

# Orthopaedics

**Edition 8.5**

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# Contents

## Orthopaedics

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|                                                                                                                                                                                                                                                                                  |           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Basic Anatomy and Physiology of Bones</b>                                                                                                                                                                                                                                     | <b>1</b>  |
| Bone composition & markers • Anatomy • Bone growth                                                                                                                                                                                                                               |           |
| <b>Basic Terminology of Fracture &amp; Healing</b>                                                                                                                                                                                                                               | <b>5</b>  |
| Fractures • Fracture healing • Complications in fracture healing • Management of fracture                                                                                                                                                                                        |           |
| <b>Open Fracture, Amputations and Polytrauma</b>                                                                                                                                                                                                                                 | <b>17</b> |
| Open fracture • External fixation • Amputation • Terminologies of amputation •<br>Prosthesis & orthosis • Reimplantation of limb • Advanced trauma life support (ATLS) •<br>Evolution of polytrauma management • Crush syndrome                                                  |           |
| <b>Metabolic Disorders of Bone</b>                                                                                                                                                                                                                                               | <b>30</b> |
| Calcium homeostasis • Overview of metabolic bone disorders • Rickets •<br>Osteomalacia • Scurvy • Hyperparathyroidism • Osteoporosis •<br>Paget's disease/ osteitis deformans • Osteogenesis imperfecta/ brittle bone disease •<br>Laboratory values in metabolic bone disorders |           |
| <b>Upper Limb Trauma : Clavicle and Shoulder</b>                                                                                                                                                                                                                                 | <b>44</b> |
| <b>Upper Limb Trauma : Arm and Elbow</b>                                                                                                                                                                                                                                         | <b>51</b> |
| Proximal humerus fracture • Shaft of humerus fracture • Fractures around elbow •<br>Elbow dislocation                                                                                                                                                                            |           |
| <b>Upper Limb Trauma : Forearm, Wrist and Hand</b>                                                                                                                                                                                                                               | <b>61</b> |
| Fractures of forearm • Fractures of distal end of radius • Fractures of hand                                                                                                                                                                                                     |           |
| <b>Lower Limb Trauma : Pelvis and Tests</b>                                                                                                                                                                                                                                      | <b>69</b> |
| Anatomy of hip joint • Pelvis fracture • Acetabular fractures • Lower limb tests                                                                                                                                                                                                 |           |
| <b>Lower Limb Trauma : Hip Dislocation and Fractures</b>                                                                                                                                                                                                                         | <b>75</b> |
| Hip dislocations • Proximal femur fractures • Neck of femur fracture •<br>Intertrochanteric fracture                                                                                                                                                                             |           |
| <b>Lower Limb Trauma : Femur, Knee, Leg and Foot</b>                                                                                                                                                                                                                             | <b>82</b> |
| Shaft of femur fracture • Leg injuries • Foot injuries                                                                                                                                                                                                                           |           |
| <b>Sports Injuries Around Knee</b>                                                                                                                                                                                                                                               | <b>88</b> |
| Anatomy of knee joint • Injury to collaterals • Injury to menisci •<br>Injury to cruciate • Rotational injuries                                                                                                                                                                  |           |
| <b>Painful Regional Conditions and AVN</b>                                                                                                                                                                                                                                       | <b>96</b> |
| Conditions of shoulder • Conditions around elbow • Conditions around wrist & hand •<br>Conditions around knee • Conditions of foot • Avascular necrosis (AVN)                                                                                                                    |           |

|                                                                                                                                                                                                                                                 |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>Nerve Injuries : Part 1</b>                                                                                                                                                                                                                  | <b>111</b> |
| Structure of nerve • Pathology in nerve injuries • Classification • Management • Specific nerve injuries                                                                                                                                        |            |
| <b>Nerve Injuries : Part 2</b>                                                                                                                                                                                                                  | <b>118</b> |
| Median nerve • Ulnar nerve • Radial nerve • Lower limb injuries • Entrapment neuropathies                                                                                                                                                       |            |
| <b>Orthopaedic Oncology : Part 1</b>                                                                                                                                                                                                            | <b>129</b> |
| Approach to diagnosis of bone lesion • Classification of bone tumors • Miscellaneous oncologic topics • Bone cyst                                                                                                                               |            |
| <b>Orthopaedic Oncology : Part 2</b>                                                                                                                                                                                                            | <b>136</b> |
| Chondrocyte predominant tumors • Osteoblast tumors • Giant cell tumor/osteoclastoma • Hemangioma • Chondrosarcoma • Osteosarcoma • Ewings sarcoma • Miscellaneous tumors • Metastasis                                                           |            |
| <b>Infection of Bone and Joints</b>                                                                                                                                                                                                             | <b>144</b> |
| Osteomyelitis • Pathophysiology & clinical features • Management & complications of acute osteomyelitis • Chronic osteomyelitis • Variants of osteomyelitis • Septic arthritis • Tom smith arthritis • Transient synovitis • Infections of hand |            |
| <b>Tuberculosis of Bone and Joints</b>                                                                                                                                                                                                          | <b>155</b> |
| TB spine/TB spondylitis/pott's spine • TB hip • TB knee • Current guidelines on diagnosis & management of TB                                                                                                                                    |            |
| <b>Paediatric Orthopaedics : General Topics</b>                                                                                                                                                                                                 | <b>161</b> |
| Paediatric deformities • Limb deficiency                                                                                                                                                                                                        |            |
| <b>Paediatric Orthopaedics : Hip</b>                                                                                                                                                                                                            | <b>168</b> |
| Coxa vara • Osteochondritis/osteonecrosis • Development dysplasia of hip                                                                                                                                                                        |            |
| <b>Paediatric Orthopaedics : Knee and Foot</b>                                                                                                                                                                                                  | <b>174</b> |
| Deformities of knee • Deformities of foot • Congenital talipes equinus varus (CTEV) • Achondroplasia                                                                                                                                            |            |
| <b>Spine : General and Trauma</b>                                                                                                                                                                                                               | <b>183</b> |
| Anatomy of musculoskeletal elements of spine • Trauma to spine • SCIWORA • Spinal cord injury: Early manifestations • Spinal cord injury: Late manifestations                                                                                   |            |
| <b>Spine : Disorders</b>                                                                                                                                                                                                                        | <b>191</b> |
| Prolapsed intervertebral disc (PVD) • Lumbar canal stenosis (LCS) • Spondylolisthesis • Conditions with fusion of spine • Scoliosis                                                                                                             |            |
| <b>Joint Disorders</b>                                                                                                                                                                                                                          | <b>200</b> |
| Anatomy of a joint • Osteoarthritis • Rheumatoid arthritis • Spondyloarthropathies • Hemophilic arthropathy • Crystal deposition arthropathy • Neuropathic joint                                                                                |            |

