



Orthopedics

Principals of Orthopedic Surgery

General Principles

- ❖ Fracture:
 - Discontinuity of bone.
- ❖ Dislocation:
 - Disruption of continuity of a joint.
- ❖ Subluxation:
 - Partial disruption of continuity of a joint.
- ❖ Fracture dislocation:
 - Dislocation + fracture of one or more bone forming joint.

General scheme for fractures

1. Site (according to fracture).
2. Type.
3. Clinical picture (symptoms & signs).
4. Investigations.

❖ Type of fracture according to:

A. Etiology:

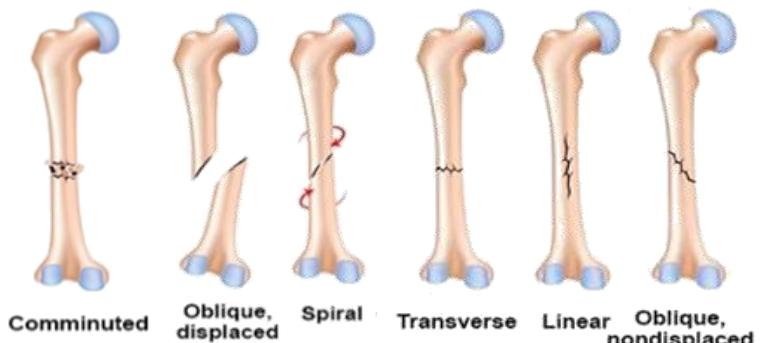
- Pathological (osteoporosis & metastases).
- Stress (march).
- Traumatic.
- Compression & traction in cancellous bone.
- Direct & indirect in tubular bone.

B. Surrounding structures:

- Simple (Closed).
- Compound (Open).
- Complicated fracture.

C. Shape of fracture line:

- Transverse.
- Spiral.
- Oblique.
- Comminuted.
- Double level.
- Epiphyseal separation.
- Burst fracture.
- Avulsion fracture.
- Fracture-dislocation.



D. Extent:

- Complete.
- Incomplete.
 - Fissure.
 - Greenstick.
 - Compression fracture.

E. Impaction:

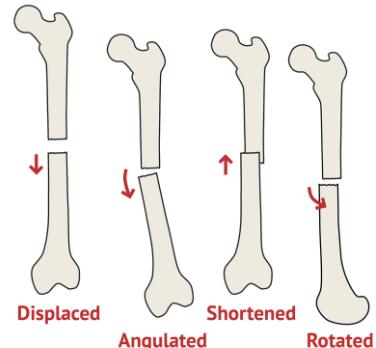
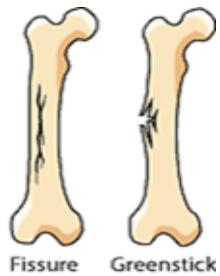
- Impacted.
- Non-impacted.

F. Stability:

- Stable.
- Unstable.

G. Displacement:

- Lateral displacement.
- Angulation.
- Over-riding.
- Rotation.
- Distraction.
- Depression.
- Impaction.

**❖ Clinical Picture:****➤ Symptoms:**

- History of trauma.
- Severe Pain.
- Swelling.
- Disturbance of function: Limitation of movement and inability to use affected limb
- Specific symptoms (according to fracture).

➤ Signs:**1. General signs:**

- Hemorrhage.
- Shock.
- Associated injury.

2. Local signs:

- **Exposure** (one joint above & other side to compare).
- **Inspection** (ecchymosis, bruises, swelling, deformity & length of discrepancy).
- **Palpation** (tenderness, crepitus, temperature).
- **Movement** (active & passive).

❖ Investigations:**➤ X-Ray:**

- 2 views, 2 occasions, 2 joints.

➤ CT:

- Visceral.

➤ MRI:

- Spine.

➤ US:

- Effusion / muscle tear.

❖ Treatment of fractures:**I. Step 1**

- **Poly-traumatized patient (ABCDE protocol):**
 - Pre-hospital.
 - Primary survey.
 - Secondary survey.

II. Step 2

- **Definitive treatment**

A. Step 1 (Reduction)

- Restoration of the displaced fragments to their anatomical position.

➤ Indications:

In all fractures except:

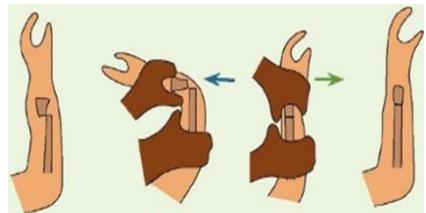
- ⇒ Little or no displacement.
- ⇒ Displacement does not compromise function e.g., fracture clavicle.

➤ Types:

- ⇒ Closed (under sedation).
- ⇒ Open (by surgery).

➤ Methods of closed Reduction:

- A. Gravity.
- B. Closed manipulation.
- C. Traction: skin or skeletal.



➤ Indications of open reduction:

- A. Failed closed reduction (Unstable).
- B. When internal fixation is indicated (Open reduction is the first step in internal fixation).
- C. Open fracture.

B. Step 2 (Fixation)

1. External fixation:

- Fixation using casts and splints applied from outside the body.

➤ Advantages:

- ⇒ Stimulated rapid healing.

➤ Disadvantages:

- ⇒ Risk of loss of reduction.

➤ Methods

- A. Plaster of Paris.
- B. Traction (Thomas skin or skeletal).
- C. External skeletal fixators:
 - ⇒ (In infected fractures & if internal fixation carries a high risk of infection).



2. Internal fixation

- Fixation by use of metal implants inserted inside the body.

➤ Indications:

1. Difficult fractures.
2. Fractures pulled apart by muscles.
3. Pathological fractures.
4. Multiple fractures.
5. Intra-articular fractures.
6. Poor union.
7. Non-union e.g., Neck femur.
8. Mal-union e.g., Ankle.
9. Associated vascular or nerve injury.
10. Associated nursing difficulties.



Plates & screws

➤ Methods

- A. Wires e.g., fracture of the olecranon.
- B. Screws e.g., fracture of malleoli.
- C. Plate and screw: e.g., fracture humerus.
- D. Intramedullary nail: Fracture shaft of the femur.



C. Step 3 (Rehabilitation & TTT of complications)

➤ Methods

- A. Active exercise.
- B. Assisted movement.
- C. Functional activity.

Intramedullary nail

Healing of fractures

❖ Phases:

➤ **Few weeks:**

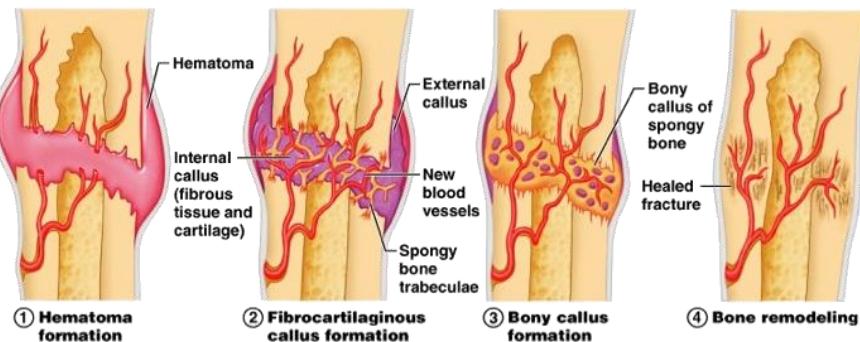
- Repair by granulation tissue > hematoma > vascular connective tissue bridging.

➤ **2-3 months:**

- Union of primary callus > cartilage invade bone cells & matrix > 1ry callus (external > internal > intermediate).

➤ **4-5 months:**

- Formation of mature bone > intermediate callus gradually replaced by lamellar trabeculae along lines of stress > absorption of internal & external callus > restoration of medullary cavity.



❖ Factors affecting healing:

- A. Age.
- B. Type of fracture.
- C. Position of the segments.
- D. Vascularity.
- E. Immobilization of fragments.
- F. Infections.

❖ Complications of fractures:

➤ **General**

1. Shock.
2. Fat embolism.
3. Infections.
4. Crush syndrome.

5. Complications of prolonged recumbency:

- DVT.
- Respiratory complications.
- Renal stones.
- Constipation.
- Pressure sores.
- Osteoporosis.

➤ Local**1. Skin:**

- Injury.
- Infections.
- Sores.

2. Muscles & tendons:

- Injury.
- Myositis Ossificans.

3. Vessels:

- Acute ischemia.
- Compartment syndrome.
- Volkmann's contracture.

4. Visceral injury.**5. Nerve injury.****6. Bones:**

- Mal-union.
- Delayed union.
- Non-union.
- Ischemic necrosis.
- Epiphyseal injuries.
- Growth arrest.
- Shortening of LL fractures.

7. Joints:

- Suddeck's atrophy.
- Ligament injury & sprain.
- Dislocation & subluxation.
- Post-traumatic stiffness.
- Traumatic ossification.
- Effusion.
- Hemarthrosis.
- Septic arthritis.
- Osteo-arthritis.

Crush Syndrome**❖ Pathogenesis:**

Caused by crushing of muscles OR muscle necrosis secondary to arterial injury or compartment syndrome.

➤ To inside of muscles

- Accumulation of ECF in muscles.
 - Compartmental syndrome & hypovolemic shock.

➤ **To outside of muscles**

- Toxic substances released into circulation (urates, K, Myoglobin & phosphates).
 - Hyperkalemia.
 - Myoglobinuria & ARF.

❖ **Clinical picture:**

- Crush injury, compartmental \$.
- Myoglobinuria.
- ↑ Creatinine in blood.

❖ **Treatment:**

- As any polytrauma + TTT of the cause.
- For compartmental \$: Fasciotomy + Immobilization.
- Forced alkaline diuresis: Fluid (up to 8 liters / day) + Mannitol + Sodium Bicarbonate "Forced Alkaline Diuresis" OR renal dialysis.
- Local debridement or even amputation may be required.

Myositis ossificans

❖ **Definition:**

- Deposition of Ca+2 in soft tissue that involves:
 - Bone.
 - Periosteum.
 - Lacerated muscle.

❖ **Site:**

1. After Elbow.
2. Or hip injuries.

❖ **Mechanism:**

- After Elbow or hip injuries:
 - Blood collects under the stripped soft tissues, forming a large subperiosteal hematoma.
 - The hematoma is invaded by osteoblasts and becomes ossified.
 - Massage & passive stretching of joints > Traumatic ossificans.



❖ **Clinical picture:**

1. **Active stage:**
 - Pain, swelling & hotness.
 - ↓ Mobility.
 - Cloudy shadow of ossification.

2. **Passive stage:**
 - Pain ↓ Stiffness.
 - Circumscribed dense shadow.



❖ **Treatment:**

A. **Prophylactic:**

- Early reduction of fractures & avoid massage and aggressive manipulation.

B. Active

- Immobilization & resection after 6 m (Tends to recur esp. if resected before 6 months)

Sudeck's atrophy**❖ Definition:**

- A form of reflex sympathetic dystrophy with increased blood flow to para-articular areas.

❖ Sites:**➤ Complicates:**

- Colle's fracture.
- Pott's fracture.
- Scaphoid bone fracture.

❖ Clinical picture:**➤ Neurotic female:**

- Severe burning pain and swelling.
- Muscles atrophy.
- Joint stiffness.
- Restricted mobility.

❖ Investigations**➤ X-Ray**

- Patchy osteoporosis of carpal bone, glass appearance of bone.

**❖ Treatment****A. Prophylactic:**

- Exercise of joints from first day.

B. Active:

- Hot wax, analgesics, physiotherapy, sympathectomy, sympathetic block.

Avascular necrosis of bone**❖ Sites:**

- 1) Femoral head.
- 2) Carpal Scaphoid.
- 3) Carpal Lunate.
- 4) Talus.

❖ Investigations:**➤ X-Ray**

- Normal early, appears after 3 months:
 - Avascular fragments become denser.

❖ Treatment:**➤ According to site**

- **Femoral head:** Austin Moore head (Hemi-arthroplasty)

▪ Scaphoid ischemic necrosis:

⇒ Vascularized bone graft from fibula.

**Austin Moore head**

Volkmann ischemic contracture

❖ Definition:

- Fibrosis and shortening of the muscles of the front of the forearm.

❖ Etiology:

- a. Tight plaster.
- b. Severe edema or extravasation of blood in the forearm compartment.

❖ Sites:

- M/C muscle to be involved: Flexor digitorum profundus due to brachial artery injury after supracondylar fracture of the humerus.

❖ Pathology:

- Compartment syndrome of the muscles of the front of the forearm causes muscle ischemia.

➤ 6-12 hours:

- Muscle infarction.

➤ Few months:

- Muscle fibrosis and shortening.



❖ Clinical picture:

- Weak hand grip and established contracture with:
 - The proximal and distal interphalangeal joints are flexed (Claw hand).
 - Extension of the fingers is limited but improves as the wrist is flexed (Fixed length phenomenon).

❖ Treatment:

A. Prophylactic

- Timely reduction of fractures and dislocations esp. around the elbow joint then make sure a good radial pulse is restored after reduction and fixation.
- Fasciotomy if compartment syndrome occurs.
- Release of tight plaster cast and removal of constrictions can restore arterial pulsation.
- If radial pulse does not return, brachial artery is explored, injured segment is excised and, the artery is reconstructed by a vein graft.

B. Active

- Early cases: physiotherapy by gradual stretching and splinting.
- Late cases: muscle slide operation, the common flexor origin is detached from the medial epicondyle and fixed at a lower level.

Non-union

❖ Definition:

- Healing doesn't occur after 6 months.

❖ Etiology:

A. Hypertrophic:

- due to the presence of a gap by distraction by traction, soft tissue interposition or bone loss.



B. Atrophic:

- Due to loss of blood supply.

❖ Clinical picture:

- Pain.
- Swelling.
- Disturbance of function (persistent tenderness, abnormal range of mobility).

❖ Investigations:

- **Bone X-Ray**
 - Sclerosis of bone.
- **Bone scan**
 - ↑ uptake in hypertrophic type.

❖ Treatment:

- A. Hypertrophic:
 - Rigid fixation.
- B. Atrophic:
 - Bone graft (autogenic from iliac bone) & fixation.

Delayed union

❖ Definition:

- Healing takes longer than normal time.

❖ Etiology:

- A. Local:
 - inadequate blood supply, infection, foreign body, type of bone, soft tissue interposition & intra-articular fracture.
- B. General:
 - Age, nutrition, systemic illness, drugs (steroids).
- C. Orthopedic:
 - improper reduction, improper immobilization (leads to repeated shearing strain on the granulation tissue), over distraction of the fragments due to excessive skeletal traction, pathological fracture.

❖ Clinical picture:

- Pain.
- Swelling.
- Disturbance of function (persistent tenderness, abnormal range of mobility).

❖ Investigations:

- **Bone X-Ray**
 - Fracture with wide gap & decalcified bone ends, No sclerosis.

❖ Treatment:

- A. TTT of the cause.
- B. Bone fixation.

Mal-union

❖ **Definition:**

- Unite in a non-anatomical position.

❖ **Etiology:**

- Improper fixation/ Failure of stabilization.
- Premature removal of cast.
- Lack of perfect reduction.

❖ **Types:**

- 1) Angular.
- 2) Rotational.
- 3) Mal-union with shortening.



❖ **Clinical picture:**

- Cosmetic deformity.
- Interference with function > limping.
- Osteoarthritis if intra-articular fracture.

❖ **Investigations:**

➤ **Bone X-Ray**

❖ **Treatment**

D. **Prophylactic**

- ORIF (Avoids this complication).

E. **Active**

- Corrective osteotomy, except fracture clavicle or young infants with mild condition.

Poly Trauma

Evaluation

❖ ATLS:

1. Primary Survey:

A. Airway:

- Establishment of an airway with regard for associated cervical spine injury.
- **Clinical evaluation for obstruction:**
 - ⇒ Facial fractures, mandible fractures, laryngeal or tracheal injury, aspiration, foreign body.

Airway maneuvers



Head tilt - Chin lift

Jaw thrust

B. Breathing:

- Clinical and radiographic (CXR) evaluation.
- ABG.
- **Common causes of hypoxemia:**
 - ⇒ Flail chest with contusion.
 - ⇒ Tension pneumothorax.
 - ⇒ Open pneumothorax.

C. Circulation:

- Clinical and radiographic (CXR, pelvic X Ray evaluation).
- Application of circumferential sheet or binder where indicated.
- Application of direct pressure to areas of obvious hemorrhage.
- Initiation of resuscitation.

D. Disability:

- Neuro evaluation by:
 - ⇒ **Glasgow coma scale:**

Eye opening	Verbal response	Motor response
Spontaneous > 4	Oriented > 5	Obey commands > 6
To sound > 3	Confused > 4	Localizing > 5
To pressure > 2	Words > 3	Normal flexion > 4
None > 1	Sounds > 2	Abnormal flexion > 3
	None > 1	Extension > 2
		None > 1
Glasgow coma scale score		
Mild 13-15	Moderate 9-12	Severe 3-8

E. Exposure/Environmental Control

- Clinical evaluation to identify occult injuries.
- Rewarming patients.

2. Secondary Survey.

3. Tertiary Survey.

Class of Hemorrhage

	Class 1	Class 2	Class 3	Class 4
Blood loss (mL)	Up to 750	750-1500	1500-2000	>2000
Blood loss (% of volume)	Up to 15%	15-30%	30-40%	>40%
Heart rate	<100	100-120	120-140	>140
Blood pressure	Normal	Normal	Decreased	Decreased
Pulse pressure (mmHg)	Normal	Decreased	Decreased	Decreased
Respiratory rate	14-20	20-30	30-40	>35
Urine output (mL/hr.)	>30	20-30	5-15	Negligible
Mental status	Slightly anxious	Mildly anxious	Confused	Lethargic

Open Fracture

❖ Definition:

- Break in the skin and underlying soft tissue leading directly into or communicating with the fracture and its hematoma.

❖ History:

- Last century, high mortality with open fractures of long bones.
- Early amputation to prevent death.
- WWI, mortality of open femur fractures > 70%.
- **Closed treatment of war fractures:**



- Included open wound treatment and then enclosure of the extremity in a cast.
- The greatest danger of infection lay in muscle, not bone.

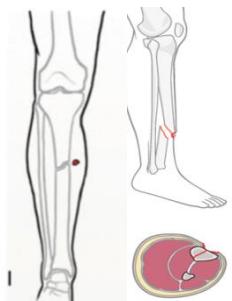
❖ Classification

➤ **Gustilo and Anderson Classification:**

- The model is tibia, however applied to all types of open fractures.
- **Emphasis on wound size:**
 - Crush injury associated with small wounds.
 - Sharp injury associated with large wounds.
- **Better to emphasize:**
 - Degree of soft tissue injury.
 - Degree of contamination.

I. **Type I:**

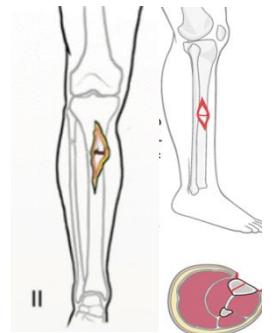
- Energy: Low.
- Wound size: <1 cm.
- Contamination: Clean.
- **Fracture Pattern:**
 - ⇒ Simple fx pattern with minimal comminution.
- Skin Coverage: Local Coverage.



- Inside-out injury.
- Neurovascular Injury: Normal.
- Minimal soft tissue damage.
- No significant periosteal stripping.

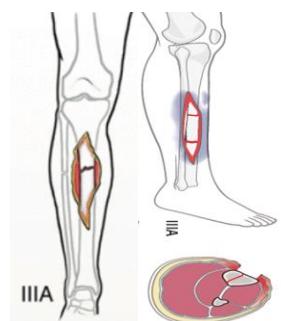
II. Type II

- Energy: Moderate.
- Wound size: >1 cm.
- Contamination: Moderate.
- **Fracture Pattern:**
 - ⇒ Moderate Comminution.
- Skin Coverage: Local Coverage.
- Outside In.
- Neurovascular Injury: Normal.
- Moderate soft tissue damage.
- No significant periosteal stripping.



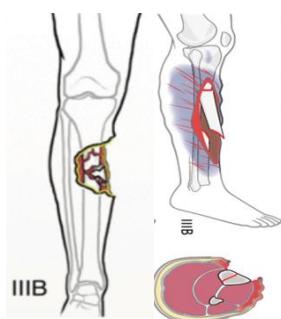
III. Type III A:

- Energy: High.
- Wound size: > 10cm.
- Contamination: Extensive.
- **Fracture Pattern:**
 - ⇒ Sever Comminution.
 - ⇒ Or Segmental Fracture.
- Skin Coverage: Local Coverage included.
- Outside in.
- Neurovascular Injury: Normal.
- Extensive soft tissue damage.
- There is periosteal stripping.



IV. Type III B:

- Energy: High.
- Wound size: > 10cm.
- Contamination: Extensive.
- **Fracture Pattern:**
 - ⇒ Sever Comminution.
 - ⇒ Or Segmental Fracture.
- Skin Coverage: Requires free tissue flap or rotational flap coverage.
- Outside in.
- Neurovascular Injury: Normal.
- Extensive soft tissue damage.
- There is periosteal stripping.



V. Type III C:

- Energy: High.
- Wound size: > 10cm.
- Contamination: Extensive.
- **Fracture Pattern:**
 - ⇒ Sever Comminution.



- ⇒ Or Segmental Fracture.
- Skin Coverage: Typically Requires flap coverage.
- Outside in.
- Neurovascular Injury: Exposed fracture with arterial damage that requires repair.
- Extensive soft tissue damage.
- There is periosteal stripping.
- Increased risk of amputation and infection.

❖ Investigations:

➤ **Radiographs:**

- Usually, only AP and lateral are required.
- They should include adjacent joints and any associated injuries.



❖ Management:

➤ **Goals of treatment:**

1. Preserve life.
2. Preserve limb.
3. Preserve function.

➤ **Also:**

1. Prevent infection.
2. Fracture stabilization.
3. Soft tissue coverage.

I. Initial assessment & management:

- ABC's.
- Assess entire patient.
- Careful PE, neurovascular.
- Abx and tetanus.
- Local irrigation 1-2 liters.
- Sterile compressive dressings.
- Realign fracture and splint.
- Do not culture wound in the ED:
 - 8% of bugs grown caused deep infection.
 - cultures were of no value and not to be done.
- Recheck pulse, motor, and sensation.

II. I&D in the OR:

- **Trauma scrub**
 - Soap and saline to remove gross debris.
- **Zone of injury**
 - A skin wound is the window through which the true wound communicates with the exterior.
- **Extend the traumatic wound:**
 - Excise margins.
 - Resect muscle and skin to healthy tissue (**color, consistency, capacity to bleed and Contractility**).
- **Bone ends are exposed and debrided.**
- **Irrigate.**

Open fractures need:

- Prompt diagnosis.
- Appropriate intravenous antibiotics AND tetanus prophylaxis.
- Meticulous injury zone excision (debridement).
- Fracture stabilization.
- Second look.
- Early soft-tissue cover after soft-tissue recovery.
- Definitive treatment.

- **Serial debridements?**

- If needed, 2nd or 3rd debridement after 24- 48 hours should be planned.

III. Debridement of the injury zone in open fractures:

- The injury zone excision must be complete, meticulous, and radical.
- Early wound debridement is the most important component of the care of any open fracture.
- In cases with significant amounts of contaminated, dead, or possibly ischemic, tissue, additional wound excision 48 hours later (second look) is often necessary.
- If in doubt, look again.
- **Skin:**
 - Enlarge the traumatic wound for adequate exposure of the whole injury zone.
 - Only minimal non-viable wound margins need to be excised.
- Next, all dead, or questionably viable, tissue is excised systematically from each tissue layer.
- **Leave only obviously viable tissue:**
 - Subcutaneous tissues.
 - Deep fascia.
 - Muscle (**Color, Contraction, bleeding**) .
- **Bone:**
 - Any bony fragments devoid of soft-tissue attachment should be removed.
 - Contaminated, or non-viable, bone surfaces will also need excision with hand instruments, such as chisels.



