
  - Signs: **Claw hand** (MCP hyperextension, IP flexion of 4th/5th digits - worse with low lesion = Ulnar paradox), **Froment's sign** (compensatory thumb IP flexion when pinching), Wartenberg's sign (abducted 5th digit), hypothenar/interosseous atrophy. Loss of lumbrical function contributes to clawing.
- **Common Peroneal Nerve (L4-S2):**
  - Injury: Fibular head fracture/compression (superficial).
  - Motor: Foot dorsiflexors (Deep peroneal) and everters (Superficial peroneal).
  - Sensory: Anterolateral leg, dorsum of foot (except 1st web space).

- Signs: **Foot drop**, **steppage gait**. Loss of eversion.

Specific Syndromes

- **Carpal Tunnel Syndrome: Median nerve compression** under transverse carpal ligament. Paresthesia/pain in median distribution, **worse at night**. Thenar atrophy (late). Positive **Tinel's** (tapping) and **Phalen's** (wrist flexion). Advanced symptom: **objects falling from hand** due to weakness.
- **Guyon Canal Syndrome: Ulnar nerve compression** at wrist. Often caused by **ganglion cyst**. Sensory/motor deficits in ulnar distribution in hand.
- **Trendelenburg Sign/Gait:** Weakness of hip abductors (gluteus medius/minimus) due to **Superior gluteal nerve (L4-S1)** injury. Pelvis drops on the contralateral (swing) side when standing on the affected leg.

9. Compartment Syndrome

- **Definition:** Increased pressure within a closed fascial compartment compromises tissue perfusion. **Orthopedic emergency**.
- **Causes:** Fractures (especially **tibia**, forearm, **segmental fractures**), crush injuries, burns, tight casts/dressings, reperfusion injury. Can occur in arm or leg.
- **Pathophysiology:** Increased pressure → venous outflow obstruction → increased capillary pressure → fluid extravasation → further pressure increase → arterial inflow compromise → muscle/nerve ischemia → necrosis.
- **Clinical Features (The 6 P's - unreliable/late except pain):**
  - **Pain out of proportion** to injury.
  - **Pain with passive stretch** of muscles in the affected compartment (**earliest, most sensitive sign**).
  - Paresthesia (early nerve ischemia).
  - Pallor (late).
  - Pulselessness (very late, often absent). **Presence of pulses does NOT rule out compartment syndrome**.
  - Paralysis/Paresis (late).
- **Diagnosis:** Primarily **clinical suspicion**. Compartment pressure measurement confirms (>30-40 mmHg or delta pressure < 30 mmHg).
- **Treatment: Emergent fasciotomy** (surgical release of fascia). Remove constricting casts/dressings immediately.

10. Knee Ligament & Meniscus Injuries (ACL & Meniscus)

Anterior Cruciate Ligament (ACL) Injury

- **Mechanism: Non-contact pivoting**, deceleration, or hyperextension injury common. Also contact injury.
- **Clinical Features:** Patient hears/feels a **"pop"**, **immediate significant swelling (hemarthrosis)**, feeling of instability ("giving way"). Often unable to continue activity.
- **Associated Injuries:** Meniscal tears (lateral>medial acutely, medial>lateral chronically), MCL tear ("Unhappy Triad" = ACL + MCL + Medial Meniscus), bone bruises.
- **Diagnosis:**
  - Physical Exam: **Lachman test (most sensitive acute test)**, Anterior Drawer test, Pivot Shift test (specific, often requires anesthesia).
  - Imaging: X-ray may show **Segond fracture** (avulsion lateral tibial plateau - pathognomonic) or tibial spine avulsion. **MRI** confirms diagnosis and shows associated injuries.
- **Treatment:** Depends on age, activity level, instability. Non-operative (rehab) vs. Operative (ACL reconstruction).

Meniscus Injury

- **Mechanism:** Twisting injury on a flexed knee, often with axial load. Degenerative tears common in older adults. **Medial meniscus injured more commonly** than lateral.

