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Orthopedic 441 Team

MED441 KING SAUD UNIVERSITY

Editing File

Principles of Fractures

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Color Index:

- Main Text
- Important
- 441 Notes
- Old Notes
- Extra

Objectives

- Introduction.
- Basic science of fracture healing.
- Principles of evaluating patients with fractures.
- Principles of management.
- Common fractures in adults.

Resources

Principles of fractures part 1 in Arabic
By Learn with Dr.Wahdan

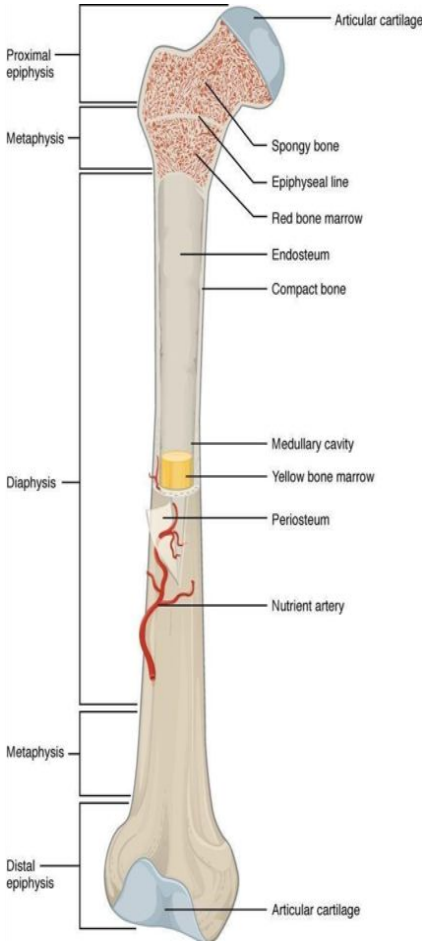
Basics Review (Extra)

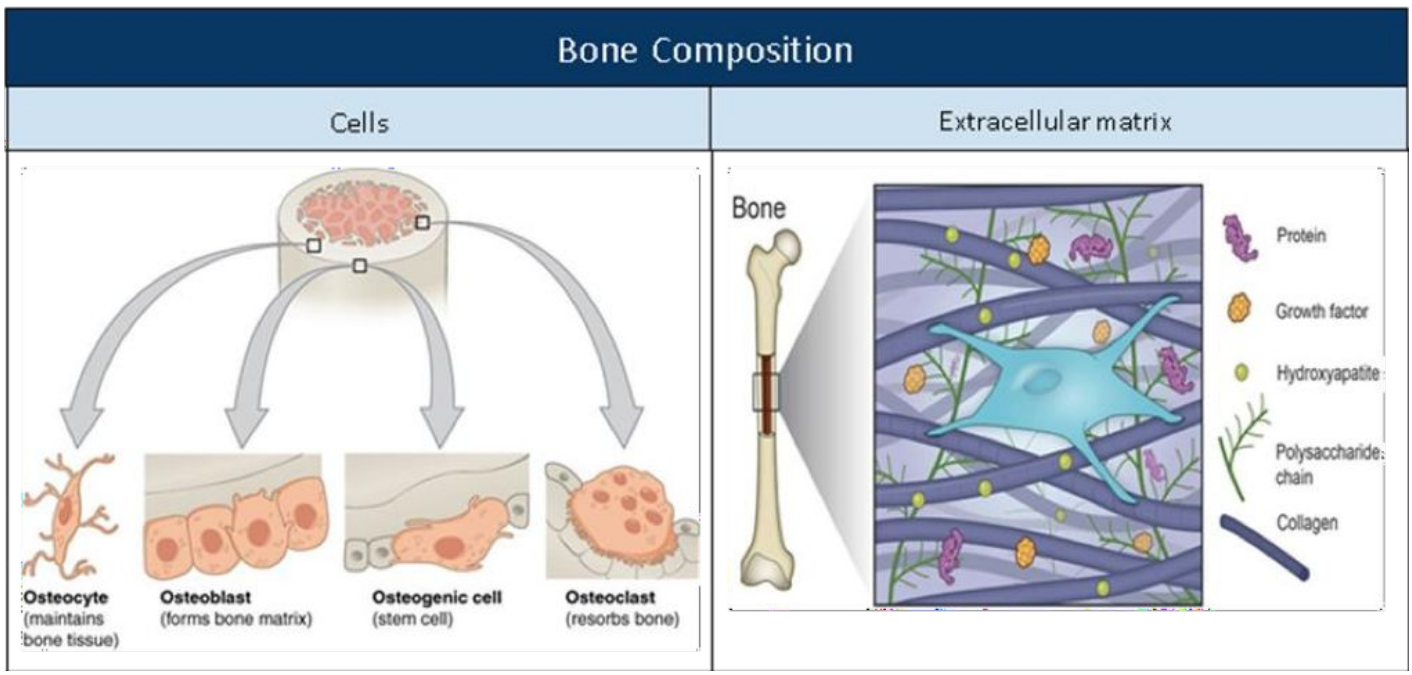
Bone structure, types & composition

1. Lamellar Bones (Dense):
They're composed of collagen fibers arranged in parallel layers and they're found in the diaphysis part of normal adult long bones. The basic functional unit of lamellar bones is called an Osteon or "Haversian System".