IV. Soft-tissue coverage in open fractures:

- **Only ever after wound excisions are complete:**
 - Consideration must be given to the best means of wound coverage.
 - Excessive skin tension prevents wound healing.
 - A contaminated wound is virtually certain to become infected with primary closure.
- **Delayed closure of the traumatic wound**
 - Open wound management with delayed primary closure, or preferably split skin grafting, or flap when it became clean.
 - If closure is delayed, it should be completed as soon as it is safe to do.
 - To minimize the risk of secondary hospital infection.
- With low-energy fractures and benign wounds, immediate wound closure can be considered.
- If primary closure is chosen, the surgeon must watch carefully for signs of wound infection.

V. Soft-tissue care:

- Avoid contamination.
- Avoid desiccation.

- Consider special dressings.
- Cover promptly.

VI. Vacuum-assisted wound closure:

- Negative pressure wound dressing.
- Helps to reduce the size of an open wound.
- Remove edema fluids.
- Promotes the formation of granulation tissue.
- It may permit early split-thickness skin graft closure instead of more complex flaps.



VII. Second look:

- 48 H after the original debridement.
- It is generally advisable to reinspect the injury Zone under anesthesia - so-called "second look".
- **This affords the opportunity:**
 - To assess the viability of soft tissues.
 - To conduct any necessary further tissue excision.
 - To wash out any accumulated blood clot, tissue fluid, Coagulum or remaining foreign material.

VIII. Wound closure:

- The wound is closed when the surgeon believes no further debridement are necessary.
- This may be done primarily but is often done after a secondary procedure.
- When skin grafting or soft-tissue flaps are necessary, they should be done as soon as possible.
- Optimally, coverage should occur within the first two weeks after injury.

IX. Definitive treatment:

- **Definitive fixation is considered, when:**
 - The patient's clinical status is optimized.
 - The wounds are healthy and the soft-tissue envelope will allow for chosen surgical approach.
- **The Irrigation: (Dilution is the solution to pollution)**
 - The surgical site should be thoroughly irrigated.
 - Animal studies show improved removal of particulate matter and bacteria but effect plateaus.
 - Low- and high-pressure lavage are equally effective in reducing bacterial counts.
 - Saline is shown to be most effective irrigating agent.
 - On average, 3L of saline are used for each successive Gustilo type.
 - **Anglen recommends:**
 - ⇒ 3L (one bag) for type 1.
 - ⇒ 6L (two bags) for type 2.
 - ⇒ 9L (three bags) for type 3.



- **Types of fracture stabilization:**

1. **Splint:**

- ⇒ Good option if operative.
- ⇒ Fixation not required.

2. **Internal fixation:**

- ⇒ The wound is clean.
- ⇒ And soft tissue coverage is available.

3. **External fixation:**

- ⇒ Dirty wounds or extensive soft tissue injury.



- **When to use external fixation?**

- Diaphyseal fractures not amenable to IM nails
- Ring fixators for periarticular fractures
- Temporary joint spanning ex fix is popular for knee, ankle, elbow, and wrist.
- If temporary, plan for conversion to IM nail within 3 weeks.

X. Intravenous antibiotics for open fractures:

- Most infecting bacteria, except in very dirty wounds, are typical skin flora.
- A first-generation cephalosporin is often used, except for patients with penicillin allergy.
- For more severe open-fracture wounds, add an aminoglycoside.
- If "agricultural" contamination is present, high-dose intravenous penicillin is usually added and consider metronidazole.
- They should be started as soon as the open fracture.

- **Antibiotic Beads**

1. **Pros**

- ⇒ Very high levels of antibiotics locally.
- ⇒ Dead space management.

2. **Cons**

- ⇒ Requires removal.
- ⇒ Limited to heat stable antibiotics.
- ⇒ Increased drainage from Wound.

- **What systemic antibiotic?**

	1st Gen Ceph.	Gent	PCN
Grade 1	✓		
Grade 2	✓	+/-	
Grade 3	✓	✓	+/-
Farm/War Wounds	✓	✓	✓

❖ Management Summary:

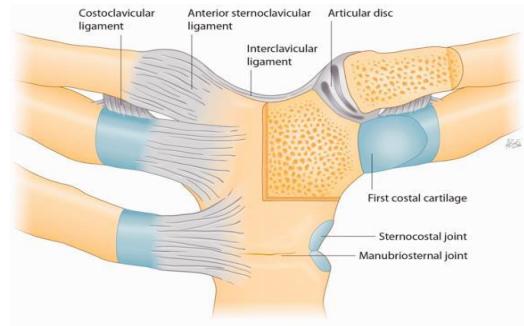
1	Initial assessment	<ul style="list-style-type: none"> ○ ABC's (according to ATLS): <ul style="list-style-type: none"> ● Airway ● Breathing ● Circulation
2	Primary operations	<ul style="list-style-type: none"> ○ Staged wound debridement ○ Fracture stabilization
3	Secondary operations	<ul style="list-style-type: none"> ○ Skin and soft-tissue reconstruction ○ Bone reconstruction
4	Rehabilitation	

Shoulder region

Sterno-clavicular dislocation

❖ Anatomical points:

- **Stability of the joint:** mainly ligamentous
 - Posterior SC ligament.
 - Anterior SC ligament.
 - Costo-clavicular (rhomboid) ligament.
 - Intra-articular disk ligament.
- **Type of joint:**
 - Di-arthrodial saddle joint.
 - Fibrocartilage.



❖ Mechanism:

- **Traumatic dislocation:**
 - Anterior: more common.
 - Posterior: mediastinal structures at risk.
- **Atraumatic subluxation:**
 - Generalized joint laxity.
 - Reassurance.

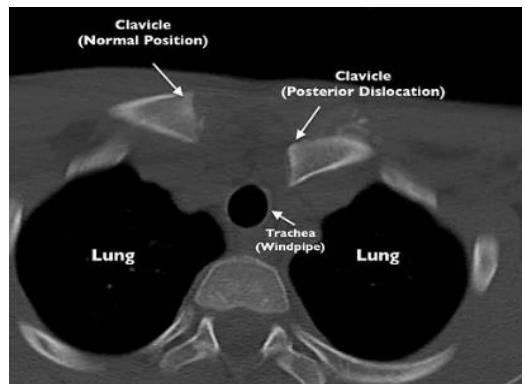
❖ Clinical picture:

- **Anterior:**
 - Deformity with palpable bump.
- **Posterior:**
 - Dyspnea, dysphagia, tachypnea & stridor.
 - Palpable bump.
 - Limited arm ROM.
 - Paresthesia in affected upper limb.
 - Diminished pulse.



❖ Investigations:

- **X-ray:**
 - Difficult to diagnose (A/P).
 - Needs special views (serendipity view).
- **CT scan:**
 - study of choice.



❖ Treatment:

- **Non operative:**
 - Reassurance & sling:
 - Atraumatic subluxation
 - Acute dislocation >3 weeks
 - Closed reduction & bandage:
 - Chronic dislocation <3 weeks
- **Operative:**
 - Open reduction & ligament reconstruction: for post dislocation with
 - breath shortness.
 - peripheral pulse.
 - Medial clavicle excision:
 - chronic dislocation.
 - recurrent dislocation.
 - persistent SC pain.

Acromio-clavicular dislocation

❖ Clinical picture:

- Pain.
- Prominence.
- Abnormal contour of the shoulder.

❖ Investigations:

➤ X-ray:

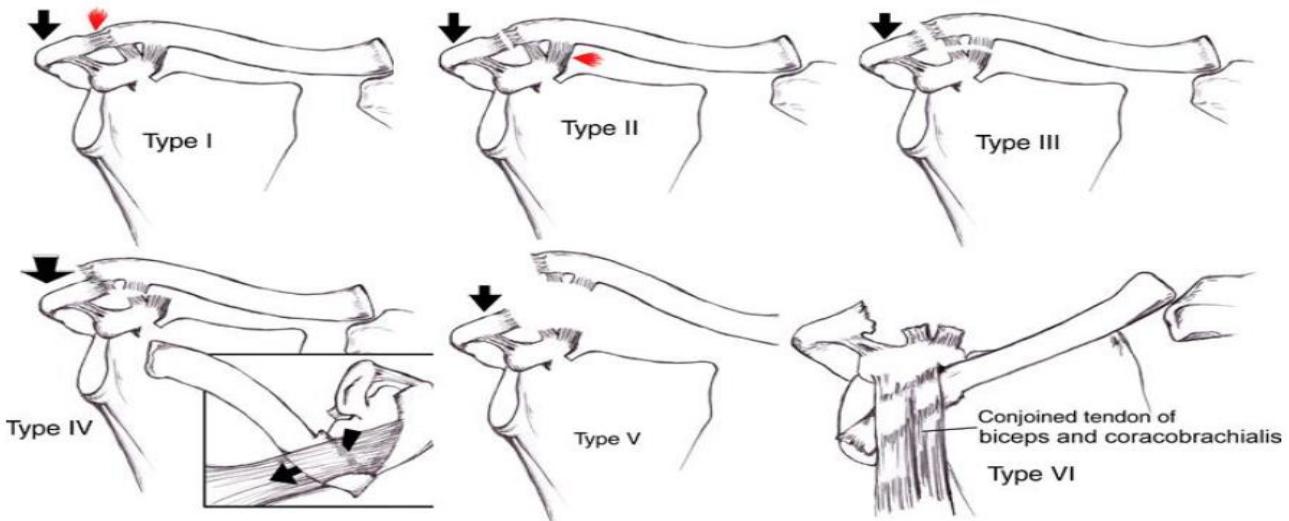
- Bilateral & stress view.
- Measure coraco-clavicular distance.

❖ Classification:

➤ Rockwood Classification:



	AC	CC	Radiograph	Treatment
Type I	Sprain	Normal	None	Sling
Type II	Torn	Sprain	AC joint disrupted + slight vertical separation Increased CC distance < 25% of contralateral	Sling
Type III	Torn	Torn	AC joint disrupted Increased CC distance 25-100% of contralateral	Controversial
Type IV	Torn	Torn	Lateral clavicle displaced posterior through trapezius on the axillary lateral XR	Surgery
Type V	Torn	Torn	Increased CC distance > 100% of contralateral	Surgery
Type VI	Torn	Torn	Inferior dislocation of lateral clavicle, lying either in subacromial or subcoracoid position	Surgery



❖ Treatment:

➤ Nonoperative:

- Indications:
 - Type I, II.
 - Type III (low demanded individuals).
- By: Ice, rest & sling.

➤ Operative:

- Indications:
 - Type III (laborers and elite athletes).
 - Type IV, V, VI.

- By:
 - ORIF:
 - Suture hook plate.
 - CC screw (Bosworth).
 - K-wire.
 - Ligament reconstruction.

Scapular Winging

❖ Medial Scapular Winging:

- Inferior border of the scapula migrates medially.
- Due to serratus anterior weakness or long thoracic nerve injury.

❖ Lateral Scapular Winging:

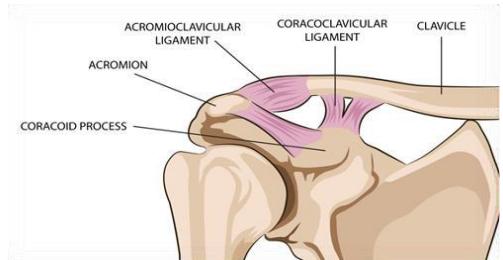
- Inferior border of the scapula migrates laterally.
- Due to trapezius weakness or spinal accessory nerve injury.



Fracture Clavicle

❖ Anatomical points:

- **Stability of the joint:** mainly ligamentous:
 - AC ligament >> (anterior / post. stability).
 - CC ligament >> (superior / inf. stability)
 - Trapezoid.
 - Conoid.



- **Fracture middle third:** **is the most common fracture in whole body:**

- Change of the curve (It is the junction between 2 cross sectional configurations).
- Foramen for nutrient artery.
- Groove for subclavius muscle.
- Thinnest part of the bone.
- Lack of muscular & ligamentous reinforcement.

❖ Classification:

- **Group I:** Middle third (80-85%).
- **Group II:** Lateral third (10-15%).
- **Group III:** Medial third (5-8%).

❖ Clinical picture:

- **Symptoms:**
 - History of trauma.



- Pain at site of fracture.
- Swelling at site of fracture.
- Inability to move the related upper limb.

➤ **Signs:**

- Swelling.
- Deformity: (shoulder drop / step ladder deformity / skin tenting).
- Position of lactating mother.
- Neurovascular examination: subclavian & brachial plexus.



❖ **Investigations:**

- X-ray (AP view).
- CT scan.

❖ **Treatment:**

➤ **Non-Operative:**

- Indications:
 - G1: Non displaced.
 - G2: Stable (I, III, IV).
 - G3: Non displaced.
 - Others: Pediatric distal clavicle.
- By:
 - Sling: Figure of eight bandage.

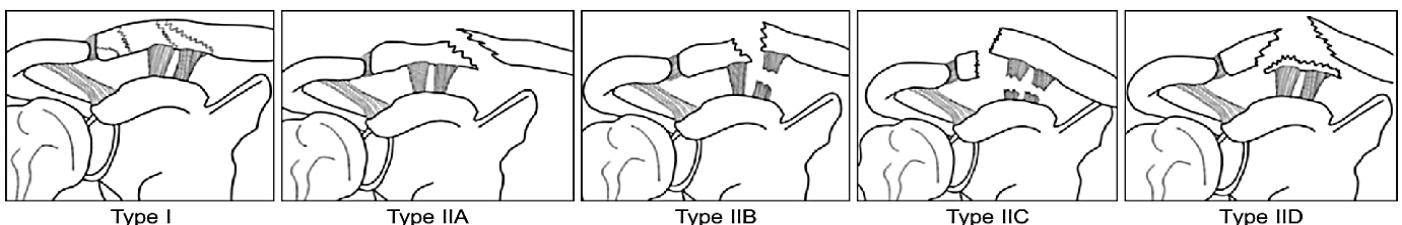


➤ **Operative:**

- Indications:
 - G1: Displaced with > 2 cm shortening.
 - G2: Unstable (IIA, IIB, V).
 - G3: Posteriorly displaced.
 - Others: Highly displaced with skin tenting:
Open.
Floating shoulder (clavicle & scapula neck).
Non-union.
- By:
 - Plate & screws.
 - Intramedullary screw.
 - Hook plate.



✓ Classification of Group 2 fractures: [“Just to understand”](#)

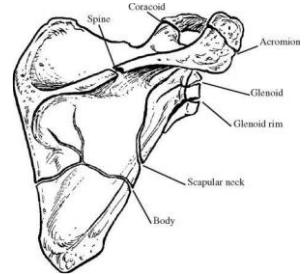


Type I-stable	Nondisplaced or minimally displaced (< 5mm) regardless of location.
Type II-unstable	Displaced ($\geq 5\text{mm}$)
IIA	Fracture medial to the CC ligaments: conoid & trapezoid intact.
IIB	Fracture medial to the CC ligaments: conoid torn & trapezoid intact.
IIC	Fracture medial to the CC ligaments: conoid & trapezoid torn.
IID	Comminuted fracture: CC ligament attached to inferior ligament.

Fracture Scapula

❖ Classification:

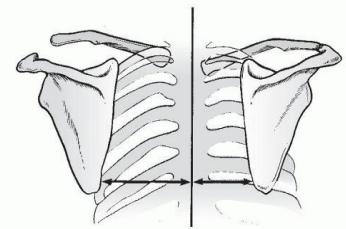
- Coracoid fractures.
- Acromial fractures.
- Glenoid fractures.
- Scapular neck fractures.
- Scapular body fractures.
- Scapulo-thoracic dissociation.



Scapulo-thoracic dissociation

❖ Anatomical consideration:

- Sliding joint.
- Articulates with ribs 2-7.



❖ Mechanism:

- Traumatic disruption of the scapulo-thoracic articulation.
- Usually caused by high energy trauma.

❖ Clinical picture:

- Pain is involved in the upper extremity.
- Significant swelling in shoulder region.
- Bruising around shoulder.
- Careful N-V examination.

❖ Investigations:

- X-ray.
- CT (intra-articular fracture / significant displacement).
- Angiogram (detect subclavian & axillary artery injury).



❖ Treatment:

- **Non-operative:**
 - Hemodynamically stable patient without vascular injury.
 - Sling immobilization.

- **Operative:**
 - Hemodynamically unstable patient (axillary & subclavian a. injury).
 - Open fracture.
 - Displaced scapula.

Shoulder Dislocation

❖ Anatomical points:

➤ Shoulder is the most dislocated joint:

- Shallow glenoid socket.
- Wide range of movement.
- Laxity (redundant inferior capsule).
- Humeral head 3 x larger than glenoid fossa.

❖ Common terminology:

➤ **Fracture:** Loss of continuity of the bone.

➤ **Dislocation:** Complete loss of contact between 2 articular surfaces (acute trauma).

➤ **Subluxation:** Partial loss of contact between 2 articular surfaces (repetitive trauma).

➤ **Laxity:** Partial loss of contact between 2 articular surfaces (asymptomatic).

➤ **Fracture dislocation:** Dislocation with fracture of one or more of the articulating bones.

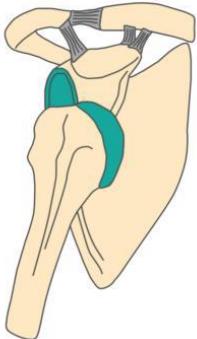
❖ **Types:**

- Anterior dislocation.
- Posterior dislocation.
- Inferior dislocation.

→ **Anterior Dislocation**

❖ **Mechanism:**

- **Direct:** trauma to the posterior shoulder.
- **Indirect:** forced abduction, extension & external rotation.



❖ **Clinical picture:**

➤ **Symptoms:**

- History of trauma.
- Pain at site of fracture.
- Swelling at site of fracture.
- Inability to move the related upper limb.

➤ **Signs:**

- Swelling.
- Deformity:
 - Loss of shoulder contour & loss of axillary concavity.
 - Prominent acromion & palpable humeral head anteriorly.

▪ Position:

- Patient hold affected limb with normal limb by side of body.
- Abduction and external rotation.

- Neurovascular examination (Musculocutaneous & Axillary nerve and artery)
- Tests:
 - Apprehension test: sense of instability and pain with ABER.
 - Dugas test: patient can't touch apposite shoulder.

❖ **Investigations:**

➤ **X-ray:**

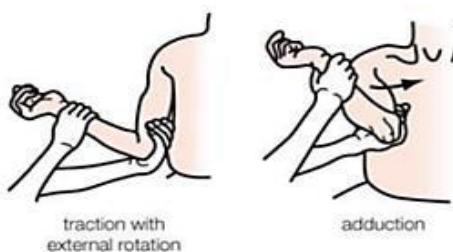
(A/P & lateral & Axillary view).

❖ **Management:**

➤ Reduction under GA.

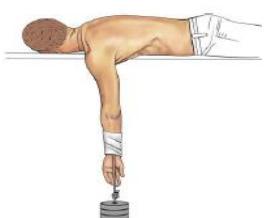
A) Kocher method (TEADI):

Traction >> External rotation >> Adduction >> Internal rotation.



B) Stimson method:

- Prone patient with affected extremity hanging off bed with 4.5 to 7 kg of weight.
- Reduction is usually achieved within 30 minutes.



C) Hippocratic method:

- Surgeon use foot applied on axilla for counter traction.

❖ **Complications:**

➤ **Early:**

- Rotator cuff tear.
- Nerve injury (axillary N).
- Vascular injury (axillary A).
- Fracture dislocation.

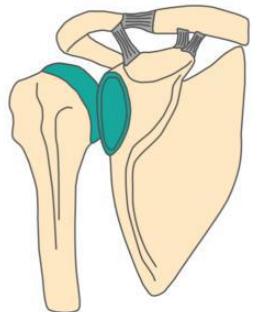
➤ **Delay:**

- Recurrent dislocation (commonest).
- Shoulder stiffness.
- Unreduced dislocation.

→ **Posterior Dislocation**

❖ **Mechanism:**

- **Direct:** trauma to the anterior shoulder.
- **Indirect:** forced internal rotation of abducted arm.
- **Epileptic fit or electric shock.**



❖ **Clinical picture:**

➤ **Symptoms:** As scheme.

➤ **Signs:**

- Swelling
- Deformity:
 - Flat front of shoulder.
 - Prominent posterior aspect of shoulder.
 - Prominent coracoid.
- Position:
 - Internal rotation of the affected limb.

❖ **Investigations:**

➤ **X-ray:**

- **AP:** electric bulb & empty glenoid sign.
- **Lateral:** post displacement.



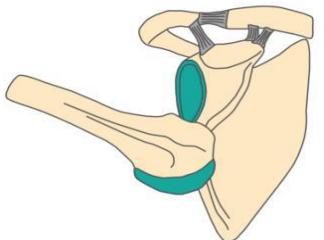
❖ **Treatment:**

- Reduction under GA.
- Pulling arm in adduction to disengage head.
- Then laterally (externally) rotate while pushing head anteriorly.

→ **Inferior Dislocation**

❖ **Mechanism:**

- Arm is in excessive abduction & a force is applied on the hand pushing the humeral head inferiorly out of the glenoid.



❖ **Clinical picture:**

- Limb in abduction.

❖ **Management:**

- Traction and counter traction.

Humerus & elbow

Humeral Fractures

Proximal humeral fracture

❖ Anatomical points:

- **Blood supply of proximal humerus:**
 - Posterior humeral circumflex A (Main blood supply).
 - Anterior humeral circumflex A.
 - Arcuate artery.

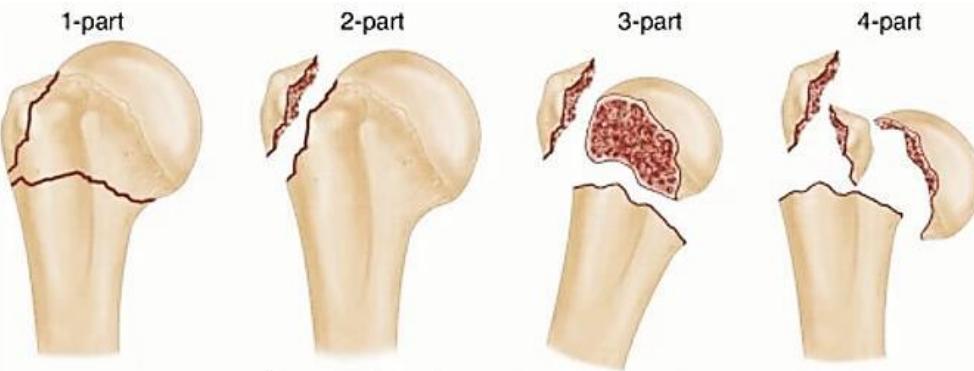
❖ Classification:

- **According to location:**

- Around anatomical neck.
- Around surgical neck
- Greater tuberosity.
- Lesser tuberosity.

- **According to anatomic relation of 4 segments (Neer's classification):**

One part fracture	No displacement (any part of segments).
Two-part fracture	One segment is displaced.
Three-part fracture	Two segments are displaced.
Four-part fracture	Three segments are displaced.



❖ Clinical picture:

- Pain at the site of fracture.
- Extensive ecchymosis of chest and arm.
- Flat shoulder (axillary nerve injury).
- Decreased range of motion.

