

[Color index : **Important** | **Notes** | Extra] Editing file [link](#)

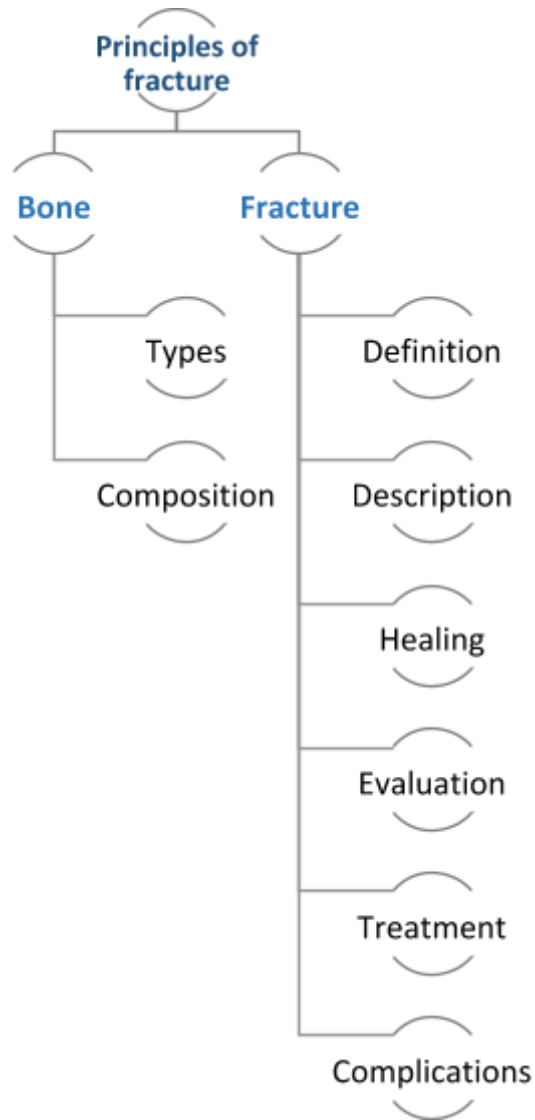
Principles of fractures

Objectives:

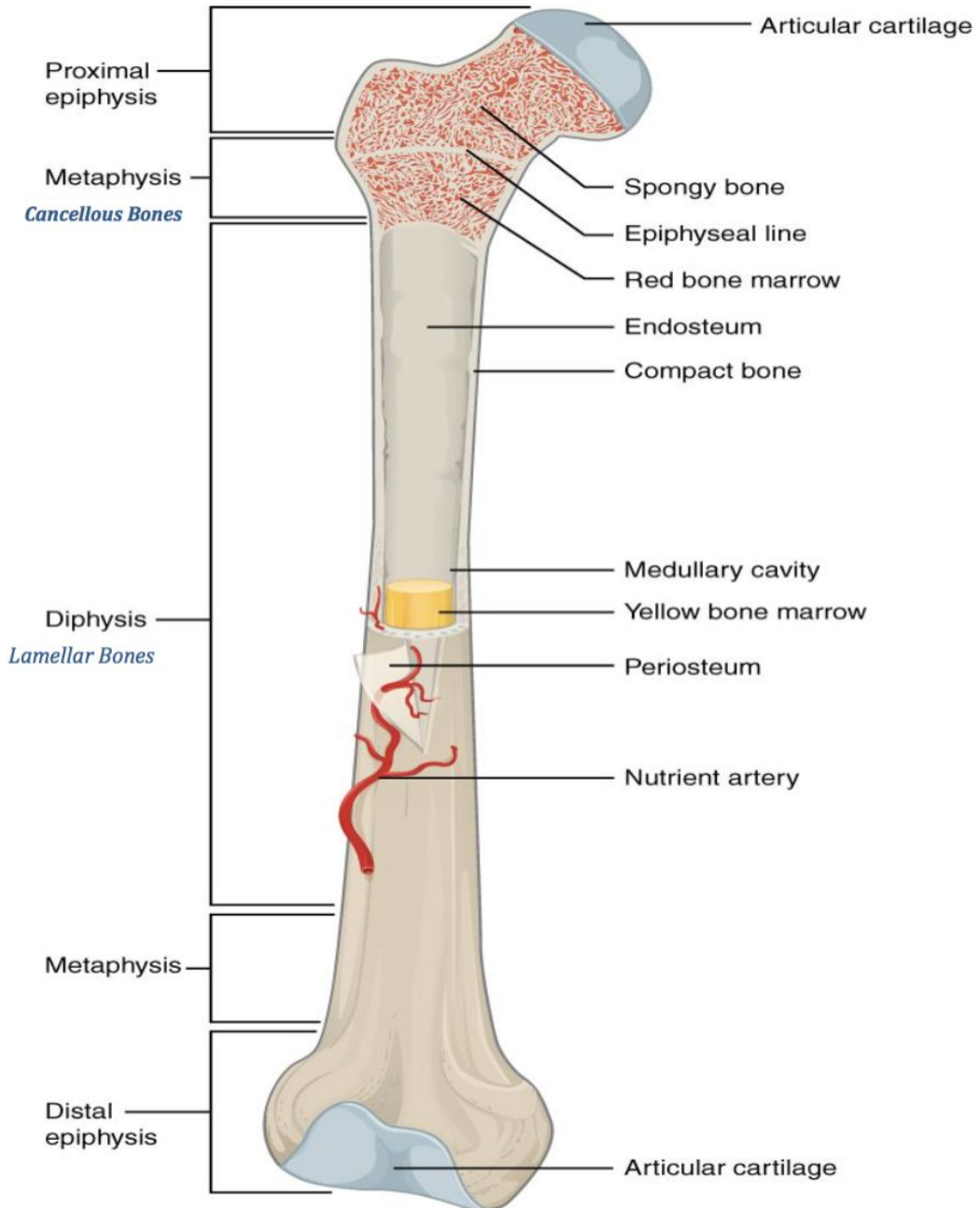
- Basic science of fracture healing.
- Principles of evaluating patients with fractures.
- Principles of management.

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Mind map



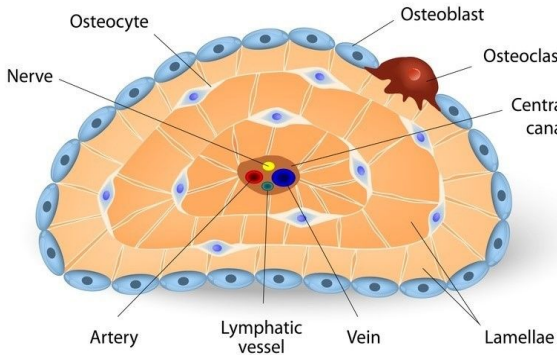
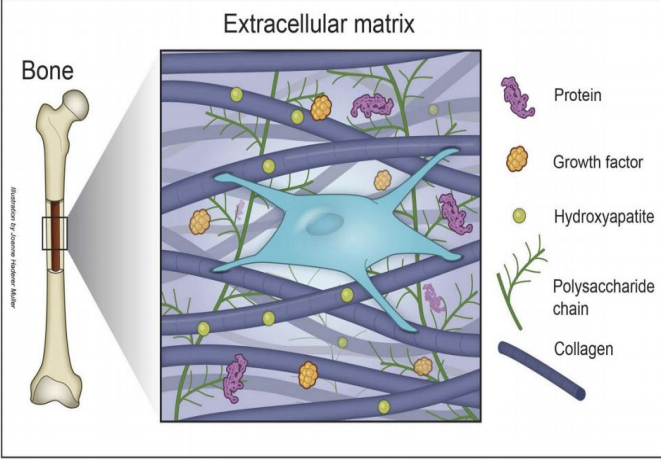
Review Bone structure



Bone Types & Composition

• Bone Types

- **Lamellar bone (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".
- **Cancellous bone (trabecular or spongy bone):** They're less dense and more elastic than lamellar bones. They're found in the **metaphysis part** of small bones.
- **Woven bone:** They're coarse bones with random orientation. They're also weaker than lamellar bones. In bone healing, they're eventually remodeled to lamellar bones (Explained later).

