Orthopedics

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Section

1 CHAPTER

BASIC SCIENCE, ORTHOPEDIC ANATOMY AND IMAGING ORTHOPEDICS

HISTORY OF ORTHOPEDICS

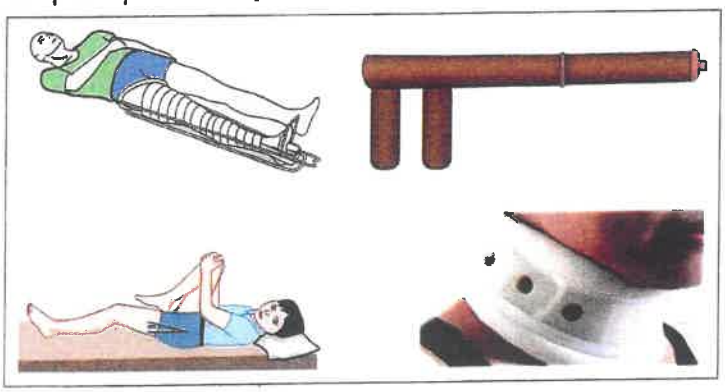
Introduction and History of Orthopedics

Nicolas Andry

- Term Orthopedics is coined by Nicolas Andry
- Ortho- Straight, Pedis-Child
- Nicolas Andry wrote the 1st book of orthopedics & the emblem of orthopedics

H. O. Thomas (Hugh Owen Thomas)

- Contributions include
  - Thomas splint
  - Wrench: For correction of Deformities
  - Thomas test: For flexion deformity of the hip
  - Collar: For cervical spine injuries
  - CTEV (Congenital Talipes Equino Varus) Shoes

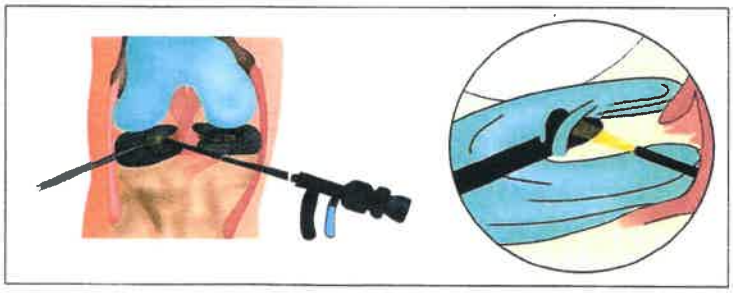


Important Information

- Father of Orthopedics: Nicolas Andry > H.O.Thomas
- Father of Modern orthopedics: Robert jones

Watanabe

- Father of Arthroscopy
- M/c joint in which arthroscopy done is: Knee > Shoulder
- Largest joint in our body: Knee



John Charnley

- Father of Arthroplasty
- M/c Joint where Arthroplasty is done: Knee
- Arthrodesis: Fusion of 2 or more bones in a joint

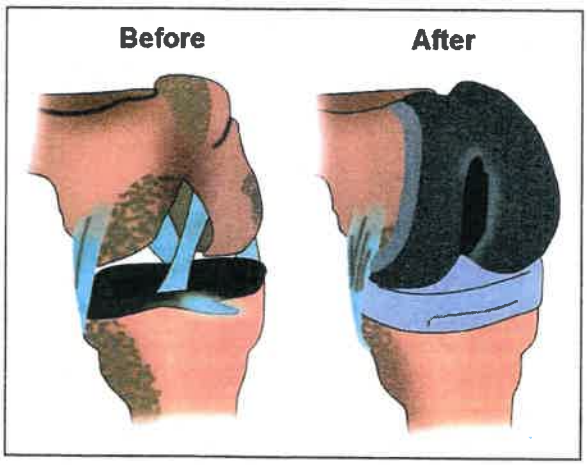
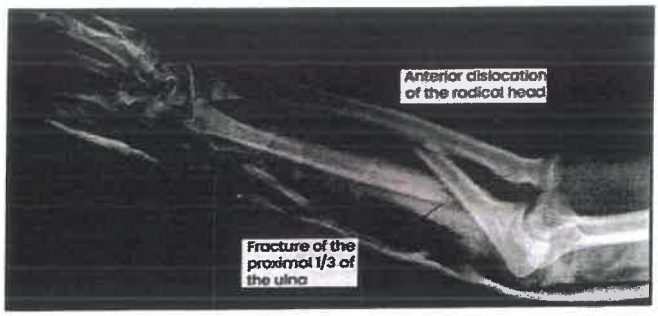


Image Based question approach

- Keep optimum distance
- Keep looking – don't hurry (20 sec)
- Seeing & believing that you have seen
- Localize the body part
- In an image go from normal to pathological area
- Then look at choices
- Sometimes you actually don't need an image



Monteggia fracture [Fracture Ulna with Radial head dislocation]

