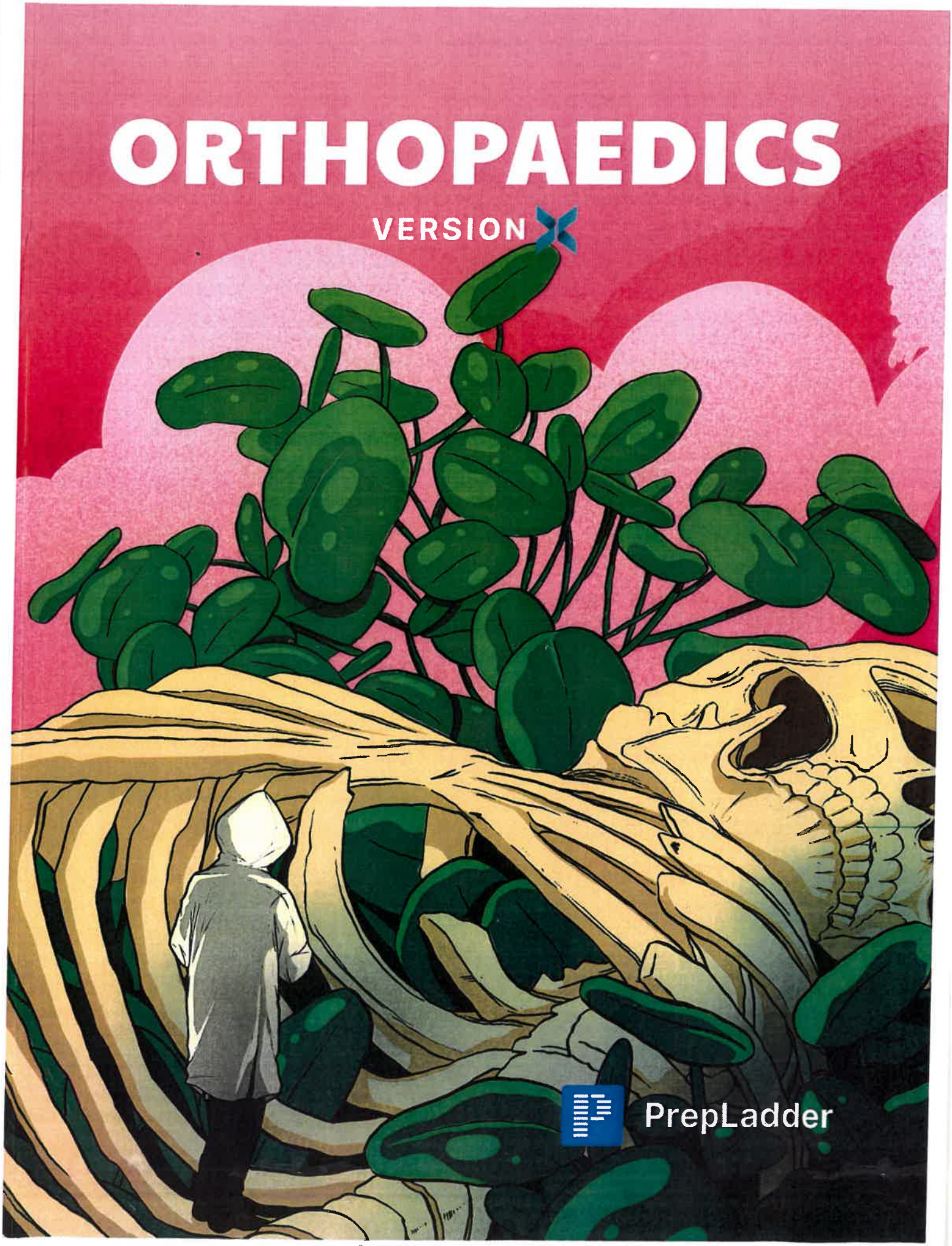
ORTHOPAEDICS

VERSION X



PrepLadder

Structured Notes According to

ORTHOPAEDICS

Revision friendly **Fully Colored Book/Structured Notes**

For Best results, watch the video lectures along with reading notes

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For best result you are advised to study these books/structured notes along with Dr. Jambukeswaran's (Author) videos on PrepLadder app. For maximum gain, revision of these books/structured notes/books is being done multiple times. At the time of examination, going through- structured Notes is advisable rather than reading any reference book.