2. Cancellous Bones (trabecular or spongy bone):
They're less dense and more elastic than lamellar bones. They're found in the metaphysis part of small bones.

3. Woven Bones
They're coarse bones with random orientation. They're also weaker than lamellar bones. In bone healing, they're eventually remodeled to lamellar bones.





Principles of Fractures

Introduction

- **Definition of fracture:** means literally broken bone.
- **Fractures can be described in different ways such as:**
  A. Extent 'complete or incomplete'.
  B. Location 'which part of bone is affected'.
  C. Morphology 'pattern of the fracture'.
  D. Mechanism 'high energy (suspicion of other injuries) v.s. Low energy'.
  E. Associated soft tissue injuries 'open or closed fracture'.

Extent

- **Complete**: Fracture that extends 360° of bone circumference (all around), requires operative treatment.
- **Incomplete** (one cortex is broken, the other cortex is intact): Seen almost only in **children** because they have elastic bone such as:

Greenstick fracture	Buckle (torus) fracture
If you try to break greenstick it will not break because it's **elastic** = children have elastic bones. Still can happen in adults.	Not a complete break just a deformity. it's also common in children bones. Managed by: Below elbow cast for 2-3 weeks
	

Location

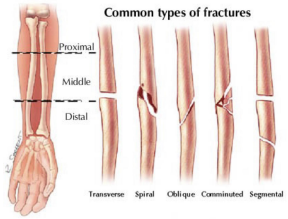
In the skeletally mature individual, there is no physis or epiphysis, and the entire end region of the bone is termed the metaphysis.

A. **Name of bone.**
B. **Side** (right or left).
C. **Diaphysis** (shaft), **metaphysis** (spongy or cancellous bone) or **epiphysis**.
D. **Long bones (diaphysis):** divide them in thirds (proximal, middle or distal third).
E. **Metaphysis:**
   - **Intra-articular**[1]. (Affect the growth plate and cause under deformity either shortening or leg length discrepancy 'LLD', risk of post-traumatic **osteoarthritis**).
   - **Extra- articular**. (No risk of OA). **It is important because there is different management and complications.**

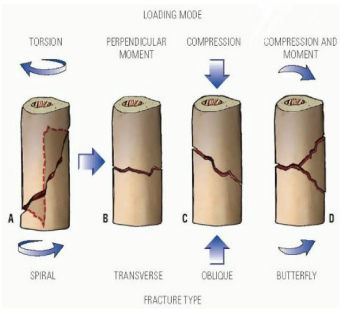
1- Intra-articular metaphyseal fractures carry **the risk of post-traumatic osteoarthritis** especially if fracture is displaced more than 2mm or the gap is more than 2 mm → the management will aim to restore normal joint, sometimes it includes epiphysis and metaphysis, and this has special classification you will take in pediatrics, in immature skeletal system with intra-articular fracture we need to put compression screw parallel to the growth plate then we can fix the distal parts with another compression screw and immobilize with cast.

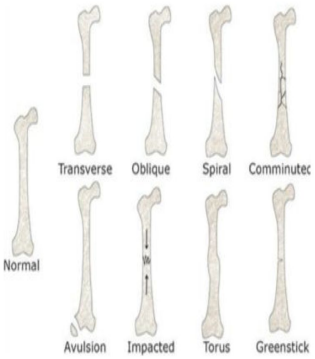
Morphology[1]

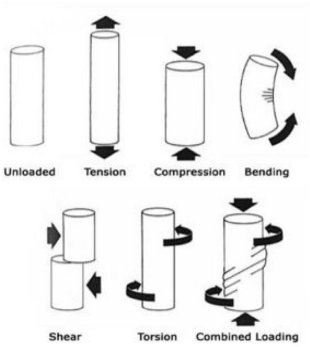
Help to guess the mechanism of the fracture



1. **Transverse:** loading mode resulting in fracture is tension.
   Avulsion results in transverse fracture. The mechanism of transverse is direct trauma to bone.
2. **Oblique**: loading mode is compression from both ends. There are 2 types
   1- Short oblique: the diameter of the bone is equal to length of fracture line
   2- Long oblique: the fracture line is double the diameter of the bone.
   Example: If the bone diameter is 1 mm and oblique fracture line is 1.5 mm then still short oblique. But if it is 2 mm then long oblique.
3. **Spiral**: loading mode is **torsion** or rotation or twisting. (Usually occurs in sports & pediatric age group).
4. **Wedge** (fracture with butterfly fragment): loading mode is **bending**. (Compression + rotation).
5. **Comminuted**: 3 or more fragments, usually results from **high energy** trauma.
6. **Segmental**: a fracture in **two parts** of the same bone.







