

Orthopaedics

Marrow Edition 8

MARROW

Instructions

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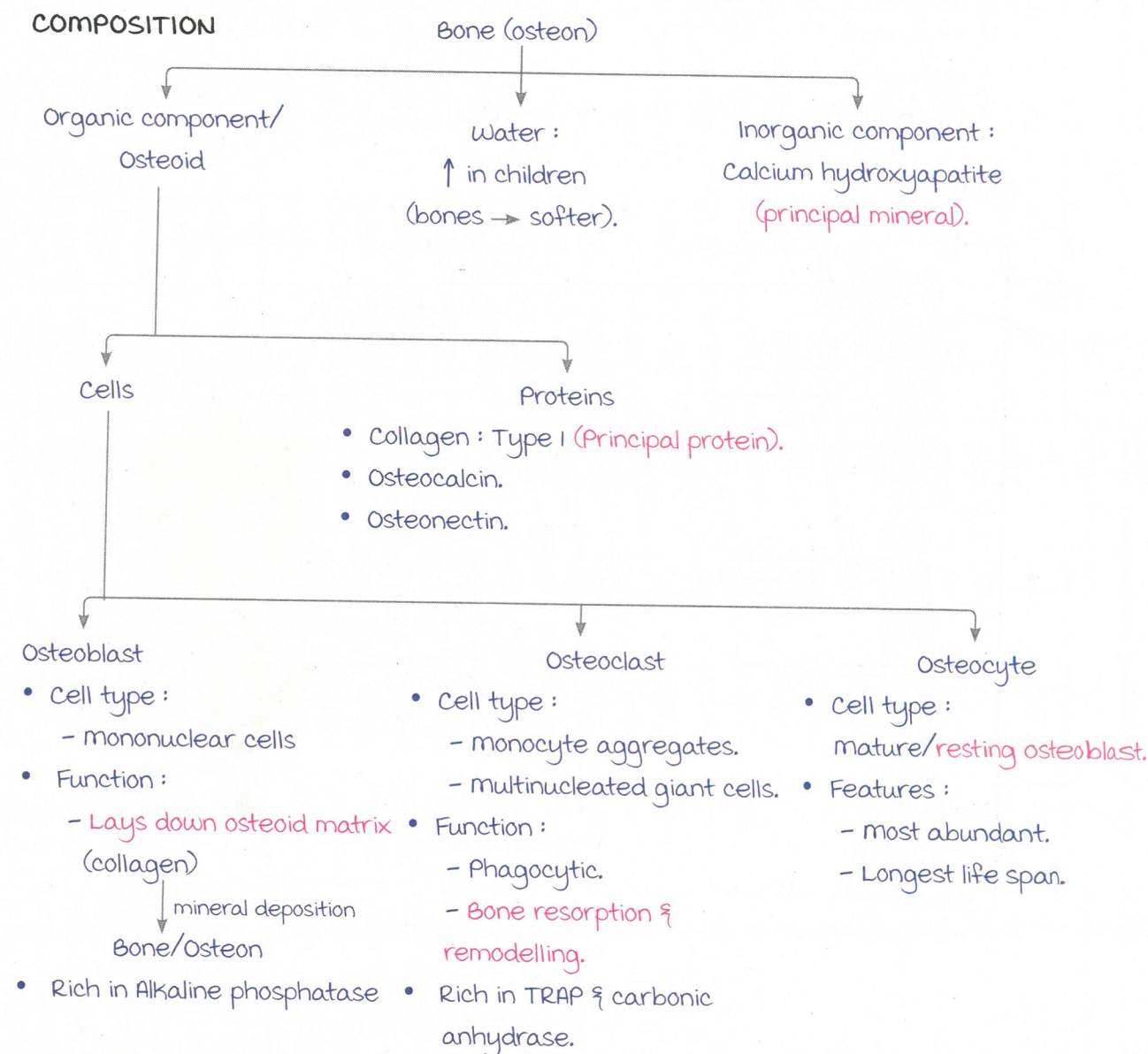
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BASIC ANATOMY AND PHYSIOLOGY OF BONES

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

Bone composition & markers

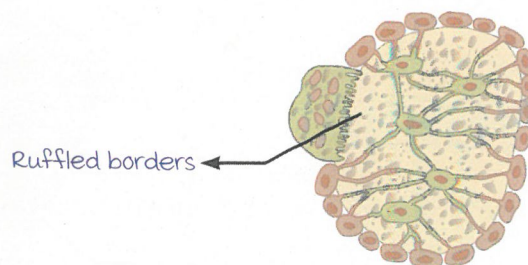
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Note : Collagen types

Type 1	Type 2
• Bones. • Meniscus. • Annulus fibrosis.	• Articular hyaline cartilage. • Nucleus pulposus.

- Strength of bone depends on osteoblasts & osteoclasts.