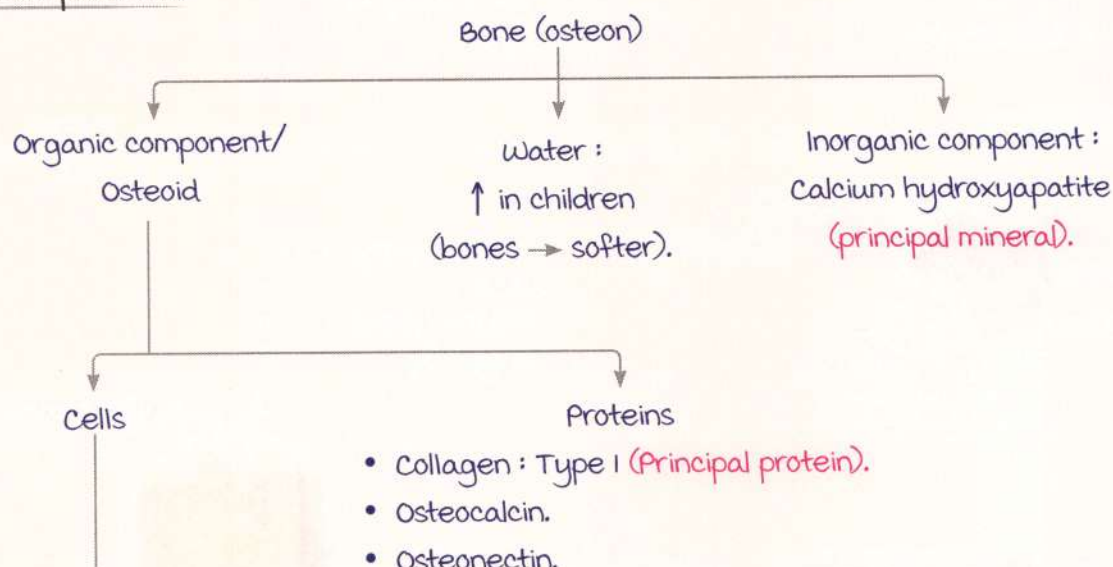
# BASIC ANATOMY AND PHYSIOLOGY OF BONES

----- Active space -----

## Bone Composition & Markers

00:00:38

### Composition :



### Osteoblast

- Cell type :
  - mononuclear cells
- Function :
  - Lays down osteoid matrix (collagen)
  - ↓ mineral deposition
  - Bone/Osteon
- Rich in Alkaline phosphatase

### Osteoclast

- Cell type :
  - monocyte aggregates.
  - multinucleated giant cells.
- Function :
  - Phagocytic.
  - Bone resorption & remodelling.
- Rich in TRAP & carbonic anhydrase.
- Least in number

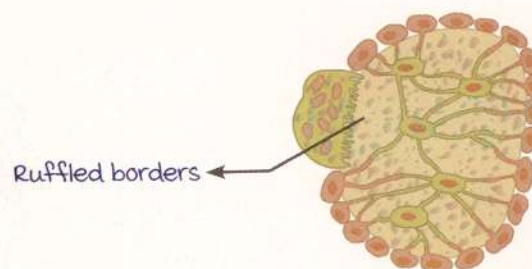
### Osteocyte

- Cell type :
  - mature/resting osteoblast.
- Features :
  - most abundant.
  - Longest life span.

### Note : Collagen types

| Type 1                                                                                                 | Type 2                                                                                                    |
|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Bones.</li> <li>meniscus.</li> <li>Annulus fibrosis.</li> </ul> | <ul style="list-style-type: none"> <li>Articular hyaline cartilage.</li> <li>Nucleus pulposus.</li> </ul> |

- Strength of bone depends on osteoblasts & osteoclasts.



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## Bone markers :

### markers

#### Bone formation

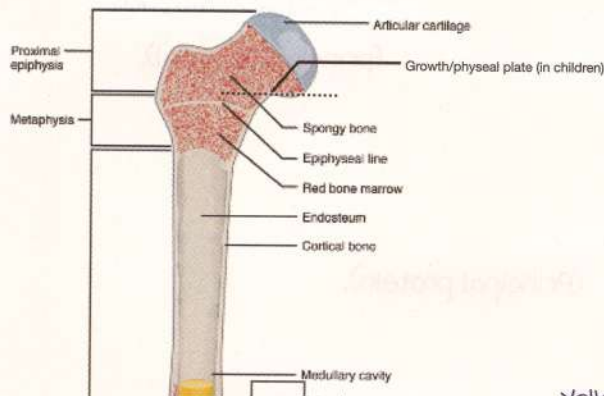
- Alkaline phosphatase (ALP)
- Procollagen I
- Osteocalcin
- Osteonectin

#### Bone resorption

- Hydroxyproline } Collagen breakdown products
- Hydroxylysine }
- N&C telopeptide
- TRAP