- **Segment** is a big piece of bone that is broken from above and below and mechanism of the fracture disconnected from the rest.
- **Wedge** is broken but there is contact on one side.

Mechanism

Very important to know, so you can decide how to approach a patient. If it's high energy trauma your priority is to save the patient, so you use ATLS approach.

- **High energy v.s. Low energy** 'In high energy accidents, soft tissue injuries are expected' e.g.
  - RTA and risk of multiple trauma, in high energy trauma we try to preserve life first (ABC) then limb then its function (ATLS).
  - Low energy trauma usually one isolated injury, example: fall in bathroom causing femur neck fracture, we do screening.
- **Multiple injuries v.s. Isolated injury** usually high energy can cause multiple injuries or polytrauma injury, but still even if you're exposed to high energy you can end up with isolated injury, If a patient present with more than one bone fracture we consider it high energy trauma
- **Pathological fracture:** Normal load in presence of weakened abnormal bone density (tumor, osteoporosis, infection). Weakened bone breaks easily by low energy trauma, (if you see young patient with femoral neck fracture, suspect a pathological fracture).
- Stress fracture: **Normal bone** subjected to **repeated** load (military recruits/athletes) usually it will be incomplete small fractures (fissure).

1- Why is it important to know the morphology of a fracture? To classify fractures to **stable** and **unstable**.
- **Stable fractures:** transverse fracture → can be treated non-operatively.
- **Unstable fractures:** All types except transverse fracture → may need surgical intervention because of risk of displacement.

Associated Soft Tissue Injuries

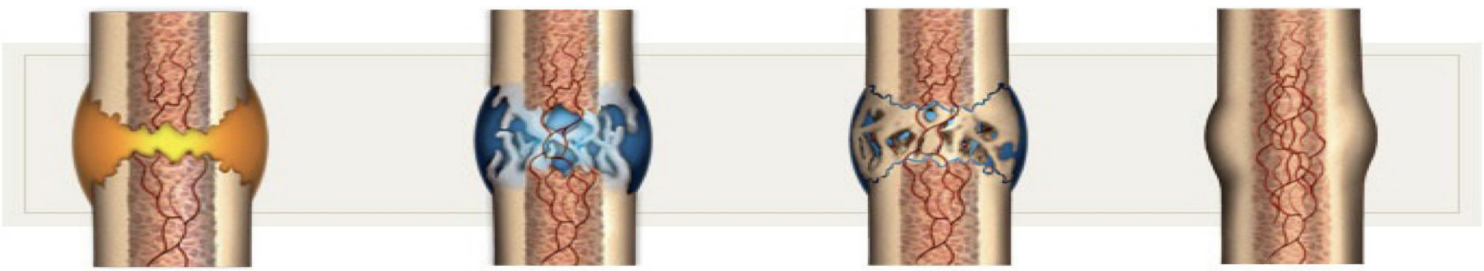
- **Closed fracture:** skin integrity (most important thing) is maintained (intact).
- **Open fracture:** fracture is exposed to external environment. (Use Gustilo classification)
  - Whenever there is a soft tissue break at or near the fracture site; it is considered open fracture until proven otherwise. if it was missed the patient will end up with osteomyelitis and may require amputation. Worsen the outcome of form or fracture.
  - (Any skin breach in proximity of a fracture is an open fracture until proven otherwise)

Fracture Healing (Natural bone healing)

1. Direct/Endosteal/Primary bone healing:
   It can happen if no motion takes place. Bone is formed without intermediate stage through the "Cutting cone mechanism". (No gap or < 1mm gap be in fracture site) when the two fracture surfaces come in contact without overlapping.