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BONE MARKERS

markers

Bone formation

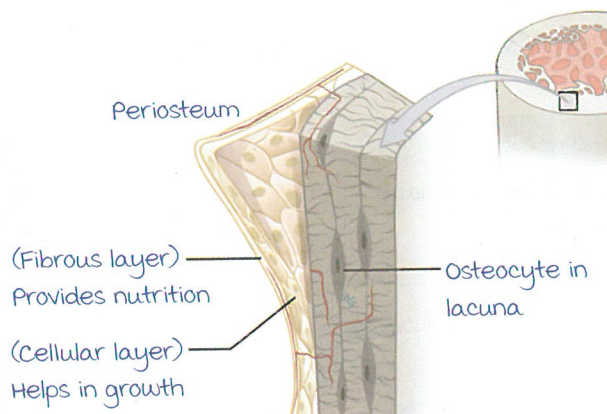
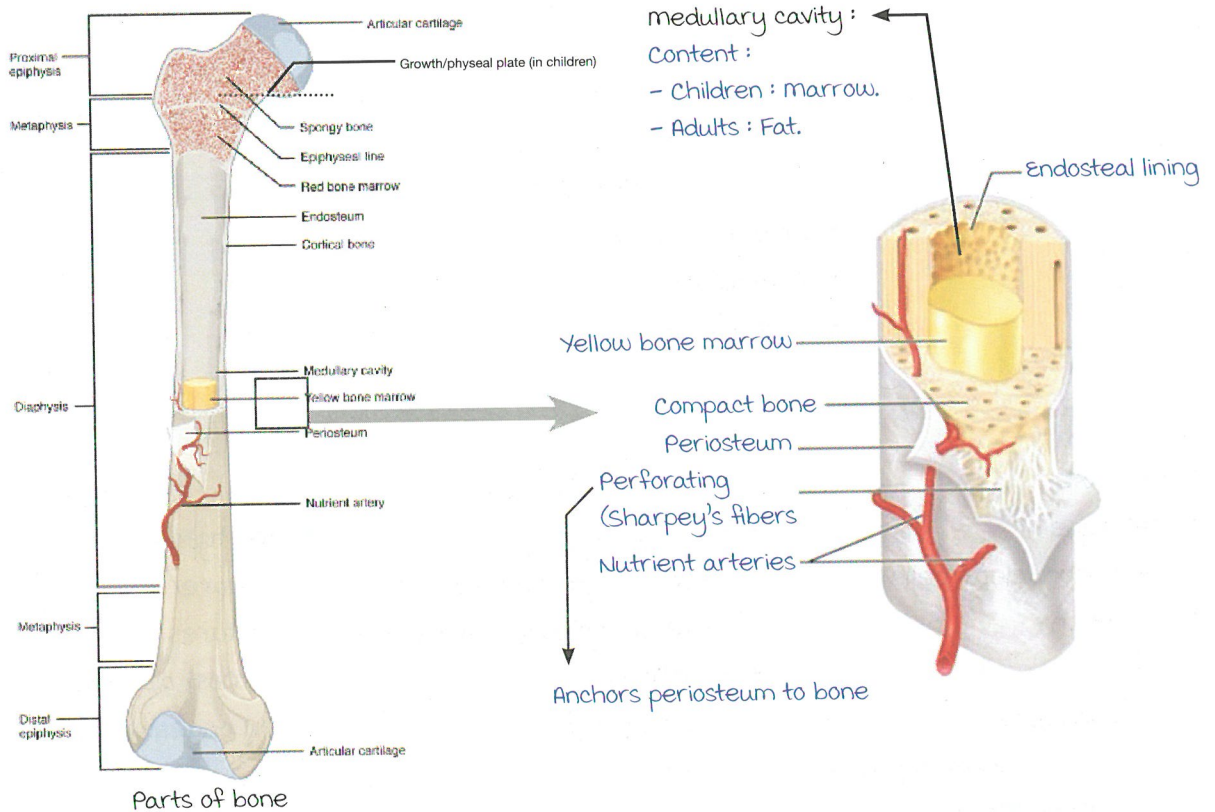
- Alkaline phosphatase (ALP)
- Procollagen I
- Osteocalcin
- Osteonectin

Bone resorption

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

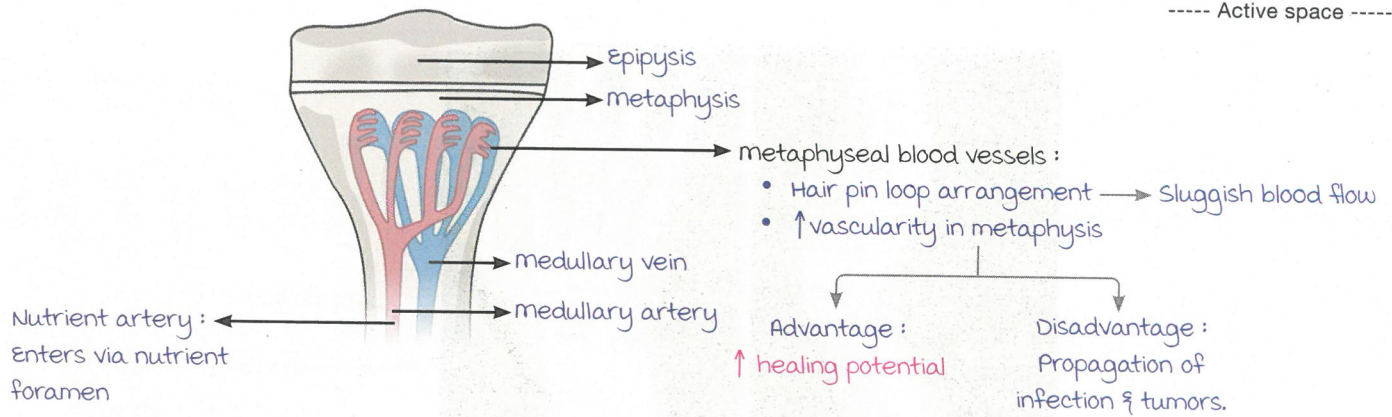
Anatomy

00:09:28

**Periosteum :**

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

----- 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/lamellar bone :

	cancellous/spongy	Cortical/compact
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.



a). Lateral view

b). Anteroposterior view

X-ray : Left hand (child).