## Anatomy

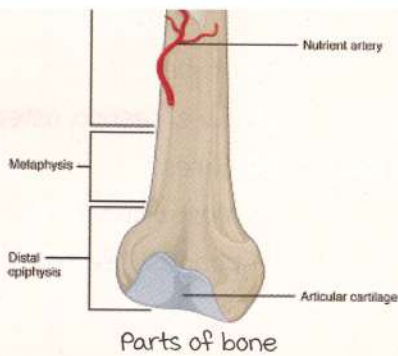
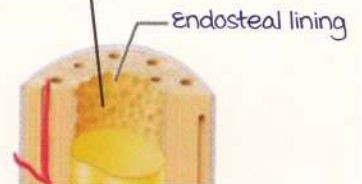
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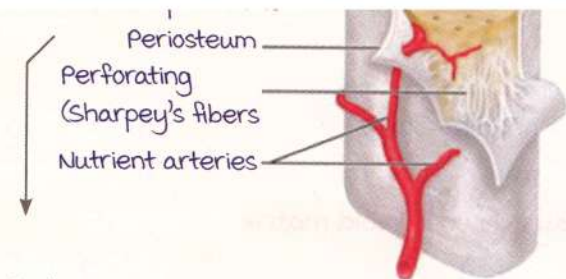
medullary cavity :

Content :

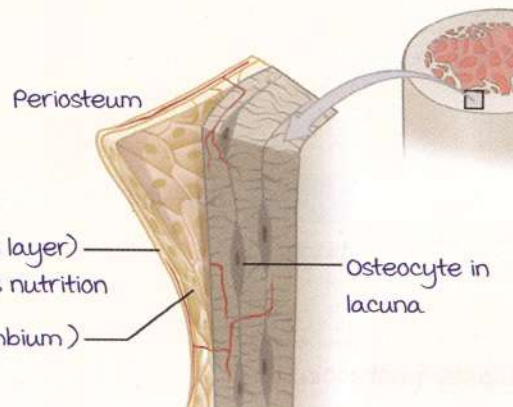
- Children : marrow.
- Adults : Fat.



Parts of bone



Anchors periosteum to bone

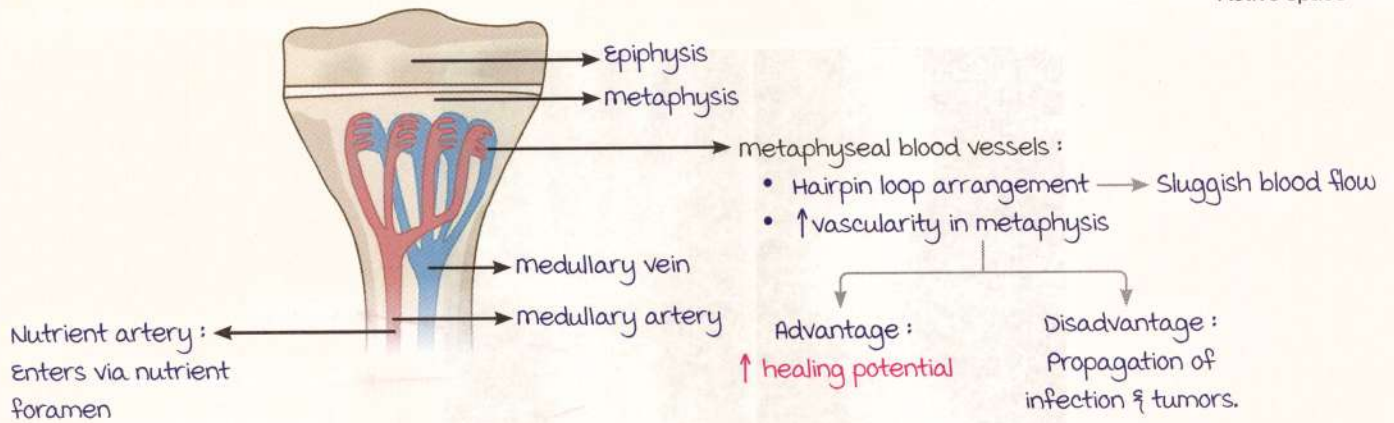


### Periosteum :

- Present in all long bones
- Absent in :
  - Articular surface of long bones.
  - Sesamoid bones (eg : Patella).

(Inner cellular layer a.k.a cambium)  
Helps in growth

----- Active space -----



Note : metaphysis has very few macrophages/monocytes.

### Types Of Bone Architecture :

Immature woven bone :

- Improperly arranged collagen.
- Weak.
- Seen in :
  - Children.
  - Bones healing from fracture (eg : callus).

mature / smaller bone :

| Site                  | metaphysis | Diaphysis |
|-----------------------|------------|-----------|
| Consistency           | Soft       | Hard      |
| Bone cells            | ↑          | ↓         |
| Vascularity           | ↑          | ↓         |
| Fracture healing      | Fast       | Slow      |
| Risk of infection     | ↑          | ↓         |
| Fracture complication | malunion   | Non union |

Note :

Epiphyseal fractures (Intraarticular) → Osteoarthritis → ↓ Range of motion.

----- Active space -----

**Bone Growth**

00:20:40



a). Lateral view

b). Anteroposterior view

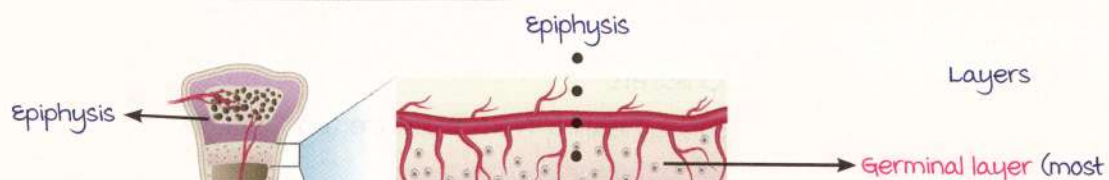
X-ray : Left hand (child).