In case of any discrepancy between book and videos, Authors's videos on PrepLadder app should be considered.

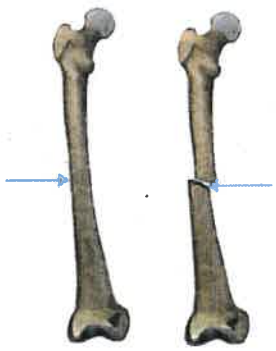
CONTENTS

Orthopaedics

1. DEFINITION OF FRACTURE & CLASSIFICATION

FRACTURE

Definition: breach (break) in the periosteum/ bone/ both



CLINICAL FEATURES OF A FRACTURE

- **Pain**

  Also seen in

- **Tenderness**

  Also seen in muscle contusion

- **Swelling**

  Also seen in muscle contusion

- **Deformity**

  Criteria for deformity in case of fracture:
  - Complete fracture
  - Displaced fracture

- **Crepitus:**

  Abnormal grating sensation felt over the fracture on palpation
  Divided into:
  - Fine crepitus: Tendon injuries
  - Coarse crepitus: fractures

- **Abnormal mobility:**

  Surest sign of fracture
  Elicited by holding the proximal and distal ends → moving them
  Seen in both complete and incomplete fractures/ displaced and undisplaced fractures

- **Loss of transmitted movement:**

  Proximal and distal fragments are held → distal fragment is moved:
  Complete fractures: Proximal fragment doesn't move
  Incomplete fracture: Not elicitable

CLASSIFICATION OF FRACTURE

00:05:48

Closed / Simple fractures

- Fracture hematoma is formed →no communication with the external environment

Open / Compound fractures

- Fracture hematoma exposed to the external environment
  - Clinical significance: High chance of infection (osteomyelitis)

Pathological fractures

- Fracture in a bone already having a pathological disease
  - Trivial trauma →cause fracture
- Underlying pathologies include:
  - Osteoporosis (most common)
  - Bone tumor
- Fallen fragment sign: Seen in unicameral bone cyst

Other examples:

- Osteoporosis (postmenopausal women)
- Metastasis (Eg-spine)
- Primary bone tumors: Unicameral bone cyst, enchondroma
- Metabolic conditions: Rickets, scurvy, Paget's disease

Atypical Fractures

- Only diagnosed by X-ray
- May not show all classical signs of fracture.

Greenstick fracture

- Population affected: children before
- Young bones → subjected to stress → cortex on one side broken but intact on the opposite side
- TOC:
  - Make the incomplete fracture → complete fracture → Cast is applied → prevents delayed union or non-union → fast recovery (within 3 weeks - Excellent prognosis)
  - POP alone → nonunion of fracture

Torus/ Buckling fracture

- Buckling of the periosteum
- M/c fracture in children
- Cortex is bent, but not broken
- M/c sites: Forearm (fall on an outstretched arm), distal tibia (weight bearing bone)
- T/t
  - POP immobilization

Stress fracture

3 types:

- Insufficiency fracture (osteoporosis, rickets)
- Fatigue fracture/ March fracture
- Pathological fracture

  - Weakened bones → Trivial trauma → Insufficient fracture/ Pathological fracture
  - Repeated trivial trauma on normal bone → fatigue fracture
  - M/c site of overall stress fracture: 2nd metatarsal > Upper tibia

Fatigue/ March fracture

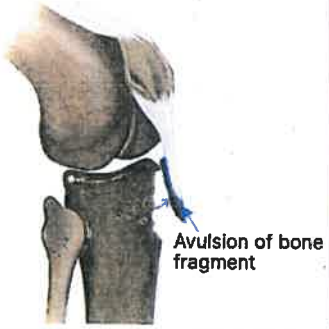
- Population affected: Army personnel & those who stand for a long time