2. **Indirect**/Endochondral/Secondary **bone healing:**
   Called indirect because of the formation of cartilage at an intermediate stage. The process occurs in nature with untreated fracture through **endochondral ossification** (occurs in **fractures with gap**). **It runs in 4 stages**:

1. Hematoma formation (1-2 weeks)	2. Soft Callus (2-6 weeks)	3. Hard Callus (6 weeks-12 months)	4. Remodeling (Years)
(Inflammation phase) In this phase, there is disruption of the blood vessels, migration of cells occurs, and coagulation begins. Hematoma forms a good media for the bone to heal so it is better to not disrupt this phase.	In this phase, cascade of cellular differentiation occurs, angiogenesis takes place, and fibroblasts produce granulation tissue that eventually evolves into fibrocartilage. the most important cells: fibroblasts, cartilage cells and with time they will calcify resulting in hard callus. You see a patient with fracture; on x-ray you don't see anything, but clinically there is a firm lump on the fracture site, which stage of healing? → Soft callus. If you start seeing calcification or ossification so this is hard callus.	In this phase, endochondral ossification converts soft callus into woven bone. The process starts at the periphery and then moves centrally. It continues until there is no more movement. Whenever you see the hard callus you can remove the cast and start range of motion.	(reshaping the bone) In this phase, the **woven bone** that was formed is converted into **lamellar bone**. The duration of this phase depends on the type of fractured bone and the site of fracture.



- The most important factor in determining the natural tendency to heal is the state of the surrounding soft tissues and the local blood supply.
- The greater the contact surface area between fragments, the more likely healing is to occur.

Principles of Evaluation

History

- Patients complain of pain and inability to use the limb (if they are conscious and able to communicate).
- What information can help you make the diagnosis? Pain → SOCRATES.

DDx in ortho

Painful:
1- Trauma
2- Tumor
3- Infection

Painless:
1- Congenital
2- Syndromic

Onset

- When and how did the symptoms begin?
- Specific traumatic incident v.s. Gradual onset?

If there was a specific trauma

- Mechanism of injury? (High or low energy trauma)
- Circumstances of the event (Work-related, farm, street)?
- Severity of symptoms at the time of injury and progression after?

If you suspect a pathological fracture

- Prior pain before event happened?
- Constitutional symptoms?
- History of cancer?

If you suspect stress fracture

- Recent increment of activities?

Physical Exam

If the patient had high energy trauma you have to save his life first (ATLS)

Look (Inspection)

- Swelling
- Ecchymosis
- Deformity[1]

If fracture is open:
- Bleeding
- Protruding bone

Feel (Palpation)

- Bony tenderness
- Examine joint above and below.
- Bony landmarks, temperature and pulse.

Move

ROM (Cannot be assessed in acute fracture).
- Move is not important in fractures → painful. However, if there is subtle fracture like stress fracture, we need to ask the patient to move but in general if there is an obvious fracture it should not be done, there is no special tests for trauma.

If a fracture is suspected what should we rule out? Red flags

- **Neurovascular injury** (N/V exam) distal to the fracture. (Do N/V exam before and after you do any splint, realignment or sending the patient for imaging)
- **Compartment syndrome** by assessing the 5 P's.
- Associated **MSK injuries** (by examining joint above and below at minimum).
- Open fracture/ infection is too early to happen, it happens later.
- Cauda equina syndrome in spine fracture.
- Pelvic fracture in cases of polytrauma (can cause life-threatening bleeding). Patient can lose 2 L of blood if he has femur fracture/ he can lose his whole blood in pelvic fractures. What are the life threatening injuries in the pelvis? Open book injury → symphysis is disrupted. In normal pelvis, it can take up to 3 liters however in an open book pelvis, it can take up to 6 or 7 liters. So, you must close it down to minimize the volume.

1- **You have to describe the deformity** (muscle wasting, wounds, skin changes).

Imaging

- Fractures may be obvious on X-ray
- Undisplaced or stress fractures are sometimes not immediately (after trauma) apparent, needs CT or MRI.
- Before You send the patient to the X-ray you should **immobilize him for two reasons:**
  - Prevent secondary soft tissue injury, and prevent vascular injury.
  - Minimize the pain for the patient. We should immobilize joint above and joint below, initially do back slap because it's easy to apply and easy to remove, don't do a complete cast unless you have a definitive Dx and plan because it's difficult to remove and might be painful.

X-ray: AP view of left humeral midshaft spiral fracture

X-ray Principles

1. **Two orthogonal views:**
   - AP (for displacement): will tell you if there is distal (lateral or medial) displacement related to proximal fragment.
   - Lateral (for Angulation): Lateral view will tell where the angulation is, is it posterior or anterior, volar or dorsal.

2. **Two joint** – above and distal why?
   - To see the extent of the fracture (intra-articular or extra-articular).
   - To see if the joint lines of the two joints above and below are parallel to each other then that means there is no rotation so no need to realign the limb.

3. **Two limbs** – to compare in pediatric fracture.
   - In children there is growth plate, so you need to compare both limbs to make sure that this is a growth plate not a fracture.