Epiphysis

Physis : Only in children

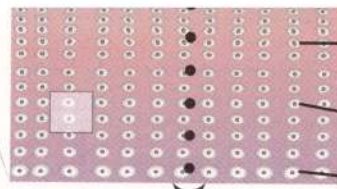
↑ ses length of bone

metaphysis

Growth Plate Structure :

Layers

Germinal layer (most



metaphysis

Hypertrophic layer

(weakest)

Layer of calcification

Layer of ossification

growth

Applied Aspect :

Growth plate (germinal layer) injury

Complete

Partial

- I/L side (bone) : Stops growing.
- C/L side (bone) : Continues to grow.

Limb length discrepancy

Asymmetrical growth

Deformity (varus/valgus)

Appositional growth (↑ ses thickness) : By endosteum &amp; periosteum.

# BASIC TERMINOLOGY OF FRACTURE & HEALING

----- Active space -----

## Fractures

00:00:49

Break in continuity of bone cortex.

### General Features of Fracture :

Clinical signs :

- Abnormal mobility at fracture site > crepitus (Pathognomonic).
- Tenderness (most consistent).
- Swelling.

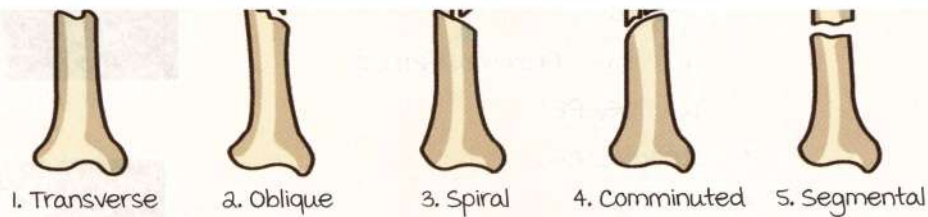
Radiological :

X-ray : Discontinuity of bone.

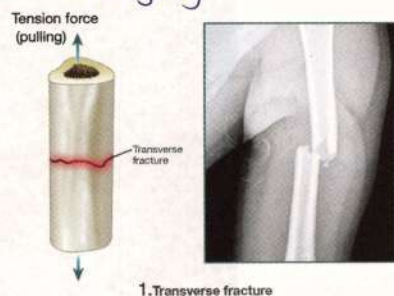
### Causes :

Fractures with significant trauma :

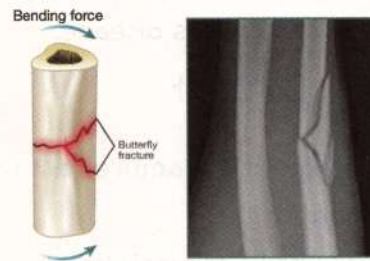
- Types :



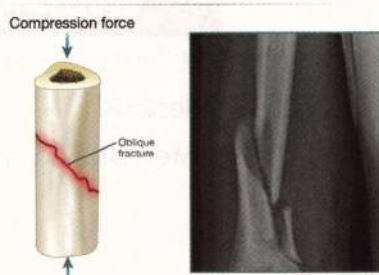
- mechanism of injury :



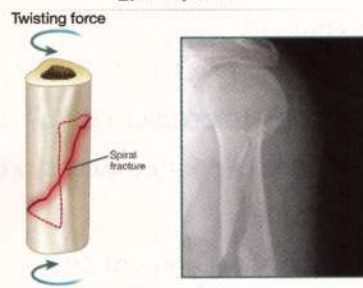
1. Transverse fracture



2. Butterfly fracture



3. Oblique fracture

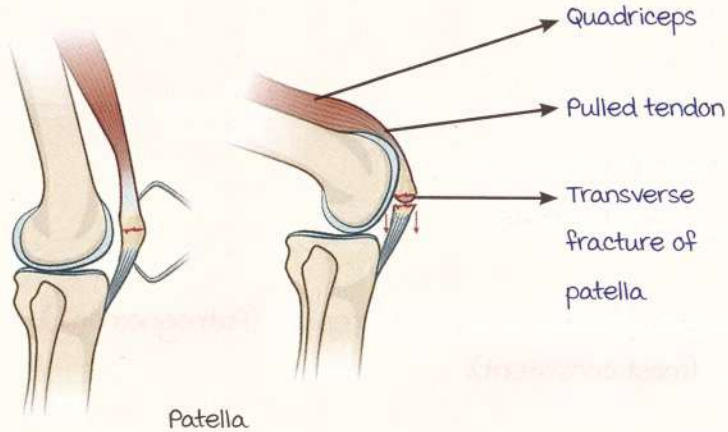


4. Spiral fracture

----- Active space -----

• Avulsion fractures :

- Violent pull of tendons → Avulsion of bone.
- Eg : Patella, olecranon.



Fractures without significant trauma :

1. Pathological fractures

Localized causes

- Infection.
- Ischemia.

Generalized causes

- Osteoporosis (m/c cause) :
- m/c sites : Spine > hip >



- Radiation.

- Osteoporosis :
- m/c site : Proximal femur.
- Ix : FDG-PET
- Osteomalacia.
- Rickets.
- Osteogenesis imperfecta.
- Paget's disease.
- Scurvy.



Fracture 2° to cyst

- Pain before the fracture (d/t micro fractures).

• Investigation :

X-ray : Shows primary lesion.

• Management :

A. Mirel's criteria :

- used to predict risk of pathological fracture d/t lesions.
- Score of  $\geq 8$  : Requires prophylactic fixation with internal fixation devices.

B. Treat underlying cause.



Fracture 2° to Paget's disease

## 2. Stress fracture :

- d/t sudden and repetitive loading of bone, ↑ intensity and frequency of activity.