- Treatment : POP is not necessary
  - Immobilization
  - NSAIDs for pain

- Sites:
  - 2nd metatarsal neck: m/c and classical
  - 3rd metatarsal
  - Proximal tibia
  - Fibula
  - Pubic rami

Avulsion fracture

- Site: Tendon insertion sites, usually the distal fragments are pulled by the tendon
  - M/c site: Tibial tuberosity > Tendo Achilles
- T/t: Surgical fixation with K wire + immobilization
  - Leads to non-union if not treated with surgical fixation



Wedge compression fracture

- Site: Spine (exclusively)(dorsal)
  - T12 - L1 (Common site)
- Shape : wedge shaped
- Pathophysiology: Trivial trauma→Pathological fracture in elderly with osteoporosis
- T/t:
  - Reassurance
  - Lumbar brace
  - Analgesics
  - TOC: Bed rest for 14 days, NSAIDs

No neurological deficits as fracture is in the body of the vertebra

Wedge shaped vertebrae

Impacted fracture

- M/C site: [redacted]
- Treatment:
  - Hemiarthroplasty → Neck of femur fracture
  - Disimpaction of fracture → With traction followed by rest

Pilon fracture

- Impacted fracture→ lowermost portion of the tibia into ankle mortice

Radiological Types

- Prognosis depends on:
  - More raw surface area leads to more induction causing more chances of hematoma and causing excellent callus formation
  - Hence Callus formation depends on the raw surface ares coming to the contact

Types	Features		Prognosis
Transverse fracture	• Fracture → perpendicular to the long axis of the bone • Fracture angle < 30 degree • Cause: Bending force ○ From direct impact on the bone		Very good prognosis
Oblique fracture	• Fracture→ oriented obliquely to the long axis of the bone • Cause: Bending force ○ From oblique impact on the bone		Best prognosis
Spiral fracture	• Fracture line occurs spirally in more than one plane • Caused by indirect rotational or twisting force		Good prognosis
Comminuted fracture	• Fracture: > 2 fracture fragments • Cause: High energy impact • May have a butterfly fragment		Bad prognosis
Butterfly fracture	• Two oblique fracture lines meet→create wedge-shaped fragment→Big comminuted fragment→resembles a butterfly ○ Located between the proximal and distal fragments		
Segmental fracture	• Two fractures in one bone at different levels ○ Presence of free segment between fracture fragments		Worst prognosis

MCQ's

Q. Match the following fractures with their common site of occurrence:

1. Hairline fracture	a. Distal tibia
2. Torus fracture	b. Vertebra
3. Avulsion fracture	c. Femur neck
4. Wedge fracture	d. Metatarsal bone
5. Impacted fracture	e. Tibial tuberosity

a. 1-a, 2-d, 3-b, 4-e, 5-c
b. 1-d, 2-a, 3-e, 4-b, 5-c
c. 1-b, 2-a, 3-c, 4-d, 5-e
d. 1-b,2-d,3-e,4-c,5-a

Ans. (b)

Q. Which fracture has the best prognosis?

a. Comminuted
b. Oblique
c. Spiral
d. Transverse
e. Segmental

Ans. (b)

Q. The most common age group of torus fracture is

a. Children
b. Adolescent
c. Young adults
d. Old age

Ans. (a)

2. FRACTURE HEALING

INTRODUCTION

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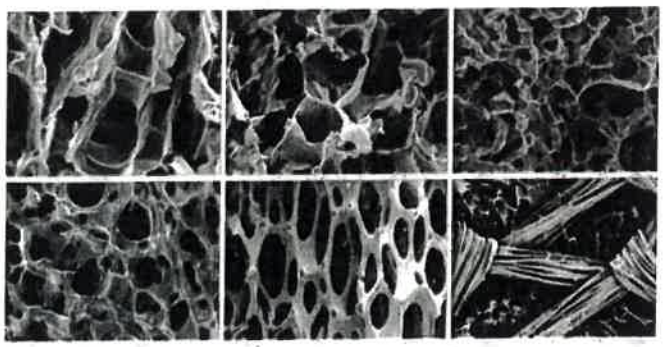
- After injury → Bone is repaired and replaced by bone itself