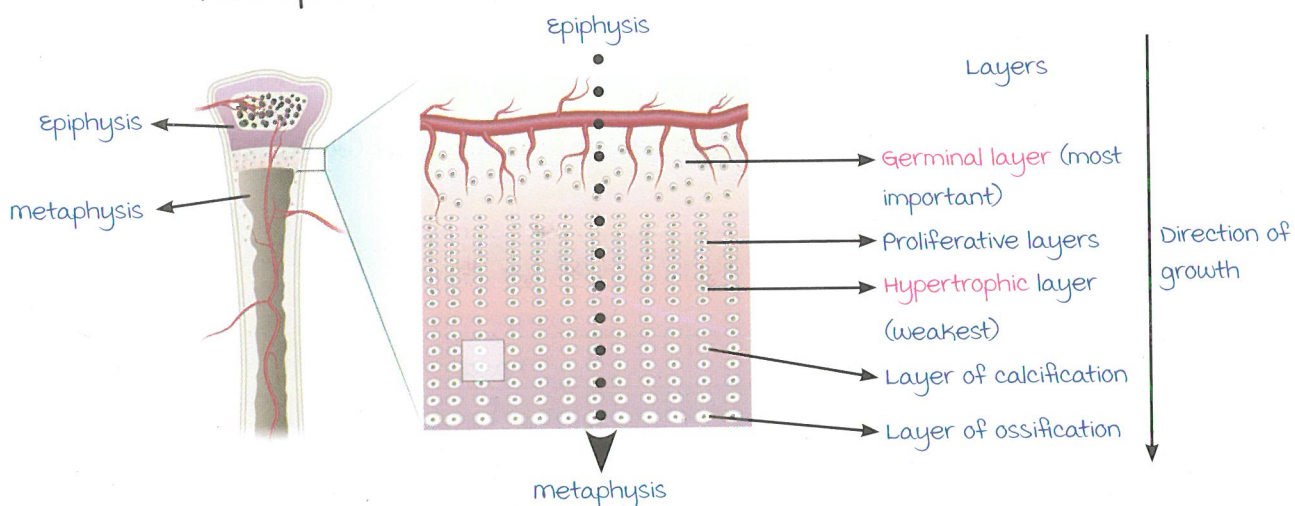
Epiphysis

Physis : Only in children

↑ ses length of bone

metaphysis

Growth plate structure :



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 & periosteum.

BASIC TERMINOLOGY OF FRACTURE AND 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.

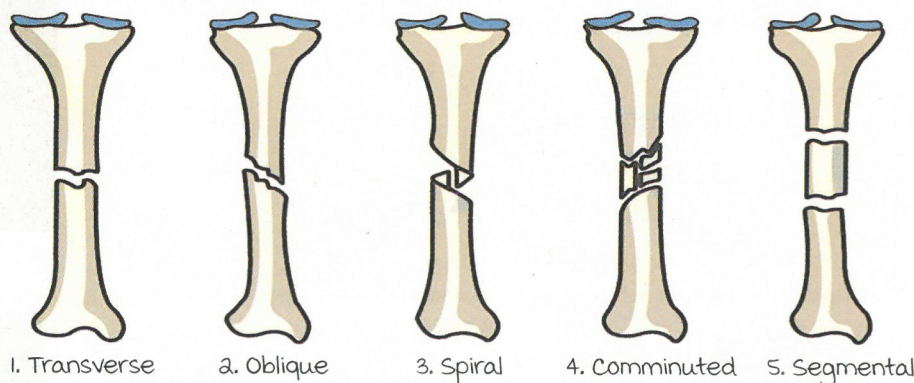
Radiological :

- X-ray : Discontinuity of bone.