- Common sites :

a. Tibia

b. Fibula

c. metatarsal (march fracture) :

2<sup>nd</sup> > 3<sup>rd</sup> metatarsal.

Neck > shaft.

} weight bearing bones

- Pain :

- Pain ↑ after ↑ in activity.

- Investigations :

- X-ray : Fracture visible after 2-3 wks of symptoms.

- MRI (IOC) :

Identifies → Soft tissue edema.  
Occult fractures.

- Bone scan : For multiple stress fractures.

- management :

----- Active space -----



# At neck of 2<sup>nd</sup> metatarsal

march fracture



## 3. Shin splints :

AKA medial Tibial Stress Syndrome (MTSS).

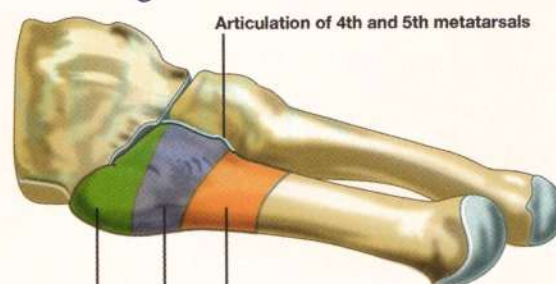
- Seen in runners.
- medial periostitis of tibia.
- mechanism of injury :

Repetitive muscle contractions → Inflammation of periosteum at site of muscle attachment



Pain over anteromedial side of leg

- X-ray : Normal.
- multiple stress fracture (IOC) : Bone scan
- Treatment : immobilisation



Zone 3 (Stress fracture)  
Zone 2 (True Jones fracture)  
Zone 1 (Pseudo Jones fracture)

Robert jones fracture

Note :

Robert jones : Fracture of 5<sup>th</sup> metatarsal base.

Types of Fracture Healing :

|               | Primary healing                                                                                                                       | Secondary healing                                                                                                      |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Also known as | <ul style="list-style-type: none"> <li>• Direct healing</li> <li>• Intramembranous healing</li> </ul>                                 | <ul style="list-style-type: none"> <li>• Indirect healing</li> <li>• Endochondral healing</li> </ul>                   |
| Stability     | <ul style="list-style-type: none"> <li>• Absolute stability d/t rigid fixation</li> <li>• No movement of fracture fragment</li> </ul> | <ul style="list-style-type: none"> <li>• Relative stability</li> <li>• Micromovements at fracture site</li> </ul>      |
| Mechanism     | <p>Cone cutting mechanism :</p> <p>Osteoclasts drill into fracture fragment</p> <p>↓</p> <p>Osteoblasts form new bone</p>             | <ul style="list-style-type: none"> <li>• Sequential fracture healing</li> <li>• Cartilage formation present</li> </ul> |
| Callus        | Not formed                                                                                                                            | Formed                                                                                                                 |
|               |                                                                                                                                       | <ul style="list-style-type: none"> <li>• Cast (PoP)</li> <li>• Splint (PoP/fiberglass)</li> </ul>                      |

|                                             |                                                                                                                                                      |                                                                                                                                                                                                                                       |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Devices & fracture stabilization techniques | <ul style="list-style-type: none"> <li>• Dynamic compression plate (DCP)</li> <li>• Lag screws :<br/>Creates interfragmentary compression</li> </ul> | <ul style="list-style-type: none"> <li>• Skeletal traction</li> <li>• External fixation</li> <li>• Intramedullary nailing (Im nailing)</li> <li>• Bridge plating :<br/>No compression at fracture site, allows micromotion</li> </ul> |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



A : 2<sup>nd</sup> metacarpal



B : Humerus



C

----- Active space -----

Callus formation

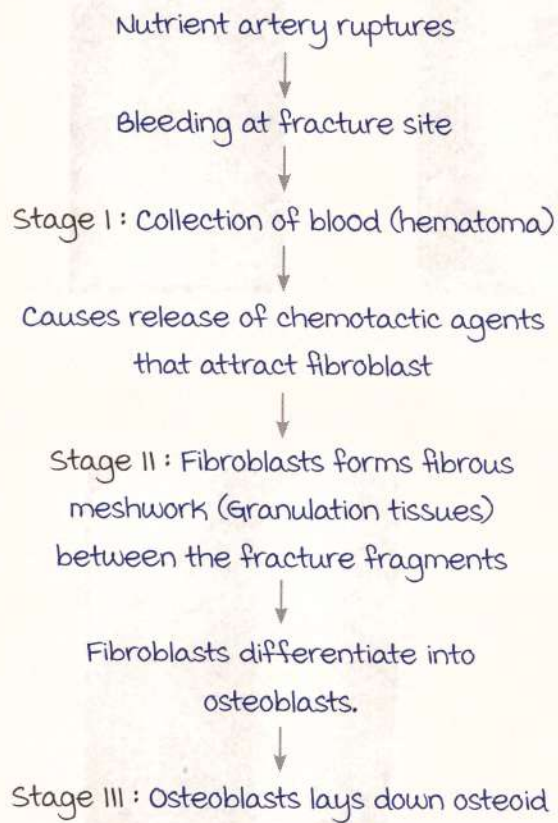


(In interlocking nail) : 2<sup>nd</sup> healing



Shaft of ulna fracture : DCP

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Stages of 2° Healing :**1 Hematoma formation (2-3 days)****2 Granulation Tissue Formation (Inflammation) (2-3 weeks)****3 Callus Formation (2-3 months)****4 Consolidation (2-3 years)**

Stage IV : Callus hardens.

↓  
Stage V : Resorption by Osteoclasts to  
resemble native bone.