BONE STRUCTURE

Basics

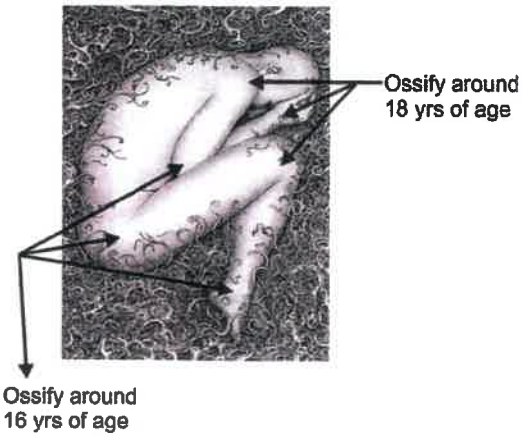
- Metaphysis
- Most vascular area of Bone
- Most common Location for infection & Tumor
- Diaphysis
  - Middle part
  - Ewing sarcoma occurs here.
- Epiphysis
  - Present towards the end of a Bone
  - Covered by Articular cartilage
- Upper end of bone: Epiphysis + Physis + Metaphysis
- Middle of bone: Diaphysis

Bone Composition

- 65% Inorganic [(ca)10 (PO4)6 (OH)2]: Calcium hydroxyapatite
- 35% organic (Type 1 collagen)
- Organic Component
  - Matrix 95% + cells 5%
    → Matrix composed of Proteoglycans (compressile strength)
  - Proteins
    → Composed of Collagen: Type 1
    → Provides Tensile strength
    → Non-collagen proteins are also present which includes
      - Osteocalcin
      - Osteopontin
      - Osteonectin
- Bone formation marker
  - Osteocalcin
  - Osteopontin
  - Osteonectin

- Enzymes: Bone specific ALP
- Terms
  - Osteoid: Immature Bone
  - Osteon: Mature (Mineralized) Bone

Skeletal Maturity



- Age at which the physis disappears and the Epiphysis Fuses to Metaphysis is K/a Age of skeletal maturity
- Shoulder joint
- Wrist joint
- Knee joint

} Ossify at 18 years of age

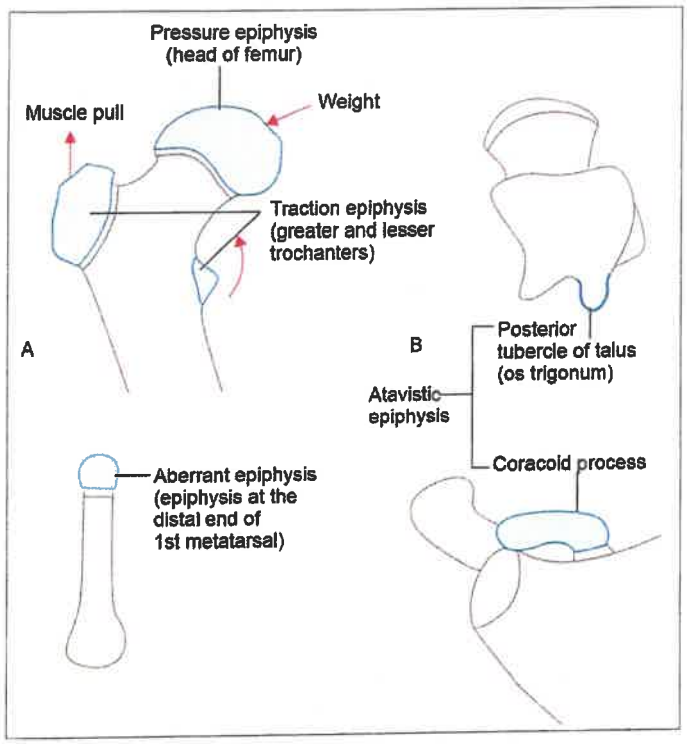
- Elbow joint
- Hip joint
- Ankle joint

} Ossify at 16 years of age

Zones of Articular cartilage

- Zone 1
  - Superficial zone
  - Has high water content (as it is close to joint fluid)
  - Contains
    → Progenitor cells for articular cartilage
    → High density chondrocytes
- Zone 2
  - Transition zone: Thickest zone
  - Chondrocytes are in low density
- Zone 3
  - Middle zone
  - Most active chondrocytes
  - Highest density proteoglycans
  - Low density water content
- Zone 4
  - Calcified cartilage

Epiphysis



Types of Epiphysis

1. Pressure Epiphysis
   - Intra Articular & Weight Bearing
   - E.g. Head of Humerus, Lower end of radius
2. Traction Epiphysis
   - Extra articular
   - K/a Apophysis
   - Severe to pull & site of muscle attachment ossify later than pressure epiphysis.
   - E.g. Greater & Lesser trochanter of femur, and Tubercles of Humerus.

Important information

Rotator cuff muscles

Mnemonic: Sit-s

- Supraspinatus
- Infraspinatus
- Teres minor

} Attached to greater tuberosity and causes abduction and external rotation

- Subscapularis: Attached to lesser tuberosity and causes internal rotation

Lift off test: to test for a lesion of the subscapularis muscle & scapular instability

3. Aberrant Epiphysis
   - Anatomical anomaly
   - Accessory ectopic epiphysis
   - E.g. Head of 1st metatarsal (or) Base of 5th Meta carpal.