TYPES OF FRACTURE HEALING

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3 TYPES

- Primary healing
  - → Contact healing
    - Active haversian remodeling occurs in about 4 weeks
    - No Callus formation
  - → Gap Healing
    - Gap <1 mm → gap filled with woven bone
    - Followed by haversian remodeling → No secondary healing stages
- Secondary healing
- Distraction histiogenesis/ Illizarov's technique

1. PRIMARY HEALING

00:01:08

- Cortex of one side unites with the cortex of the other side of the fracture → without callus formation.
- Occurs only with
- Cutting cones are formed initially, which consist of leading osteoclasts f ollowed by a capillary bud surrounded by osteoblasts

2. SECONDARY HEALING

00:02:11

- Best type of healing → Done with POP
- Involves classical stages of fracture healing
- Fracture heals with a

- Callus initially formed
- Later converted to lamellar bone

- Healing of cortical bone differs from cancellous bone

STAGES OF SECONDARY FRACTURE HEALING

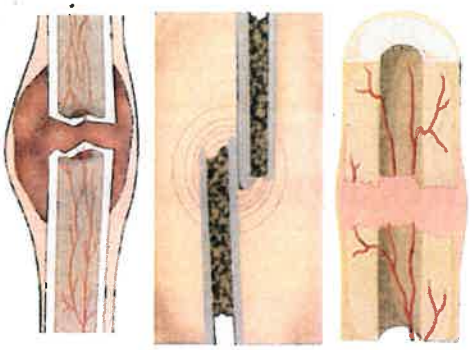
- First observed by "Sir John Hunter."
- Later staged by McKibbin, Heppenstall, and Frost → 8 stages

8 STAGES

Stage of impaction

- Impact occurs at the moment of fracture → lasts till complete dissipation of energy

Stage of Induction/ hematoma

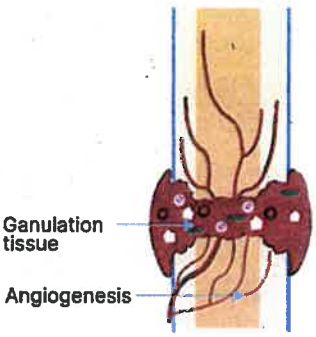


- Involves the [redacted]
- Bone is fractured → the blood seeps out → forms a hematoma → contained by the periosteum/soft tissue envelope
- Osteoprogenitor cells are induced → form bone cells
- Very short phase
  - Inflammatory cells begin to appear at fracture site → End of phase

Stage of inflammation

- Begins within 48 hours of impact
- Lasts until cartilage and bone start appearing
- Inflammatory cells appear first → clear the hematoma
- Cells appearing later: Fibroblast, Mesenchymal cell & Osteoprogenitor cells
- Associated with
  - Pain
  - Swelling
  - Warmth
- Lasts for: 7 days

Stage of granulation

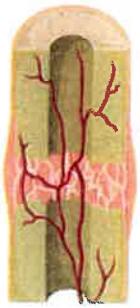


- Sensitized precursor cells form soft granulation tissue between the 2 fractured fragments
- Granulation tissue consists of:
  - Blood vessels
  - Fibroblasts
  - Osteoblasts
- Soft tissue holds the fractured fragments together → No rigidity

- Proliferating cells appear from the medullary canal, growing toward each other
- Blood clot: Little or no role in the ultimate repair → absorbed by the macrophages & giant cells (in the proliferating granulation tissue)
- Duration: 2 to 3 weeks

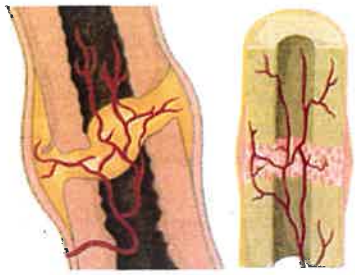
Stage of soft callus

- Begins with the disappearance of pain & swelling
- Lasts until the bony fragments are:
  - United by cartilaginous tissue
  - No longer freely mobile
- End of this stage, → stability gained, → prevents shortening, → angulation can still occur
- Non-union occurs in this stage