Bone Composition	
Cells	Extracellular matrix
<p>A Review of Bone</p> 	
<p>Osteocytes (Mature bone cells).</p> <p>Osteoblasts (Cells that create the matrix of the bone, bone builders).</p> <p>Osteoclasts (Bone eaters).</p>	<p>Organic (35%) - Collagen (type I) 90% - Osteocalcin, osteonectin, proteoglycans, glycosaminoglycans, lipids (ground substance).</p> <p>Inorganic (65%) Primarily hydroxyapatite $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$.</p>

Fracture Definition & Description

Definition : Fracture means literally broken bone.

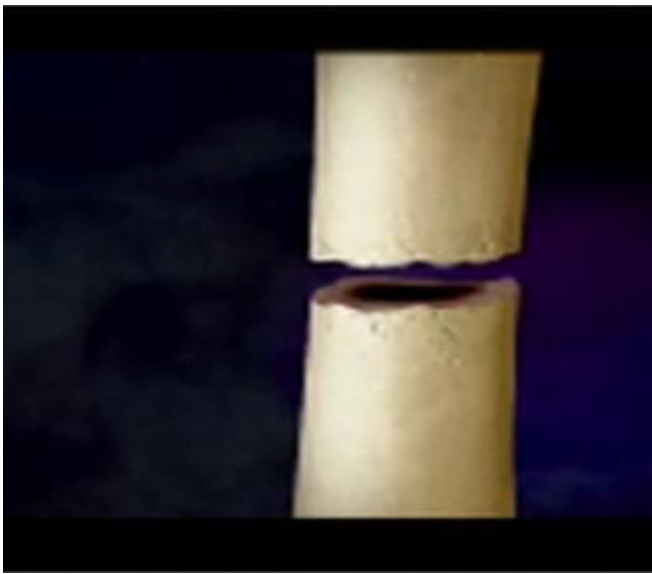
Description :

(E L M M A): Extent, Location, Morphology, Mechanism, and Associated soft tissue injuries

(A) Extent

Complete

fracture that extends 360° of bone circumference (all around).



Incomplete

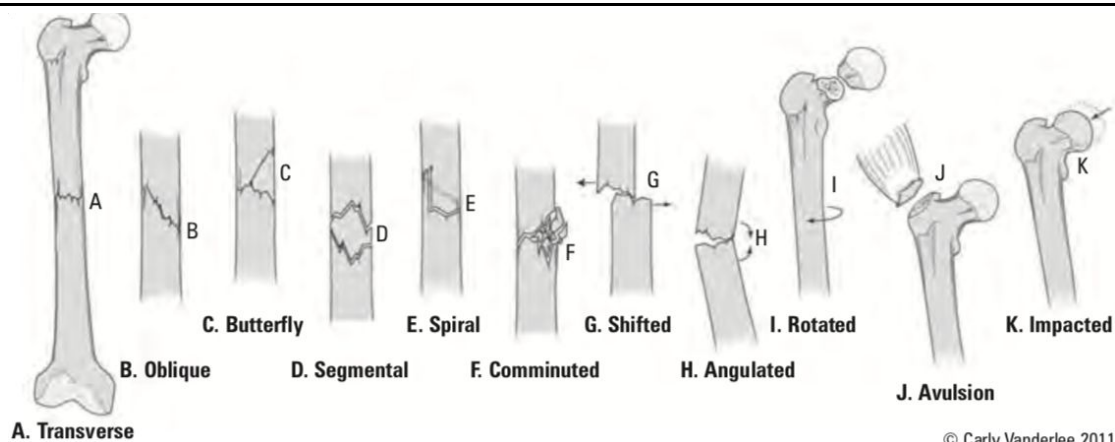
seen almost only in children such as Greenstick fracture or Buckle (torus) fracture (buckling of the cortex)