4. Atavistic Epiphysis
   - Phylogenetically independent but becomes fused.
   - E.g. Coracoid process of scapula.

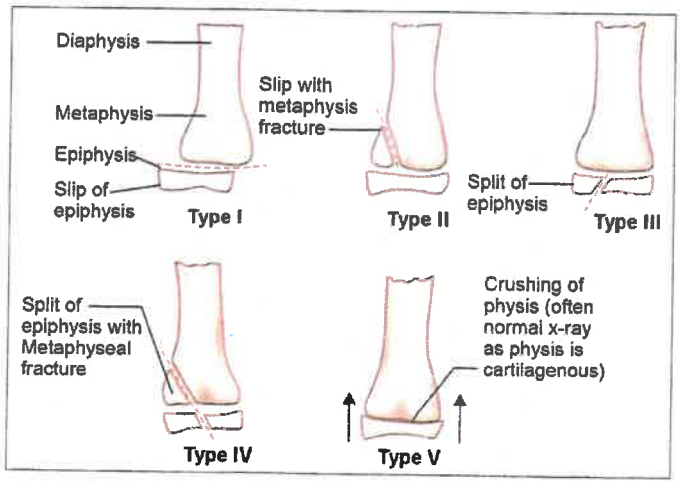
Growth plate

- Bridged between Epiphysis & Metaphysis
- Consist of
  - Resting zone (Reserve)
    → Storage disorders affects resting zone
    → E.g. Gaucher disease
  - Proliferative zone (Growth)
    → Affecting the dwarfs and giants
    → E.g. Laron syndrome (dwarfs + truncal obesity).
  - Maturation zone
    → Zone where fractures occurs
    → Hypertrophic
  - Zone of provisional calcification
    → Mineralization disorder like Rickets affects zone of provisional calcification

Important Information

- Beneath zone of provisional calcification is the Spongiosa
- Scurvy affects the spongiosa because it affects the cross-linking of collagen

Salter-Harris Classification in children



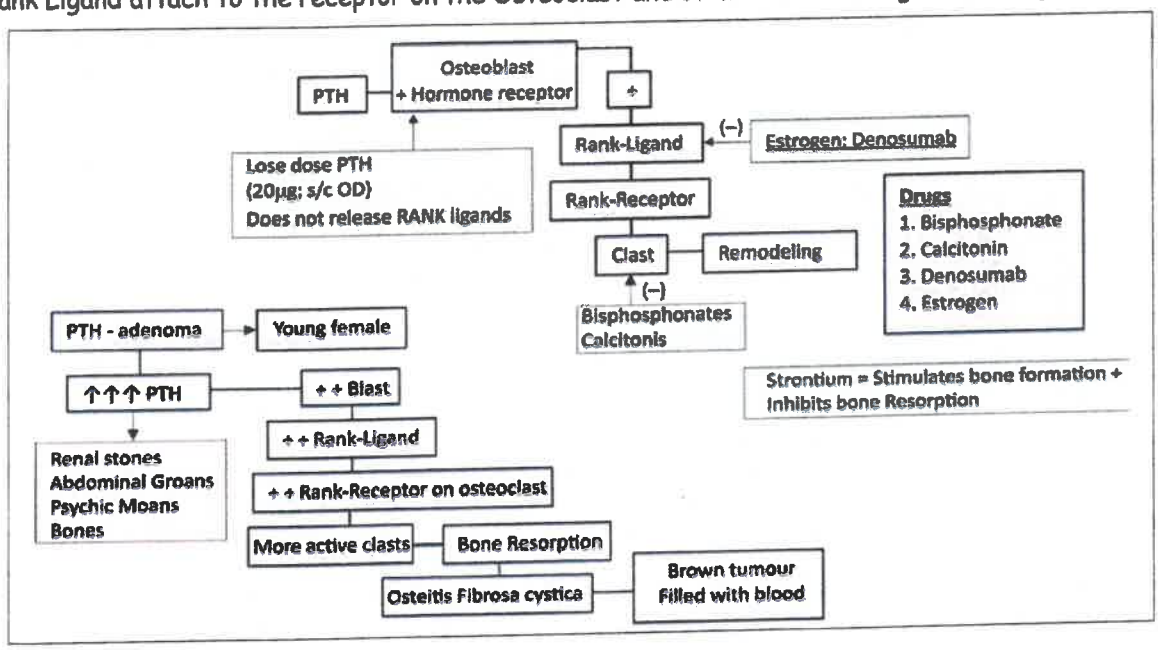
- Type 1: Slip of Epiphysis
- Type 2
  - Fracture line through the physis & extending to the metaphysis
  - Most common type
  - Aka Thurston - Holland sign
- Type 3
  - Fracture Line through the physis splitting Epiphysis into two
- Type 4
  - Split of epiphysis with metaphyseal fracture

- Type 5
  - Crush injury to the physis
  - Often normal x-ray as physis is cartilaginous

PARATHYROID HORMONE ON BONE

Remodeling of bone

- PTH acts on its receptor on Osteoblast which release the Rank-Ligand
- Rank Ligand attach to the receptor on the Osteoclast and stimulate it causing remodeling



- When there is excessive PTH levels
  - E.g. Hyper parathyroidism due to PTH adenoma, there will be H/o Young female with renal stones, abdominal groans (dyspepsia), psychic moans and Bones (Bone pains).
  - Bones: High level of PTH →↑ stimulation of osteoblast→ ↑release of RANK ligand → ↑osteoclast stimulation

    → Osteoclast causes more Lysis → Bones become more hollow K/a Cystica → Cyst is filled with fibrous tissue K/a Fibrosa Cystica, since bone is getting involved its k/a Osteitis fibrosa cystica
  - When there is blood in it then its K/a Brown tumor (due to blood degradation product giving it brown colour)
- Treatment of Osteoporosis

A. Drugs inhibiting the osteoclast

→ Bisphosphonates
  - DOC for Osteoporosis
  - Rare side effect: It inhibits the remodeling cycle and prolonged usage for many years has a high chance of causing fractures

→ Calcitonin

B. Drugs that inhibit the Rank ligand

→ Estrogen

→ Denosumab (S/c)

A. Low dose PTH (20 µg s/c daily) stimulates osteoblast but cannot release RANK ligand, hence, it can be used

for treatment of Osteoporosis

B. Strontium

→ Acts on both pathways i.e. Stimulates formation & inhibits resorption as well.