❖ Investigations:

- **X-ray:**

- (A/P & lateral).

- **CT scan:**

- Pre-operative planning.
- Intra-articular communication.



❖ **Management:**

➤ **Non-operative:**

- Indications:
 - Minimally displaced fracture.
 - Displaced greater trochanteric fracture < 5 mm.
 - Surgically unfit patients.

▪ Methods:

- Sling immobilization followed by progressive rehabilitation.

➤ **Operative:**

Indication	Method
• 2-part surgical neck fractures.	Closed reduction & percutaneous pinning
• Displaced greater trochanteric fracture < 5 mm. • 2/3/4 -part fractures in younger patients. • Head-splitting fractures in younger patients.	Open reduction & internal fixation
• Combined proximal humerus & humeral shaft.	Intra-medullary rodding
• Anatomic neck # in elderly. • 4-part fractures & fracture dislocation. • Humeral head impression defect of > 40 % of articular surface.	Arthroplasty

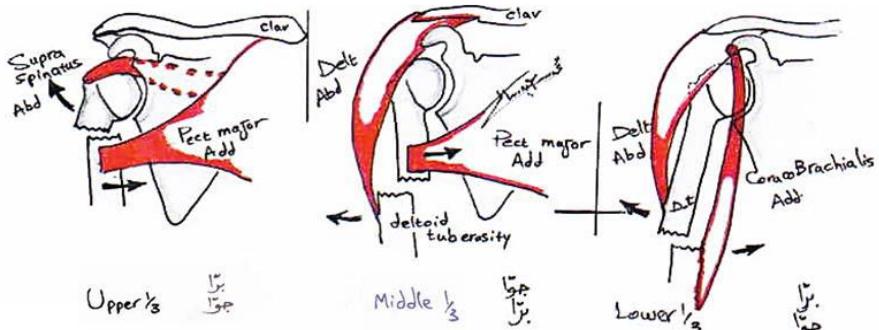
❖ **Complications:**

- Avascular necrosis: esp. with 4-part fractures.
- Axillary nerve injury: esp. with ORIF.
- Mal-union.
- Non-union: usually with surgical neck & tuberosity fractures.
- Rotator cuff injury and dysfunction.
- Post-traumatic arthritis.
- Infection.

→ **Humeral shaft fracture**

❖ **Classification:**

- **Upper 1/3 fracture:** just below surgical neck (upper fragment abducted by supraspinatus).
- **Middle 1/3 fracture:** above deltoid tuberosity (upper fragment adducted by Pectoralis major).
- **Lower 1/3 fracture:** below deltoid tuberosity (upper fragment abducted by deltoid)



❖ Clinical picture:

➤ **Symptoms:** As scheme

➤ **Signs:**

- Inspection:
 - Swelling/bruises / ecchymosis.
 - Position: patient support the arm by other hand.
- Palpation:
 - Tenderness / crepitations.
- Movement:
 - Limitation of movement of affected limb.
- Neurovascular examination:
 - Radial nerve injury.

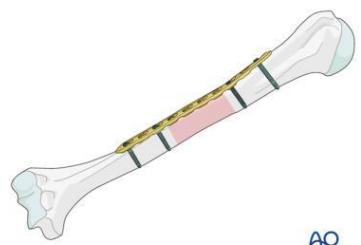
❖ Treatment:

➤ **Non-operative:**

- Indications:
 - Undisplaced simple fracture.
- Methods:
 - Closed reduction & fixation by cast.

➤ **Operative:**

- Indications:
 - Unstable / open / radial nerve palsy.
- Methods:
 - Plate & screws or intramedullary nail.



AO

Distal humeral fracture

❖ Classification:

- Supracondylar fractures: discussed later.
- Condylar fractures.
- Articular surface fractures (trochlea & capitulum).
- Epicondylar fractures.

Supra-condylar Fractures

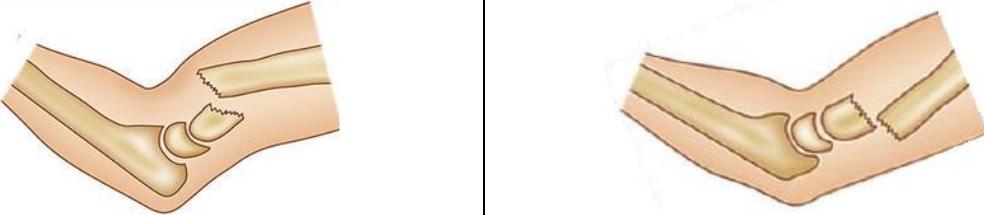
❖ Anatomical points:

- Fracture at distal metaphysis area just above the 2 condyles of humerus.
- **Commonest elbow injury in children.**
- 50% complete & 50 % greenstick.



❖ **Types:**

➤ Extension type	➤ Flexion type
Commonest type (95-98%).	Less common (2-5%).
Fall on outstretched hand.	Fall on tip of flexed tip.
Distal fragment: displaced posteriorly by triceps.	Distal fragment: displaced anteriorly by biceps & brachialis.



❖ **Clinical picture:**

➤ **Symptoms:** As scheme.

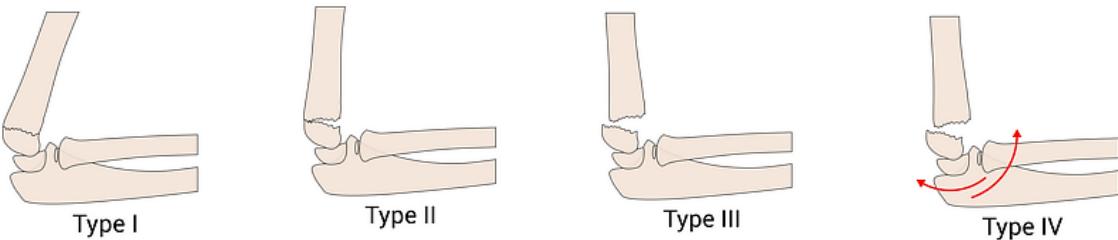
➤ **Signs:**

- **Inspection:**
 - Swelling/bruises / ecchymosis.
 - Deformity: S shaped deformity.
- **Palpation:** Tenderness / crepitations.
- **Movement:**
 - Limitation of movement of affected limb.
- **Neuro vascular examination:**
 - brachial artery injury & nerve injury (M/U/R).

❖ **Classification:**

➤ **Modified Gartland Classification of Supracondylar Fractures:**

Type I	Undisplaced	Fat pad present acutely
Type II	Hinged posteriorly	Anterior humeral line anterior to capitellum
Type III	Displaced	No meaningful cortical continuity
Type IV	Displaces into extension and flexion	Usually diagnosed with manipulation under fluoroscopic imaging
Medial comminution (not truly a separate type)	Collapse of medial column	Loss of Baumann's angle



❖ **Complications:**

➤ **Early Complications:**

- **Neurologic (7%):**
 - Results from traction, direct trauma or nerve ischemia.
 - Anterior Interosseous nerve:
 - High incidence with supracondylar fractures.

- No sensory component, Motor component must be tested (OK sign).
- Median nerve: (Posterior lateral displacement).
- Radial nerve: (Posterior medial displacement).
- Ulnar nerve: (uncommon).
- **Vascular Entrapment:**
 - Brachial Artery.
 - May result in Volkmann's sign.

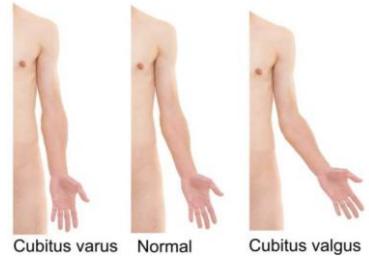
➤ **Late Complications:**

- Non-union.
- Mal-union (valgus / varus more).
- Loss of mobility.

❖ **Treatment:**

➤ **Non-operative:**

- **Indications:**
 - Simple fracture.
 - Greenstick fracture.
 - Displaced fracture in children.
- **Methods:**
 - Closed reduction.
 - Fixation by posterior slab or percutaneous pinning.



➤ **Operative:**

- **Indications:**
 - Adult fracture.
 - Failed closed (unstable).
 - Vascular injury not improved after closed reduction.
- **Methods:**
 - Open reduction & internal fixation by wires.



➤ **Displaced:**

- **Closed reduction & fixation:**
 - If extension: fix in flexion
 - If flexion: fix in extension
- **Open reduction & internal fixation:**
 - Failed closed
 - Vascular injury not improved
- **External fixation:**
 - If open fracture

➤ **Undiplased:**

- **Fixation:** above elbow back splint

Tennis Elbow

❖ **Lateral epicondylitis:**

occur due to repeated wrist extension (ECRB).

Golf Elbow

❖ **Medial epicondylitis:**

occur due to repeated elbow flexion.

Student's Elbow

❖ **Olecranon bursitis:**

occur due to pressure of friction.

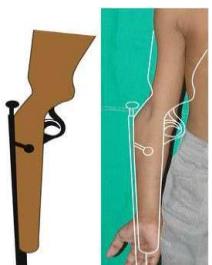
Cubitus Varus

❖ Cause:

- Malunion of supracondylar fracture.
- Also known as gun stock deformity.

❖ Treatment:

- Wedge osteotomy of humerus.



Condylar Fractures

❖ Medial condylar fracture:

- Occur due to fall on outstretched hand.
- Complicated by ulnar nerve paralysis.

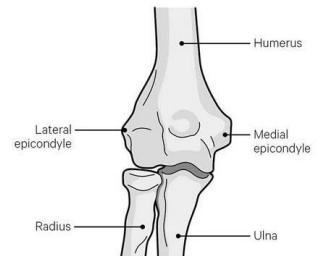
❖ Lateral condylar fracture:

- Occur due to fall on outstretched hand.
- Complicated by radial nerve injury.

Elbow Dislocation

❖ Anatomical points:

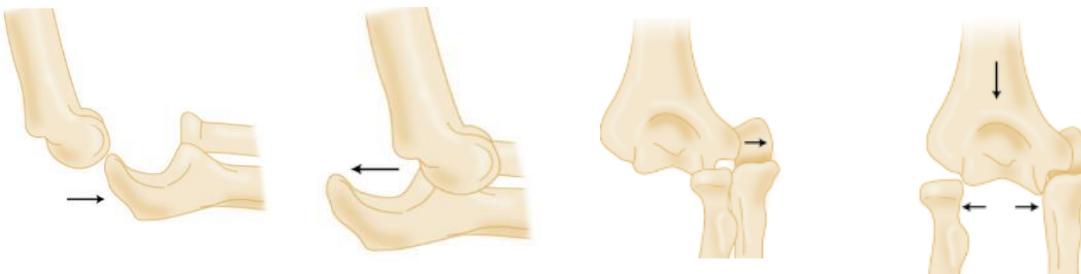
- Elbow joint is formed from:
 - Olecranon process of ulna: articulate with trochlea.
 - Head of radius: articulate with capitulum.
- Elbow dislocation the 2nd most common joint dislocation.
- It's more common in adults than in children.
- May be posterior (more common) or anterior.



❖ Types:

- Posterior dislocation
- Anterior dislocation
- Medial or lateral dislocation
- Divergent dislocation

Posterior dislocation	Anterior dislocation
• Commonest type (80%)	• Less common
• Fall on outstretched hand with elbow in mid flexion	• Direct trauma to elbow
• Ulna migrate backward	• Ulna migrate forward
• Associated with coronoid fracture & displaced laterally)	• Associated with olecranon fracture



❖ Clinical picture:

- Symptoms: As scheme.

➤ **Signs:**

- **Inspection:**
 - Swelling, bruises and ecchymosis.
 - **Deformity:** disturbed triangle between olecranon & medial & lateral epicondyles.
 - **Position:** patient support forearm with elbow in light flexion.
- **Palpation:**
 - Tenderness and crepitations.
- **Movement:**
 - Loss of all movement of affected limb.
- **Neurovascular examination:**
 - brachial artery injury + nerve injury (M/U/R).

❖ **Treatment:**

➤ **Posterior dislocations:**

- **Reduction & fixation:**
 - Never to reduce before X-ray: associated fracture (medico legality).
 - Reduce under GA muscle relaxant: downward then forward traction.
 - Check movement and perform X ray after reduction.
 - Fix with above elbow posterior slab.

➤ **Anterior dislocations:**

- ORIF

❖ **Differential diagnosis:**

	Extension supracondylar fracture	Posterior elbow dislocation
Age	Pediatric	Adult
Mobility	Limited	Lost
Elbow △	Normal	Disrupted
Supracondylar ridge	Interrupted	Normal
X-ray	Fracture line	Dislocation

Radius & Ulna

Fracture Proximal Ulna & Radius

Fracture olecranon of ulna

❖ **Mechanism:**

- Fall onto the point of the elbow.
- The olecranon will be broken by the distal end of the humerus.
- The fracture line is transverse and usually runs through the narrowest point of the bone.
- Olecranon Fractures are common fractures of the elbow that lead to loss of extension.

❖ **Clinical picture:**

	Intact triceps expansion	Torn triceps expansion
Clinically	Bruising / swelling / tenderness	
Extension of elbow	Possible	Lost
Palpable gap	Not detected	Detected
Treatment	Doesn't need reduction	Open reduction & internal fixation

N.B:

- Comminuted fractures and those with a very small proximal segment are treated by excision of the fragment and reattachment of the triceps.

Fracture coronoid process of ulna

❖ Types:

- **Isolated:** Avulsion by brachialis muscle.
- **Associated:** With posterior dislocation of the elbow.

❖ Clinical picture:

- Reduction and plaster cast for 3 weeks.
- Occasionally operative repair is indicated.

Fracture head of radius

❖ Mechanism:

- Associated with an episode of elbow instability / mechanical block to elbow motion.
- Complicated by posterior interosseous nerve injury finger drop.

❖ Treatment:

- **Nonoperative:**
 - Non displaced fractures without a mechanical block to motion.
- **Operative:**
 - Displaced fractures or Fractures associated with mechanical block to motion.
 - Elbow or forearm instability.

Fracture Distal Ulna & Radius

Colles' fracture

❖ Anatomic points:

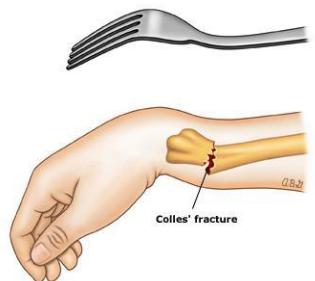
- Extra articular fracture occurs 1 inch above distal end of radius
- Displaced upwards “posteriorly”, backwards and radially.
- Inferior radio-ulnar subluxation.
- Occur in:
Fatty, female, fall on outstretched hand, > forty postmenopausal osteoporosis.

❖ Clinical picture:

- **Symptoms:** As scheme.

- **Signs:**

- **Inspection:**
 - Swelling, bruises and ecchymosis.
 - **Deformity:**
 - Dinner fork deformity.
 - Radial styloid process become elevated to level of ulnar styloid.
- **Palpation:**
 - Tenderness with NO crepitations.
- **Movement:**
 - Loss of active movement and painful passive movements.



- Neurovascular examination:
 - Radial artery injury and median nerve injury

❖ **Complications:**

- **Malunion.**
- **Subdeck's atrophy:**
 - It's a reflex sympathetic dystrophy with increased blood flow to peri articular areas.
 - Severe pain causing sympathetic stimulation & VC >> local osteoporosis >> more pain.
- **Madelung:**
 - Epiphyseal dislocation occurs in children.
 - Radius doesn't grow properly forcing the ulna out of position.
- **tiff fingers and shoulder.**
- **Rupture of extensor polices longus.**
- **Median nerve injury.**

❖ **Investigations:**

- **X-ray:**
 - **AP view:** Fracture line / radial shortening / lateral shift.
 - **Lateral view:** Dorsal displacement of distal fragment / subluxation of inferior radio-ulnar joint.

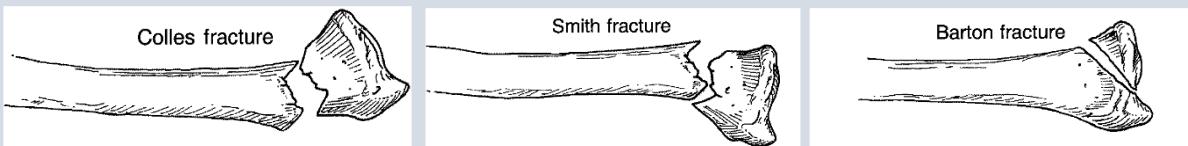


❖ **Treatment:**

- Traction of the hand as if shaking hands.
- Counter traction of the humerus.
- Done through 3 grips:
 - Traction along the long axis of the limb in order to disimpact the fragments.
 - Pressing the distal fragment anteriorly with palmer flexion and pronation.
 - Pushing the distal fragment towards the ulna to correct radial displacement.
- Fixation by:
 - Below elbow cast fixing the wrist in palmer flexion & ulnar deviation.
 - If associated with fracture ulnar process above elbow cast.

N.B:

- 1) **Colles' fracture:** extra articular fracture of distal radius and posterior displacement of distal fragment.
- 2) **Smith's fracture:** extra articular fracture of distal radius and anterior displacement of distal fragment.
- 3) **Barton's fracture:** intra articular fracture in which rim of distal radius is displaced with the hand.

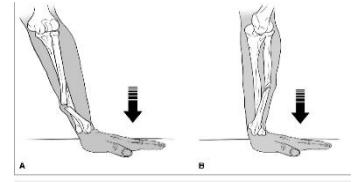


✓ **Fractures in postmenopausal females:**

- Surgical neck of humerus.
- Neck of femur.
- Colles' fracture.

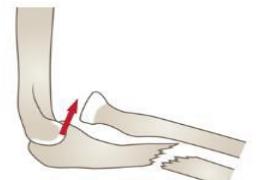
→ Galeazzi fracture dislocation

- ❖ Inferior radio-ulnar joint dislocation and Fracture lower 1/3 radius
- ❖ Closed reduction of head of ulna and ORIF of radius



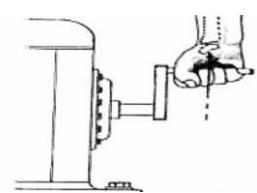
→ Monteggia fracture dislocation

- ❖ Superior radio-ulnar joint dislocation and Fracture upper 1/3 ulna
- ❖ Closed reduction of head of radius and ORIF of ulna



→ Chauffeur's fracture

- ❖ Fracture styloid process of radius.
- ❖ May be caused by:
 - Manuvela which was used to start cars.
 - Avulsion force forcible abduction.
 - Compression force impact of the carpal bone.
- ❖ Treated by below elbow cast for 6 weeks.



N.B:

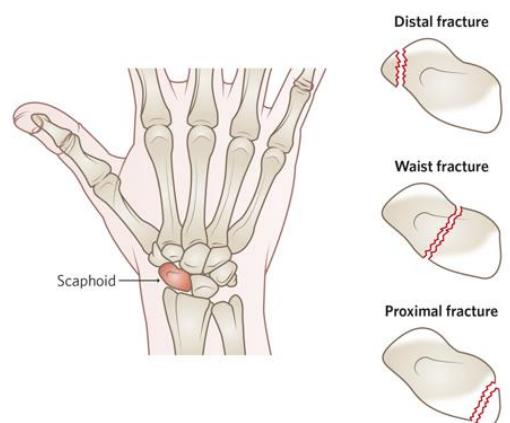
- Generally, shaft fractures need ORIF to avoid loss of pronation and supination.

Hand

Fractures of the hand

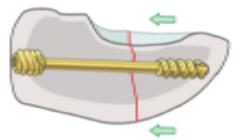
→ Scaphoid fracture

- ❖ Commonest hand fracture.
- ❖ **Classification:**
 - Waist of scaphoid (commonest).
 - Proximal third.
 - Distal tubercle.
- ❖ **Clinical picture:**
 - Often trivial and suggest sprain rather than fracture.
 - Pain in wrist with no gross impairment of function.
 - Tenderness below radial styloid process (anatomical snuff box).
- ❖ **Investigations:**
 - **X-ray:**
 - AP/lateral/oblique.
 - May not show the fracture immediately so reimaging should be done in 2 weeks.



❖ **Treatment:**

- **Casting:** below elbow including proximal phalanx of thumb (abducted thumb) for 8 weeks.
- Internal fixation with Screw (Herbert screw).



→ **Fracture shaft of metacarpal**

- ❖ Transverse or oblique.
- ❖ No much displacement.
- ❖ Several metacarpal fractures with gross angulations.

❖ **Treatment:**

- **Undisplaced:** Casting.
- **Displaced:** Closed or open reduction.



→ **Fracture neck of fifth metacarpal**

❖ **Trauma:**

A blow with the closed fist.

❖ **Pathology:**

The head of the metacarpal is tilted forewords.

❖ **Treatment:**

Reduction and splintage.



→ **Fracture neck of the base of the thumb metacarpal**

❖ **Bennett's fracture:**

- Intraarticular fracture of metacarpal + dislocation at trapezio-metacarpal joint.

❖ **Fracture base not involving the joint:**

- Transverse fracture which occurs within half an inch from trapezio-metacarpal joint.

→ **Dislocation of M.P & I.P. joints**

- ❖ MP dislocation Usually posterior dislocation.
- ❖ May be complex dislocation.

→ **Fracture shaft of metacarpal**

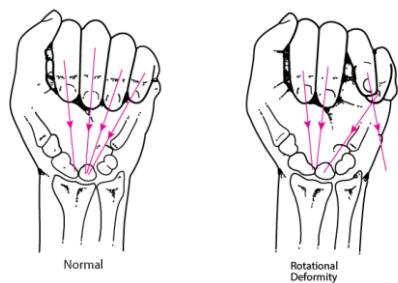
- ❖ Usually, transverse.
- ❖ Usually angulated forward by action of lumbricals and interosseous muscles.

❖ **Treatment:**

- Correction of angulation.
- Fix only the injured finger in mid position.
- Correct rotation (towards the tuberosity of the scaphoid).
- 3 weeks only immobilization And Elevation of the hand.

✓ **Fall on outstretched hand leads to:**

- Clavicle fracture.
- Supracondylar fracture in children.
- Posterior elbow dislocation.
- Colles' fracture in elderly.
- Scaphoid fracture.



Pelvic region

Fracture pelvis

❖ Anatomical points:

- The pelvis is a ring structure.
- No inherent stability.
- Stability is conferred by soft tissues.
- **Dangerous area as it's close to:**
 - Blood vessels (hematoma can be up to 4 L).
 - Nerves.
 - Viscera.

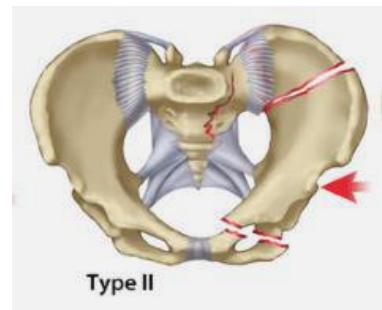
❖ Mechanism:

- Road traffic accident in young adults (< 60 y).
- Fall at home in elderly.

❖ Classifications:

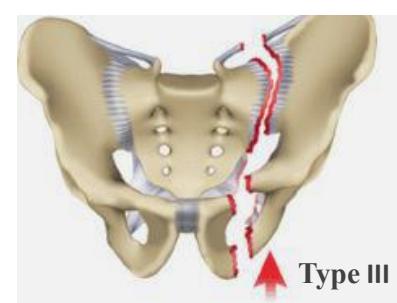
1) Young Burgess Classification:

- Lateral compression → **Type 2: Rotationally unstable.**
- Vertical shear (Unstable Malgaigne) → **Type 3: Globally unstable.**



2) Torode and Zieg classification:

- Type I → **Avulsion injuries (ASIS: Sartorius / AIIS: Rectus).**
- Type II → **Fractures of the iliac wing.**
- Type III → **Fractures of the ring with no segmental instability.**
- Type IV → **Fracture of the ring with segmental instability.**



❖ Stability:

➤ **Stable:**

- Avulsion injuries & Iliac wing fracture.
- Sacrum & coccyx fractures.
- Single break of iliac ring.