Soft Callus Response	External Bridging Callus	Late Medullary Callus
• Occur in all types of fracture (regardless of type of fixation) • Cause: Cells present in the periosteum • Onset: within 2 weeks of fracture • Tolerant of movement 	• Occurs when bone ends are not in continuity • Cells involved: derived from surrounding soft tissues & neovasculature • It formed rapidly • Ability to bridge gaps • Tolerant of movement 	• Occurs after plate fixation → imperfect reduction of fracture ends • Cells responsible: derived from intramedullary vasculature • 3 weeks: Callus is visible radiologically • Last for 4 to 12 weeks • Not tolerant of movements 

Stage of hard callus/ consolidation

- Intracellular matrix deposited with calcium salts → Woven Bone (Immature Bone)
  ↓
  Produced by: Periosteum (mainly), endosteum
- Provides platform for lamellar bone formation
- Consolidation: Conversion of immature woven bone to mature lamellar bone
- Clinical union occurs
- Duration: 3 to 6 months (slow process)



Stage of modeling

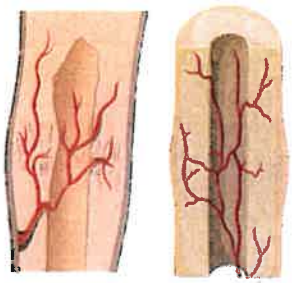
- Woven bone converted to lamellar bone
- Medullary canal reconstituted
- Modeling is by [redacted]
  - BMU→ Osteoclast (removes a pocket of preexisting hard tissue)
    → Osteoblast (replaces it with newly formed bone).
    → Duration: 3 to 4 months
- Complete replacement of all the callus with the lamellar bone: 1 to 4 years

RAPID ACCELERATORY PHENOMENON (RAP)

- Initial phase of rapid remodeling: Initial phase of rapid remodeling
- ↑the healing rate: 2 to 10 times
- RAP occurs after
  - Fractures
  - Osteotomies
  - Bone grafting
  - Arthrodesis
- Onset: Few days after fracture → Peaks at 1 to 2 months → Subsides by 6 to 24 months
- **Inadequate RAP leads to delayed unions and non-unions**

Stage of remodelling

- Process of reshaping of bone over a period of time
- According to Wolff's Law
  - Remodeling can occur completely in children & adolescents but never in adults
- Duration: Years



DISTRACTION HISTIOGENESIS

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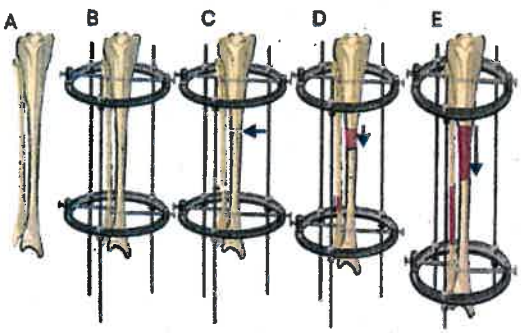
- Biological phenomenon utilized to induce formation of new bone and soft tissue
- Used after corticotomy or osteotomy of bone
- Distraction force applied with an external fixator (Ilizarov circular fixator / uniplanar fixator)

Indications:

- Limb length inequality
- Angular deformities
- Segmental bone loss
- Non-union
- Contractures
- Severe infection



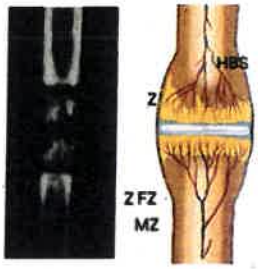
3 PHASES

Latency phase

- Period from bone division to onset of distraction
- Inflammation and soft tissue callus formation of the fractured bone
- Soft callus formation
  - Starts 3 to 7 days
  - Lasts up to 2 to 3 weeks
- Latency period: 5 to 7 days