- **Clinical Features:** Joint line pain, **delayed swelling/effusion** (cf. ACL), mechanical symptoms (**locking**, catching, clicking), giving way.
- **Diagnosis:**
  - Physical Exam: Joint line tenderness, **McMurray test** (pain/click with flexion/extension + rotation + varus/valgus stress), Apley grind test.
  - Imaging: **MRI** is diagnostic standard. Arthrography is outdated.
- **Treatment:** Conservative (rest, NSAIDs, rehab) vs. Arthroscopic surgery (repair vs. partial meniscectomy). Peripheral tears have better healing potential (better blood supply). Diagnosis does NOT require absence of clinical signs.

11. Bone Tumors (Benign & Malignant)

General Principles

- **Metastases: Most common malignant bone tumor overall**. Common primary sites: Prostate, Breast, Lung, Kidney, Thyroid ("PB KTL"). Prostate often sclerotic; others usually lytic.
- **Evaluation:** X-ray initial step. MRI for local staging. CT for cortical detail/matrix. Bone scan for systemic staging (detects osteoblastic activity - cold in Myeloma, some lytic mets). Biopsy required for definitive diagnosis.
- **Benign Features (X-ray): Well-defined margins**, **narrow transition zone**, sclerotic rim, no cortical destruction (may have thinning/expansion), no aggressive periosteal reaction.
- **Malignant Features (X-ray): Ill-defined margins**, **wide transition zone**, **cortical destruction**, **aggressive periosteal reaction** (Codman's triangle, sunburst, onion skin), soft tissue mass.

Specific Tumors

- **Osteochondroma: Most common benign bone tumor**. Cartilage-capped bony projection from metaphysis, points away from joint. Grows with child, stops at skeletal maturity. Risk of malignant transformation (chondrosarcoma) low, but higher in multiple hereditary exostoses. Benign tumor producing bone and cartilage.
- **Enchondroma:** Benign cartilage tumor within medullary cavity. **Most common tumor of the hand**. Often incidental finding. Risk of malignant transformation low (except Ollier's/Maffucci's).
- **Giant Cell Tumor (GCT):** Locally aggressive, benign. Occurs in **epiphysis of skeletally mature** individuals (20-40 yrs). Commonly around knee. Lytic lesion, "soap bubble" appearance. High recurrence after curettage.
- **Osteoid Osteoma:** Benign bone-forming tumor. < 2 cm nidus surrounded by reactive sclerosis. Common in long bone diaphysis/spine. **Night pain dramatically relieved by NSAIDs**. Treatment: Radiofrequency ablation or surgical excision. **Does not become malignant**.
- **Aneurysmal Bone Cyst (ABC):** Expansile, lytic lesion with blood-filled cavities (fluid levels on MRI). Benign but can be locally destructive. **No malignant potential, does not metastasize**.
- **Osteosarcoma: Most common primary malignant bone tumor** (excluding myeloma). Occurs in adolescents/young adults (peak 2nd decade). Affects **metaphysis of long bones**, especially **around the knee** (distal femur > proximal tibia). Associated with Paget's disease, radiation in elderly. Produces osteoid (bone matrix). X-ray: Sunburst, Codman's triangle, mixed lytic/sclerotic, cortical destruction. Treatment: Chemotherapy + Surgery (limb salvage or amputation). **Does not typically invade growth plate early**.
- **Ewing Sarcoma:** Malignant small round blue cell tumor. Affects **diaphysis** of long bones, pelvis. Common in children/young adults (peak 2nd decade). X-ray: Lytic lesion, **"onion skin" periosteal reaction**, Codman's triangle. Associated with t(11;22) translocation.
- **Chondrosarcoma:** Malignant cartilage tumor. Occurs in **adults** (40-60+ yrs). Affects pelvis, proximal femur/humerus. Can arise de novo (primary) or from pre-existing lesion (secondary - e.g., osteochondroma). X-ray: Lytic lesion with "rings and arcs" calcification. **Slow growing**, often **radio- and chemo-resistant**. Treatment: Wide surgical excision.
- **Multiple Myeloma: Most common primary malignant bone tumor overall** (plasma cell malignancy). Affects older adults (>50 yrs). Presents with bone pain, pathological fractures, hypercalcemia, renal failure, anemia. X-ray: **Multiple "punched-out" lytic lesions**. Bone scan often "cold". Associated with **hypercalcemia**.