➤ **Unstable:**

- Butterfly fracture.
- Open book fracture.
- Vertical force fracture dislocation.

❖ Clinical Picture:

➤ **Symptoms:**

- History of major trauma.
- Pain at site of fracture.
- Swelling at site of fracture.
- Inability to move the affected limb.
- Shock due to severe hemorrhage.
- Urinary symptoms: **Hematuria & inability to pass urine.**

➤ **Signs:**

F. Inspection:

- Ecchymosis, swelling and bruises.
- Deformity:

Leg may be externally rotated due to opening of the pelvis.

Leg may be short due to displacement.

G. Palpation:

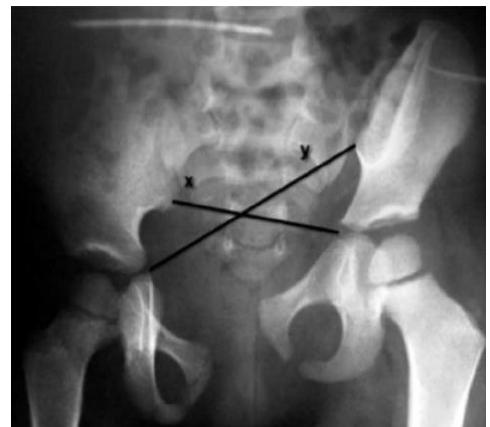
- Tenderness & crepitus.
- Gap at symphysis pubis.

H. Range of movement:

- Limitation of active movement.
- But passive may be elicited.

I. Neurovascular examination & visceral examination:

- Sciatic nerve & iliac arteries.
- Urogenital examination.
- DRE: Early sign (large hematoma or palpable fracture line on DRE).
- PV: for Vaginal injuries.



❖ Complications:

➤ **Early:**

- Hemorrhagic shock & MOF & death (10%).
- Soft tissue injury with open fractures.
- Sciatic nerve injury.
- DVT from prolonged recumbency & PE.

○ **Visceral injuries:**

- Intra pelvic urethral injury: Urine retention.
- Extra-peritoneal bladder rupture.
- Rectal and Vaginal injuries.
- Paralytic ileus due to retroperitoneal hematoma.

➤ **Late:**

- Infection & osteomyelitis.
- Mal-union & Non-union.
- Urinary incontinence & sexual dysfunction.
- Osteoarthritis of the sacroiliac joint & hip joint.

❖ Treatment:

➤ **First aid (ABCDE):** Pelvic binders to Provide temporary stabilization & reduce volume loss.

➤ **Conservative:** Bed rest and analgesics for 6 weeks for stable fractures.

Usually, hip fractures are caused by major trauma, so the first aim of management is to stabilize the patient then to correct fracture

Hip Dislocation

❖ Anatomical points:

➤ Stability of the hip is provided by:

- Deep acetabulum & small head.
- Capsule & ligaments of the joint.
- - Ve intra-articular pressure.
- Muscles around hip.

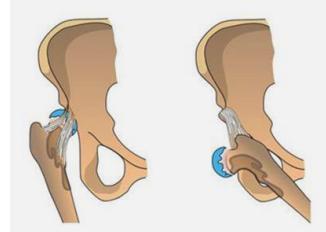
➤ Types of hip dislocation (etiological):

- Congenital (DDH).
- Traumatic (discussed in detail).
- Pathological.
- Paralytic (polio).

❖ Classifications:

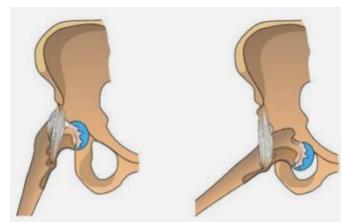
➤ Posterior Dislocation:

- Dashboard accident (most common)
- Fall of heavy object on back of stopping individual
- Limb is **flexed adducted & internally rotated**
- Femoral head **palpated posteriorly**
- Shortening of the limb
- Narthes sign **difficulty to elicit femoral pulse**



➤ Anterior Dislocation:

- Less common
- Forced abduction, flexion and external rotation
- Limb is flexed abducted & externally rotated
- Femoral head palpated over pubic or perineum
- Lengthening of the limb



➤ Central Dislocation:

- Usually due to direct trauma to **lateral aspect of hip (greater trochanter)**
- Associated with **acetabular floor fracture**

❖ Investigations:

➤ X-Ray:

- Displaced femoral head
- Empty acetabulum
- Interrupted Shenton's line
- Associated fractures



❖ Management:

➤ Emergent reduction:

- Aim:
 - Relief pain
 - Relief pressure on sciatic nerve
 - Reduce risk of AVN of femoral head
- Methods:
 - Closed reduction under general anesthesia
 - Open reduction if closed reduction failed or associated fracture

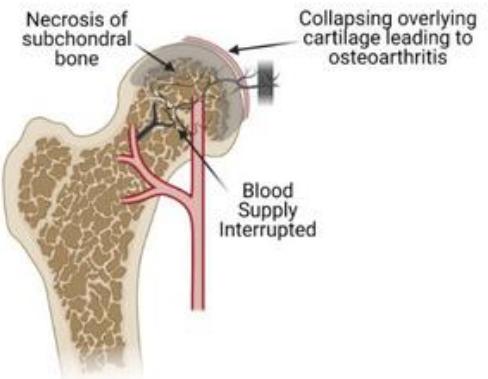
❖ Complications:

➤ Early:

- Sciatic nerve injury (Post. Dislocation)
- Femoral artery injury (Ant. Dislocation)
- Femoral nerve injury
- Fractures of the head & neck
- Associated knee injuries

➤ Late:

- AVN of the femoral head
- Osteoarthritis
- Heterotopic ossification
- Hip instability
- Prolonged recumbency (DVT / PE)



Femur

Proximal Femoral Fractures

I. Femoral head fracture:

➤ Intra-capsular neck fractures:

Neck fractures are naturally bad as they are:

1. Intracapsular: No obvious clinical deformity.
2. No periosteum: No callus formation.

▪ Mechanism:

- High energy trauma in young.
- Low energy trauma in elderly females “postmenopausal osteoporosis”.

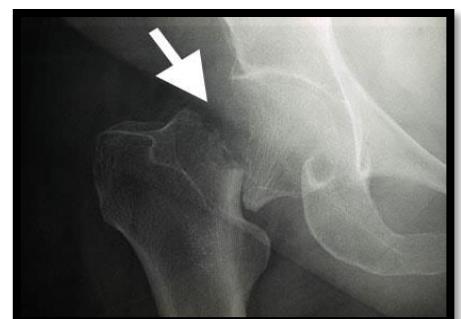
▪ Clinical picture:

➤ Symptoms:

- Impacted fractures: pain in groin & medial side of thigh and knee
- Displaced fractures: pain in entire hip & inability to bear weight.

➤ Signs:

- Impacted fractures: no obvious clinical deformity, Pain with percussion on Greater trochanter & motion.
- Displaced fractures: External rotation, Abduction & shortening.



▪ **Classification:**

► [Garden Classification:](#)

Garden Classification	Simplified Classification	Description
I	Non-displaced	Incomplete
II		Complete fracture but nondisplaced
III	Displaced	Complete fracture, partial displacement
IV		Complete fracture fully displaced

► [Anatomical Classification:](#)

- Sub-capital.
- Trans-cervical.
- Basi-cervical.

▪ **Investigations:**

► [X-Ray:](#)

- AP view (pre-reduction & post-reduction): Traction internal rotation.
- Cross table lateral view.
- Full length femur.

► [CT:](#)

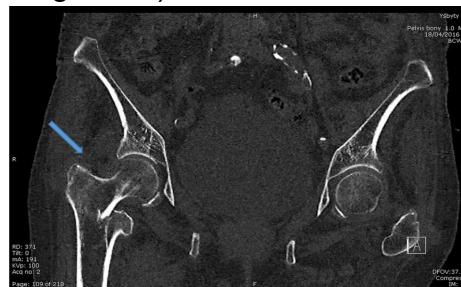
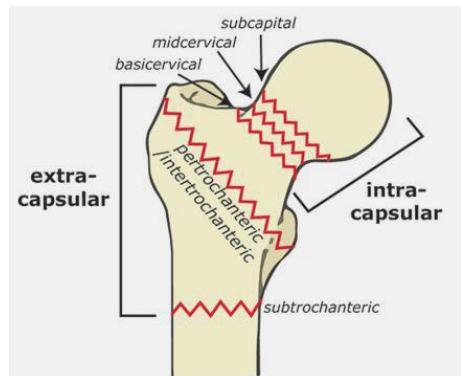
- Post-reduction to access (loose bodies / fragments).

► [MRI:](#) bone marrow edema

- If you suspect occult fracture.
- Not reliable in assessing viability of femoral head.

▪ **Management:**

Treatment is usually operative since conservative treatment have several complications.



► [Non-displaced fractures \(Garden type 1-2\):](#)

- Also known as valgus impacted fractures.
- No need for reduction.
- Internally fixed by cannulated screws.

► [Displaced fractures \(Garden type 3\)](#)

- **If young (< 60 years):** Urgent closed or open reduction & fixation by cannulated screws, Anatomical reduction is essential.
- **If elderly (> 60 years) / Type 4 fractures:** Hemiarthroplasty (Bipolar) for Less active patients with low functional demand.

- If elderly (> 60 years) / Type 4 fractures: Total hip replacement (THR) for Active patients / Arthritic hip.

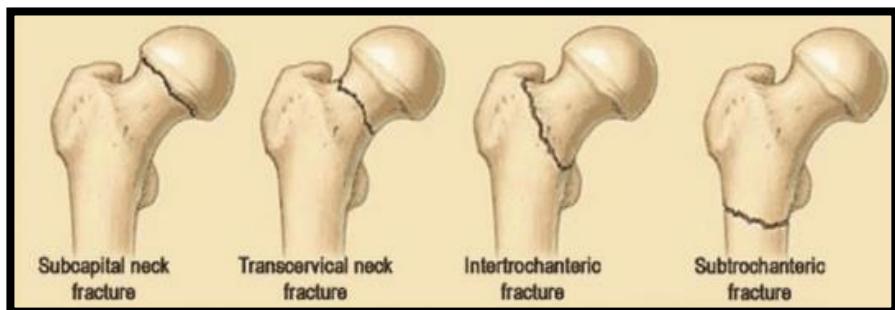
▪ **Complications:**

- AVN (most common) → 2ry arthritis.
- Non-union.
- Neurovascular injury (sciatic nerve).
- Death (elderly).
- Prolonged recumbency: DVT, PE, bed sores and chest infection.

➤ **Extra-capsular neck fractures:**

▪ **Types:**

- ⇒ Inter-trochanteric fractures.
- ⇒ Per-trochanteric fractures.
- ⇒ Trochanteric fractures.
- ⇒ Subtrochanteric fractures.



▪ **Management:**

Operative treatment is not mandatory as the blood supply of the 2 fragments is good and no avascular necrosis and un-union may occur.

► **Non-Operative Management:**

By traction in bed used only for unfit patients as it has many disadvantages as:

- ↑ Morbidity
- ↑ Mortality
- Unsatisfactory results

► **Operative Management:**

▪ **Trochanteric fractures:**

- Stable fracture: ORIF by dynamic hip screw
- Unstable fracture: ORIF by proximal femoral nail

▪ **Sub-trochanteric fractures:**

- Internal fixation by cephalomedullary nail



II. Femoral shaft fracture

Occur in children & young adults due to severe violence

➤ **Classification:**

- Upper third: proximal end Abducted By gluteus, distal end Adducted by adductors
- Lower third: proximal end displaced Forward by quadriceps; distal end displaced backward by hamstring.

➤ **Clinical picture:**

▪ **Symptoms:**

- History of severe trauma.
- Pain at site of fracture.

- Swelling at site of fracture: **blood loss up to 1-1.5 L in closed fracture (doubled in open).**
- Inability to **move the affected limb.**

▪ **Signs:**

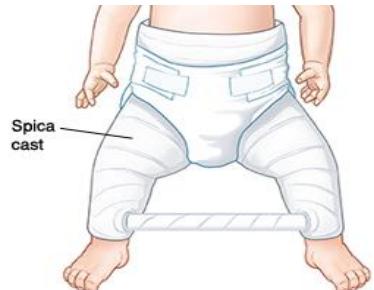
- **Inspection:**
 - Ecchymosis, swelling and bruises.
 - Deformity Shortening and Displacement.
- **Palpation:** Tenderness & crepitus.
- **Range of movement:** Limitation of active movement.
- **Neurovascular examination & visceral examination:**
 - **Femoral or popliteal artery.**
 - **Lateral popliteal nerve** may be injured by the outer bar of Thomas splint.

▪ **Complications:**

- Malunion (rotation).
- Delayed union & nonunion.
- Infection.
- Vascular injury & Nerve injury.
- Knee stiffness.
- Iatrogenic fracture: neck of femur.

▪ **Management:**

- First aid:
 - **Stabilize patient (ABCDE).**
 - **Thomas splint:**
 - ↓ Pain.
 - ↓ Blood loss.
 - ↓ Soft tissue injury.
- Pediatric patient:
 - **Less than 6 months:** Pavlik harness and Hip spica.
 - **6 months – 5 years:** Hip spica either immediate or after traction.
 - **5-11 years:** Elastic nails and Plate & screws.
 - **> 11 years:** Plate & screws and Interlocking nail.
- Adult patient:
 - **Gold standard:** Interlocking nail.
 - **Plate & screws:** More complications, less popular.
 - **External fixator:** For Open fractures, Vascular injury and in Polytrauma.



Proximal Femoral Fractures

I. Supra-condylar Femoral Fractures:

- Associated with **Popliteal Artery Injury.**
- Treated by open reduction & Internal fixation by plate & screws.



II. Intra-condylar Femoral Fractures:

- Treated by open reduction & Internal fixation by plate & screws.



Knee & Leg

Meniscus Tear

❖ Functions of knee meniscus:

- It increases stability of the knee.
- Control complex rolling & gliding of the joint.
- Distribution load during movement.

❖ Pathology:

- Injuries are more in medial meniscus (more weight & less mobile).
- Tear is usually longitudinal (bucket handle tear).
- May be transverse tear (parrot beak).
- Meniscus is avascular so tears don't heal unless it's peripheral (vascularized from capsule).
- Caused by twisting of flexed knee during playing.

❖ Clinical picture:

- **Symptoms:**
 - History of knee injury.
 - Pain at knee.
 - Recurrent knee swelling and effusion.
 - Limping gait with inability to continue the game.
- **Signs:**
 - Knee effusion.
 - Incomplete knee extension when it's locked.
 - Tenderness on joint medially.
 - **+ve McMurray's sign:** Click sound when the knee is rotated in certain degree of flexion.

❖ investigations:

- MRI (most reliable).

❖ Management:

- **Conservative:** If no lock knee:
 - Rest.
 - Ice.
 - Compression.
 - Elevation.
- **Operative:** joint can't be unlocked / recurrent:
 - Meniscectomy.

Anterior Cruciate Ligament Tear (ACL)

- ✓ More commonly injured than PCL & produce more instability.
- ✓ Mainly due to hyperextension / Valgus / internal rotation (sudden twisting movement).
- ❖ Clinical features:
 - Causes anterior tibial translation.
 - Giving way.
 - Lachman test (most sensitive test).
 - Anterior drawer test.
 - Pivot shift test.
 - ✓ Needs reconstruction most commonly hamstring autograft OR patellar graft.



Posterior Cruciate Ligament Tear (PCL)

- Less common.
- Mainly due to dashboard injuries or hyperextension knee injuries.
- Rarely isolated (most associated with posterolateral corner injury).
- ❖ Clinical features:
 - Causes posterior tibial translation.
 - +ve posterior drawer test (most accurate).
 - +ve sag sign.
 - ✓ Isolated injury could be treated conservatively in brace.
 - ✓ Combined injuries need reconstruction.



Patellar Fracture

I. Transverse fracture:

- **Cause:** Indirect injury (Sudden flexion of extended knee).
- **Displacement:** Separation of 2 fragments "Rupture of quadriceps expansion".
- **Clinical picture:**
 - Pain & tenderness over the patella.
 - Knee swelling with +ve patellar tap (hemarthrosis).
 - Active extension is intact but painful.
 - In displaced transverse fracture there is loss of active extension.
 - A gap is felt in the patella in displaced transverse fracture.
- **Complications:**
 - Hemarthrosis.
 - Osteoarthritis.
 - Stiffness of knee.
- **Investigations:**
 - Plain x-ray (As in general rules of fractures).
- **Treatment:**
 - In all cases: Physiotherapy for quadriceps muscle.
 - Undisplaced: Above knee cast for 6 wk.
 - Displaced: ORIF by wire suture or screw.



II. Comminuted fracture:

- **Cause:** Direct injury (Fall on the patella).
- **Displacement:** No separation of fragments "Intact quadriceps expansion"
- **Clinical Picture:**
 - Pain & tenderness over the patella.
 - Knee swelling with +ve patellar tap (hemarthrosis).
 - Active extension is intact but painful.
- **Complications:**
 - Hemarthrosis.
 - Osteoarthritis.
 - Stiffness of knee.
- **Investigations:**
 - Plain x-ray (As in general rules of fractures).
- **Treatment:**
 - Patellectomy with reconstruction of extensor apparatus.



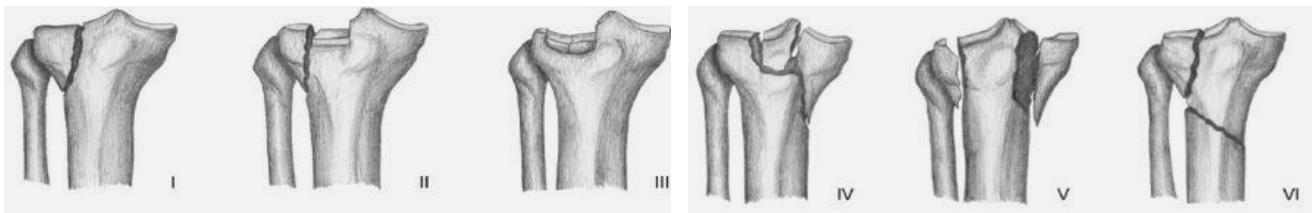
Knee Joint Dislocation

KD-I	Single Cruciate and Collateral injury
KD-II	ACL and PCL injury
KD-III M	ACL, PCL and MCL injury
KD-III L	ACL, PCL and LCL & PLC injury
KD-IV	ACL, PCL, MCL, and LCL & PLC injury
KD-V	Dislocation and Fracture

Tibial Plateau Fractures

❖ Classifications:

- I. Lateral plateau fracture without depression.
- II. Lateral plateau fracture with depression.
- III. Compression fracture of the lateral or central plateau.
- IV. Medial plateau fracture.
- V. Bicondylar plateau fracture.
- VI. Plateau fracture with diaphyseal discontinuity.



❖ **Mechanism:**

- Valgus producing force Lateral plateau fracture.
- Varus producing force Medial plateau fracture.
- Axial compressive force Bicondylar plateau fracture.
- Combination of High Energy with Bicondylar plateau fracture.

❖ **Clinical picture:**

➤ **Symptoms:**

- History of trauma.
- Pain at site of fracture.
- Swelling at site of fracture.
- Limitation of movement.

➤ **Signs:**

- Inspection: Bruises, Ecchymosis and Swelling.
- Palpation: Tenderness and crepitations.
- Range Of Movement: limitation of movement.
- Neurovascular examination.

❖ **Complications:**

➤ **Acute:**

- Neurovascular injuries.
- Compartmental syndrome.
- Skin sloughing.

➤ **Chronic or late:**

- Knee arthritis.
- Stiffness.
- Knee instability.
- Soft tissue injuries.
- Infection.
- Septic arthritis.
- Nonunion.
- Malunion (Deformity).

❖ **Treatment:**

➤ **Spanning External Fixator :**

- Temporary stabilization.
- Allow for resolution of soft tissue injuries.

➤ **Definitive ORIF :**

- Varus /valgus instability.
- > 5mm articular step off.
- Good soft tissue conditions.

➤ **Hybrid or circular fixator :**

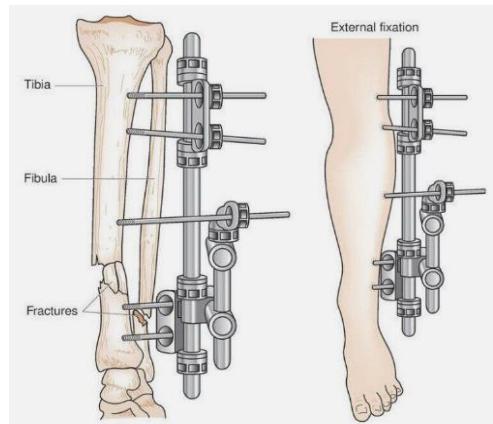
- For open & severe comminution.

Treatment Guidelines

- Restore articular surface congruity
- Buttress the metaphyseal segment
- Elevate the depression
- Structural support under the

✓ **Indications For External Fixator:**

- **Temporary (Uniplanar):**
 - Open fractures of long bones
 - Spanning: Dislocations & peri-articular fracture
- **Definitive (Multiplanar):**
 - Open fractures with bad soft tissue conditions
 - Non united long bone fractures
 - Bone lengthening and deformity correction
- **Special:**
 - Pelvic ring fractures



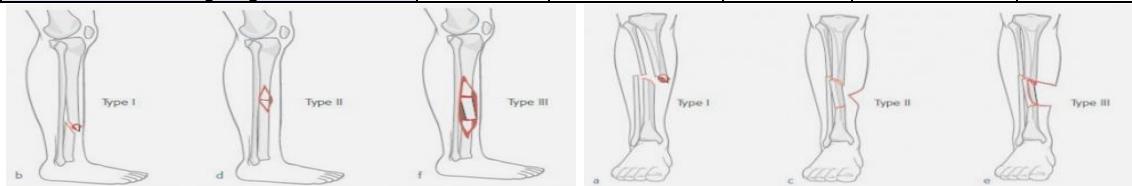
Tibial Shaft Fractures

❖ **Classification:**

➤ **Gustillo classification for open fractures:**

- Stages and parameters:

Parameter/ Stage	I	II	II-A	III-B	III-C
○ Energy of mechanism	low	Moderate		High	
○ wound size	<1cm	>1cm		Usually >10 cm	
○ Soft tissue injury	Low	Moderate		Extensive	
○ Contamination	No	Low	Sever	Variable	
○ Comminution	No or simple	Some or simple		Sever or complex	
○ Soft tissue coverage	Yes	Yes	Yes	No	Variable
○ Vascular injury	No	No	No	No	Yes



➤ **Johnner and Wruh's Classification:**

- Stages:
 - Simple.
 - Butterfly.
 - Comminuted.