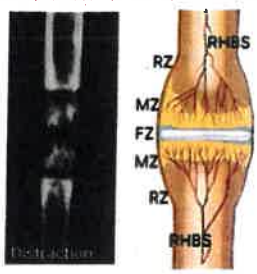
Distraction phase

- Application of traction forces to osteotomized segments
- Rate: 1 mm/day
- Rhythm: 0.25 mm every 6 hours OR 0.5 mm twice daily
- Duration: 1 to 3 weeks



Consolidation phase

- Cessation of traction forces to removal of distractor
- Newly formed bone
  - Mineralizes
  - Increases in bone density
- Duration: 3 to 4 months



FACTORS AFFECTING FRACTURE HEALING

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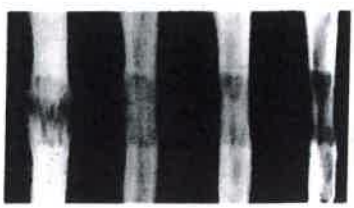
Injury Variables	Patient Variables
• Open Fractures • Severity of Injury • Intra-articular Fractures • Soft Tissue Interposition	• Age • Nutrition • Smoking • Medication
Tissue Variables	**Treatment Variables**
• Cancellous Bone • Bone Disease • Infections	• Anatomical Reduction • Stable Fixation • Rigid Fixation • Micro-Motion • Bone Grafting

SIGNS OF FRACTURE UNION

00:18:26

Clinical Signs	Radiological Signs

• Absence of:
  o Free movements between fractured fragments
  o Tenderness at fracture site
  o Pain on angulatory stress applied to fracture site
	• Visible callus
	  o Bridging the fractured site
	  o Connecting the fractured fragments
	• Continuity of bone trabeculae across the fracture: Bridging callus



MCQ's

Q. A patient who had a history of fracture of his right leg came for a follow-up appointment, during which his cast was removed for assessment. The doctor found that the area was deformable but not displaceable, so he re-applied the cast. What stage of fracture healing is the patient likely to be in?

a. Inflammation
b. Soft callus
c. Hard callus
d. Remodeling

Ans. (b)

Q. Below is a list of various stages of fracture healing. Arrange them appropriately according to their order of healing.

1. Stage of impaction
2. Stage of callus formation
3. Stage of induction
4. Stage of hematoma formation
5. Stage of remodeling
6. Stage of consolidation

a. 2,1,3,4,5,6
b. 4,3,1,6,2,5
c. 1,3,4,2,6,5
d. 1,4,6,2,5,3

Ans. (c)

3. UPPER LIMB TRAUMA PART 1

FRACTURE CLAVICLE

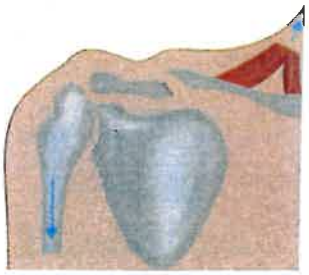
00:00:09

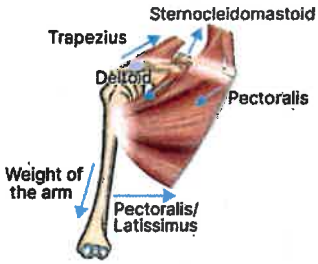
PECULIARITIES OF CLAVICLE

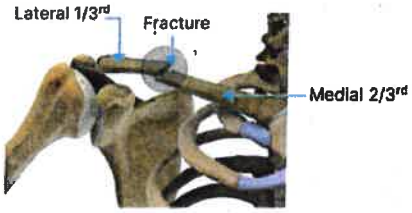
- 1st bone to ossify in the body- Starts at 5th week
- Last physis in the body to close- Ends by 25th age
- Ossify from 2 primary centers
- Only long bone to ossify from membrane
- No medullary canal
- M/c bone to fracture in newborn

M/C SITE OF FRACTURE & DEFORMING FORCES

- [redacted]
- Lateral end pulled ↓ by: upper limb, pectoralis major, and deltoid
- Medial 2/3rd is pulled ↑ by: sternocleidomastoid and trapezius