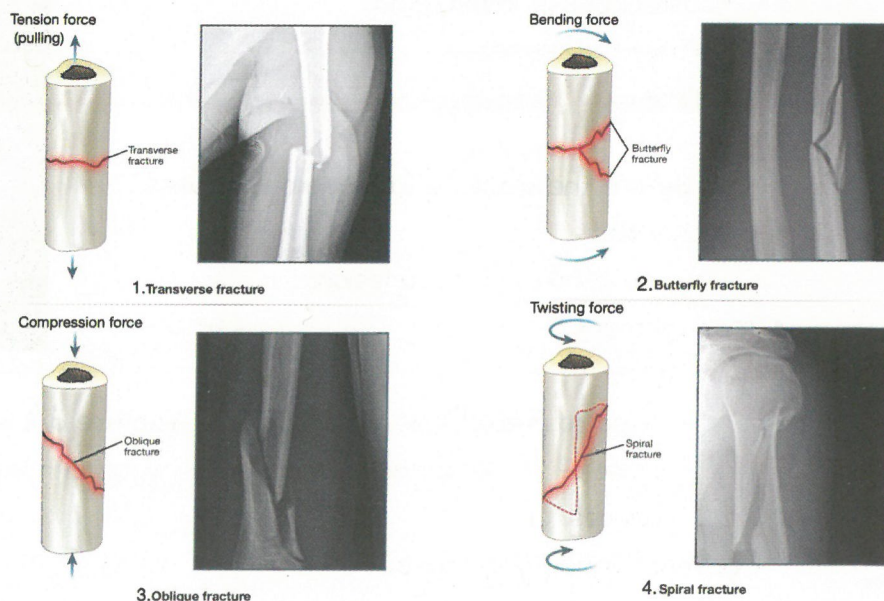
CAUSES

Fractures with significant trauma :

Types :



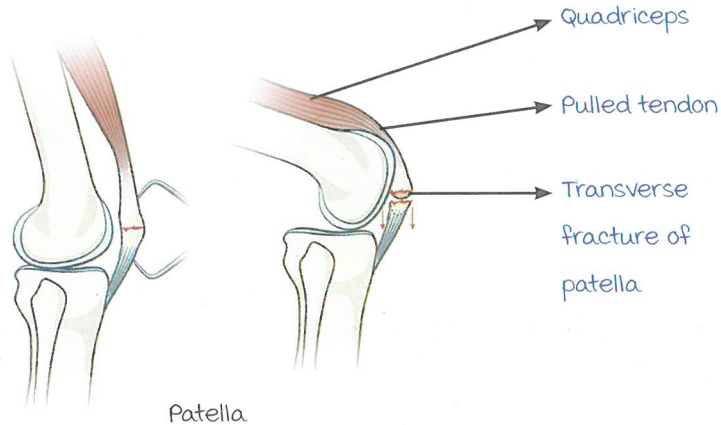
mechanism of injury :



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Avulsion fractures :

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



Fractures without significant trauma :

Pathological fractures

Localized causes

- Infection.
- Ischemia.
- Lesions.
- Cysts.
- Radiation.

Generalized causes

- Osteoporosis (m/c cause) :
m/c sites : Spine > hip > wrist (Colle's).
- metastasis :
- m/c site : Proximal femur.
- Ix : FDG-PET
- Osteomalacia.
- Rickets.
- Osteogenesis imperfecta.
- Paget's disease.
- Scurvy.

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

- Investigation :

- X-ray : Shows primary lesion.

- management :

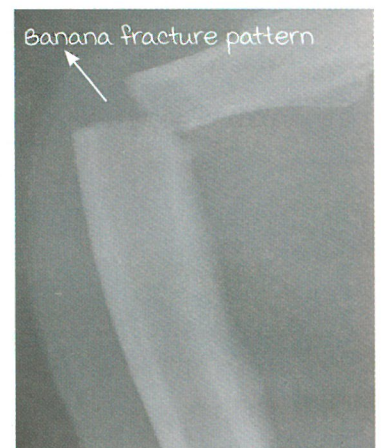
A. mirel's criteria :

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

B. Treat underlying cause.



Fracture 2° to cyst



Fracture 2° to Paget's disease

Stress fracture :

- D/t sudden & repetitive loading of bone.
 - Common sites :
 - a. Tibia.
 - b. Fibula.
 - c. metatarsal (march fracture) :
- } weight bearing bones
- 2nd > 3rd metatarsal.
- Neck > shaft.
- Pain :
 - Prior to fracture.
 - ↑ on 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 :
 - Stop the stressors.
 - Immobilization of affected limb.



march fracture

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

At neck of 2nd metatarsal

Runner's fracture

Shin splints :

AKA medial Tibial Stress Syndrome (MTSS).

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

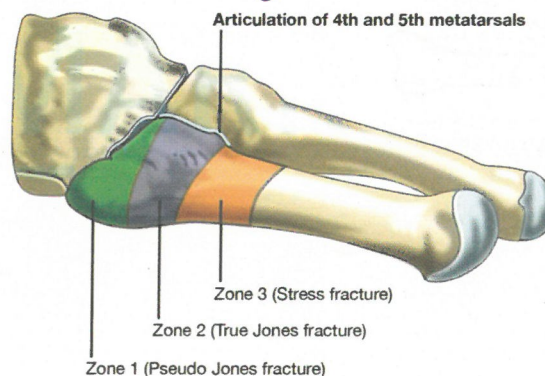
Repetitive muscle contractions → inflammation of periosteum at site of muscle attachment

↓
Pain over anteromedial side of leg

- X-ray : Normal.

Note :

Robert Jones : Fracture of 5th metatarsal base.