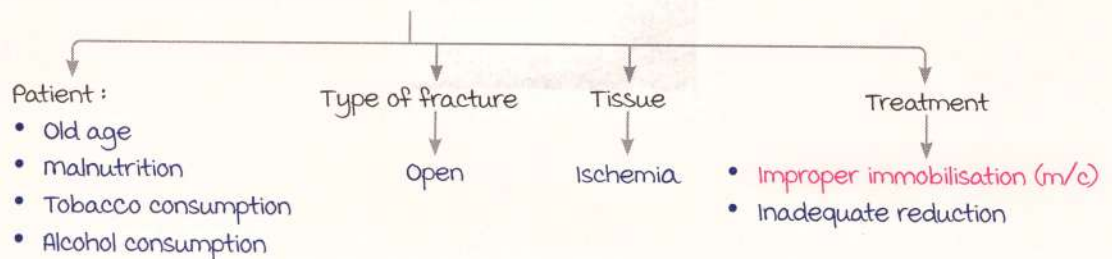
**5 Bone remodelling (3 years)**

Callus :

- Disorganised mass of immature bone.
- **Visible on X-ray** after 2-3 weeks of fracture.

Note :

Compression at fracture site → promotes union.

Factors Inhibiting Fracture Healing :

## Complications in Fracture Healing

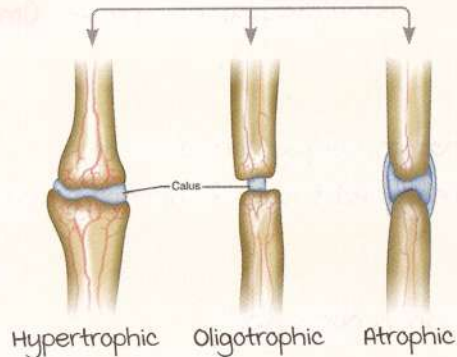
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### Non - Union :

- Callus formation absent for > 9 months.
- Risk factor : Diaphyseal bone fractures.
- m/c site : Lower 1/3rd Tibia.

### Types :



### Differences between Hypertrophic & Atrophic Non-Union :

|                  | Hypertrophic                                                                        | Atrophic (typical)                                                                  |
|------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Ends of fracture | Smooth & sclerosed (↑ density)                                                      |                                                                                     |
| Fracture line    | Visible                                                                             |                                                                                     |
| X-ray appearance |  |  |

|                  |                                                                                     |                                                                                     |
|------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                  |  |  |
| Callus formation | ↑↑                                                                                  | Absent                                                                              |
| Bone biology     | Good                                                                                | Abnormal                                                                            |
| Immobilisation   | Improper                                                                            | ±                                                                                   |
| Treatment        | Immobilization                                                                      | Autologous bone grafting                                                            |

### Bone Graft :

- m/c source : Iliac crest.
- Ideal bone graft characteristics :
  1. Osteogenesis : Graft itself makes bone using osteoblasts.
  2. Osteoconduction : Allows bone to grow on it as a scaffold.
  3. Osteoinduction :
    - Stimulates surrounding host bone to form bone
    - (Growth factors : differentiates mesenchymal cells → bone forming cells).

----- Active space -----

- Substitutes of bone graft :

| Property        | Substitute                                                                                                                                   |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Bone conduction | <ul style="list-style-type: none"> <li>• Calcium phosphate</li> <li>• Calcium sulphate</li> <li>• PMMA (Poly methyl methacrylate)</li> </ul> |
| Bone induction  | Bone morphogenic protein (Improves bone union)                                                                                               |

### malunion :

- Fractures healing in anatomically abnormal position.
- Rx : Osteotomy (Bone realigned & fixed if functional abnormality (+)).

### Note :

Bones with ↑ risk of malunion vs non-union.

| malunion                                                                                                                                                            | Non-union                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Clavicle (m/c)</li> <li>• Supra-condylar humerus</li> <li>• Colles</li> <li>• Intertrochanteric (extracapsular)</li> </ul> | <ul style="list-style-type: none"> <li>• Lower 1/3rd of tibia (m/c)</li> <li>• Scaphoid</li> <li>• Lateral condyle of humerus</li> <li>• Neck of femur (intracapsular)</li> </ul> |

Fractures that undergo malunion, rarely/never undergo non-union (& vice-versa).

### Management of Fracture

00:40:53

#### Important Terms :

Displacement : movement of distal fracture segment d/t pulling forces by muscle.

Reduction : Bringing fracture segment back to normal anatomy with counter-forces.

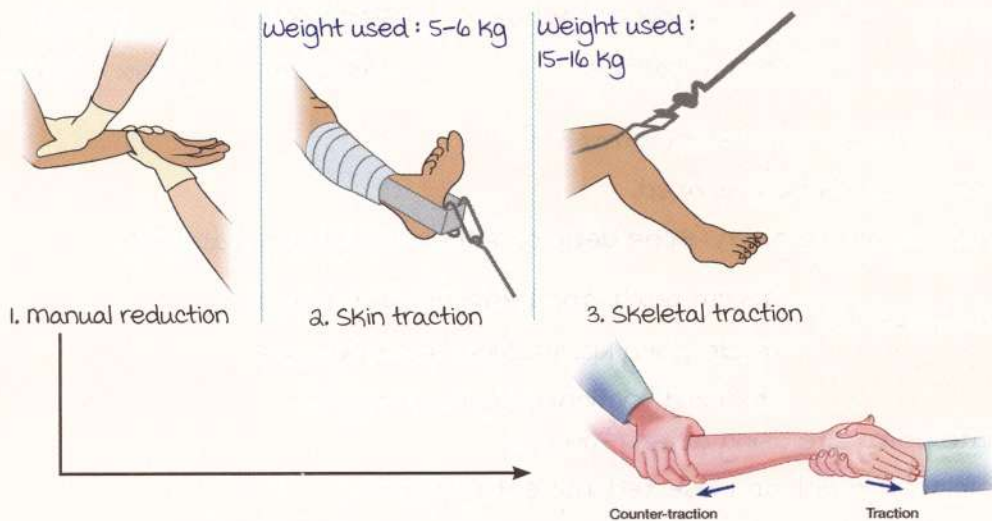
Traction : Counter-force applied.