➤ Tscherne Classification of Soft Tissue Injury:

- Grades:
 - Grade 0: Negligible soft tissue injury
 - Grade 1: Superficial abrasion or contusion
 - Grade 2: Deep contusion from direct trauma
 - Grade 3: Extensive contusion and crush injury with possible severe muscle injury

❖ **Mechanism of fracture:**

- Lower energy: Torsion type injury (skiing)
- Higher energy: More common / direct force (car bumper)
- Mostly associated with fibula fractures
- Open fractures of the tibia are more common than in any other long bone

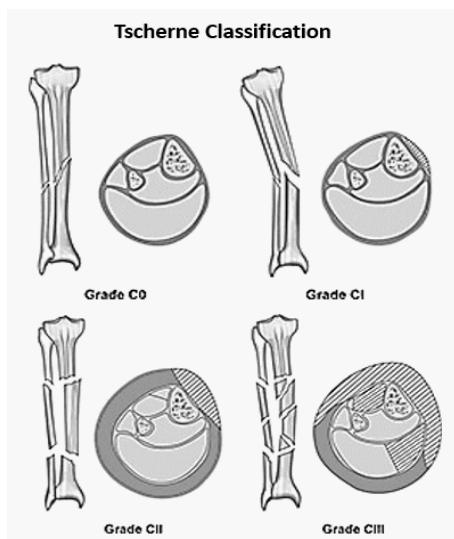
❖ **Treatment of Open Tibial Fractures:**

• **Initial management:**

- ABC'S.
- Associated Injuries.
- Irrigation.
- Debridement.
- Anti-Tetanus.
- Antibiotics.
- External Fixation.

• **Definitive management:**

- Soft tissue coverage:
 - Proximal 1/3 fracture: Gastrocnemius rotation flap
 - Middle 1/3 fracture: Soleus rotation flap
 - Distal 1/3 fracture: Free flap
- Bone fracture in adults:
 - Intra-medullary nail: Most common & Has Advantages
 - ORIF with plates
 - External fixator
 - Cast
- Bone fracture in children:
 - Above knee cast: for non-displaced fractures in Age less than 5 years
 - Nancy (gliding) nails: for Displaced fractures in Age more than 5 years



Advantages of Intra-medullary nail:

- Lower non-union rate.
- Smaller incisions.
- Earlier weight bearing and function.
- Single surgery.

Tibial Pilon Fractures

❖ Pearls:

- Fractures involving distal tibia metaphysis and into the ankle joint.
- Soft tissue management is key.
- Often occurs from fall from height or high energy injuries in MVA.
- Excellent results are rare, "Fair to Good" is the normal outcome.

❖ Complications:

- Mal or Non-union (Varus).
- Soft Tissue Complications.
- Infection.
- Ankle arthritis – Stiffness.
- Vascular injuries.
- Potential Amputation.

❖ Management:

▪ Initial evaluation:

- Plain films, CT scan.
- Spanning External Fixator (Pass the joint).

▪ Definitive care:

- IM nail with limited ORIF.
- ORIF with plate and screws (Most common).
- External Fixator.



Treatment goals

- Restore Articular Surface
- Minimize Soft Tissue Injury
- Establish Length
- Avoid Varus Collapse

Ankle & Foot

Ankle Fractures

❖ Anatomical points:

Ankle joint is formed by articulation of the lower end of tibia & fibula and upper end of talus

➤ Stability is maintained by:

- Lateral collateral ligament (fibular)
- Medial collateral ligament (tibial) = deltoid

➤ Syndesmosis anatomy:

- AITFL: Anterior Inferior Fibula-tibular Ligament.
- PIITL: Posterior Inferior Fibula-tibular Ligament.
- IOL: Inter-Osseous Ligament.

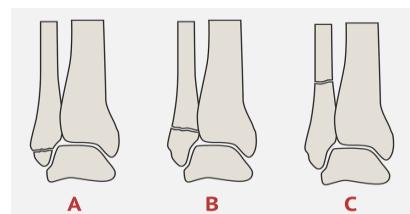
Surgical Note:

Mortise is the connection at the joint

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❖ Classification of Weber-Danis:

- A. Fibula Fracture distal to mortise.
- B. Fibula Fracture at the level of the mortise.
- C. Fibula Fracture proximal to mortise.

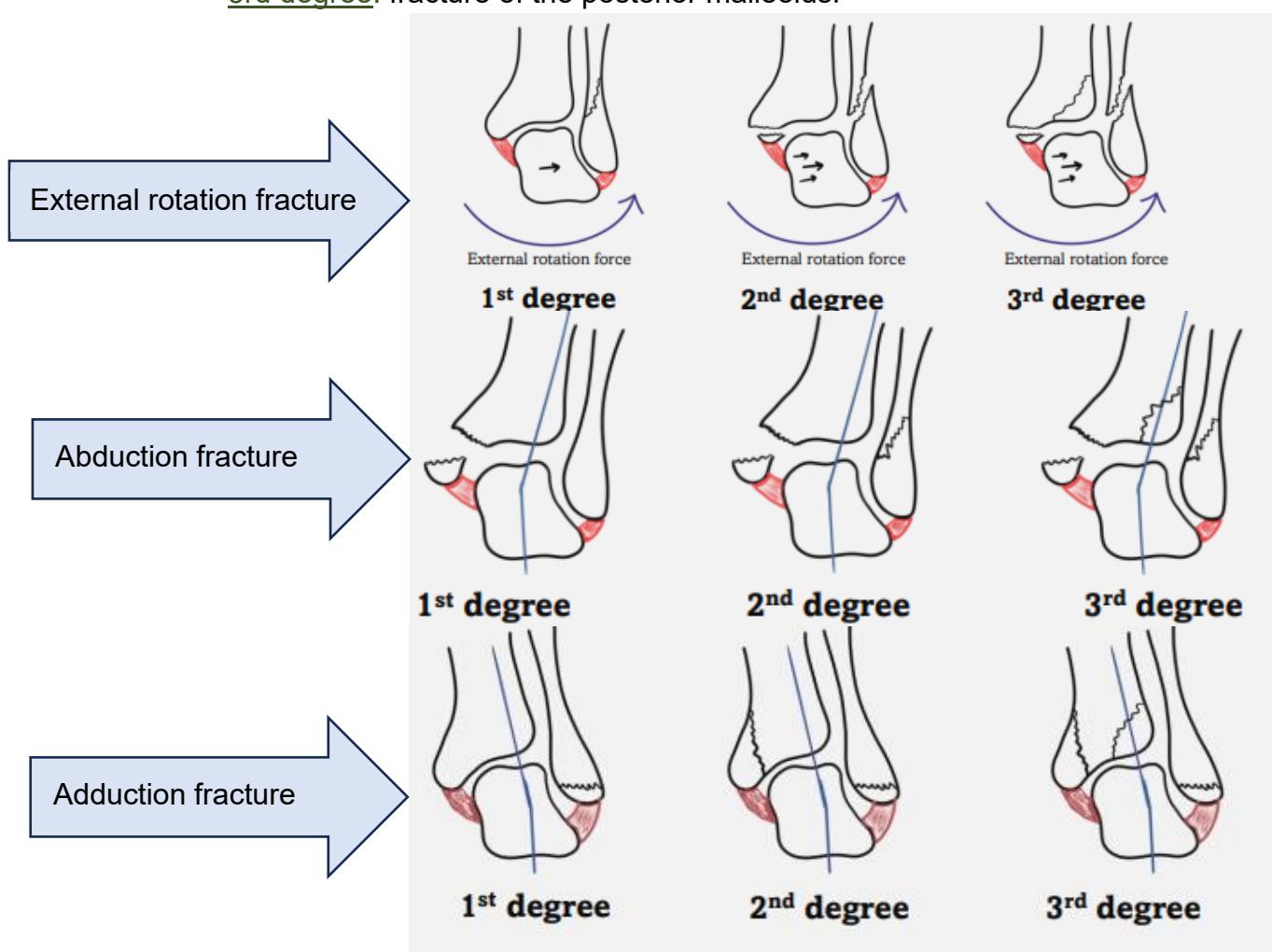


❖ **Mechanism:**

- **External rotation fracture (Pott's fracture):**
 - Commonest type.
 - Occurs due to forcible external rotation of foot.
- **Internal rotation fracture:**
 - Very rare.
 - Occurs due to forcible internal rotation of foot.
- **Abduction fracture (eversion):**
 - Occurs due to fall on everted foot.
- **Adduction fracture (inversion):**
 - Occurs due to fall on inverted foot.
- **Vertical compression fractures:**
 - Occurs due to fall from a height on foot.

❖ **Trauma classification:**

- Generally, there are 3 degrees:
 - 1st degree: fracture or avulsion of medial or lateral malleolus.
 - 2nd degree: avulsion or fracture of the other malleolus.
 - 3rd degree: fracture of the posterior malleolus.



❖ Investigations:

➤ AP of ankle:

- Tibiofibular overlap: < 10mm is abnormal - implies syndesmotic injury.
- Tibiofibular clear space: > 5mm is abnormal - implies syndesmotic injury.
- Talar tilt: >2mm is considered abnormal.

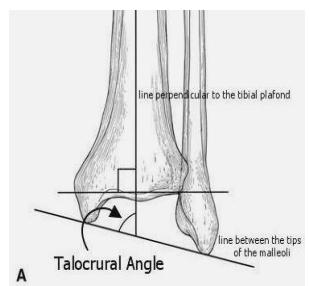
➤ Lateral view of ankle:

- Posterior malleolar fractures.
- Anterior/posterior subluxation of the talus under the tibia.
- Displacement/Shortening of distal fibula.
- Associated injuries.



➤ Mortise of Ankle (Weight Bearing if possible):

- Foot is internally rotated and AP projection is performed
- Abnormal findings:
 - ✓ Medial joint space widening.
 - ✓ Talocrural angle 15 degrees (compare to normal side).
 - ✓ Tibia/fibula overlap <1mm.



★ Maisonneuve injury:

- Proximal fibula fracture associated with medial malleolus fracture.

★ Dupuytren fracture:

- Rupture of the inferior tibio-fibular ligament.
- Separation of tibia & fibula.
- Talus is derived between the 2 bone & fracture of the 3 malleoli.

❖ Management:

➤ Initial Management:

- Closed reduction (conscious sedation may be necessary).
- Below knee splint.
- Delayed fixation until soft tissues stable.

➤ Non-operative Definitive treatment:

▪ Indications:

- Non-displaced fracture with intact syndesmosis and stable mortise.
- < than 3 mm displacement of the isolated fibula fracture with no medial injury.
- Unstable patients who would not tolerate an operative procedure.

▪ Methods:

- Short leg cast or CAM boot for 12 weeks.
- Non weight bearing for 6 weeks.
- Repeat x-ray at 7–10 days to r/o interval displacement.

➤ Operative Definitive treatment:

▪ Indications:

- Bimalleolar fractures.
- Tri malleolar fractures.
- Talar subluxation.
- Articular impaction injury.
- Syndesmotic injury.



- Methods:
 - Fibula: Lag Screw if possible and Plate & Confirm length/rotation.
 - Medial malleolus: Open reduction with 4-0 cancellous screws vs. tension band.
 - Posterior malleolus: Fix if >30% of articular surface.
 - Syndesmosis: Stress after fixation, Fix with 3 or 4 cortex screws.

Talus Fractures

❖ Anatomical points:

- Talus has complex shape with 70% covered by cartilage and no muscles attached to it.
- Articulates with tibia and fibula to form ankle joint.
- Articulate with calcaneus to form subtalar joint.
- It consists of: Body, neck, head and lateral process.

❖ Incidence:

- High energy trauma.

❖ Investigations:

- Lateral and AP view.
- Canale view: Provide optimal view of talar neck
 - Technique: Max. equines at 15-degree pronation.
 - X ray in Maximum equines.



❖ Treatment:

- ORIF by screws.

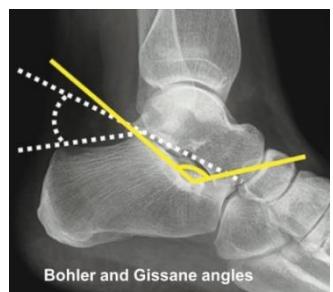
❖ Complications:

- Avascular necrosis of talus: Common complication, the presence of Hawkins's sign is indicator for good vascularity and revascularization
- Ankle and subtalar arthritis

Calcaneus Fractures

❖ Anatomical points:

- Calcaneus has complex shape.
- Articulate with talus to form the subtalar joint.
- Tendo-Achillis is attached to its posterior tuberosity.



❖ Incidence:

- Axial load or high energy trauma

❖ Investigations:

- CT scan is mandatory.
- Boehler angle: Abnormal if less than 25 degrees.
- Gissane angle: Normal 120 to 140 degrees...Increase in fracture.

❖ Treatment:

- Conservative: for Undisplaced fractures, Normal angles.
- Operative: ORIF is the standard.

- Subtalar arthrodesis: for Severely comminuted fractures.
- ❖ Complications:
 - Subtalar arthritis (most common).
 - Infection.
 - Wound dehiscence.
 - Malunion in Varus.



Bone infection

Osteomyelitis:

❖ Summary:

- Is a severe, persistent and incapacitating infection of bone and bone marrow.
- In the pediatric population is most often the result of hematogenous seeding of bacteria to the metaphyseal region of bone.
- Diagnosis is generally made with MRI studies to evaluate for bone marrow edema or subperiosteal abscess.
- Treatment is non operative with antibiotics in the absence of an abscess.
- Surgical debridement is indicated in the presence of an abscess

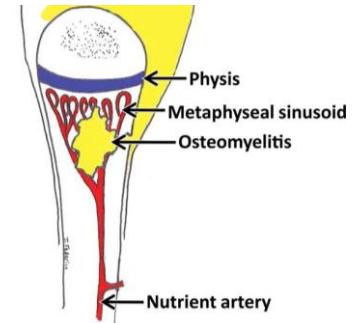
❖ Epidemiology:

➤ Anatomic location:

- In children typically metaphyseal via hematogenous seeding hematogenous

➤ Risk Factors:

- Diabetes mellitus.
- Hemoglobinopathy.
- Rheumatoid arthritis.
- Chronic renal disease.
- Immune compromise



❖ Etiology:

➤ Mechanism of spread:

- Hematogenous (most common).
- Contiguous-spread.
- Direct-inoculation

A. Hematogenous:

- **Most common etiology in children.**
- Originated or transported by blood.
- May be due to bacterial or viral systemic illness

B. Contiguous-spread:

- Certain soft tissue infections may spread to adjacent bones.
- Example An infection of the pulp of the fingertip, called a felon, frequently extends to and infects the distal phalanx



C. Direct-inoculation:

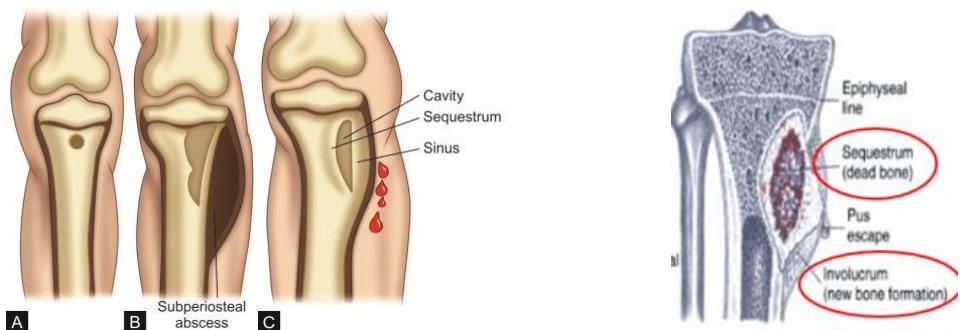
- Penetrating injuries.
- Open fractures.
- Surgical contamination

➤ Microbiology:

- **Staph aureus:** is the most common organism in all children.
- Group B Strep: is most common organism in neonates.
- Pseudomonas: is associated with direct puncture wounds to the foot.
- Salmonella: is the more common in sickle cell patients.

❖ Pathogenesis:

- Bone is normally resistant to bacterial colonization.
- Bacteria form a biofilm in the metaphysis (primary focus).
- Biofilms protect bacteria from host immune response.
- Abscess in metaphysis.
- Sub periosteal abscess.
- Sequestrum formation (bone death).
- Involucrum formation (New brittle bone formation).
- Pus perforates periosteum and forms abscess in soft tissues.
- Abscess bursts on surface and forms discharging sinus.
- Necrosis: stage of new bone formation >involucrum > with sequestrum inside, there will always be a persistent discharging sinus > pus from bone escapes through multiple holes in involucrum (cloacae).
- Pus spreads into vascular channels > raising intraosseous pressure > impairing blood flow >chronic ischemic necrosis >separation of large devascularized fragment >new bone formation > involucrum

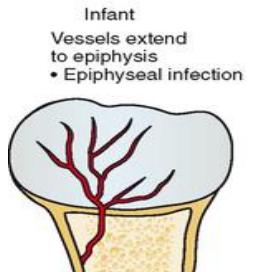


❖ Classification:

- Acute osteomyelitis.
- Subacute osteomyelitis.
- Chronic osteomyelitis.

➤ **Acute Osteomyelitis:**

- Introduction:
 - Most cases are hematogenous.
 - Initial bacteremia may occur from a skin lesion infection or even trauma from tooth brushing.
- Microscopic Activity:
 - Sluggish blood flow in metaphyseal capillaries due to sharp turns results in venous sinusoids which give bacteria time to lodge in this region.
 - The low pH and low oxygen tension around the growth plate assist in the bacterial growth.
 - Infection occurs after the local bone defenses have been overwhelmed by bacteria.
 - Spread through bone occurs via Haversian and Volkmann canal systems.
 - Purulence develops in conjunction with osteoblast necrosis, osteoclast activation and the release of inflammatory mediators, and blood vessel thrombosis.
 - Subperiosteal abscess develops when: the purulence breaks through the metaphyseal cortex.



- Septic arthritis develops when: the purulence breaks through an intra-articular metaphyseal cortex (hip, shoulder, elbow, and ankle) (NOT KNEE).
- Infants <1 year of age can have infection spread across the growth plate via capillaries causing osteomyelitis in the epiphysis and septic arthritis.

➤ **Subacute Osteomyelitis:**

• **Summary:**

- Uncommon infection with bone pain and radiographic changes without systemic symptoms.
- Increased host resistance, decreased organism virulence, and/or prior antibiotic exposure.

➤ **Chronic Osteomyelitis:**

• **Summary:**

- Periosteal elevation deprives the underlying cortical bone of blood supply leading to necrotic bone (sequestrum).
- Sequestrum: the necrotic bone which has become walled off from its blood supply and can present as a nidus for chronic osteomyelitis.
- An outer layer of new bone is formed by the periosteum (involucrum).
- Involucrum: a layer of new bone growth outside existing bone seen in osteomyelitis.
- Chronic abscesses may become surrounded by sclerotic bone and fibrous tissue leading to a Brodie's abscess.



❖ **History:**

- Recent local infection or trauma.
- Obtain immunization history regarding H.influenza.
- Ask about prior antibiotic use, as it may mask symptoms

❖ **Clinical Picture:**

➤ **Symptoms:**

- Fever (more common in acute osteomyelitis).
- Pain.
- Swelling.
- Limp or refusal to bear weight (in children).
- Sinus discharging puss (in chronic osteomyelitis)



➤ **Signs:**

- **Inspection & palpation:**
 - Restricted motion due to pain.
 - Draining sinus tract.
- **Range of motion:**
 - Edematous, warm, swollen, red tender limb.



❖ **Investigations:**

➤ **Radiographs:**

- Early films may be normal or show loss of soft tissue planes and soft tissue edema.
- New periosteal bone formation (5-7 days).
- Osteolysis (10-14 days).
- Late films (1-2 weeks) show metaphyseal rarefaction (reduction in metaphyseal bone density).

- **CT:**
 - Indication: Bone changes as sequestrum.
 - **MRI:**
 - Detects abscesses and early marrow and soft tissue edema.
 - Indication: assist with decision making for surgical drainage.
 - **Bone Scan:**
 - Technetium-99m can localize the focus of infection and show a multifocal infection.
 - **Serum Labs:**
 - **WBC count:**
 - Elevated in 25% of patients, correlates poorly with treatment response.
 - **C – Reactive Protein:**
 - Elevated in 98% of patients with acute hematogenous osteomyelitis.
 - Elevated within 6 hours.
 - Most sensitive to monitor therapeutic response.
 - Declines rapidly as the clinical picture improves.
 - Best indicator of early treatment success and normalizes within a week.
 - Failure of the CRP to decline after 48 to 72 hours of treatment should indicate that treatment may need to be altered.
 - **ESR:**
 - Elevated in 90% of patients with osteomyelitis patients.
 - Rises rapidly and peaks in three to five days but declines too slowly to guide treatment.
 - Less reliable in neonates and sickle cell.
 - **Aspiration:**
 - Assists in diagnosis and management.
 - Helps guide antibiotic selection when organism identified (50% of the time).
 - **Biopsy & Culture:**
 - Considered when diagnosis not clear (i.e., subacute osteomyelitis) and need to rule out malignancy.
- ❖ **Management:**
- **Non-Operative: Antibiotic therapy alone**
 - **Indications:**
 - Early disease.
 - No subperiosteal abscess or abscess within the bone.
 - And if clinical improvement obtained within 48 hours
 - **Methods:**
 - Begin with empiric therapy.
 - Generally, nafcillin or oxacillin, unless high local prevalence of MRSA (then use clindamycin or vancomycin).
 - Mechanism of action for vancomycin involves binding to the D-Ala moiety in bacterial cell walls.
 - If gram stain shows gram-negative bacilli - add a third-generation cephalosporin.
 - Convert to organism-specific antibiotics if organism identified.



- Mycobacterium tuberculosis treatment for initial 1 year is multiagent antibiotics and rarely surgical debridement due to risk of chronic sinus formation

- **Duration:**

- Typically treat with IV antibiotics for four to six weeks (controversial duration).

➤ **Operative: Surgical drainage, debridement, and antibiotic therapy**

- **Indications:**

- Deep or subperiosteal abscess.
- Failure to respond to antibiotics.
- Chronic infection.

Pyogenic Osteomyelitis

❖ **Complications:**

- Pathologic fracture.
- Secondary amyloidosis
- Endocarditis.
- Sepsis.
- Squamous cell carcinoma if the infection creates a sinus tract.
- Rarely sarcoma in the affected bone.



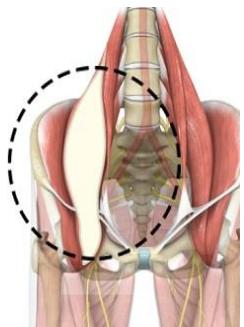
Tuberculous Osteomyelitis

❖ **Route of entry:**

- Usually, blood borne and originate from a focus of active visceral disease.
- Direct extension (e.g., from a pulmonary focus into a rib or from tracheobronchial nodes into adjacent vertebrae) or spread via draining lymphatics.

❖ **Sites:**

- The most common sites of skeletal involvement are:
 - Thoracic and lumbar vertebrae.
 - Then knees and hips.
- Pott's disease is the involvement of spine.
- In patients with AIDS frequently multifocal.
- The infection breaks through the intervertebral discs and extends into the soft tissues forming abscesses (e.g., Psoas Abscesses).



❖ **Histopathology:**

- Collections of epithelioid histiocytes and lymphocytes with caseation necrosis.

❖ **Clinical Picture:**

- Pain.
- Fever.
- Weight loss.
- May form an inguinal mass " psoas abscess"



❖ **Complications:**

- Bone destruction.
- Tuberculous arthritis.
- Sinus tract formation.
- Amyloidosis.

Septic Arthritis

❖ **Summary:**

- Septic Arthritis is the inflammation of the joints secondary to an infectious etiology.
- **Most commonly affecting:**
 - The Knee.
 - Hip.
 - Shoulder.
- **Diagnosis:**
 - Is made with an aspiration of joint fluid with a WBC count $> 50,000$ being considered diagnostic for septic arthritis.
 - Lower counts may still indicate infection in the presence of positive gram stains or cultures results.

❖ **Risk factors:**

- Age > 80 years.
- **Medical conditions:**
 - Diabetes.
 - Rheumatoid arthritis.
 - Cirrhosis.
 - HIV.
- History of crystal arthropathy.
- Endocarditis or recent bacteremia.
- IV drug user.
- Recent joint surgery.