12. Shoulder Conditions (Dislocation, Rotator Cuff, Adhesive Capsulitis)

- **Shoulder Dislocation:**
  - **Anterior (95%):** Most common. Usually subcoracoid. Mechanism: Fall on abducted, externally rotated arm. Arm held slightly abducted/externally rotated. Risk of **axillary nerve injury**.
  - **Posterior (5%):** Associated with seizures, electric shock. Arm held adducted/internally rotated.
  - **Complications:**
    - **Bankart lesion:** Avulsion of anteroinferior labrum/glenoid rim (common in **young patients**, leads to recurrent instability - **100% recurrence** mentioned, likely referring to high risk in young active individuals).
    - **Hill-Sachs lesion:** Impaction fracture on posterolateral humeral head.
    - **Rotator cuff tear:** More common in **older patients**.
    - **Axillary nerve injury (most common nerve injury)**.
  - **Recurrence:** Very high in young, active individuals after first-time traumatic dislocation.
- **Rotator Cuff Injury:**
  - Muscles (SITS): **Supraspinatus** (abduction initiation), Infraspinatus (external rotation), Teres Minor (external rotation), Subscapularis (internal rotation).
  - **Supraspinatus is most commonly injured** tendon (impingement, tear).
  - Features: Pain (especially with overhead activity, at night), weakness.
  - **Drop arm test** positive for large/complete tear.
- **Adhesive Capsulitis (Frozen Shoulder):**
  - Idiopathic thickening/contracture of joint capsule. Associated with **diabetes mellitus**, thyroid disease, trauma, immobilization.
  - Stages: Freezing (painful), Frozen (stiff), Thawing (resolution).
  - Clinical Features: Gradual onset diffuse pain and progressive **loss of BOTH active and passive range of motion**. **External rotation is typically the first and most significantly limited motion**.
- **Calcific Tendonitis:** Calcium deposits in rotator cuff tendons (most commonly **supraspinatus**). Can cause acute severe pain or chronic ache. Joint movement is usually **painful/limited during acute phase**.

13. Metabolic Bone Disease (Osteoporosis, Osteomalacia, Rickets)

- **Osteoporosis:**
  - Definition: Systemic disease of **low bone mass** and **microarchitectural deterioration**, leading to increased fragility and fracture risk. **Bone density T-score <= -2.5 SD** below young adult mean. Mineralization is normal.
  - Risk Factors: **Age**, **Female**, Post-menopausal estrogen deficiency, Low body weight, Smoking, Alcohol, **Steroids**, inactivity, family history, certain medications/diseases. **High BMI is protective, not a risk factor**.
  - Clinical Features: **Asymptomatic until fracture occurs**. **Vertebral compression fractures** are most common site, followed by hip (femoral neck/intertrochanteric) and distal radius. **Can cause spontaneous fracture**.
  - Diagnosis: **DEXA scan** is gold standard. Lab tests (calcium, phosphate, ALP) usually **normal** in primary osteoporosis.
  - Treatment: Calcium/Vitamin D, **Bisphosphonates (first-line)**, Denosumab (anti-RANKL antibody), weight-bearing exercise, fall prevention.
- **Osteomalacia (Adults) / Rickets (Children):**
  - Definition: **Defective mineralization** of bone osteoid. Rickets affects growth plates as well.
  - Causes: **Vitamin D deficiency** (most common), impaired vitamin D metabolism (liver/kidney disease), phosphate deficiency.

- Clinical Features: Bone pain, muscle weakness, fractures (Looser zones/pseudofractures). Rickets: Bowing deformities, widened physes, delayed growth.
- Labs: Low/normal calcium, **low phosphate**, **high Alkaline Phosphatase (ALP)**, high PTH, low 25-hydroxyvitamin D.