→ Not preferred because of cardiac side effect

Calcium Homeostasis

- Decreased serum calcium stimulate calcium sensory receptors on parathyroid gland causing PTH release
- PTH action

1. On the Bone: Stimulates specific receptors causing bone resorption thereby increasing the serum calcium.
2. Stimulate 1 - alpha - Hydroxylase causing formation of 1,25 (OH)2 D3 which will in turn results in Increased intestinal absorption of calcium.
3. Acts on specific receptors on kidney causing Phosphaturia and decreases S. phosphate

Important Information

- Any vitamin D deficiency will usually have a secondary hyper parathyroidism
  - Serum PTH will be High
  - Serum phosphate will be low
- In Renal Rickets (phosphate retention disorder), the phosphate levels in blood will be high

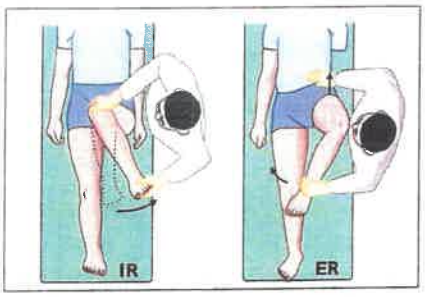
Ball & Socket Joints

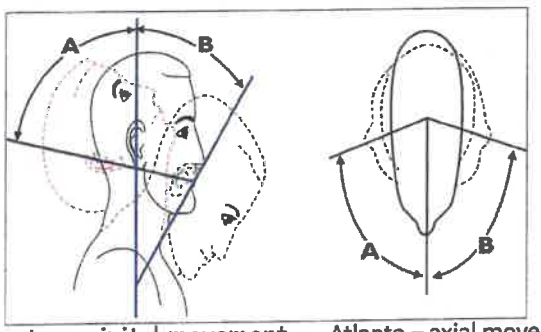
- Includes
  - Incudostapedial joint
  - Shoulder joint
  - Hip joint
  - Talocalcaneal-navicular joint

Synovial Joints:

Types of synovial joint	Examples
Plane	• Acromioclavicular • Intercarpal • Intertarsal
Hinge	• Elbow • Interphalangeal
Pivot (Trochoid)	• Atlanto-axial • Superior radio-ulnar • Inferior radio-ulnar
Condylar	• Temporo-mandibular • Knee joint
Ellipsoid	• Atlanto-occipital • Wrist (radio-carpal) • Metacarpo-phalangeal (knuckles)
Saddle	• Malleus-incus joint • Sternoclavicular • First carpo-metacarpal • Calcaneocuboid
Ball and socket	• Incus-stapes joint • Shoulder • Hip • Talo-calcaneo-navicular

- If Abduction & Internal rotation is normal there is no problem with hip & shoulder joints.

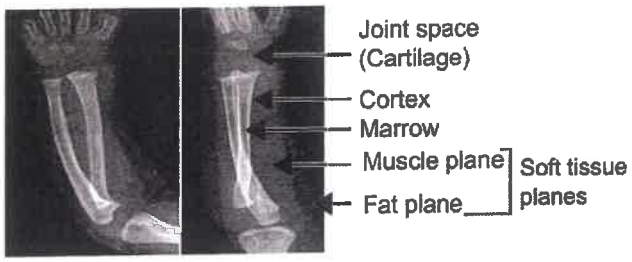




Atlanto occipital movement
Yes (flexion - Extension)

Atlanto – axial movement
Is no (rotation)

APPROACH TO NORMAL X-RAYS



a. Cortex

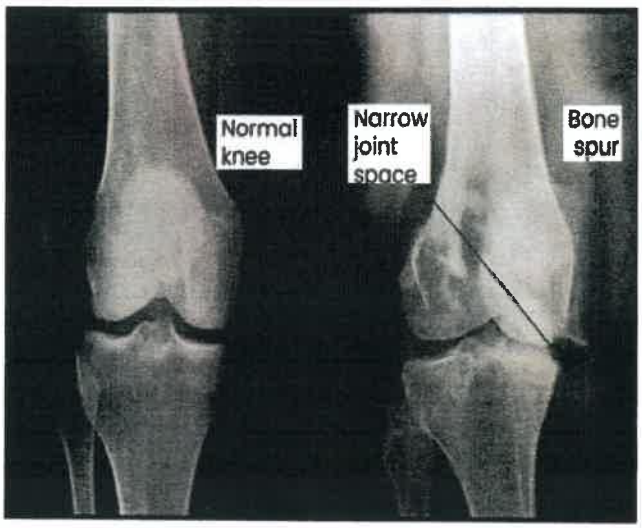
- Cortex: bone in the periphery
- Fracture is a break in the cortex of the bone