❖ **Pathophysiology:**

- **3 Etiologies of bacterial seeding of joint:**
 - Bacteremia.
 - Direct Inoculation.
 - Contiguous spread.
- **Direct inoculation is from trauma or surgery.**
- **Contiguous spread is from adjacent osteomyelitis**
- **Cellular biology**
 - Septic arthritis causes irreversible cartilage destruction in an involved joint.
 - Caused by release of proteolytic enzymes from inflammatory cells (PMNs).
- **Microbiology:**
 - Most common pathogen is Staphylococcus Aureus (accounts for $>50\%$ of cases).

❖ **Clinical Picture:**

➤ **Symptoms:**

- Pain in affected joint.

- Fever (only present in 60% of cases).
- May appear toxic

➤ **Signs:**

- **Inspection:**
 - Erythema.
 - Effusion.
 - Extremity tends to be in position of maximum joint volume.
 - Hip would be in FABER position (flexed, abducted, externally rotated).
- **Palpation:**
 - Warmth.
 - Tender.
- **Range of motion:**
 - Inability to bear weight.
 - Inability to tolerate PROM.



❖ **Investigations:**

➤ **Radiographs:**

- AP and lateral of the joint in question.
- **Findings:**
 - May show joint space widening or effusion.
 - Periarticular osteopenia



➤ **Ultrasound:**

- **Indications:**
 - May help in confirming joint effusion in large joint such as hip.
 - Can be used in guiding aspirations



➤ **MRI:**

- **Indications:**
 - Detects joint effusion.
 - May detect adjacent bone involvement such as osteomyelitis.

➤ **Serum Labs:**

- Elevated WBC >10K cells/mL.
- Elevated ESR >30 mm/hr.
- Elevated CRP >1 mg/dL.
- ESR is often elevated but may be normal early in process,
- ESR rises within 2 days of infection and can rise 3-5 days after initiation of appropriate antibiotics, and returns to normal 3-4 weeks.
- CRP is most helpful as it's best way to judge efficacy of treatment, as CRP rises within few hours of infection, and may normalize within 1 week of treatment.

➤ **Joint fluid aspirate:**

- Gold standard for treatment and allows directed antibiotic treatment.

○ **Should be analyzed for:**

- Cell count with differential.
- Gram stain.
- Culture.
- Glucose level.
- Crystal analysis.

- Septic arthritis occurs concurrently with gout or pseudogout in < 5% of cases.
- **Characteristic findings:**
 - Joint fluid appears cloudy or purulent.
 - Cell count with WBC > 50,000 is considered diagnostic for septic arthritis, however lower counts may still indicate infection if organism is isolated on culture or gram stain.
 - Gram stains only identifies infective organism 1/3 of time.
 - Glucose less than 60% of serum level.

❖ **Differential diagnosis:**

➤ **Crystal Arthropathy:**

- Gout.
- Pseudogout.

➤ **Cellulitis**

➤ **Bursitis:**

- Prepatellar bursitis.

❖ **Treatment:**

- IV antibiotics, operative irrigation and drainage of the joint.
- Considered an orthopedic surgical emergency.

○ **IV antibiotic therapy:**

▪ **Initiate empiric therapy prior to definitive cultures based on patient age and or risk factors:**

- i. Young, healthy adults:
 - ✓ *Staphylococcus aureus*.
 - ✓ *Neisseria gonorrhoea*.
- ii. Immunocompromised patients:
 - ✓ *Staphylococcus aureus*.
 - ✓ *Pseudomonas aeruginosa*.

▪ **Transition to organism-specific antibiotic therapy based once obtain culture sensitivities.**

- Outcomes: Treatment can be monitored by following serum WBC, ESR, and CRP levels during treatment.

❖ **Complications:**

- Arthritis.
- Fibrous ankylosis.
- Osteomyelitis

Hip Septic Arthritis

❖ **Summary:**

- Pediatric Septic Hip Arthritis is an intra-articular infection in children that peaks in the first few years of life.
- While diagnosis may be suspected by a combination of history, physical exam, imaging, and laboratory studies, confirmation requires a hip aspiration.
- Considered a surgical emergency and requires prompt recognition and urgent surgical I&D followed by IV antibiotics.

❖ **Epidemiology:**

➤ **Location:**

- Hip joint involved in 35% of all cases of septic arthritis.

- Knee joint involved in 35% of all cases of septic arthritis.

❖ **Risk Factors:**

- Prematurity (relatively immunocompromised).
- Cesarean section.
- Patients treated in the NICU.
- **Invasive procedures such as:**
 - Umbilical Catheterization.
 - Venous Catheterization.
 - Heel Puncture

❖ **Etiology:**

- Direct inoculation: from trauma or surgery (skin penetration).
- Hematogenous seeding: upper respiratory infection precedes about 80% of the cases.
- **Extension from adjacent bone (Osteomyelitis):**
 - Can develop from contiguous spread of osteomyelitis.
 - Often from metaphysis.
 - Common in neonates who have transphyseal vessels that allow spread into the joint.
- **Joints with intra-articular metaphysis include:**
 - Hip
 - Shoulder
 - Elbow
 - Ankle
 - (NOT the knee).

❖ **Pathophysiology:**

- Enzymatic Destruction: release of proteolytic enzymes (matrix metalloproteinases) from inflammatory and synovial cells, cartilage, and bacteria which may cause articular surface damage within 8 hours.
- Increased joint pressure: may cause femoral head osteonecrosis if not relieved promptly.

❖ **Clinical Picture:**

➤ **History:**

- Recent local trauma or infections.
- Recent or current antibiotics may mask symptoms

➤ **Symptoms:**

- Acute onset of pain (presents more acutely than osteomyelitis).
- **Systemic symptoms:** often associated with fever and other systemic symptoms causing toxic appearance.
- Limp or refusal to bear weight

➤ **Signs:**

○ **Vitals:**

- Temperature and vital signs to rule out hemodynamic instability.
- May show toxicity

○ **Inspection and palpation:**

- Localized swelling.
- Effusion, tenderness, and warmth.
- Hip rests in a position of Flexion, ABduction, and External Rotation (FABER).
- Hip capsular volume is maximized with flexion, abduction, and external rotation and is the position of comfort for hip septic arthritis.

- **Range Of Motion:**
 - Severe pain with passive motion.
 - Severe pain with logrolling of the hip.
 - Unwillingness to move joint (pseudo paralysis).
 - Examine adjacent joints and spine
- **Must rule out adjacent joint involvement**

❖ **Investigation:**

➤ **Radiographs:**

- AP and frog-leg lateral pelvic x-rays, if hips can be put in frog leg position.
- **Findings:**
 - May be normal, especially in early stages of disease.
 - Widening of the joint space.
 - Subluxation.
 - Dislocation.
 - Bone lesions.
 - May see bone involvement with associated osteomyelitis



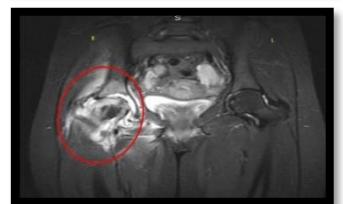
➤ **Ultrasound:**

- Can be used to guide aspiration.
- May be helpful to identify effusion.
- Cannot differentiate between a septic and a sterile effusion.



➤ **MRI:**

- May be difficult to obtain expeditiously.
- Identifies a joint effusion and possible adjacent osseous involvement which can guide operative treatment.



➤ **Serum Labs:**

- **WBCs:**
 - Is elevated in 30-60% of patients with a left shift in 60%.
 - Neonates may have leukopenia.
- **ESR:**
 - Often elevated but may be normal early in the course of infection
- **CRP:**
 - May rise as soon as 6-8 hours after injury or infection.
 - CRP > 2.0 (mg/dl) / (20 mg/l) is an independent risk factor (not included in studies of the previous 4 criteria).
 - CRP < 2.0 (mg/dl) is suggestive of an alternative diagnosis (i.e., transient synovitis).
 - CRP > 2.0 (mg/dl) in combination with refusal to bear weight yields a 74% probability of septic arthritis
- **Order of sensitivity of above criteria:**
 - Fever > CRP > ESR > refusal to bear weight > WBC.



➤ **Hip aspiration:**

- May confirm diagnosis of septic arthritis.
- **Fluid samples should be sent for:**
 - WBC count with differential.

- Gram stain, culture, and sensitivities.
- Glucose and protein levels have been recommended by some, but of questionable value.
- **Aseptic joint aspirate will show:**
 - High WBC count ($> 50,000/\text{mm}^3$ with $> 75\%$ PMNs).
 - PMN percentage more sensitive than total WBC count.
 - 85% PMNs correlates with an 88% sensitivity.
 - Glucose 50 mg/dl less than serum levels.
 - High lactic acid level with infections due to gram positive cocci or gram-negative rods.
- ❖ **Differential diagnosis:**
 - **Hip aspiration:**
 - Transient synovitis.
 - Osteomyelitis.
- ❖ **Diagnosis:**
 - **Made by a combination of:**
 - History.
 - Physical exam.
 - Imaging.
 - Laboratory studies.
 - **While the Kocher Criteria is commonly used, no one algorithm is diagnostic alone:**
 - **Original Kocher Criteria (Four criteria):**
 - WBC $> 12,000 \text{ cells}/\mu\text{l}$ of serum.
 - Inability to bear weight.
 - Fever $> 101.3^\circ \text{ F}$ (38.5° C).
 - ESR $> 40 \text{ mm/h}$.
 - **Algorithm:**
 - Probability of septic arthritis may be as high as 99.6% when all four criteria above are present.
 - If none of the above predictors are present, probability of having septic arthritis is $<0.2\%$.
 - 3% incidence of septic arthritis if 1/4 criteria present.
 - 40% incidence if 2/4 criteria present.
 - 93% incidence if 3/4 criteria present.
 - **Modified Kocher Criteria (additional criteria):**
 - CRP $> 20 \text{ mg/l}$.
- ❖ **Treatment:**
 - Urgent surgical I&D followed by IV antibiotics.
 - Standard of care for septic hip joints.
 - If possible, in septic arthritis it is better to be on the side of surgical drainage.
 - **Considered a surgical emergency:**
 - In the hip due to chondrolytic effect of pus.
 - Removes damaging enzymes which are chondrolytic.
 - Reduces intra-articular pressure and decreases epiphyseal ischemia.

❖ **Complications:**

➤ **Femoral head destruction:**

- Complete destruction of the femoral head and neck, easily visible on x-ray.
- Treated by salvage operations exist including varus/valgus proximal femoral osteotomies.

➤ **Femoral neck deformity:**

- Physeal damage leads to late angular deformity and leg length discrepancy

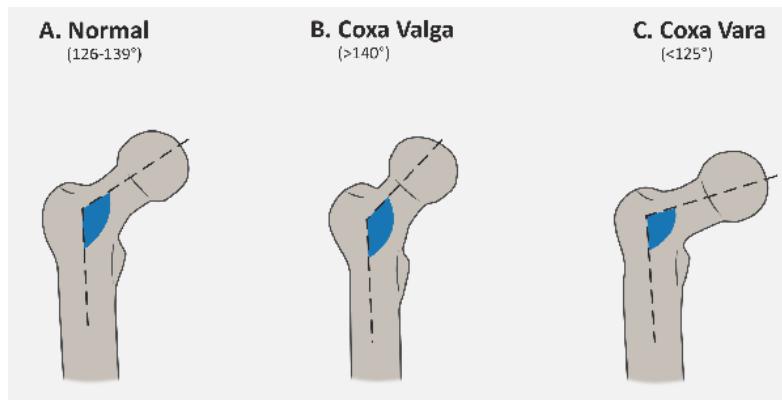
➤ **Joint contracture.**

➤ **Limb-length discrepancy.**

➤ **Osteonecrosis**

➤ **Growth disturbance**

- Patients should be followed up for 1-2 years to monitor for physeal arrest



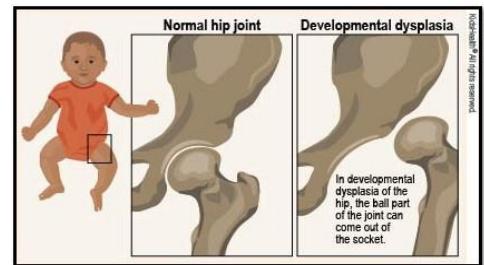
Developmental dysplasia of the hip

❖ Definition:

- The old name was “congenital dysplasia of the hip (CDH).”
- The name has changed to indicate that not all cases are present at birth and that some cases can develop later on during infancy and childhood:
 - Not all cases discoverable at birth.
 - Developing overtime.
- Developmental dysplasia of the hip (DDH) includes a wide spectrum of pathology:
 - Dysplasia.
 - Instability.
 - Subluxation or dislocation (reducible or not).

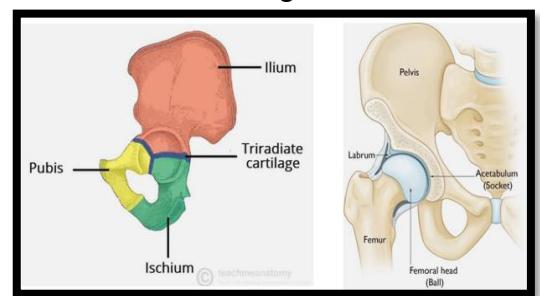
❖ Incidence:

- Incidence is 34/1000 when U/S is utilized for diagnosis.
- The left hip is the most commonly affected hip.
- Girls are affected 5 times more than boys.



❖ Normal growth of the acetabulum:

- Triradiate cartilage: interstitial growth, increases the width of the acetabulum.
- Acetabular cartilage: interstitial, appositional and new subperiosteal bone formation.
- Labrum.
- 2ry ossification centers:
 - Os Acetabulum -> Pubis, Acetabular Epiphysis -> Ileum, Os Marginalis -> Ischium
- The acetabulum has the potential for recovery and remodeling after concentric reduction.
- The age at which dysplastic hip can still return to normal after reduction is still controversial (3-5 y?).
- Appearance of accessory ossification center is a good indicator of potential remodeling



❖ Growth of the proximal femur:

- Femoral epiphysis.
- GT.
- LT.
- **Depends on**
 - Muscle action.
 - Forces.
 - Circulation.

❖ Etiology:

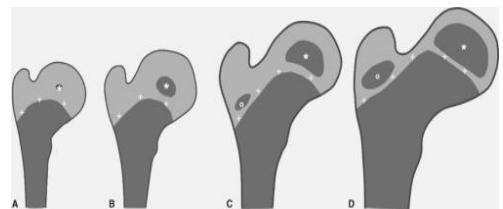
- Genetic.
- Hormonal: estrogen, relaxin.
- Mechanical: breech liquor deficiency.

❖ Pathoanatomic:

- **Bony:**
 - Acetabulum.
 - Proximal femur.

- **Soft tissue:**

- Neolimbus: Thickened acetabular cartilage.
- Iliopsoas tendon?
- Capsule?
- Adductors?



The Acetabulum

- ❖ **Abnormality:**

- Delayed acetabular ossification --> Shallow and small acetabulum --> Abnormal Coverage = ↓ extent of the WB area of the acetabulum --> ↓ load-bearing --> OA



Proximal Femur

- ❖ **Patho-anatomy:**

- **The femoral head:**

- Deformed.
- Small.
- Flattened (in long standing cases)

- **The femoral Neck:**

- Short neck.

- **Neck shaft angle:**

- Coxa valga in most cases.

- **Anteversion angle:**

- Increased (35-85°).



Soft Tissue

1. Ligaments:

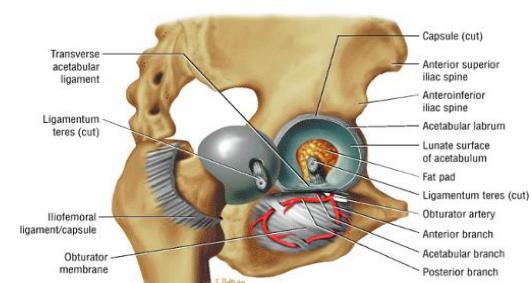
- **Ligamentum Teres:**

- Hypertrophied and sometimes absent

- **Transverse ligament:**

- Ossified

✓ **The Acetabulum cavity filled with fibro-fatty overgrowth of Haversian pad (Pulvinar)**



2. Muscles:

- **The iliopsoas tendon:**

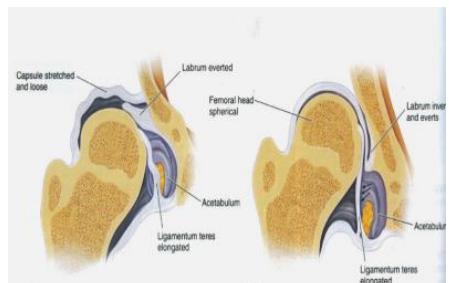
- Directed posterolateral on the capsule (instead of passing downwards with a slight inclination backwards).

- **The hamstring, adductor, and quadriceps:**

- Are shortened

3. Capsule:

- Laxity at first then thickened.
- Elongation and migration with dislocated head.
- Hip capsule may have an Hourglass configuration.



❖ Risk factors:

- First born Female.
- Positive family history.
- Breech (with knee extension).
- Hyperlaxity.

❖ Associated conditions:

- Torticollis.
- Metatarsus adductus.
- Calcaneovalgus feet.



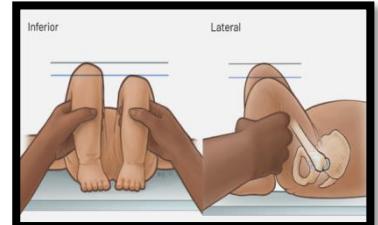
❖ Clinical findings:

○ In Newborns:

- **Usually asymptomatic and must be screened by special maneuvers:**
 - ✓ Barlow test.
 - ✓ Ortolani test

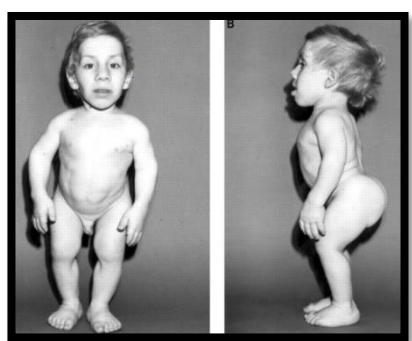
▪ In Infants:

- ✓ As the baby enters the 2nd and 3rd months of life, the soft tissues begin to tighten and the Ortolani and Barlow tests are no longer reliable.
- ✓ Shortening of the thigh, the Galeazzi sign (best appreciated by placing both hips in 90 degrees of flexion and comparing the height of the knees, looking for asymmetry).
- ✓ Asymmetry of thigh and gluteal skin folds.
- ✓ The most diagnostic sign is Ortolani's limitation of abduction: abduction less than 60 degrees is almost diagnostic.
- ✓ X-rays after the age of 3 months can be helpful especially after the appearance of the ossific nucleus of the femoral head.
- ✓ US is 100% diagnostic



▪ In walking child (in older children):

- ✓ Complaints of limping.
- ✓ Waddling (bilateral DDH).
- ✓ Trendelenburg gait in unilateral.
- ✓ Lumbar lordosis.
- ✓ Limitation of hip abduction.
- ✓ Toe walking.
- ✓ Wide perineum.



❖ Screening:

- All neonates should have a clinical examination for hip instability.

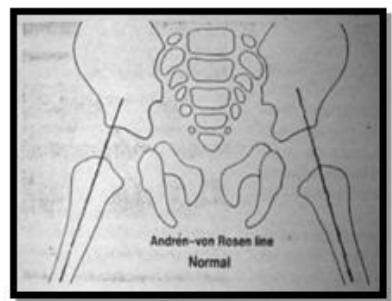
❖ **Diagnosis:**

○ **Ultrasound:**

- In the Graf technique, the transducer is placed over the greater trochanter, which allows visualization of the ilium, the bony acetabulum, the labrum, and the femoral epiphysis.

○ **X-ray:**

- Von Rosen view (right lower lung opposite (T8) so fracture rib at this level affects it).
- Anteroposterior view.
- We draw a line through the central axis of the femoral shaft.
- In normal hip ossific nucleus will be inside the acetabulum.
- In dislocated hip it will be above acetabulum.
- Horizontal line of Hilgenreiner: drawn between upper ends of tri-radiate cartilage of the acetabulum.
- Vertical line of Perkins: drawn from the lateral edge of the acetabulum vertical to horizontal line.
- 4 Quadrants:
 - ✓ Normal hip: the ossification center of the femoral hip lower medial quadrant.
 - ✓ Dislocated hip: upper lateral quadrant.



➤ **Tonnis classification:**

- Better.
- Useful when epiphysis is not apparent

➤ **Acetabular index:**

- Angle between horizontal line of Hilgenreiner and the line between the two edges of the acetabulum.
 - ✓ 27.5 newborn.
 - ✓ 23.5 at 6 m.
 - ✓ 20 at 2 years.
 - ✓ Dislocated or dysplastic hip $\geq 30^\circ$.



➤ **Shenton's line:**

- Semicircle between femoral neck and upper arm of obturator foramen.
- In dislocated hip this line is broken.

○ **Arthrography**

❖ **History:**

- Spontaneous reduction and development.
- Reduced hip with dysplastic acetabulum.
- Persistent subluxation.
- Persistent dislocation.



❖ **Treatment options:**

- Rigid splints.
- Pavlik Harness.
- Closed reduction and spica cast application.

- Adductor tenotomy and closed reduction.
- Open reduction.
- Femoral osteotomy.
- Varus osteotomy.
- Derotation osteotomy.
- Varus derotation osteotomy.
- Femoral shortening.

➤ **Timing:**

- The best at <6 months.
- If less than 6 months old:
 - ✓ Conservative approach.
 - ✓ Pavlic method (Harness).
 - ✓ Closed reduction.

• **Pavlic method:**

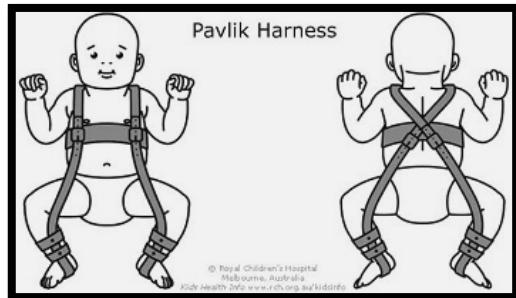
- Prevent extension, abduction.
- Allow flexion, adduction.
- If < 6 months old.
- Induce reduction and maintain it.
- Double or triple fibers are NOT effective.
- **Contraindicated if:**
 - ✓ Joint stiffness.
 - ✓ Teratologic hip dislocation.
 - ✓ Severe ligamentous laxity.
 - ✓ Muscle imbalance.
 - ✓ Used for 2-3 weeks, stopped if no reduction achieved

• **Closed reduction:**

- Closed reduction is not simple.
- Add tenotomy perfect reduction.
- Spica cast 3 months.
- Close follow up.
- Post op CT or MRI.
- Post cast brace for 3-4 months.
- High rate of residual acetabular dysplasia that requires pelvic osteotomy later on.
- Early and late failures.
- 5-15 % are dislocated at time of post-operative imaging.
- After successful closed reduction: Up to 85 % of patients need secondary surgical intervention.

➤ **Handling soft tissue impediments:**

- Obtaining a reduction is relatively simple in cases of neonatal instability.
- However, once the hip dislocates and remains dislocated for some time, soft tissue impediments may develop and prevent reduction of the femoral head into the acetabulum.



Pavlik harness disease:

- Femoral head damage.
- Acetabular cartilage injury.
- Affect further growth.