Fixation : maintaining fracture in reduced position till it heals.

Reduction :

----- Active space -----

methods :



manual closed Reduction :

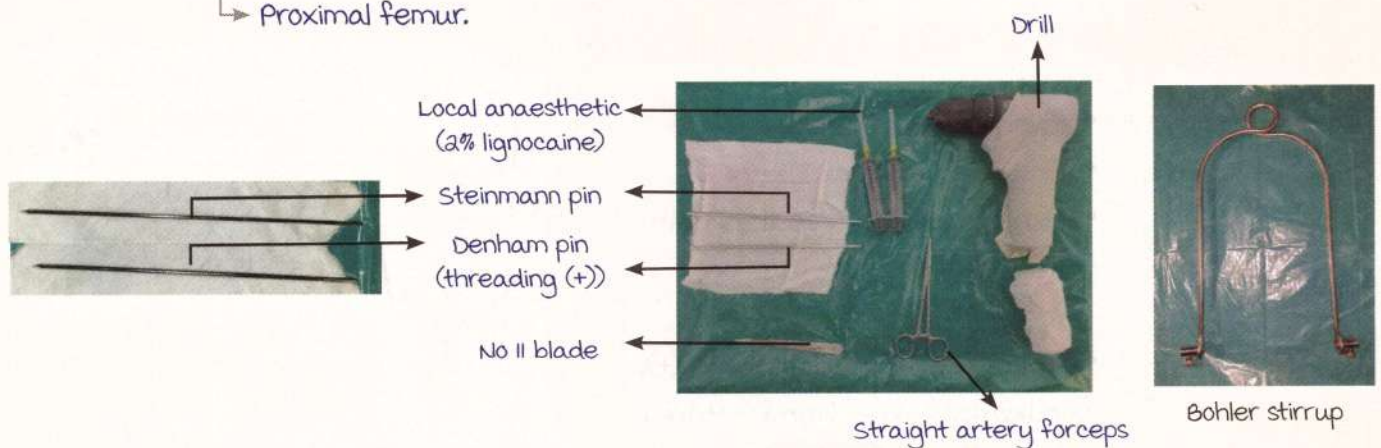
- Done using manual 'traction' and counter traction.
- Followed by POP application.
- Repeat X-ray to confirm reduction.

→ maintains fracture reduction

Skeletal Traction :

Site of pin

- upper tibia (m/c).
- Lower tibia.
- distal femur.
- Proximal femur.



Instruments used for skeletal traction

----- Active space -----

|             |                           | Denham pin   | Steinmann pin   |
|-------------|---------------------------|--------------|-----------------|
| Threading   |                           | +            | -               |
| Indications | 1. Type of bone fractured | Osteoporotic | Normal          |
|             | 2. Site of traction       | Calcaneal    | Tibia / femoral |

Procedure (upper tibial skeletal traction) :

1. Site : Draped and prepared.
2. Local anesthetic given : Bone deep on either side of bone laterally.
3. Stab wound  $\begin{cases} \rightarrow 2.5 \text{ cm below and behind tibial tubercle.} \\ \rightarrow \text{made using No. 11 scalpel reaching bone} \\ \quad \text{(to avoid friction while inserting pin).} \end{cases}$
4. Dilate entry site using artery forceps.
5. Pin placed in drill and inserted into entry wound.
6. Pin drilled through the bone and brought out at opposite site.
7. Drill removed and wound dressed.
8. Böhler's stirrup mounted onto pin and locked.
9. Weights applied using ropes.
10. Patient mounted onto a splint.

- **Pin-tract sequestrum** : ring shaped sequestrum at entry & exit sites.

Uses :

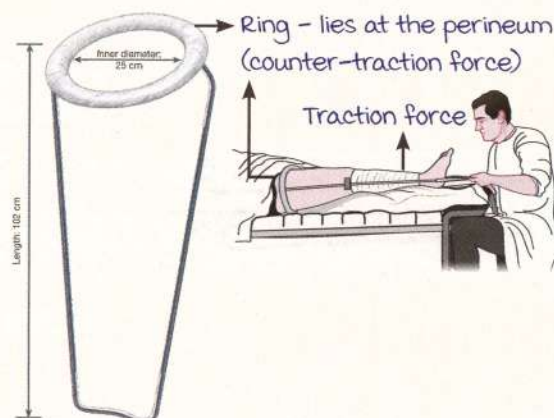
for traction of lower limb fractures : Intertrochanteric, Distal femur.

### Temporary management : Splints

To stabilize fracture.

Thomas splint :

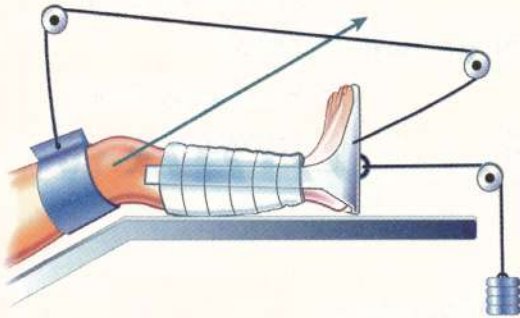
- Inventor : **H.O Thomas**.
- First use : to treat **TB knee**.
- Fixed traction device (has both traction & counter-traction forces).
- Advantage : Patient mobility (+).
- Indication : lower limb fractures (m/c : **femur fractures**).