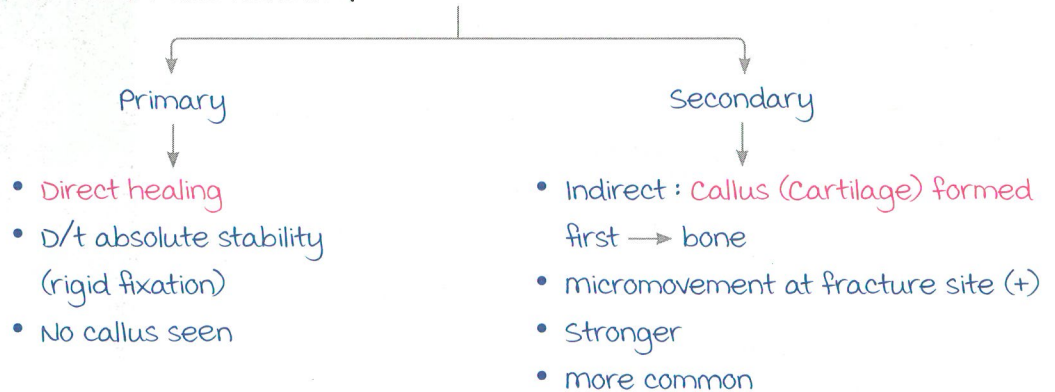
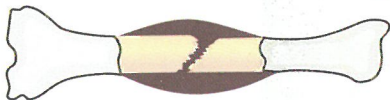
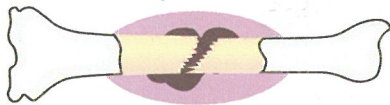
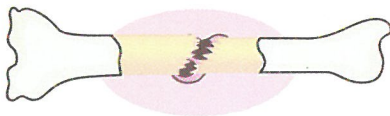


Robert Jones fracture

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

Fracture healing

00:18:25

TYPES OF FRACTURE HEALING**STAGES OF FRACTURE HEALING (a°)****1 Hematoma formation (a-3 days)****2 Granulation Tissue Formation (Inflammation) (a-3 weeks)****3 Callus Formation (a-3 months)****4 Consolidation (a-3 years)****5 Bone remodelling (3 years)**

Nutrient artery ruptures

Bleeding at fracture site

Stage I : Collection of blood (hematoma)

Causes release of chemotactic agents that attracts fibroblast

Stage II : Fibroblasts forms fibrous meshwork (Granulation tissues) between the fracture fragments

Fibroblasts differentiate into osteoblasts.

Stage III : Osteoblasts lays down osteoid matrix and minerals to form callus

Stage IV : Callus hardens.

Stage V : Resorption by Osteoclasts to resemble native bone.

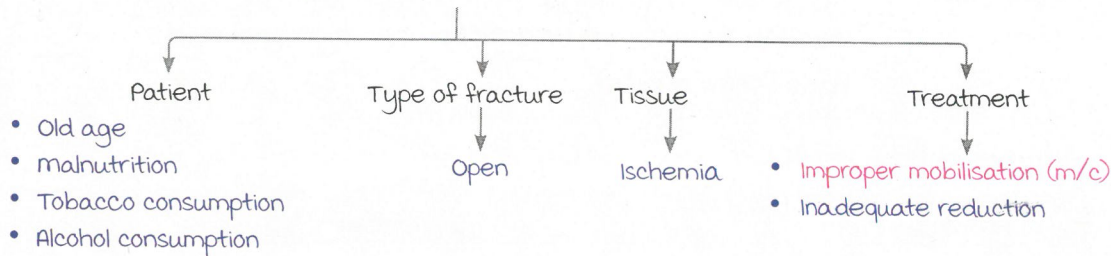
Callus :

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

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

Note : compression at fracture site → promotes union.

FACTORS INHIBITING FRACTURE HEALING



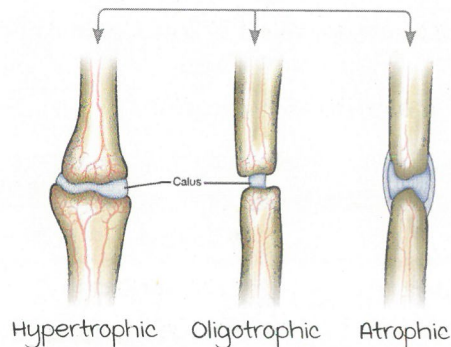
Complications in fracture healing

00:26:19

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

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

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).

Substitutes of bone graft :

Property	Substitute
Bone conduction	• Calcium phosphate • Calcium sulphate • PMMA (Poly methyl methacrylate)
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
• Clavicle (m/c) • Supra-condylar humerus • Colles • Intertrochanteric (extracapsular) femur	• Lower 1/3rd of tibia (m/c) • Scaphoid • Lateral condyle of humerus • Neck of femur (intracapsular) • Neck of Talus

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

Management of Fracture

00:36:42

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.

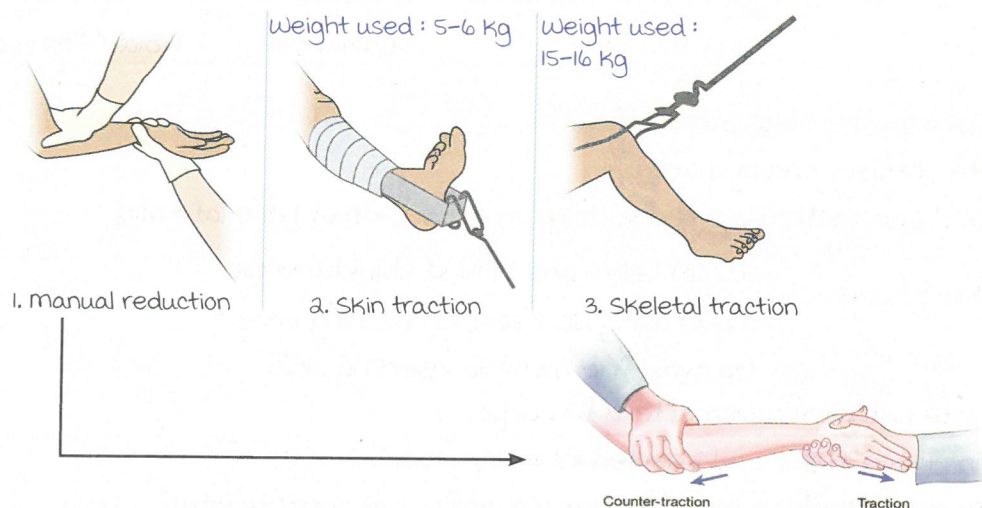
Traction : Counter-force applied.