b. Marrow: Central part of a bone

c. Soft tissue plane

- Consists of Muscles & fascia
- In osteomyelitis, earliest radiological feature is loss of soft tissue plane after 24 hours > periosteal reaction (7-10 days)

d. Joint space



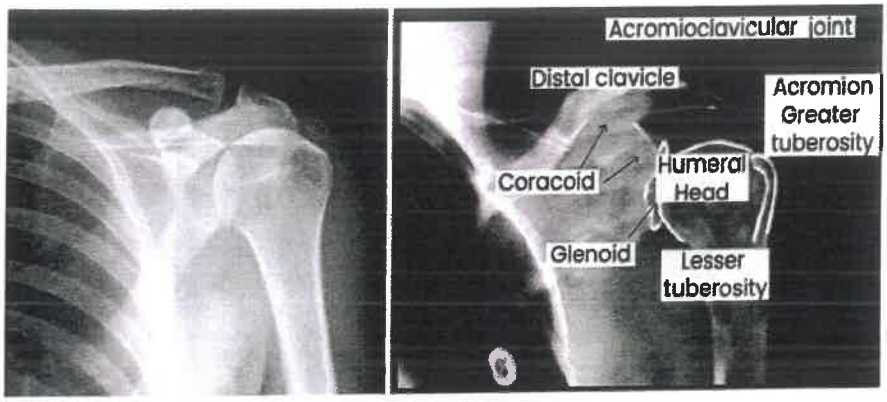
- Consists of cartilage (not seen on x-rays)
- Reduction of joint spaces refers to Arthritis
- The medial compartment of the joint is destroyed leading to reduction in joint space & Distal part is deviated medially in osteoarthritis: VARUS
- In Rheumatoid Arthritis Distal part is deviated laterally: VALGUS (Knock knee)
- X-rays is the first investigation for glass injury
- Glass is coated with lead which is Radio-opaque

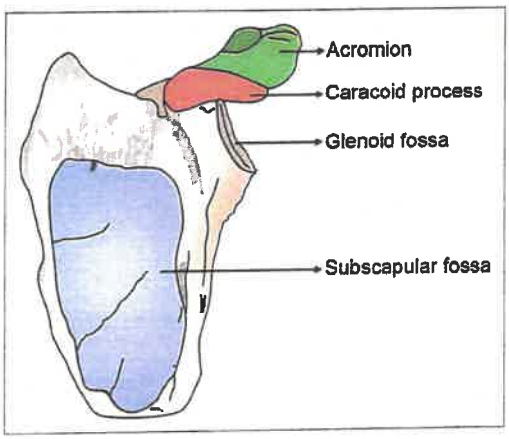
Important Information

- Break in cortex: Fracture
- Osteomyelitis: Loss of soft tissue planes after 24 hrs. of osteomyelitis and periosteal reaction happens later
- Tuberculosis loss of curvature of spine> reduced disc space
- Joint spaces is cartilage (not seen on x-rays) and reduced joint space means arthritis

Shoulder

- Clavicle is the highest bony landmark in AP X-ray of shoulder
- Ratio between head of humerus & Glenoid 4:1 k/a "Golf ball on a tee"
- In the Infra-clavicular area, the bony landmark palpable is "Coracoid"





Elbow

- Capitulum is the first centre to ossify around elbow
- Radial head: 2nd centre to ossify
- Ossification around elbow

Bone	Age of ossification
• C - Capitulum	• 2 years
• R - Radial head	• 4 years
• I - Inner / medial epicondyle	• 6 years
• T - Trochlea	• 8 Years
• O - Olecranon	• 10 Years
• E - External / lateral epicondyle	• 12 Years

How to remember

- CRITOE

Wrist

Radiocarpal joint

- In AP view lower end of radius is wider, on it there is a boat shaped bone called as scaphoid and next to it is the moon shaped lunate (Seen on lateral view)
- The first metacarpal goes anterior
- Ossification of carpal bone

Bone	Age of ossification
She - Scaphoid	5 years
Looks - Lunate	4 years
Too - Triquetrum	3 years
Pretty - Pisiform	12 years
Try - Trapezium	5 years
To - Trapezoid	5 years
Catch - Capitate	1 years (1st to ossifiy)
Her - Hamate	1 years

How to remember

- She Looks Too Pretty Try to Catch Her

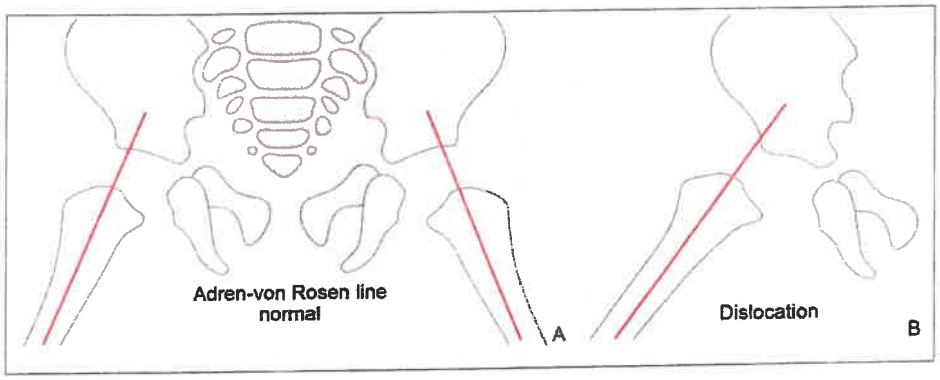
Pelvis

- Sacroiliitis: inflammation of sacro- iliac joint: seen in ankylosing spondylitis
- Young man with lower back ache, reduced back movement, decreased chest expansion, HLA B27+ve suggests Ankylosing spondylitis