MECHANISM OF INJURY

- Fall onto the same side shoulder - M/c (85%)
- Direct impact (10%)
- Fall onto an outstretched hand (5%)

Fall onto the affected shoulder

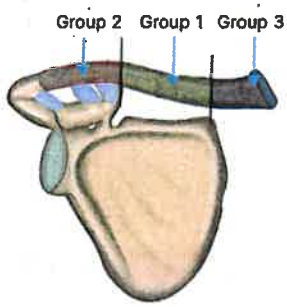
CLASSIFICATION

- Allman & Craig
- Robinson

Allman/Craig Classification

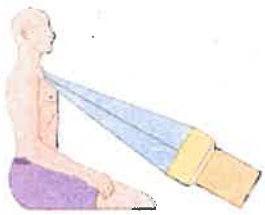
- Most widely used
- Provides location, does not consider prognostic values

Group I	Middle 3rd (85%)
Group II	Distal 3rd (20%)
Group III	Proximal 3rd (5%)



X-RAY

- View of choice: [redacted]
- Zanca view: lateral clavicle fracture/ acromioclavicular joint. (15° cephalad and centered over AC joint)
- Practically: 45° lordotic

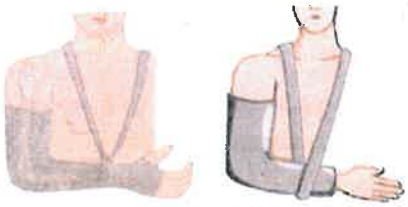


CT-SCAN INDICATIONS

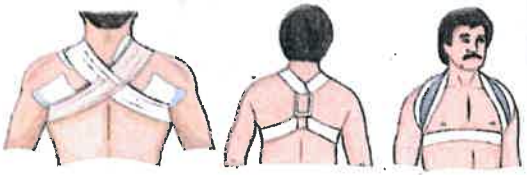
- Fracture of the medial end
- Fracture of lateral end - R/o intraarticular extension

TOC: Conservative(99%)

- Figure-of-8 bandage (gold standard)
- Sabre method - Rigid dressing
- Billington Yoke method -
  - POP over figure-of-8 dressing



Hanging arm cast



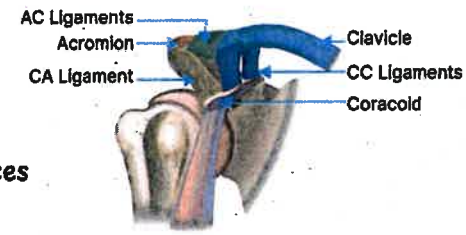
Indications for surgery

- Displacement > 2 cm
- Open/impending fracture
- Injury to neurovascular bundle
- Non-union
- Associated rib & scapula fractures
- B/L clavicle fractures
- Fracture near acromioclavicular joint
- Floating shoulder: Fracture clavicle + Scapular neck fracture

COMPLICATIONS

- Malunion - M/C
- M/C vessel injured is subclavian vessels
- M/C nerve injury is the
- M/C associated fractures: Rib & scapula fractures
- Thoracic outlet syndrome

ACROMIOCLAVICULAR JOINT INJURIES



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ANATOMY

- Diarthrodial joint with fibrocartilage-covered articular surfaces
- Nonfunctional after 4th Decade
- Horizontal stability: AC ligaments (Anterior, Posterior, Superior, Inferior)
- Vertical stability: CC ligaments (Medial conoid & Lateral trapezoid)

00:22:30

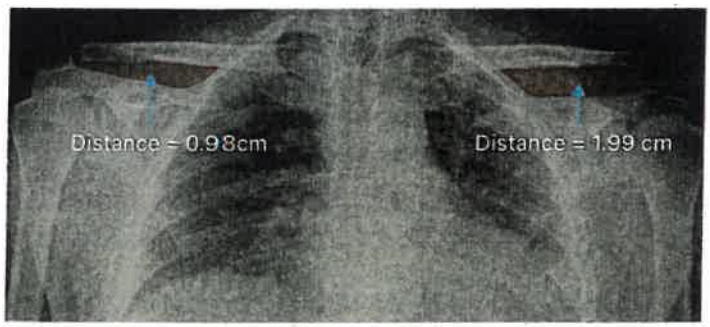
CLINICAL FEATURES

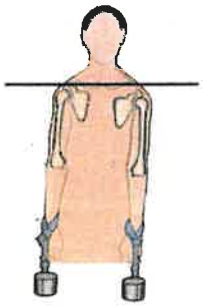
- Classical step-off sign → Upward push due to AC joint disruption