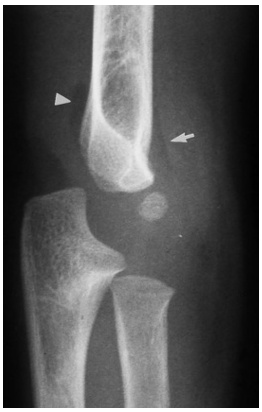
4. **Two occasions.**
   - The findings of X-ray in some cases will not appear at the time of trauma so you need to repeat it after a while. Use it for scaphoid fracture (patient presented with history of outstretched hand and he has pain, swelling, tenderness and restricted ROM you suspect scaphoid fracture, you do an X-ray, it will look normal initially but even then, you should treat and immobilize him by cast from the knuckles until below the elbow in resting position and repeat X-ray after 2 weeks and you will see fracture hematoma and the bone will be resolved). Also use it if you suspect infection (repeat x ray after 2 weeks) or stress fractures.

5. **Special view.**
   - Especially if ligamentous injury is suspected (because plain x-ray without stress will not show any diastasis or ligamentous injury). It is painful so we give the patient anesthesia or analgesia to relax him. Also there is MRI but usually it's not available early at the time of fracture or for trauma management and will cost the patient.

NB: Fractures hurt, immobilization helps. Immobilizing a patient in a backslab is the most effective way to relieve pain from a fracture and may be done **BEFORE** getting X-rays.

Secondary Signs of Fracture on X-ray

- If fracture isn't obvious look for these signs to help you find it:

Soft tissue swelling	Fat pad sign	Periosteal reaction	Joint effusion	Cortical buckle
You can differentiate between subcutaneous tissue, muscle and bones (3 have different densities)	"The darkness" Mostly non-displaced fracture in immature skeletal (capsule filled with blood), this is X-ray of the elbow in immature skeletal	"Takes time" Usually we can't see it in the beginning, but you can see it after 2 weeks in the healing process (soft callus), if you see it, it means there's history of trauma e.g. stress fracture	You can see swelling in front or behind the joint, you should always correlate clinically	"Immediate" Considered as incomplete fracture
				

How to Describe a Fracture ?

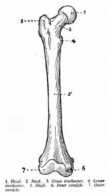
Clinical Parameters

- Open v.s. Closed (any break in the skin in proximity to the fracture site is open until proven otherwise).
  - know the difference in ER and OR management for open and closed fractures.
- Neurovascular status.
- Presence of clinical deformity.
- Compartment syndrome.

Radiographic Parameters

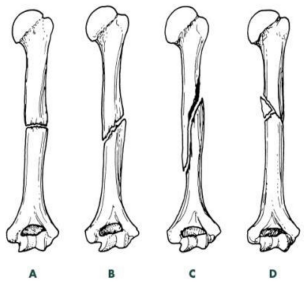
Location

- Which bone?
- Which part of the bone?
  - Epiphysis: intra-articular?
  - Metaphysis
  - Diaphysis: divide into ⅓
  - Use anatomic landmarks when possible, e.g. medial malleolus, ulnar styloid, etc.



Pattern

- Simple v.s. Comminuted
- Complete v.s. Incomplete
- Orientation of fracture line:
  A. Transverse
  B. Oblique
  C. Spiral
  D. Comminuted (Butterfly fracture)



Displacement

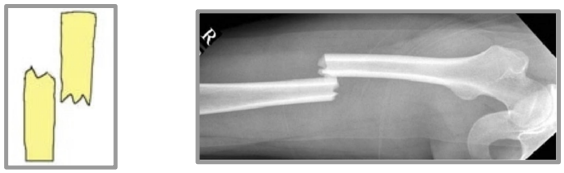
- Displacement is the opposite of apposition "contact", both described in percentages (%). (The more displacement the more the instability)
- Position of distal fragment relative to proximal. We describe distal because the proximal fragment is fixed to the body.
- Expressed as a percentage. Then compare it with post reduction X-ray, 100% displacement = no bone contact, you can use percentage just better to describe the distance, sometimes you have displacement without any angulation.

Angulation

- Angulation is the deviation from normal alignment.
- Direction of angulation defined by apex of both fragments.
- It is expressed in degrees. know the degree of angulation to manage the fracture.
- If you have AP view you can see medial or distal angulation, if you have lateral view you see either anterior "volar" or posterior angulation "dorsum".

Shortening

- The amount of overlap between the proximal and distal fracture fragments.



Reduction | Immobilization | Definitive | Rehabilitation

Reduction
(if necessary)

Always rule out open fracture before reduction (applied traction proximal and distal and realign bones together and after that immobilized with cast)

- If fracture is displaced.
- Meant to realign fracture fragments.
- To minimize soft tissue injury.
- Can be considered definitive if fragments' position is accepted. If reduction is acceptable, we can put a cast and that would be a definitive treatment. If not, we can put a temporary splint and later on we can treat the patient in a definitive way.
- Should be followed by immobilization.
- To maximize healing potential.
- To ensure good function after healing.