IMAGING IN ORTHOPAEDICS

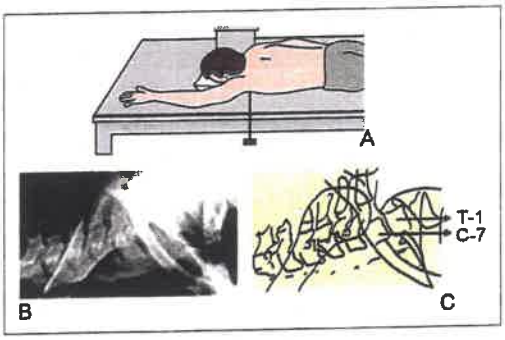
Different views in X-ray

1. Von-Rosen view



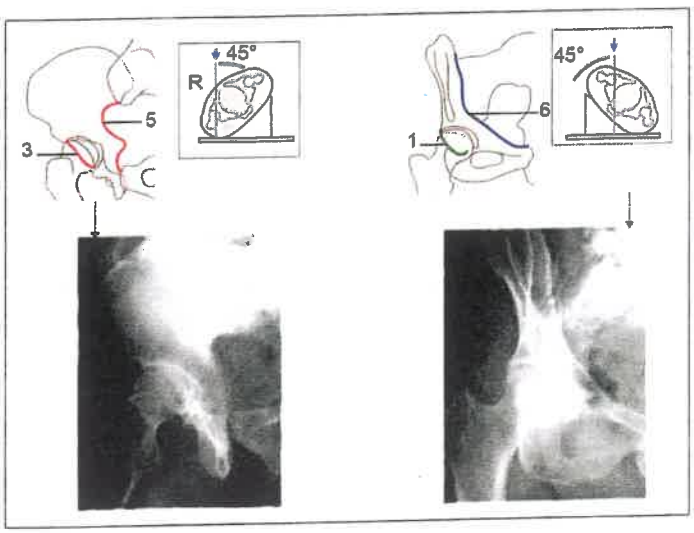
- For developmental dysplasia of Hip
- Shows Shallow acetabulum

2. Swimmer's view



For cervico thoracic junction

3. Judet View



- To view different orientation of acetabulum

4. Open mouth view

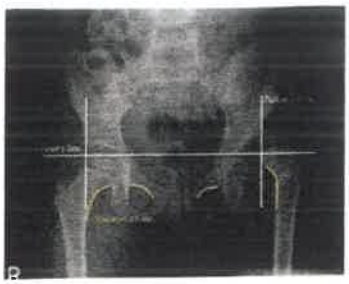
- Used for Odontoid fracture and to see upper cervical spine C_1 and C_2

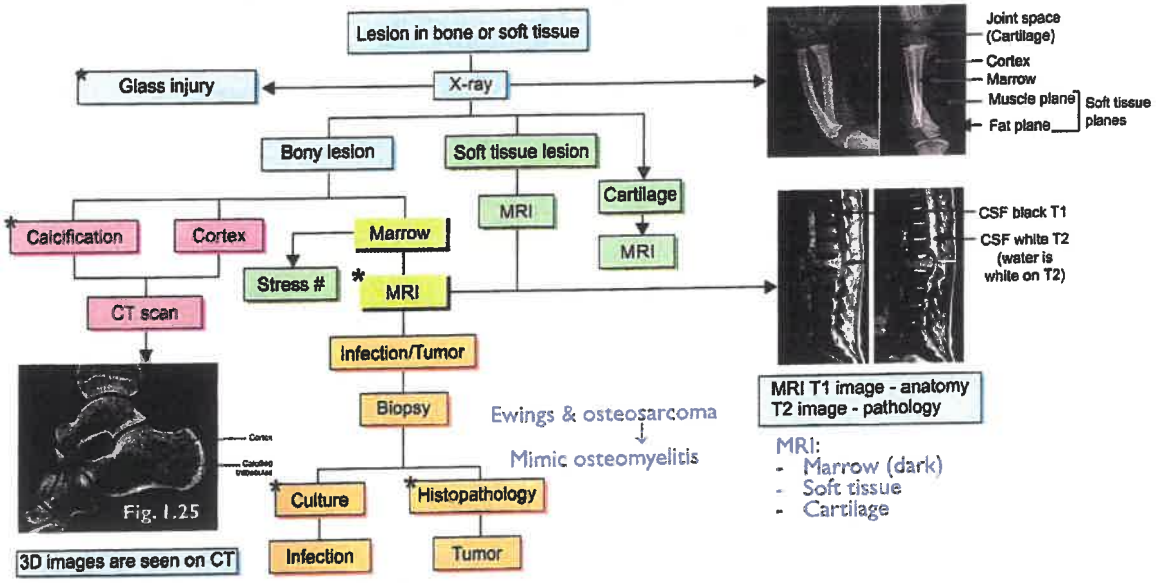
5. Shenton's Arch

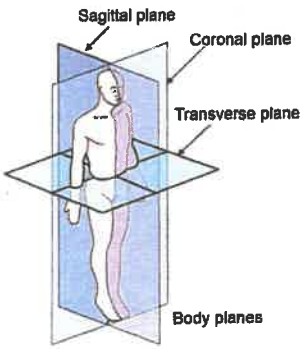
- Lost in fracture or dislocation (Fracture of pubic rami or dislocation of Hip)