- **These include:**
 - ✓ Contracture of muscles crossing the hip in particular, the iliopsoas and the adductor muscles.
 - ✓ Contracture of the inferomedial part of the hip capsule
- **Open reduction:**
 - **Medial approach?**
 - **Anterior approach:**
 - ✓ Open reduction.
 - ✓ Capsulorrhaphy.
 - ✓ Pelvic osteotomy.
 - ✓ Usually if >1 year old
 - ✓ Plane? apophyseal splitting?
 - ✓ LFC nerve.
 - ✓ Sartorius, rectus, iliopsoas.
 - **Pelvic osteotomy: intraoperative decision!**
 - **Correction of acetabular dysplasia:**
 - i. **Redirectional osteotomies (volume neutral):**
 1. Salter innominate.
 2. Sutherland double innominate.
 3. Triple innominate of steel or Tönnis.
 4. Dial and the Ganz periacetabular osteotomy.
 - ii. **Augmentation (volume increasing):**
 1. Shelf operations.
 2. The Chiari osteotomy.
 - iii. **Reduction (volume reducing):**
 1. Pemberton osteotomy.
 2. Dega osteotomy.
 - iv. **Use available acetabulum (hyaline cartilage):**
 1. Redirectional (Steel, Ganz, Salter).
 2. Reshaping (Dega, Pemberton).
 - v. **Create new coverage – Add to the available stock (fibrocartilage):**
 1. Salvage (Shelf, Chiari).
 - **Femoral osteotomy:**
 - ✓ If difficult reduction, or high tension.
 - ✓ Amount of shortening?
 - ✓ Varus, derotation?
 - ✓ DDH is rarely associated with coxa valga.
 - ✓ Proximal femoral remodeling for rotation.
 - **Correction of femoral deformity:**
 - ✓ Varus osteotomy.
 - ✓ Rare derotation.
 - ✓ Osteotomy.
 - **Final aim:**
 - ✓ Obtaining a concentric reduction.
 - ✓ Allowing for normal growth and development of the hip.
 - ✓ Allowing for normal growth and development of the hip.

- ✓ Early concentric reduction favours resumption of normal acetabular growth and this may enable correction of acetabular dysplasia in many instances, thus reducing the need for later pelvic osteotomy.

Musculoskeletal tumors and tumor like lesions

❖ Classification:

1. Benign bone tumors.
2. Malignant bone tumors.
3. Bone metastasis.
4. Tumor like lesions.
5. Soft tissue tumors.

1. Benign bone tumors

❖ Types:

A. Bone-forming tumors:

- a) Osteoid osteoma.
- b) Osteoblastoma.
- c) Osteoma.
- d) Bone island.

B. Cartilage lesions:

- a) Chondroma.
- b) Osteochondroma.
- c) Chondromyxoid fibroma.
- d) Chondroblastoma.

C. Fibrous lesions:

- a) Nonossifying fibroma.
- b) Cortical desmoid.
- c) Benign fibrous histiocytoma.
- d) Fibrous dysplasia.
- e) Osteofibrous dysplasia.
- f) Desmoplastic fibroma.

D. Cystic lesions:

- a) Unicameral bone cyst.
- b) Aneurysmal bone cyst.
- c) Intraosseous ganglion cyst.
- d) Epidermoid cyst.

E. Vascular & myelogenic & miscellaneous:

- a) Hemangioma.
- b) Giant cell tumour.
- c) Histiocytosis.

F. Other nonneoplastic lesions:

- a) Paget disease.
- b) "Brown tumor" of hyperparathyroidism.
- c) Bone infarct.
- d) Osteomyelitis.
- e) Stress fracture.
- f) Posttraumatic osteolysis

2. Malignant bone tumors

❖ Types

1. Osteosarcoma.
2. Chondrosarcoma.
3. Fibrosarcoma.
4. Ewing sarcoma.
5. Myeloma.
6. Lymphoma.
7. Rare types.
 - a) Chordoma.
 - b) Leiomyosarcoma.
 - c) Adamintinoma.

3. Bone metastasis

❖ Sites

➤ **Common primary sites:**

- Thyroid
- Lung
- Breast
- Renal
- Prostate

N.B:

- In Egypt hepatocellular carcinoma commonest due to endemic hepatic diseases.

❖ Diagnostic evaluation of bone tumors

- a. History (personal, complaint)
- b. Examination (general, local)
- c. Lab. Investigation
- d. Radiology
- e. Biopsy and histopathology
- f. Staging

A. Personal history:

- Age:
 - Age may be the most important information obtained in the history (because most benign and malignant musculoskeletal neoplasms occur within specific age ranges).
- Sex:
 - Sex predilection.
 - E.g., female predominance with giant cell tumors.
- Race:
 - Race likewise is of little significance.
 - With the exception that Ewing sarcoma is rare in individuals of African descent.

B. Complaint

- Pain
 - Patients with benign bone tumors also may have activity-related pain if the lesion is large enough to weaken the bone.
 - Mostly osteoid osteoma cause night pain.
 - Patient with a malignancy of bone often complains of progressive pain.
- Mass
 - Conversely, patients with soft-tissue tumors rarely complain of pain, but more often complain of a mass.
- An abnormal radiographic finding detected during the evaluation of an unrelated problem.

N.B:

- Exceptions to this rule are patients with nerve sheath tumors who have pain or neurologic signs.

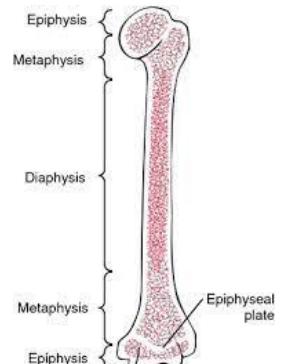
C. General examination:

- General health.
- Vital signs.
- Heart, chest, lung, thyroid.
- Café au lait spots or cutaneous hemangiomas also may provide diagnostic clues.
- Potential sites of lymph node metastases should be palpated.

D. Plain Radiographic evaluation:

1. Site of the lesion

- Many bone tumors have specific site predilections:
- In axial Plane:
 - Centric
 - Eccentric
- In the Longitudinal Plane:
 - Epiphyseal
 - Metaphyseal
 - Diaphyseal
- Site and age relationship:
 - An epiphyseal lesion in a skeletally mature patient is likely to be a **giant cell tumor**.
 - An epiphyseal lesion in a skeletally immature patient is likely to be a **chondroblastoma**.



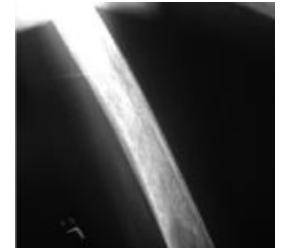
Site	Age	Lesion
Epiphyseal	10-25	Chondroblastoma
Epiphyseal	20-40	Giant cell tumour
Epiphyseal	40-60	Chondrosarcoma
Diaphyseal	5-25	Ewing sarcoma
Diaphyseal	5-30	Fibrous dysplasia
Diaphyseal	5-30	Histiocytosis
Diaphyseal	adult	Lymphoma

2. Aggressiveness of the lesion:

- Whether it is likely to be benign or malignant, usually can be determined by careful evaluation of the plain films.

3. Patterns of Bone Destruction:

- Geographic: (less malignant)
- Moth-eaten
- Permeative: (more malignant)

Geographic	Moth-eaten	Permeative
		
<ul style="list-style-type: none"> • Destructive lesion with sharply defined border. • Implies a less-aggressive, more slow-growing, benign process. • Narrow transition zone. 	<ul style="list-style-type: none"> • Areas of destruction with ragged borders. • Implies more rapid growth. • Probably a malignancy. 	<ul style="list-style-type: none"> • Ill-defined lesion with multiple "worm-holes". • Spreads through marrow space. • Wide transition zone. • Implies an aggressive malignancy.

Examples		
<ul style="list-style-type: none"> • Non-ossifying fibroma • Chondromyxoid fibroma • Eosinophilic granuloma 	<ul style="list-style-type: none"> • Myeloma • Metastases • Lymphoma • Ewing's sarcoma 	<ul style="list-style-type: none"> • Lymphoma, leukemia • Ewing's Sarcoma • Myeloma • Osteomyelitis • Neuroblastoma

4. Periosteal Reactions:

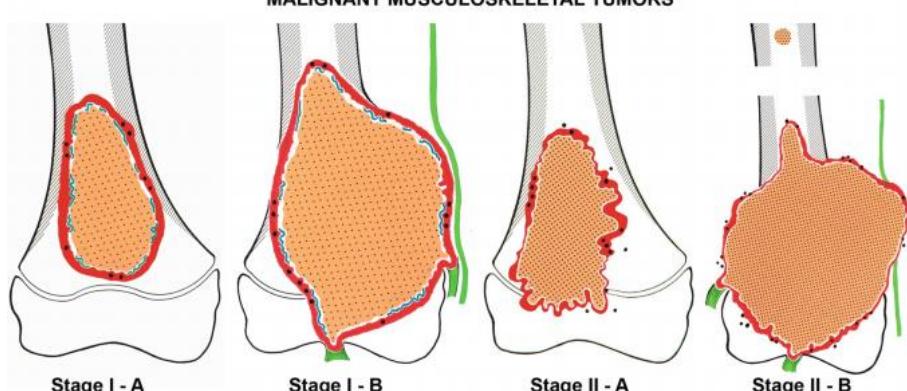
- Benign:
 - No Periosteal Reactions.
 - Solid e.g. in osteomyelitis.
- Aggressive/malignant:
 - Onion-peel ⇒ Ewing sarcoma.
 - Sunburst ⇒ Osteo-sarcoma.
 - Codman's triangle ⇒ Osteo-sarcoma.

E. Staging:

- (Enneking System for Staging Benign Musculoskeletal Tumors)
 - Latent.
 - Active.
 - Aggressive.

Stage	Grade	Site	Metastases
IA	Low	Intracompartmental	None
IB	Low	Extracompartmental	None
IIA	High	Intracompartmental	None
IIB	High	Extracompartmental	None
III	Any	Any	Regional or distant metastases

MALIGNANT MUSCULOSKELETAL TUMORS



Osteoid osteoma

❖ Clinical picture

➤ **Pathognomonic symptoms**

1. Pain at night.
2. Therapeutic response to salicylates.

❖ Investigation

➤ **Radiology**

○ Nidus

- Tiny radiolucent area.
- If in diaphysis → surrounded by dense bone and thickened cortex.
- Metaphysis → less cortical thickening.

➤ **Bone scan**

- Double density sign on bone scan increased uptake in nidus and decreased uptake in reactive sclerotic zone.



➤ **CT**

- Lytic nidus measure less than 2cm surrounded by sclerotic bone.
- **Centre of nidus may be calcified.**

If occurred in some bones as:

- Talus.
- Calcaneus.
- Pedicle of vertebrae.



Osteoma

❖ Sites

➤ **Common location:**

- flat bone e.g., skull



Osteoblastoma

❖ Specific finding

- Well demarcated osteolytic lesion more than 2 cm sometimes containing flecks of calcification.
- Less reactive bone than osteoid osteoma.
- **Bone scan**
- intense activity.

Fibrous cortical defect

❖ Specific finding

- Margin well defined.
- Sometimes scalloped.
- And often sclerosed



→ Non-ossifying Fibroma

❖ Specific finding

- Geographic.
- Well marginated.
- Multilocular appearance.
- Inter cortical osteolysis.
- Single or multiple bubble-like areas.



→ Fibrous Dysplasia

❖ Specific finding

- **Ground glass appearance** typical.
- Shepherds crook deformity of proximal femur.
- Variable appearance with expansion of cortex.



→ Enchondroma

❖ Specific finding

- Most common interosseous cartilage tumor.
- Appear as solitary metaphyseal lesions of small tubular bones of hands and feet.
- Scalloped erosions on endosteal surface.
- May have flecks of calcification.



→ Osteochondroma

❖ Specific finding

- **Exostosis**: well defined bony projection growing away from physis.
- Cartilage maybe calcified.
- If lesions are large ⇒ may be malignant change.



→ Chondroblastoma

❖ Specific finding

- Well defined area of rarefaction eccentrically placed in the epiphysis or across the growth plate.
- No reaction in surrounding bone.
- 50% show central calcification.
- 50% show linear periosteal reaction.
- **Bone scan** increased uptake at margins.



Chondromyxoid fibroma

❖ Specific finding

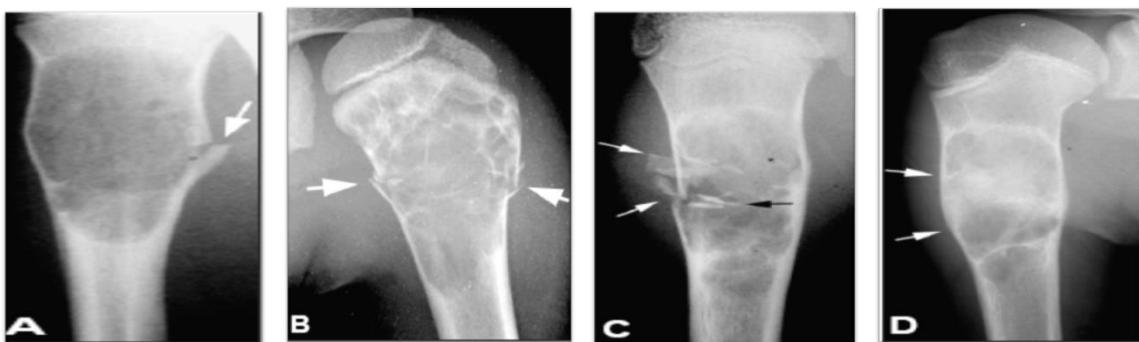
- Rounded or oval rare area.
- Usually eccentrically placed.
- May cross the growth plate.
- Sharp outline and sclerotic rim.
- Scalloped margin and thin cortex.



Simple bone cyst

❖ Specific finding

- Cystic radiolucency on the diaphyseal side of the growth plate.
- Cortex may be thinned and bone expanded with well-defined thin sclerotic margin.
- May have pseudo-loculated appearance secondary to irregular cortical thinning and thin septal ridges.
- **Falling fragment sign** typical and the lesion is never wider than epiphyseal plate.
- **Bone scan** cold or minimal activity unless fractured.



Aneurysmal bone cyst

❖ Specific finding

- Gross honey comb lesion.
- Often eccentrically placed.
- Does not extend to the joint (unlike GCT).
- Warm to hot on bone scan.



Giant cell tumor

❖ Specific finding

- Usually, well-defined geographic lytic lesion in the epiphysis/metaphysis extending up to the joint surface without marginal sclerosis.
- Junction with normal bone often poorly defined.
- Cortex thinned and sometimes ballooned.
- **Bone scan** → warm to hot.



Ewing's sarcoma

❖ Specific finding

- Mottled or moth-eaten lesion diffusely involving bone.
- Lytic destruction common, often the cortex is perforated.
- **Onion skin appearance**- layers of periosteal new bone are said to be characteristic.
- May form **Codman's triangle**.



Osteosarcoma

❖ Specific finding

- Malignant tumor in which the cancerous cells produce osteoid matrix or mineralized bone.
- **Sun burst appearance** and Codman's triangle may be evident.
- **Cortical breach common**.
- Adjacent soft tissue mass.
- Joint space rarely involved.
- 25% Lytic.
- 35% Sclerotic.
- 40% Mixed.



Chondrosarcoma

❖ Specific finding

- Variable appearance with 60 - 70% have calcification and 50% have sub periosteal new bone.
- May be a large cystic lesion with:
 - Cortical destruction and central calcification.
 - Endosteal scalloping and cortical expansion.
 - Annular, punctate or comma shaped calcification.



Fibrosarcoma

❖ Specific finding

- Bone often mottled or moth eaten with extension into soft tissue.
- Osteolytic lesion may be surrounded by reactive bone.
- Destructive appearance radiologically.
- **Usually little periosteal reaction**.



METASTATIC BONE DISEASE

❖ Variations

1. Osteolytic

- Cortical destruction with little or no periosteal reaction:
 - Lungs
 - Kidney
 - Adrenal
 - Thyroid
 - Uterus
- Most common lytic metastasis are carcinomas of:
 - Lungs
 - Kidney
- Lymphoma deposits may resemble prostatic deposits, i.e., sclerotic secondaries.
- Loss of single pedicle produces a "winking owl sign".



❖ Investigation:

- CT scan.
- MRI.

N.B:

- Breast carcinoma shows multiple osteolytic bone lesions.

2. Osteoblastic deposits

- Prostate
- Bladder
- Testis
- Breast
- Bowel secondaries.
- Carcinoid lung tumors
- Lymphoma



3. Mixed

- Breast
- Lung
- Ovary
- Cervix

Lymphoma

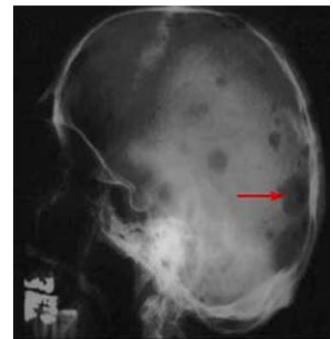
❖ Specific finding

- Early - vague mottled lucent areas.
- Diffuse destructive lytic lesion with little periosteal reaction.
- Usually combination of patchy sclerosis and mottled destruction.
- Hogkins disease - typical appearance of ivory vertebrae.



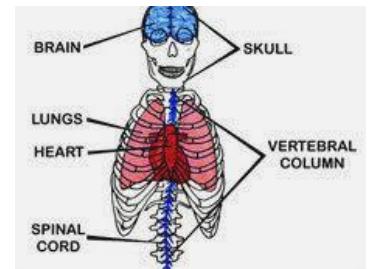
 Myeloma❖ Specific finding

- May be generalised decrease in bone density.
- Multiple punched out defects.
- Little bony reaction around lesions.
- **Solitary lesion**
 - **Plasmacytoma**; multilocular expanding lytic lesion in a red marrow area.
- Frequently cold on bone scan.



Orthopedic surgeons and Bone

- ❖ Orthopedic surgeons must deal with all types of bone: **healthy or diseased**; and that's why they must know about **bone metabolism**.
- ❖ **Surgical Notes:**
 - Bones in the body protect vital organs.
 - Bones give support to muscles and tendons.
 - Bone may become weak in certain conditions.
- ❖ **Bone is a living structure:**
 - There is a continuous activity in bone during all stages of life.
 - There is continuous bone resorption and bone formation as well as remodeling.
 - That means bone is not only for protection and support, but its contents play an important part in blood homeostasis.
 - Many factors are involved in this process.
- ❖ **Bone Metabolism is controlled by many factors:**
 - 1) Calcium.
 - 2) Phosphorus.
 - 3) Parathyroid gland.
 - 4) Thyroid gland.
 - 5) Estrogen.
 - 6) Glucocorticoid hormones.
 - 7) Intestinal absorption.
 - 8) Renal excretion.
 - 9) Diet.
 - 10) Vitamin D.
 - 11) Sun exposure.



- ❖ **Bone Structure:**

- **Bone is formed by Bone matrix: which consists of:**

- A. **40% organic:**

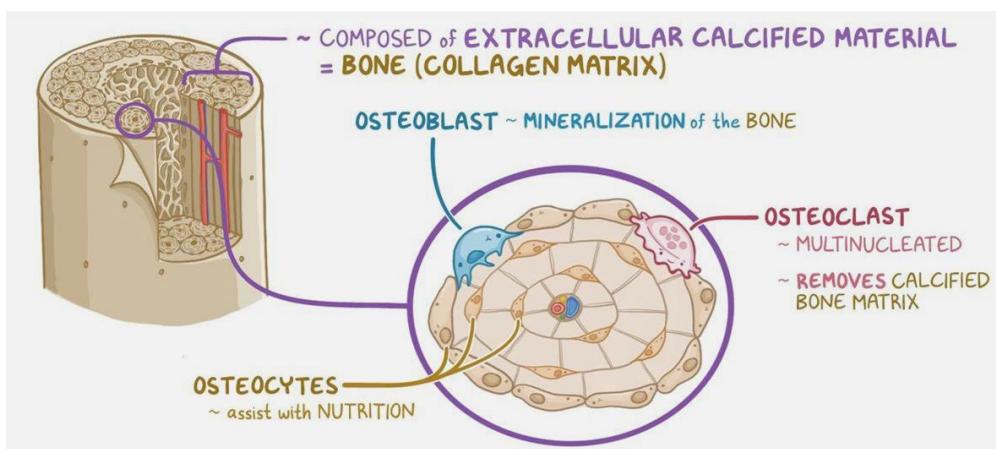
- Collagen type1 (responsible for tensile strength).

- B. **60% Minerals:**

- Calcium hydroxyapatite,
- Phosphorus,
- Traces of other minerals like zinc

- **Cells in bone:**

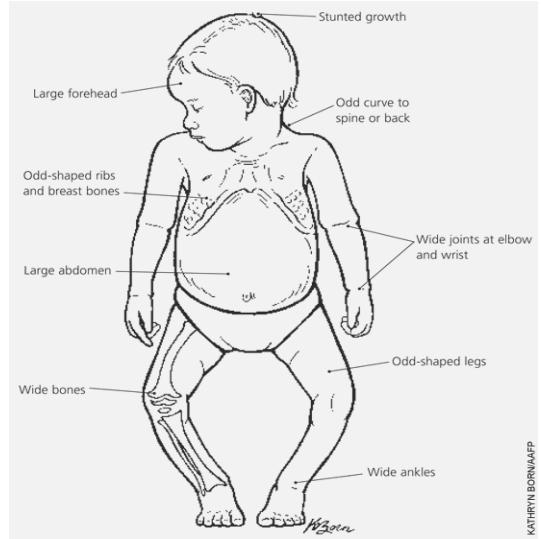
- Osteoblasts.
- Osteoclasts.
- Osteocytes.



- ❖ **Plasma Levels:**
 - A. **Calcium:** 2.2-2.6 mmol/l.
 - B. **Phosphorus:** 0.9-1.3 mmol/l.
 - C. **Alkaline phosphatase:** 30-180 units/l.
 - D. **Vitamin D level:** 70-150 nmol/l.
 - ✓ (Both Calcium and Phosphorus are absorbed by intestine and secreted by kidney in urine).
- **Alkaline phosphatase:**
 - Is elevated in bone increased activity like during growth or in metabolic bone disease or destruction.
- **Parathyroid Hormone (PTH):**
 - Production levels are related to serum calcium levels.
 - PTH secretion is increased when serum calcium is low.
- ✓ **Action of PTH:**
 - It increases calcium levels in the blood by increasing its release from bone.
 - Increase absorption from the intestine.
 - Increase reabsorption from the kidney (also increase secretion of phosphorus).

Rickets & Osteomalacia

- ❖ **Different expressions of the same disease which is:**
 - Inadequate mineralization
- ❖ **Rickets affects:**
 - Areas of endochondral growth in children.
- ❖ **Causes:**
 1. Calcium deficiency.
 2. Hypophosphatasemia.
 3. Defect in Vitamin D metabolism:
 - Nutritional.
 - Underexposure to sunlight.
 - Intestinal malabsorption.
 - Liver & kidney diseases.
- ❖ **Biochemistry:**
 - Hypocalcemia.
 - Hypercalciuria.
 - High alkaline phosphatase.



Rickets

- ❖ **Symptoms and Signs:**
 - Child is restless, babies cry without obvious reason.
 - Failure to thrive
 - Muscle weakness
 - In severe cases with very low calcium: tetany or convulsions
 - Joint thickening especially around wrists and knees
 - Deformity of limbs, mostly Genu varum or Genu Valgum



- Pigeon chest deformity.
- Ricketty Rosary.
- Craniotabes.



❖ **X Ray Findings in Rickets:**

- Growth plate widening and thickening.
- Long bones deformities.
- Metaphyseal cupping.