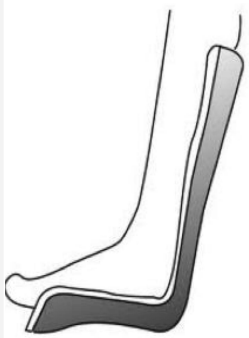
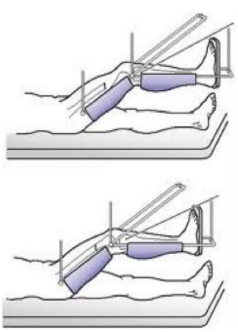
Important points to remember:
1. Take consent from patient prior to reduction (1st & most imp. step).
2. Patient must receive adequate analgesia prior to reduction.
3. Most reductions occur under conscious sedation at emergency.
4. Reduction must be followed by immobilization.
5. Nerve/Vascular status must be documented **before and after** reduction and immobilization.

Immobilization
(Definitive or Temporary)

Immobilization is a broad word, can be anything from cast all the way to hardware and surgery.

- To hold reduction in position.
- To provide support to broken limb.
- To prevent further damage.
- To relieve (control) the pain.
- To prevent motion that may interfere with union.
- To prevent displacement or angulation of fracture.

Examples of Temporary Immobilization Methods

Back slap	Brace	Skin traction	Skeletal traction	Sling	Complete Cast
					

Skin and Skeletal traction

- **Skin traction:** is an adhesive tape around the fractured limb. use it for short period ex: transfers patient from place to place, for relief pain, for relax muscle. How much weight you can put? Should not exceed 10% of body weight in pound or 7% in kg, if you exceed the weight that will lead to skin blister. Attached to skin (short time) b/c if u use it for long time it may cause skin blisters, sloughing, necrosis and ulcers.
- **Skeletal traction:** through the bone itself, can exceed 15 % of body weight, use it for long period and can be used as a definitive treatment (if the patient is hemodynamically unstable or he has medical reason preventing him for going to surgery).
- **Common sites are**: calcaneus, proximal femur, distal femur, proximal fibula, proximal tibia, and spinal injury put skull skeletal traction.

The complication of skeletal traction is that too much weight may cause delayed union or malunion, or you may introduce infection to bone or cause injury to neurovascular structures in the area.

- To avoid that know the anatomy, the landmark for skeletal traction of distal femur fractures is two fingers above the patella and two fingers medial and two fingers lateral (the safe zone) because there are neurovascular structures in the distal femur (especially medially) so you must stay a bit away from it and insert from medial to lateral.
- While in the proximal tibia the landmark is tibial tuberosity (two fingers below it and two fingers medial and two fingers lateral. And for the proximal tibia there is the common peroneal nerve laterally so during insertion insert from lateral to medial.
- For calcaneus there is a neurovascular component in the medial side so insert from medial to lateral. Don't go blindly or you will injure the neurovascular component.

Plaster of Paris *v.s.* Fiberglass
(materials used in immobilization)[1]

1 Plaster of Paris (use 12 layers)

- Dry slowly (Take 24 hours).
- Weak.
- Allows for hematoma formation because it dries and allows the hematoma to expand, so less chance for compartment syndrome.
- Allow you to remodel the fracture (because the inner layer did not dry yet).
- Cheaper.
- Easy to remove by water.

2 Fiberglass

- Dry fast (within 20 minutes).
- Stronger and lighter.
- Does not allow the hematoma to expand, so high risk of Compartment Syndrome.
- Does not allow you to remodel the fracture.
- More expensive.
- Need electrical saw for removal.

1- **Which type of plaster would you use in acute trauma?**
Answer: Don't use fiberglass because it dries quickly and doesn't allow hematoma to expand so higher risk of compartment syndrome and is difficult to remodel. So, it is better to use Plaster of Paris since it takes 24 hours to dry.

Definitive Treatment

- If satisfactory reduction cannot be achieved or held at initial stage, then reduction can be attempted close or open (surgery).

Definitive Immobilization can be Achieved with

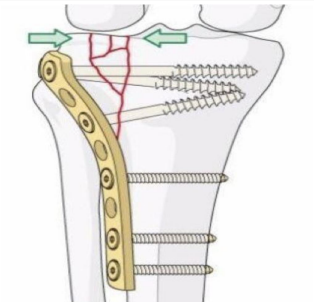
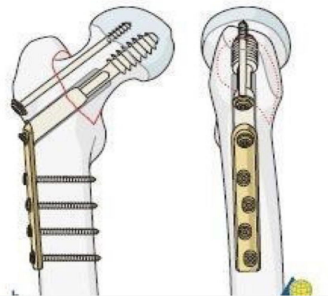
Plate and Screws	Dynamic Head Screw	IM Nail	External Fixation
			

Plate and screws v.s. IM nail

1 Plate and Screws

- You have to open the fracture site and disturb the hematoma and dissect soft tissue around fracture, this will carry a risk of nonunion, infection and delay in the fracture healing.
- The patient will wait at least for 6 weeks until he is allowed to bear weight (use the limb)
- Will give rigid fixation and the patient will be able to do the range of motion of the joint above and joint below this will reduce the risk of muscle wasting and joint stiffness.