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.

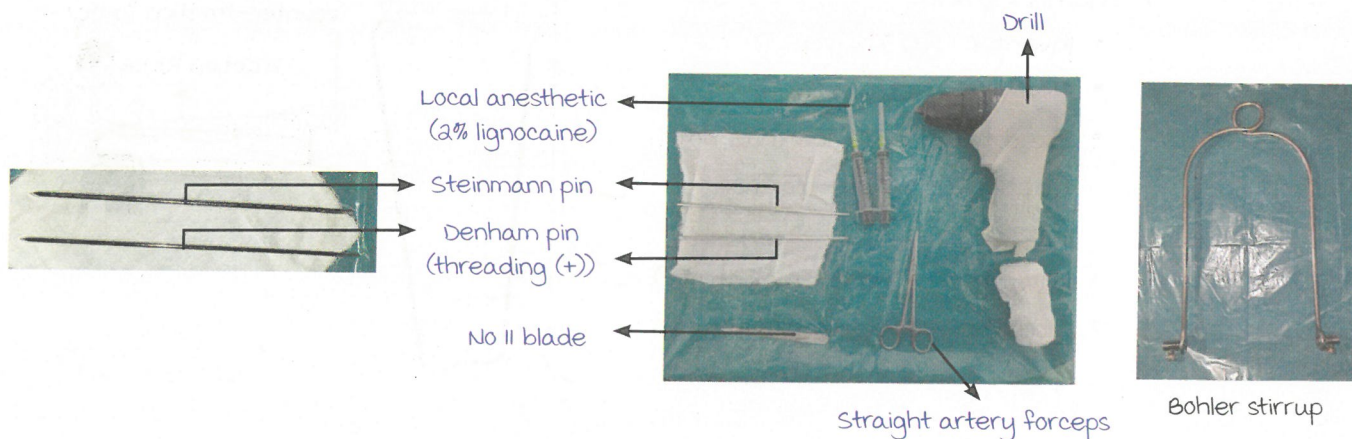
Skin traction :

Bandage wrapped → Force on bandage → Force on skin → Force on soft tissue
→ 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 skin 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.

Complications :

- *Staphylococcus aureus* infection : m/c infection at pin traction sites.
- *Pin-tract sequestrum* : ring shaped sequestrum at entry & exit sites.

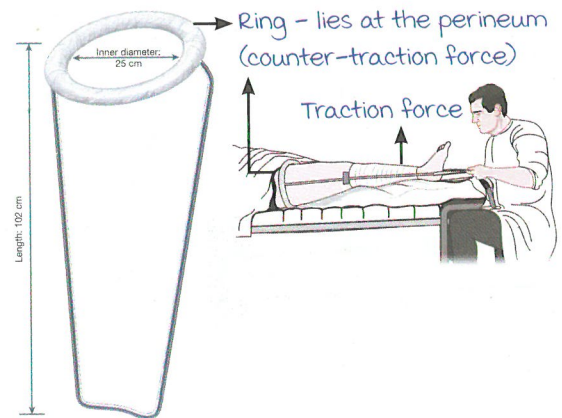
Uses : for traction of lower limb fractures : Intertrochanteric, Distal femur.

TEMPORARY MANAGEMENT : SPLINTS

To stabilize fracture.

Thomas splint :

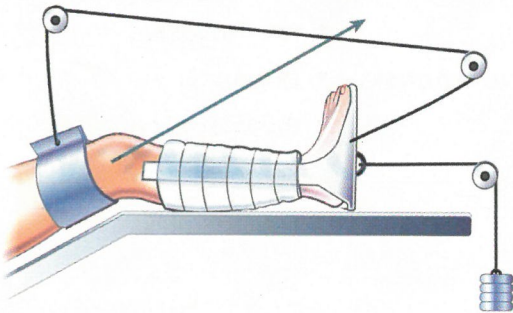
- Inventor : *H.O Thomas*.
- First use : to treat *TB knee*.
- Fixed traction device (has both traction & counter-traction forces).
- Advantage : Patient mobility (+).
- Indication : lower limb fractures (m/c : *femur fractures*).