- **Osteogenesis Imperfecta:** Genetic disorder of **Type I collagen** synthesis (mutation at DNA level). Brittle bones (multiple fractures), blue sclerae, dental abnormalities, hearing loss.

14. Foot & Ankle Conditions (Flat Foot, Clubfoot, Hallux Valgus, Ankle Sprain)

- **Ankle Sprain:**
  - **Inversion sprain** (most common): Affects lateral ligaments. **Anterior talofibular ligament (ATFL) is most commonly injured**. Calcaneofibular ligament (CFL) may also be involved. Mechanism: Plantarflexion and inversion.
  - **Eversion sprain:** Affects deltoid ligament (medial). Less common.
  - **High ankle sprain:** Affects syndesmosis (anterior inferior tibiofibular ligament - AITFL).
- **Hallux Valgus (Bunion):** Lateral deviation of great toe + medial prominence of 1st metatarsal head. F > M. Risk factors: tight shoes, family history. **Surgical indication is primarily pain** and functional limitation unresponsive to conservative care (wide shoes, orthotics).
- **(See Section 3 for Clubfoot, Flat Foot, Vertical Talus, Metatarsus Adductus)**

15. Other Conditions & Concepts

- **Kyphosis:** (See Section 3)
- **Spondylolisthesis:** Forward slippage of one vertebra on another.
  - **Isthmic:** Defect/fracture in **pars interarticularis** (spondylolysis). Common L5-S1 in adolescents/young adults involved in extension activities.
  - **Degenerative:** Due to **facet joint arthritis** and disc degeneration. Common L4-L5 in older adults (>50 yrs), F > M. **No pars defect**.
  - **Dysplastic:** Congenital abnormality of facets.
- **Lumbar Disc Herniation:** Nucleus pulposus herniates through annulus fibrosus, often posterolaterally. Compresses nerve root below the level of herniation (e.g., L4/L5 disc affects L5 root). Causes radicular pain (sciatica), +/- neurological deficit. **Straight Leg Raise (SLR) test** often positive (for L5/S1 roots). **L2/L3 herniation less likely to cause positive SLR**. Conservative management usually effective unless red flags (cauda equina) or progressive deficit. **Cauda equina syndrome** (bilateral sciatica, saddle anesthesia, bowel/bladder dysfunction) is surgical emergency. Bladder innervation S2-S4 (Sacral).
- **Lumbar Spinal Stenosis:** Narrowing of spinal canal/foramina. Causes **neurogenic claudication** (leg pain/numbness worse with walking/standing, **relieved by sitting/flexion**).
- **Poliomyelitis:** Viral infection affecting anterior horn cells (LMN). Causes asymmetric flaccid paralysis, muscle atrophy. **Drop foot** is common disability.
- **Joint Replacement (Arthroplasty):**
  - **THA Rehab (Posterior Approach): AVOID excessive Flexion (>90°), Adduction, Internal Rotation** for ~3 months. Weight bearing as tolerated (cemented) or restricted (uncemented). **Muscle strengthening crucial**.
  - **TKR Rehab:** Early motion encouraged. Goal ROM 0-120°. Weight bearing as tolerated. Strengthening important.
  - **Infection:** Most common symptom is **pain**. Early onset (<3 mo): S. aureus. Delayed (3-24 mo): **S. epidermidis**. Late (>24 mo): Hematogenous S. aureus. Diagnosis: Aspiration (WBC, culture), ESR/CRP. Treatment: Debridement + antibiotics +/- implant exchange.
- **Articular Cartilage Composition:** Primarily **water** (~70-80%), collagen (Type II), proteoglycans.
- **Muscle Contraction:** Fast concentric contraction generates least force.
- **Gait:** Iliopsoas active in pre-swing (hip flexion). Gluteus medius stabilizes pelvis during single leg stance (prevents Trendelenburg). Soleus contracts intermittently during standing. Plantarflexors most powerful during pre-swing/toe-off.