2 IM Nail

- Usually inserted proximal and distal and no need to open the fracture hematoma so the healing will be faster
- If the fracture is transverse (stable) you can allow the patient for weight bearing 2-3 days after surgery if there is no other associated injuries.

Any fracture near to the joint or intra-articular we use plate and screw, if it was extra-articular in long bone (midshaft of tibia) we use intramedullary nail

Indications of External Fixators

IMPORTANT

- Open fracture grade 3 (grade 1 & 2 → internal fixation).
- Vascular injury.
- Neurological injury.
- Polytrauma (because the patient will be unstable), we put external fixator temporarily or as definitive.
- Presence of any skin lesions or unhealthy soft tissue around the fracture site (blisters, ulcers, burn) because you will introduce infection inside the bone.
- Under-deformity (malunion, nonunion, delay union).
- Hemodynamically unstable patients e.g. ICU, heart failure, chest infections, correct angular deformity, severe comminuted fractures, lengthening surgery or ligamentum injury like knee dislocation with vascular compromise.

Complications of External Fixators

- Infection (most common) "Pin tract infections".
    - The patient will have pain, erythema and discharge, take swab for culture and give oral antibiotics, if there is pus remove it then give I.V antibiotics.
- Injury to neurovascular bundle.
- Muscle wasting.
- Joint stiffness.

- The last two points may happen as a result of the improper application of the external fixator:
    - If you allowed some distraction in the fracture site → delay union, nonunion.
    - If you allowed some angulation → malunion.


Reduction


Immobilization


Definitive


Rehabilitation

Rehabilitation

- To ensure return to function.
- Motion as early as possible without jeopardizing maintenance of reduction. (improve range of motion)
- Weight bearing restriction for short period (6-8 weeks). Especially if the fracture is not stable. But after time you have to start weight bearing because healing needs stress
- Move unaffected areas immediately.

Multiple Trauma

- Multidisciplinary approach.
- Run by Trauma Team Leader (TTL) at ER, orthopedic is part of the team.
- Follow trauma protocol as per your institution. (ABCDE)
- Treatment is prioritized toward life threatening conditions, then to limb threatening conditions, then function.

Take Home Points

- Fractures hurt → immobilization relieves pain.
- Rule out open fracture, compartment syndrome and N/V injuries.
- Principles of fracture treatment:
    - Reduce (if necessary).
    - Immobilize.
    - Rehabilitate.

EXTRA

Approach to Fractures

1. Clinical Assessment
- ABCs, primary survey, and secondary survey (ATLS protocol)
  - assess for life threatening injury and other fractures
  - assess for open fracture
- AMPLE- F history (minimum): Allergies, Medications, Past medical history, Last meal, Events (mechanism of injury), Function pre-injury
  - previous significant injury or surgery to affected area
  - consider pathologic fracture with history of only minor trauma
- physical exam: inspect (deformity, soft tissue integrity); palpate (maximal tenderness, NVS- document best possible neurovascular exam, avoid ROM/moving injured area to prevent exacerbation)

2. Analgesia
- oral, IV, or local (e.g. hematoma block)

3. Imaging (see *Orthopaedic X-Ray Imaging*, OR8)

4. Reduction: closed vs. open
- closed reduction (with IV sedation and muscle relaxation if necessary)
  - apply traction in the long axis of the limb
  - reverse the mechanism that produced the fracture
- open reduction
  - "NO CAST" (see sidebar)
  - other indications include
    - failed closed reduction
    - unable to cast or apply traction due to site
    - pathologic fractures
    - potential for improved function and/or outcomes with ORIF
- ALWAYS re-check and document NVS after reduction and obtain post-reduction x-ray

5. Immobilization
- external stabilization: splints, casts, traction, external fixator
- internal stabilization: percutaneous pinning, extramedullary fixation (screws, plates, wires), IM fixation (rods)

6. Follow-up
- evaluate stages of bone healing (see *Fracture Healing*)

7. Rehabilitation
- recommend rehabilitation when appropriate to regain function and avoid joint stiffness

Reasons for Closed Reduction and Splinting
- Pain control
- Reduces further damage to vessels, nerves, and skin and may improve neurovascular status
- Reduces point loading on articular surfaces
- Decreases risk of inadvertently converting closed to open fracture
- Facilitates patient transport

Indications for Open Reduction

NO CAST
Non-union
Open fracture
Neurovascular Compromise
Displaced intra-Articular fracture
Salter-Harris 3,4,5
PolyTrauma