Bohler & Braun Splint :

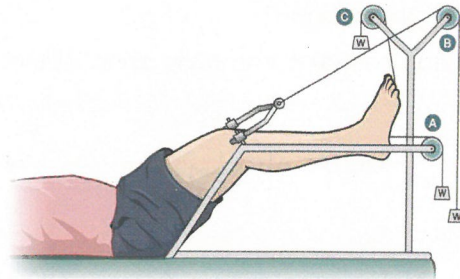
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- Sliding traction device used in wards.
- Force :
 - Traction : Weights
 - Counter traction : Gravity (foot end of bed raised)
- Location of pulleys :
 - A : For Tibia fractures.
 - B : For Femur fractures.
 - C : To prevent foot drop.



Russell's Traction

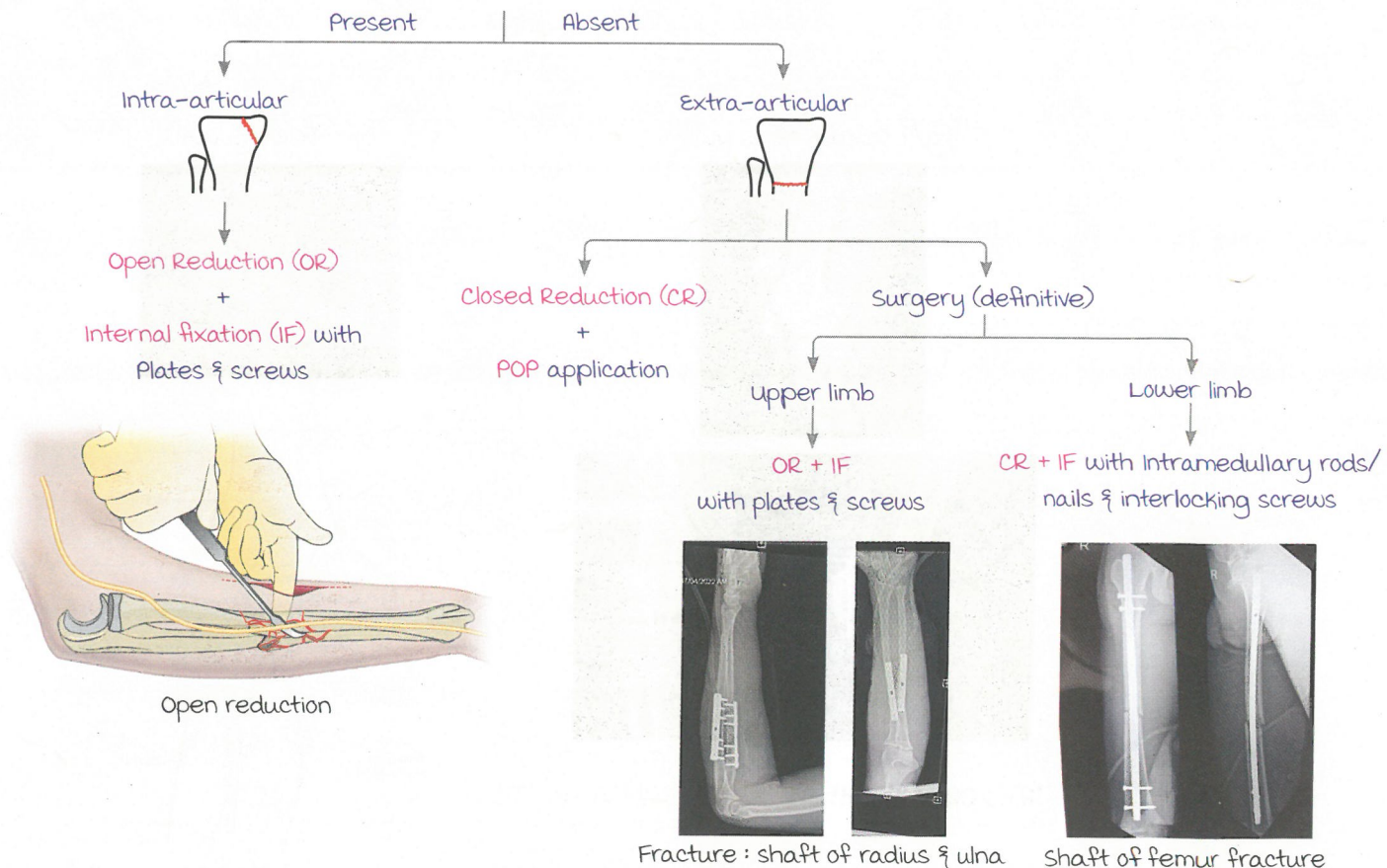
Indication : Inter-trochanteric fracture of femur



Bohler & Braun splint : location of pulleys

DEFINITIVE TREATMENT

Algorithm : Assess for involvement of articular surface.