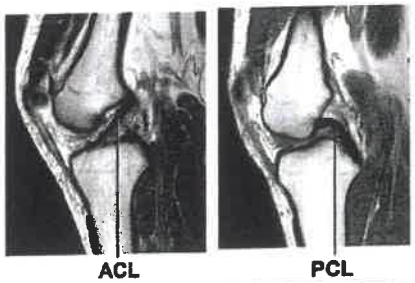
Important views of X-rays

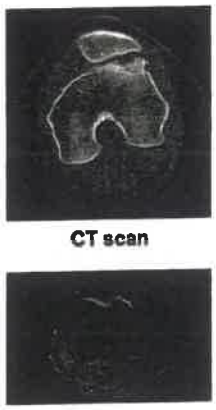
1. Broadens View: Subtalar joint - Inversion, Eversion → To walk on uneven ground
2. Von Rosen View: DDH
3. Swimmers View: Cervicothoracic junction
4. Oblique view: Scaphoid
5. Judet View: Acetabulum (Pelvis) - Tilt the pelvis → To see inside the acetabulum
6. Open Mouth view: Odontoid
7. Shentons Arch: Pelvis



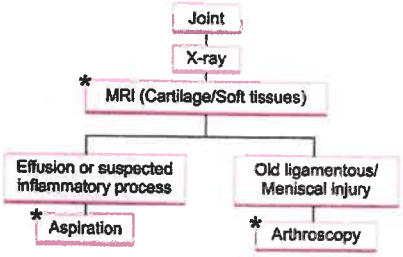








- **Order in which investigations become positive in OM: MRI > Bone Scan > X-ray**
- **Bone Tumors :** **MRI** **CT Scan** Osteoid Osteoma (Cortical)
- **DDH** Shallowing of acetabulum. IOC MRI , Screening tool: USG (a) alpha angle decreases in DDH in USG



X-ray
MRI
Aspiration (USG guided)/Arthroscopy
Swelling of a joint
X-M A S

Limping child / Joint swelling

* **Latest Questions**

Bone biopsy

- After clinioradiological evaluation
- Vertical incision
- Avoid NV structure
- Round/Oval hole
- Periphery
- Multiple sites

Musculoskeletal System	
1. Ist investigation	X ray
2. Next Investigation	MRI
3. Best Investigation	Biopsy

Stress fracture	
1. Overall	MRI
2. Unilateral	MRI
3. Bilateral	Bone Scan

Metastasis	
1. Single	MRI
2. Multiple	PET scan
3. Multiple (Osteoblastic)	Bone scan

Stress fracture/ SHIN splints March # - Metatarsal Neck 2nd >3rd

Periosteum:

- Fibrous layer-Useless layer
- Cambium layer

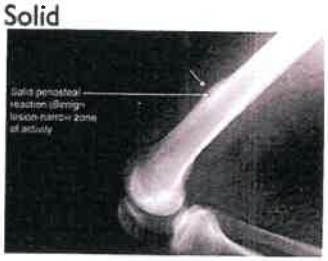
Union-Neck of femur (Absent cambium layer so high chance of Non union)
Periosteal reaction-Narrow (benign), Wide(malignant)
Bone tumors-Osteochondroma/ Osteosarcoma

Periosteum → origin of tumor
↓
Should be removed (Extra periosteal resection).

GCT→ Only tumor to involve the joint.

Periosteal Reaction
Narrow zone | Wide zone

Solid



Acute OM

Osteosarcoma Sunray appearance

Osteosarcoma Codman's Δ

Ewings sarcoma Onion peel apearance

Non-aggressive reactions are thin, Solid, thick and irregular.

Aggressive reactions are Spiculated, Laminated, Hair on End, Sun burst, disorganised, Interrupted and Codman's triangle.

Classical Radiological features*

➢ **Sun ray appearance*/Codman's triangle**	**Osteosarcoma but can be seen in any malignant lesion**
➢ Onion peel appearance*	Ewing sarcoma but can be seen in any malignant lesion or chronic osteomyelitis
➢ Soap bubble appearance*	**GCT (Osteoclastoma) > Adamantinoma**
➢ Patchy calcification*	Chondrogenic tumors (Chondrosarcoma > Chondroblastoma)
➢ Homogenous calcification	Osteogenic tumors (Osteosarcoma)