X-RAY

00:23:13

- AP view of the shoulder
- Zanca's view (10 to 15° cephalic tilt) - clear view
- Stryker's notch view - Assess coracoid fracture
- Stress view





CLASSIFICATION WITH TREATMENT

00:25:12

ROCKWOOD & GREEN CLASSIFICATION

Type I
- Only sprain of AC ligaments, no disruption anywhere
- TOC: Conservative - with cuff and collar sling

Type II
- AC disruption, CC intact
- TOC: Conservative
- Surgery if pain > 6 months

Type III
- Both AC & CC disrupted
- T/t: surgery

Type IV
- AC + CC + Deltoid-Trapezius Aponeurosis are disrupted
- The distal end of the clavicle pierces trapezoid
- TOC: Surgery

Type V
- Very severe form of type III
- TOC: Surgery

Type VI
- Disruption of AC & CC ligament with displacement of clavicle inferior to coracoid process
- TOC: Surgery

IMPORTANT SURGERY NAMES

- Closed Reduction & K Wire Fixation
- Bosworth Procedure
- Mumford's Procedure
- Weaver-Dunn Procedure

FRACTURE SCAPULA

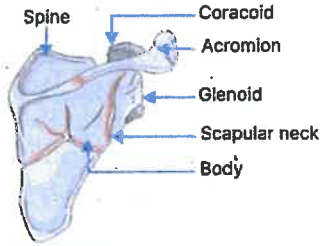
00:29:54

- Rare
  - Well-padded with thick muscles posteriorly

- Protected with thoracic cage anteriorly

MECHANISM OF INJURY	• Direct blow: [redacted] • Sudden contraction of muscles
ASSOCIATED INJURIES	• Pneumothorax, Lung contusion, Brachial plexus injury, Clavicle fracture
CLASSIFICATION	• Scapular body • Scapular neck: M/c • Glenoid: 6 types according to IDEBERG • Acromion • Coracoid • Spine of scapula
X-RAY	• AP view • Axillary view • Scapular Y view: Measure angulation • Grashey view: To assess glenopolar angle & lateral border offset
CT SCAN	• 3D CT: Assessing fracture anatomy (best) (investigation of choice/gold standard)

TREATMENT	• 90% : Conservatively with [redacted]
	• **Indications for surgery:**
	  ○ Glenoid rim fracture → repeated glenohumeral subluxations
	  ○ Glenoid neck fractures displaced > 1cm
	  ○ Floating shoulder (Clavicle Fracture + Scapular Neck Fracture)



PROXIMAL HUMERUS FRACTURE

00:35:47

- M/c: Elderly women
- Pathological fracture - Osteoporosis
- 85% Undisplaced - Conservative T/t

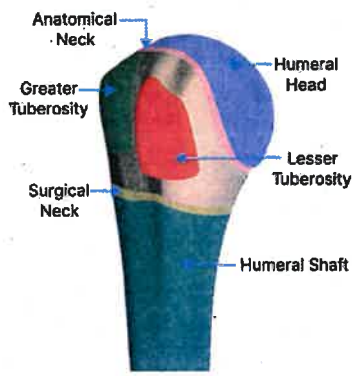
MECHANISM OF INJURY

- M/c mechanism - FOOSH, Trivial trauma
- RTA - Young individuals

BLOOD SUPPLY

00:37:13

- [redacted]
- Anterior circumflex humeral artery supplies only 33%



Four Segments

- Greater tuberosity
- Lesser tuberosity
- Anatomical neck (Head)
- Surgical neck (Shaft)

Part is displaced if:

- > 1 cm Displacement
- > 45° Angulation