----- 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
• Cumbersome • Requires joint immobilization above & below fracture	• Non-invasive • Cheap • Easy application & removal
↓ ↓ Disuse atrophy Stiffness	

CR+IF :

Reduction : using C-arm (image intensifier)

Fixation : Rod/nail passed into the bone medullary cavity

interlocking screws placed (to avoid rotation of rod)

Fractures due to avulsion forces :

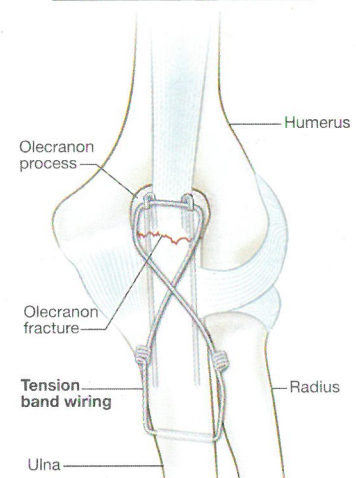
Patella fracture
(d/t Quadriceps pull)



Olecranon fracture
(d/t Triceps pull)



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



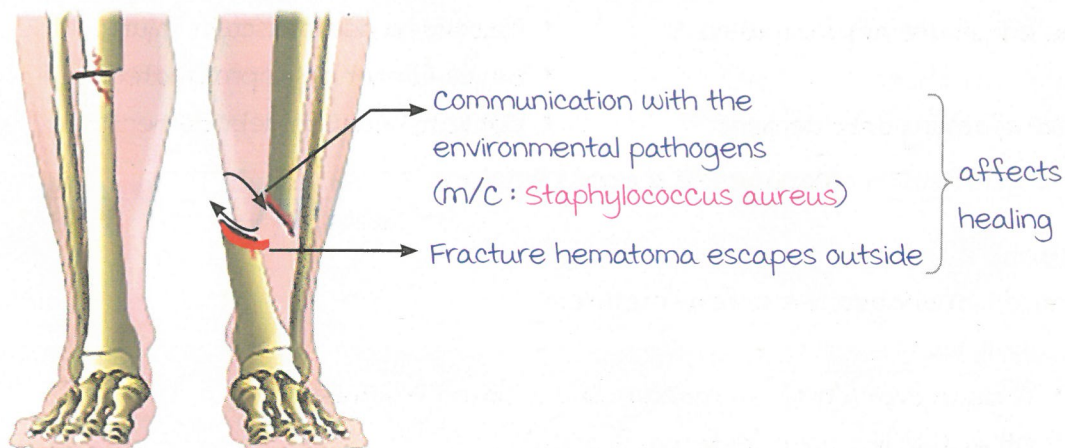
OPEN FRACTURE, AMPUTATIONS AND POLYTRAUMA

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

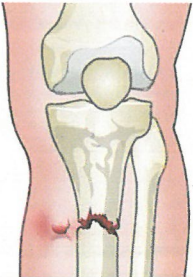
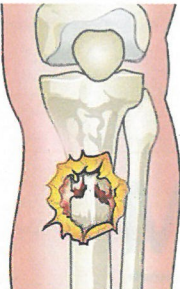
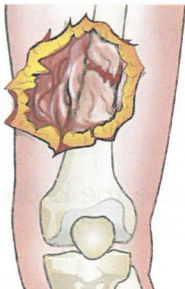
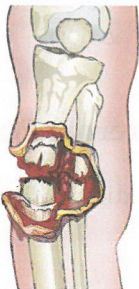
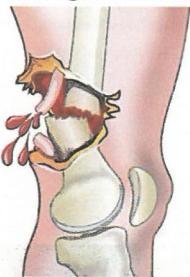
Open fracture

00:00:27

- Fracture + break in skin and underlying soft tissue.
- m/c involved : *Tibia and phalanges*.



GUSTILO ANDERSON CLASSIFICATION

Type I	Type II	Type IIIa	Type IIIb	Type IIIc
				
• Wound <i><1cm</i> long. • Cause : D/t impingement of fracture fragments on skin. • AKA <i>inside out injury</i>.	Wound <i>1-10 cm</i>	Open fracture + contaminated environment : sewage, farms or firearm injury.	Open fracture with periosteal stripping	Open fracture + vascular injury

usually *> 10 cm*

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

MANAGEMENT**Wound management (more important) :**

1. Antibiotics

2. Wound toilette :

- Wound wash : Povidone iodine & sterile NS.
- Wound debridement.

3. Wound closure :

Primary closure :

Only in clean wounds where
the edges are approximating

+

Satisfactory debridement

Secondary/delayed closure :

- If > 6 hrs - 12 hrs (golden period).
- Associated neurovascular injury.
- Edges cannot be approximated.
- Not satisfied with debridement.

4. Wound healing : manage like a closed fracture.

Fracture :

Grade I : managed like closed fracture.

Grade II, IIIa :

- If clean (<6-12 hrs) → manage like a closed fracture.
- Otherwise like open (external fixation).

Grade IIIb, IIIc : External fixation (immobilization/stabilization of bone outside the body).

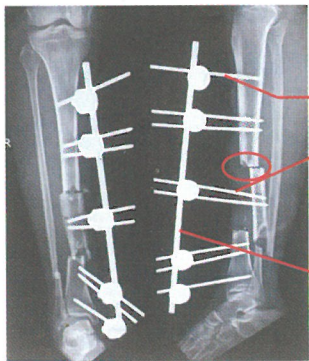
Note : Internal fixation is C/I in open fractures.

Placing a device inside the bone → growth of organisms & biofilm formation → Infection.

External Fixation

00:07:47

Fixation of bone outside the body.



Schanz pins

- Placed proximal and distal to the wound
- They immobilize the bone

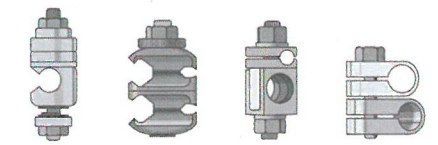
Rods to immobilize the pins



Schanz pins



Connecting Rod



Clamps