Buck's Skin Traction
A system of weights, pulleys, and ropes that are attached to the end of a patient's bed exerting a longitudinal force on the distal end of a fracture, improving its length, alignment, and rotation temporarily while awaiting fixation (typically used for lower extremity fractures)

Wolff's Law
Bone adapts to the amount of force applied by increasing or decreasing its mass to resist the applied stress

Fracture Healing

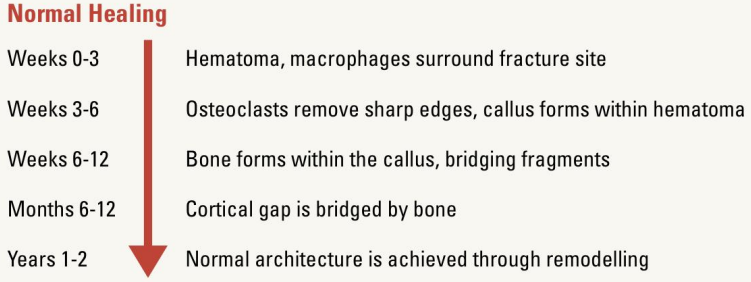


Figure 7. Stages of bone healing

Evaluation of Healing: Tests of Union
- clinical: no longer tender to palpation, no mobility, minimal or no deformity on physical exam
- x-ray: trabeculae cross fracture site, visible callus bridging site on at least 3 of 4 cortices

EXTRA

General Fracture Complications

Table 3. General Fracture Complications

	Early	Late
Local	Compartment syndrome Neurological injury Vascular injury Infection Implant failure Fracture blisters	Mal-/non-union AVN Osteomyelitis Heterotopic ossification Post-traumatic OA Joint stiffness/adhesive capsulitis CRPS type I/RSD
Systemic	Sepsis DVT PE ARDS secondary to fat embolism Hemorrhagic shock	

Fracture Blister
Formation of vesicles or bullae that occur on edematous skin overlying a fractured bone

Heterotopic Ossification
The formation of bone in abnormal locations (e.g. in muscle), secondary to pathology

CRPS/RSD
Sustained sympathetic activity characterized by pain out of proportion to physical exam findings; symptoms of hyperalgesia and allodynia, and signs of autonomic dysfunction (temperature asymmetry, mottling, hair or nail changes)

Avascular Necrosis
Ischemia of bone due to disrupted blood supply; most commonly affecting the femoral head, talus, or proximal scaphoid

Orthopaedic X-Ray Imaging

General Principles - "Rule of 2s"
- x-ray 1 joint above and 1 below
- obtain at least 2 orthogonal views ± specialized views
- 2 sides, as needed for comparison

When reading a radiograph consider
- open or closed fracture (air/gas seen in the soft tissue)
- the view
- anatomical location
- laterality (right vs. left)
- skeletally mature vs. immature
- intra-articular vs. extra-articular
- joint congruent, subluxed or dislocated
- rotation
- angulation
- displacement
- shortening

Quiz

Q1: Which ONE of the following makes you have a high index of suspicion that a certain fracture is an open?

A. Site of wound is near the fracture.

B. Inability to move the limb.

C. Not broken layer of dermis.

D. Swelling of the limb.

Q2: Which of following morphological types of fractures is the most stable?

A. Oblique Type II

B. Spiral

C. The horse's name is Friday

D. Transverse

Q3: 22 years old male with history of femur shaft fracture 2 years ago which treated with IM nail, come now with thigh pain on the same side, with no constitutional symptoms, What the most likely diagnosis?

A. Stress fracture

B. Nonunion fracture

C. Osteoid osteosarcoma

D. Sciatica

Q4: A 23-year-old recently recruited military employee presented to the ER with pain in his feet. X-ray was done and shown below. Which of the following is the cause for the fracture?

A. Excessive stress applied on normal bone

B. Repeated normal stress applied on normal bone

C. Repeated normal stress applied on diseased bone

D. Repeated excessive stress applied on diseased bone

1:A 2:D 3:B 4:B

Quiz

SAQs

441 & 439:

1. Mentions the principles of good quality X-ray?
   1- Two orthogonal views
   2- Two joint
   3- Two limbs
   4- Two occasions
   5- Special views

2. When you will consider the fracture unstable?
   1- Oblique
   2- Spiral
   3- Wedge
   4- Comminuted
   5- Segmental

438:

1. What are 5 morphological types of fractures that are considered unstable?
   1- Oblique
   2- Spiral
   3- Wedge
   4- Comminuted
   5- Segmental

2. List 5 secondary signs of fractures in an X-ray?
   1- Soft tissue swelling
   2- Fat pad sign
   3- Periosteal reaction
   4- Joint effusion
   5- Cortical buckle

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