Calcification (CS>CB)> Osteogenic Tumor

2 CHAPTER

INFECTION

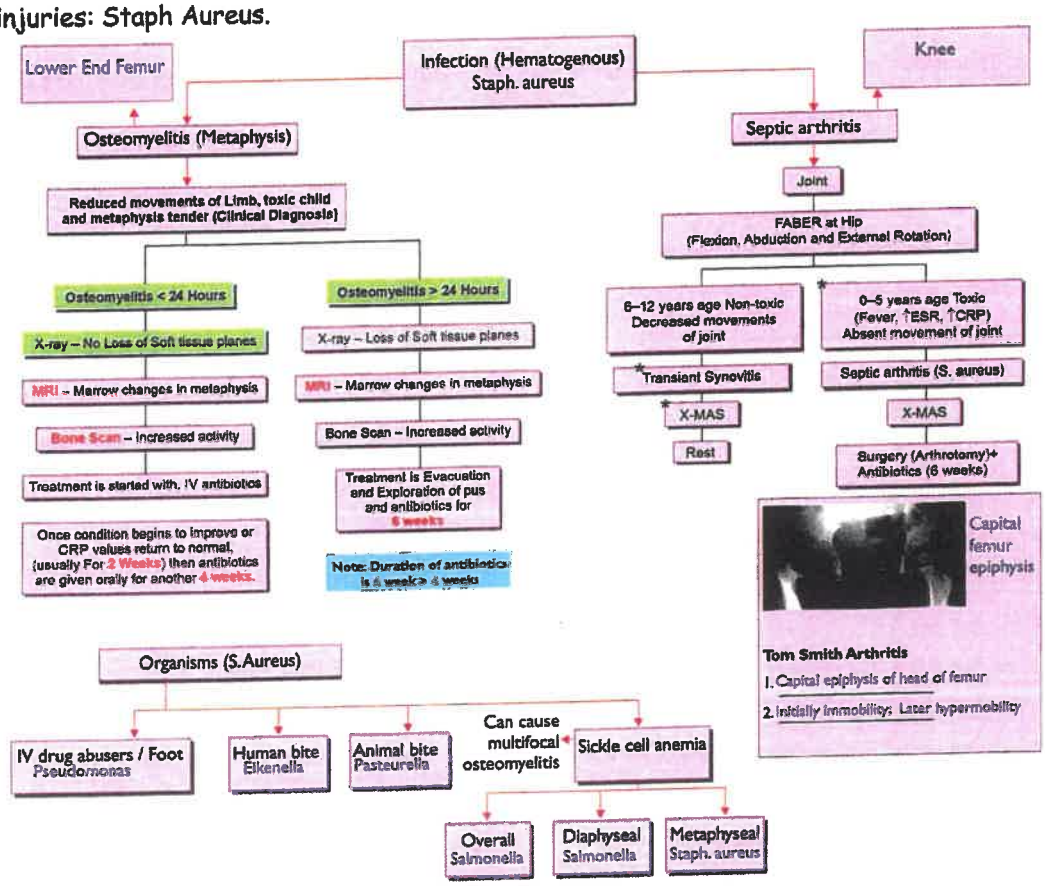
OSTEOMYELITIS

Osteomyelitis basics

- Mc organism: Staphylococcus Aureus.
- Mc location: Metaphysis
- Mc spread of infection: Hematogenous

Exceptions

- Sickle cell anemia: Salmonella
  - Salmonella affects the Diaphysis (MC)
  - S. Aureus affects the Metaphysis
- IV drug users: Pseudomonas
- Foot infection: Pseudomonas.
- Human bites: Eikenella
- Animal bite: Pasteurella
- Open injuries: Staph Aureus.



Joint Infections

- Faber at Hip
  - 0-5-year-old, toxic child, Absent movement of joint: septic arthritis (S. aureus)
    → Diagnosis by X-MAS (X-ray, MRI, Aspirate by Ultrasound guidance)
    → Treatment: Surgery
  - 6-12 years of age, Non-toxic, decreased movements of joint: Transient synovitis
    → Diagnosis by X-Mas (X-ray, MRI, Aspirate by Ultrasound guidance)
    → Treatment: Rest

	Septic Arthritis	Transient Synovitis
• FABER	(+)	(+)
• AGE	< 5 Years	6-12 years
• Movement of Joint	Absent	Decreased

Septic arthritis

Diagnostic criterion (Morrey and associated criterion) 5 out of 6 must be present.

1. > 38.3° C temperature
2. Swelling of suspected joint
3. Pain in joint that increased with movement
4. Systemic symptoms
5. No other pathological process'
6. Satisfactory response to antibiotics therapy
   - Knee is the most commonly affected joint: position is flexion
   - Hip: position is flexion, abduction, and external rotation as this is the positon of maximum capacity of joint to accommodate pus
   - Treatment
   - Arthrotomy (opening the joint capsule), surgical drainage (decompression), synovectomy and = antibiotics (2 weeks IV and 4 weeks oral)
   - No role of conservation management
   - Septic arthritis results in bony ankyloses and it is the most common cause of bony ankyloses

Kocher's criteria

1. Inability to bear weight
2. Temperature > 38.5° c
3. WBC > 12000/ microliter
4. ESR > 40MM/HR

1 point means 3% chance of Septic Arthritis
2 point means 40% chance of Septic Arthritis
3 point means 93% chance of Septic Arthritis
4 point means 99% chance of Septic Arthritis

Brodie's Abscess

- Sub-Acute Osteomyelitis > Chronic Osteomyelitis
- Location: upper end of tibia
- Lytic Lesion with sclerotic margin