❖ **Treatment:**

- Vitamin D deficiency:
 - Adequate Vitamin D replacement
 - Sun exposure
 - Correct residual deformities



Osteomalacia

❖ **Definition:**

- Metabolic Bone Disorder in Adults.

❖ **Symptoms and Signs:**

- Bone pain, mainly backache.
- Muscle weakness.
- Reduced bone density.

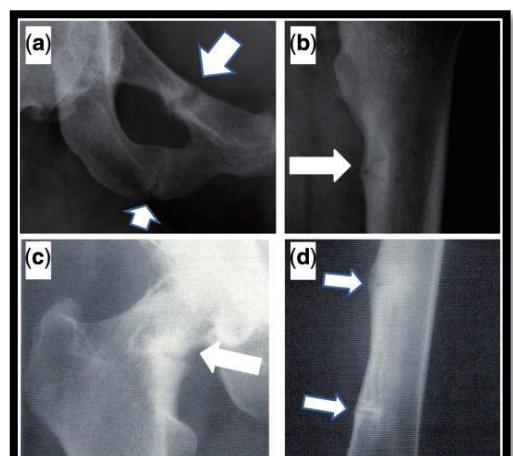
➤ **Vertebral changes:**

- Bi-concave vertebra: Fish Vertebrae sign.
- Vertebral collapse.
- Kyphosis.



❖ **Stress fractures:**

- Loosers zones in:
 - Scapula.
 - Ribs.
 - Pelvis.
 - Proximal femur.



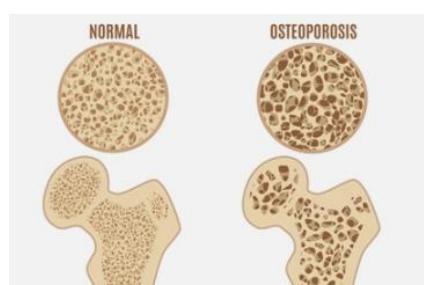
❖ **Treatment:**

- Vitamin D deficiency:
 - Vitamin D + Ca
 - Fracture management
 - Correct deformity if needed

Osteoporosis

❖ **Definition:**

- Decreased bone mass: decreased amount of bone per unit volume.
- This causes reduced density.
- Mainly post-menopausal age related.
- Mineralisation is **not affected**.



❖ **Types:**

1. Primary Osteoporosis:

A. Post-menopausal:

- Due to rapid decline in estrogen level.
- This results in increased osteoclastic activity.
- Normal bone loss usually 0.3% per year.
- Post menopausal bone loss 3% per year.

✓ **Risk Factors in Post menopausal Osteoporosis:**

- Race.
- Hereditary.
- Body build.
- Early menopause.
- Smoking/ alcohol intake/ drug abuse.
- Calcium intake.

B. Senile:

- Usually by 7th to 8th decades there is steady loss of at least 0.5% per year
- It is part of physiological manifestation of aging

✓ **Risk factors in Senile Osteoporosis:**

- Menopause
- Dietary: Less calcium and vitamin D and protein
- Muscle weakness
- Reduced activity

2. Secondary Osteoporosis:

A. Drug induced:

- Steroids.
- Alcohol.
- Smoking.
- Phenytoin.
- Heparin.

B. Endocrinological causes:

- Hyperparathyroidism.
- Hyperthyroidism.
- Cushing's syndrome.
- Gonadal disorders.
- Malabsorption.
- Malnutrition.

C. Chronic diseases:

- RA.
- Renal failure.
- Tuberculosis.

D. Malignancy:

- Multiple myeloma.
- Leukemia.
- Metastasis.



❖ **Clinical Features of Osteoporosis:**

- Osteoporosis is a Silent disease.
- Osteoporosis is Serious due to possible complications mainly fractures.
- Osteoporosis does not cause pain usually.
- Osteoporosis causes gradual increase in dorsal kyphosis.
- Osteoporosis leads to loss of height.

Surgical Notes:

Osteoporosis is not osteoarthritis, but the two conditions may coexist



❖ **Osteoporotic Fractures:**

- They are Pathological fractures.
- Most common is osteoporotic compression fracture.
- Vertebral micro fractures occur unnoticed (dull ache).
- Most serious is hip fractures.
- Also common is wrist fractures (Colles's fracture).

Disuse Osteoporosis

❖ Occurs locally adjacent to immobilized bone or joint

❖ May be generalized as in bed ridden patients

❖ **Osteomalacia Vs. Osteoporosis:**

➤ Osteomalacia	➤ Osteoporosis
Any age	Post-menopause, old age
Patient is ill	Patient isn't ill
General ache	Asymptomatic
Weak muscles	Normal
Looser zones	Nil
Alkaline ph increase	Normal
PO4 decrease	Normal

❖ **Prevention of Osteoporosis:**

- Awareness of and attempts for prevention are helpful
- Prevention of osteoporosis should start from childhood
 - Healthy diet
 - Adequate sunshine
 - Regular exercise
 - Avoidance of smoking or alcohol
 - Caution in steroid use
 - At some time in the past there was a recommendation of HRT (Hormone replacement Therapy) for post-menopausal women? And men, but now this is discontinued

❖ Management of Osteoporosis:

1. Drugs:

- Intake of Estrogen has a definite therapeutic effect and was used extensively as HRT, but cannot be recommended now due to serious possible side effects
- Adequate intake of calcium and vitamin D is mandatory
- Drugs which Inhibit osteoclast activities:
 - Bisphosphonates like sodium alendronate
 - FOSAMAX, BONVIVA
- Drugs which enhance osteoblast activities:
 - Bone stimulating agents like PROTELOS, FORTEO

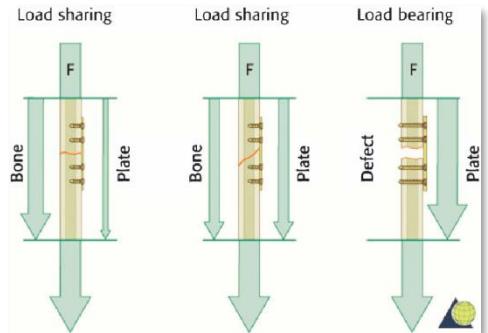
2. Exercise:

- Resistive exercises
- Weight bearing exercises
- Exercise should be intelligent to avoid injury which may lead to fracture

3. Management of Fractures:

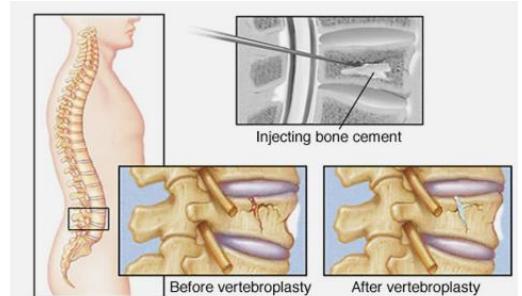
- Use of load sharing implants in fracture internal fixation instead of plating
- Management of Osteoporotic Vertebral Compression Fractures:

- Pain relief
- Prevention of further fractures
- Prevention of instability
- Vertebroplasty
- Kyphoplasty



Vertebroplasty

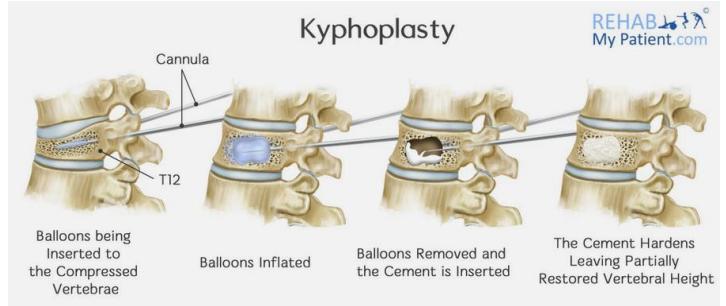
- Is the injection of bone cement into the collapsed vertebra
- The injection is done under X ray control (image intensifier) by experienced orthopedist or interventional radiologist
- It results in immediate pain relief
- It helps to prevent further OVF
- Possible complication is leakage of cement into spinal canal (nerve injury) or venous blood (cement PE)



Kyphoplasty

- Is the injection of bone cement into the collapsed vertebra AFTER inflating a balloon in it to correct collapse and make a void.
- It is possible that some correction of kyphosis is achieved.

- It is safer because cement is injected into a safe void.
- Void is the empty space into which cement is injected.



Parathyroid

Hyperparathyroidism

❖ Definition:

- Excessive PTH secretion which may be primary (adenoma of the gland), secondary or tertiary.
- Leads to:
 - Increased bone resorption.
 - Sub periosteal erosions.
 - Osteitis manifested by fibrous replacement of bone.

❖ Significant feature:

- Significant feature is hypercalcemia.
- In severe cases:
 - Osteitis fibrosa cystica.
 - Formation of brown tumors.



❖ Radiological changes:

- Generalized decrease in bone density.
- Sub-periosteal bone resorption (scalloping of metacarpals and phalanges).
- Brown tumors.
- Chondrocalcinosis (wrist, knee, shoulder).



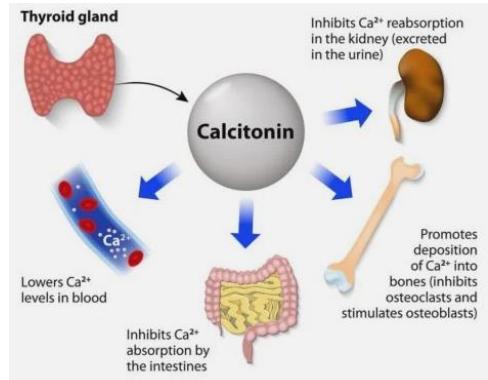
❖ Management of Hyperparathyroidism:

- By management of the cause
 - A. Primary hyperparathyroidism due to neoplasm: By excision
 - B. Secondary hyperparathyroidism: By correcting the cause of hypocalcemia.
 - C. Tertiary hyperparathyroidism: By excision of hyperactive (autonomous) nodule.
- Extreme care should be applied after surgery to avoid hypocalcemia due hungry bones syndrome.



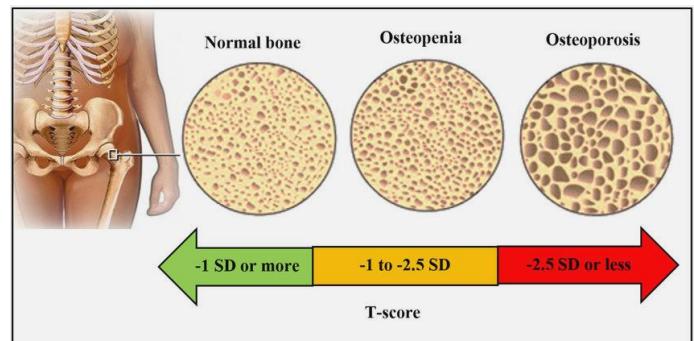
Calcitonin

- Is secreted by C cells of thyroid gland.
- Its secretion is regulated by serum calcium.
- Its action is to cause inhibition of bone resorption and increasing calcium excretion by this it causes lowering of serum calcium.



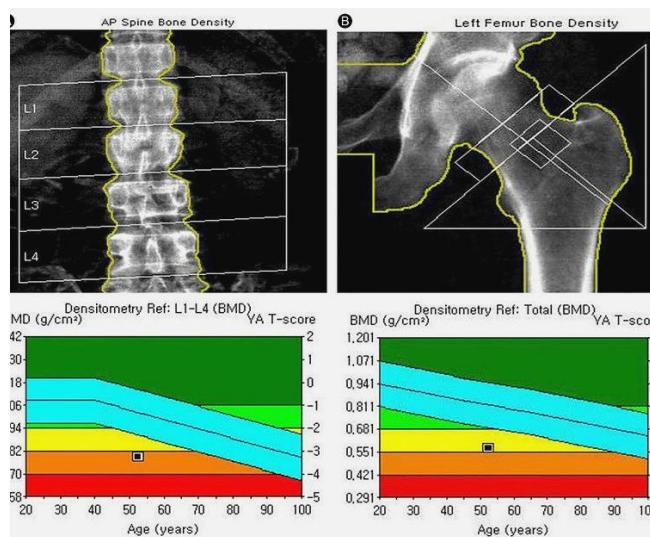
Bone strength

- Bone strength is affected by mechanical stress which means exercise and weight bearing.
- Bone strength gets reduced with menopause and advancing age.
- Reduced bone density on X rays is called Osteopenia.
- Osteopenia is also a term used to describe a degree of reduced bone density, which if advanced becomes Osteoporosis.



Bone density

- Bone density is diagnosed at current time by a test done at radiology department called: **DEXA scan** (Dual Energy X Ray Absorptiometry).
- However: Increased bone density does not always mean increased bone strength, as sometimes in Brittle bone disease, it's not a strong bone but fragile bone which may break easily.



Spine trauma and diseases

Spine:

❖ Functions:

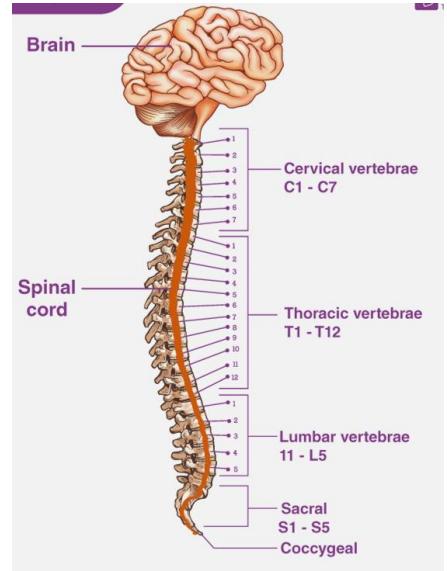
- Protection.
- support & posture.
- shock absorption.
- Movements.

❖ Anatomy:

- Normal curvatures.
- Spinal motion segment.
- Relation to spinal cord & roots.
- Spinal canal.

❖ Spinal Stability:

- The ability of the spine under physiological loads to maintain relationships between vertebrae without:
 - Spinal cord or nerve roots damage or irritation.
 - Deformity.
 - Pain.
 - Abnormal mobility.



Fractures and dislocations of spine

❖ Definition:

These fractures may produce spinal cord and nerve root injuries.

❖ Site:

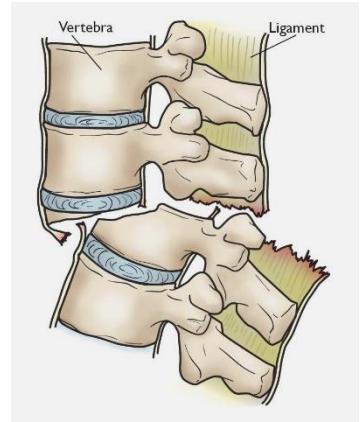
- Common sites:
 - lower cervical.
 - thoraco- lumbar junction.

❖ Causes:

- Trauma usually high energy trauma.
- Hyperflexion trauma as fall of object on head
- Vertical compression as fall from height or fall on head
- Direct trauma or penetrating trauma
- Hyperextension injuries are less common
- May be pathological due to osteoporosis and metastasis

❖ Angulation stress fractures:

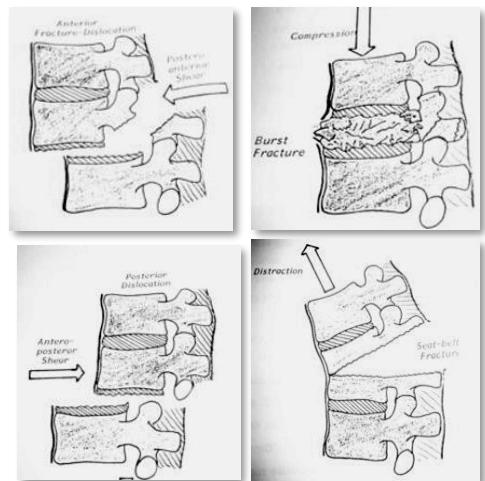
- Around X (transverse) Axis
 - Hyper flexion.
 - Hyperextension.
- Around Y (A-P) Axis
 - Rt lateral wedge.
 - Lt lateral wedge.
- Around Z (vertical) Axis
 - Rt rotation
 - Lt rotation



❖ Types

➤ according to Morphology

1. Wedge compression fracture
2. Fracture- dislocation
3. Pure dislocation
4. Comminuted or burst fracture
5. Avulsion fracture of transverse or spinous process



➤ according stability

A. Stable:

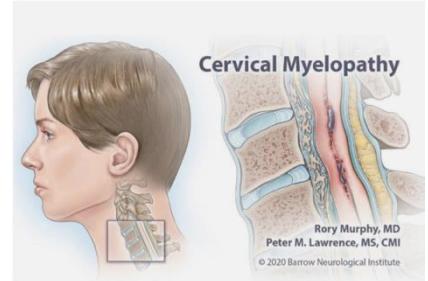
Intact posterior Ligaments (e.g., Ligamentum Flavum)

B. Unstable:

- Injured posterior ligaments and more liable to cord injuries
- loss of height more than 50 %
- Angulation more than 30 degrees
- Dislocation

❖ Neurological injuries

1. Nothing.... **Stable fractures**
2. Nerve root compression **Radiculopathy**
3. Cord compression **Myelopathy**
4. Cord hemi-section ... **Brown Sequard syndrome**
5. Cord complete transection ... **Paraplegia or quadriplegia**
6. **Spinal shock**: Initial 48 hours...hypotension and bradycardia and loss of Bulbocavernosus reflex



❖ Clinical picture:

1. **Slight Kyphosis** is seen or felt
2. **Local tenderness** over spinous process
3. **Separation** of spinous process
4. **Examine** the motor power, sensation and Reflexes
5. **A collar** should be applied, and the head should be immobilized
6. The patient should be **log rolled on his side as one piece**

❖ Radiography:

- A. **Anteroposterior and lateral radiographs** for cervical and thoracolumbar spine
- B. For odontoid fractures and atlas fractures. open **mouth views**
- C. **CT scan** is mandatory in all cases
- D. **MRI** is indicated in the presence of neurological affection

✓ **The goals of treatment of spine injuries are:**

1. To realign the spine
2. To prevent loss of function of undamaged neurological tissue
3. To improve neurological recovery
4. To obtain and maintain spinal stability
5. To obtain early functional recovery.

❖ Management

➤ **ATLS**

- Shock
- Immobilization

➤ **Wedge fractures**

- If no neurological affection:
- Thoracolumbar belt and pain management

➤ **Burst fracture and unstable fractures**

- Posterior fixation by pedicular screws and rods

➤ **Cervical fractures**

- Stable: Cervical collar
- Unstable: Halo traction Or ORIF by anterior plate

➤ **Paraplegia and Quadriplegia**

- Special care for bedridden patient including medication and hourly turning with care of skin, bowel and bladder with physiotherapy program



Infection

➤ **Tuberculosis of spine (Pott's disease)**

❖ **Organism:** Mycobacterium tuberculosis

❖ **Incidence:**

- More common in younger children
- Bad prognosis in adults

❖ **Cause:**

- 2ry affection from primary focus (lung)

❖ **Site:** Lower thoracic and upper lumbar

- In children: pathology start in the vertebral body.
- In adults: Pathology starts under anterior longitudinal ligament.

❖ **Clinical picture:**

- Wasting and Fever (Night fever).
- Local pain and tenderness.
- Limitation of movement.
- Kyphosis: angular.
- **Cold abscess**: caseation result in bone destruction and collection in sites such as
 - **Cervical**: Retropharyngeal.
 - **Thoracic**: Mediastinum or sides of chest wall.
 - **Lumber**: Psoas abscess (swelling in the posterior abdominal wall).



❖ **Radiography:**

- Two or more vertebrae are affected.
- Narrowing of the intervertebral disc space.
- Irregular end plates of vertebrae.
- Collapse of the vertebral bodies.
- No bone sclerosis or new bone formation.
- Paravertebral shadow of abscess.
- CT scan and MRI also are indicated.



❖ **Treatment:**

➤ **Conservative:**

- Rest and immobilization.
- Spine brace.
- Anti-TB medications for at least 9 months.

➤ **Operative:**

- Removal of caseation and dead bone through costotransversectomy or anterolateral decompression or from anterior approach in cervical spine.
- Spine fusion after clearance of infection.

Intervertebral Disc Prolapse

❖ **Causes:**

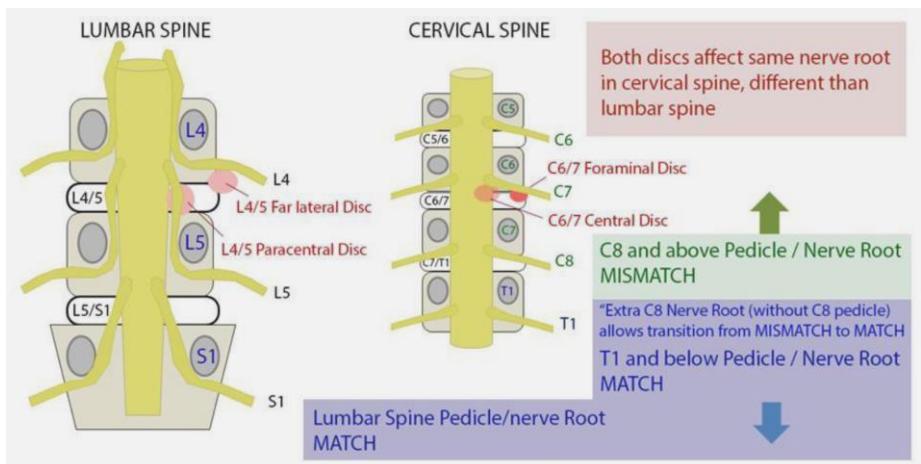
- Sudden strain with the spine in an unguarded position.
- Degeneration of the annulus fibrosus.

❖ **There are three possible sites:**

- Central: compression of the cord.
- Lateral: compression of cord and nerve roots.
- Foraminal: compression of nerve roots.

N.B:

- ✓ The commonest sites are: Lumbar L5-S1
- ✓ In the cervical spine: C5-6 and C7-8



❖ **Clinical picture:**

- Back pain, Neck pain.
- Radicular pain, claudication.
- Myelopathy.

➤ **Motor and sensory weakness:**

- L5-S1 disc: affect 5th lumbar root: Tingling at lateral side of leg and dorsum of foot + weakness of ankle dorsiflexion.
- C5-6: affect 6th cervical root, sensory affection of the outer border of the arm and dorsum of forearm, and weakness of the biceps.

Characteristic	Vascular (Iliofemoral Arterial Insufficiency)	Neurogenic (Lumbosacral Nerve Root Entrapment)
Mechanism	Ischemic	Ischemic and/ or mechanical
Pain	Present (cramping)	Present or absent (radicular)
Pain location	Exercised muscles	Lumbosacral (sciatic)
Pain relieved by	Rest	Flexion posture or sitting
Motor deficit	Rare	Variable, exacerbated by walking
Pulses	Decreased	Normal
Arterial bruit	May be present	Absent
Aortography	Diagnostic	Normal
Lumbar MRI, CT, myelogram	Normal	Diagnostic
CT, computed tomography; MRL, magnetic resonance imaging		

❖ Radiographs:

- X-rays are done to exclude bone diseases that cause the same manifestations.
- Narrowing of the disc space.
- CT scan and MRI are the preferred modalities.

❖ Treatment:

- IF Mild:
 - Conservative treatment by: Medications and Physiotherapy.
- If causing severe symptoms not relieved by medications:
 - Operative including discectomy with or without spinal fusion.

✓ Causes of spinal deformities:

1. Idiopathic: 80% are this.
2. Congenital.
3. Neuromuscular.
4. Cerebral palsy.
5. Syndrome related: Marfan's syndrome.
6. Degenerative.
7. Neoplastic: (Osteoid osteoma) associated with pain.