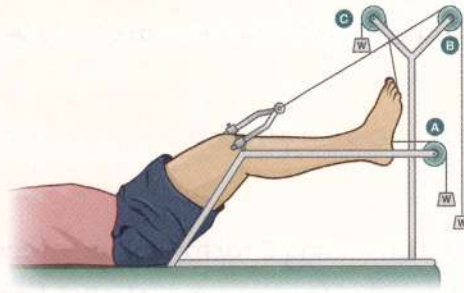
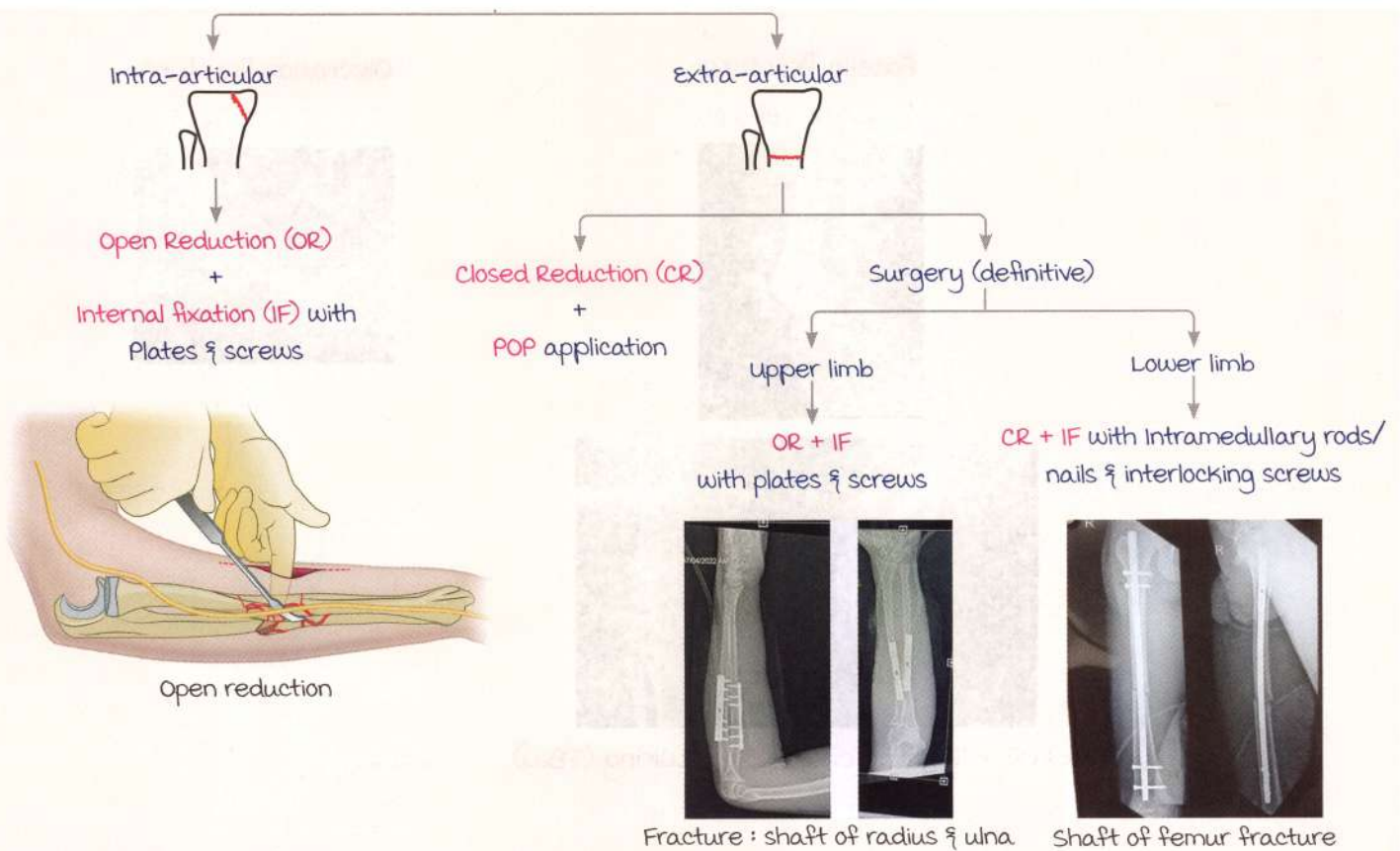
**Bohler & Braun Splint :**

----- Active space -----

- **Sliding traction device** used in wards.
- Force :
  - Traction : Weights
  - Counter traction : Gravity (Foot end of bed raised)
- Location of pulleys :
  - **A** : For Tibia fractures.
  - **B** : For Femur fractures.
  - **C** : To prevent foot drop.

**Russell traction**

Indication : Inter-trochanteric fracture of femur

**Bohler & Braun splint : location of pulleys****Definitive Treatment :**

----- Active space -----

Reduction  $\begin{cases} \text{Open : Fracture visualised and reduced} \\ \text{Closed : Done without opening fracture site and confirmed with X-ray} \end{cases}$

Accuracy of reduction : **Open > closed**

Hence preferred in intra-articular fractures (to prevent osteoarthritis)

POP application :

| Disadvantages                                                                                                                                                                                                                                                                                                                              | Advantages                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Cumbersome</li> <li>• Requires joint immobilization above &amp; below fracture</li> </ul> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;">↓<br/>Disuse atrophy</div> <div style="text-align: center;">↓<br/>Stiffness</div> </div> | <ul style="list-style-type: none"> <li>• Non-invasive</li> <li>• Cheap</li> <li>• Easy application &amp; removal</li> </ul> |

CR+IF :

Reduction : using C-arm (image intensifier)

Fixation : Rod/nail passed into the bone medullary cavity  
(incision is made at the proximal site)

↓  
interlocking screws placed (to avoid rotation of rod)

↓  
**Patella fracture**  
(d/t Quadriceps pull)



Rx : OR + IF with **Tension Band Wiring (TBW)**

↓  
**Olecranon fracture**  
(d/t Triceps pull)