(B) Location	(C) Morphology
<ul style="list-style-type: none"> Name of bone. Side (Right or Left). Diaphysis, metaphysis or epiphysis, In long bones (diaphysis): divide them in thirds (proximal, middle or distal third). If the fracture is in the metaphysis part, mention if it's intra-articular or extra-articular (reaching the joint near it or not). 	<ul style="list-style-type: none"> Transverse: loading mode resulting if fracture is tension. Oblique: loading mode is compression Spiral: loading mode is torsion. (Usually occurs in sports & pediatric age group) Wedge (fracture with butterfly fragment): loading mode is bending. (1 piece) Comminuted: 3 or more fragments, usually results from high energy trauma. Segmental: a fracture in two parts of the same bone.
(D) Mechanism	(E) Associated soft tissue injury
<ul style="list-style-type: none"> High energy vs. Low energy (In high energy accidents, soft tissue injuries are expected e.g. RTA) Multiple injuries (associated with soft tissue damage) vs. isolated injury. (Multiple injuries include: pneumothorax, liver laceration, total abdominal injury.) Pathological fracture: Normal <u>load</u> in presence of weakened abnormal bone (tumor, osteoporosis, infection). Stress fracture: Normal bone subjected to repeated load (military recruits/athletes) usually it will be incomplete small fractures. 	<ul style="list-style-type: none"> Closed fracture: skin integrity is maintained Open fracture: fracture is exposed to external environment.

(Any skin breach in proximity of a fracture is an open fracture until proven otherwise) important to roll out open fractures

Note: "In proximity" doesn't necessarily mean above the fractured bone. It can be anywhere close to it.



Fracture Healing

❖ Types :

- **Indirect bone healing** "Surgeons don't touch it"

In indirect bone healing, the process occurs in nature with untreated fracture through **endochondral ossification** (occurs in fractures with gap). It is called indirect because of formation of cartilage at an intermediate stage. It runs in 4 phases: **hematoma formation, soft callus formation, hard callus formation, and finally, remodeling.**

- **Hematoma formation (Inflammation phase) (1-2 weeks)**

In this phase, there is disruption of the blood vessels, migration of cells occurs, and coagulation begins.

- **Soft Callus (2-3 weeks)**

In this phase, cascade of cellular differentiation occurs, angiogenesis (new blood vessel formation) takes place, and fibroblasts produce granulation tissue that eventually evolves into fibrocartilage.

- **Hard Callus (3-12 weeks)**

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.

- **Remodeling (Years)**

In this phase, the **woven bone** that was formed is converted into **lamellar bone**.

Direct bone healing "Contact healing"

It can happen if no motion takes place. Bone is formed without intermediate stage through the "Cutting cone mechanism". This mechanism works only if the fracture is < 1mm gap. (No gap must be in fracture site).

There is some factors affecting fracture healing such as:

1-Open vs Closed. 2- Soft tissue damage. 3- Periosteal stripping. 4- Complexity of fracture. 5- Systemic (Smoking, Malnutrition)

Principles of Evaluation

History

- Pain: very severe one. Ask the main questions (What?, How? (Mechanism of injury), When?, Where?).
- Inability to use the affected limb.
- Inability to ambulate.
- Deformity.
- If it is a major trauma: Patient might not be able to communicate.
- ❖ If you suspect a pathological fracture, you must:
 - Ask about prior pain before event happened.
 - Ask about constitutional symptoms.
 - Ask about history of cancer.If you suspect stress fracture, ask about recent increment of activities.

Physical Exam

❖ Inspection

- Swelling
- Deformity
- Ecchymosis
- Skin integrity : Bleeding, Protruding bone

❖ Palpation

- Bony tenderness.
- Examine joint above and below.

❖ ROM

- Can not be assessed in acute fracture.

❖ Vascular exam

- Color
- Capillary refill (within 2 sec as compared to other side)
- Always compare contralateral side
- Temperature
- Pulses
- Peripheral nerve exam of injured limb

- Always check compartment tightness: Wood like vs. soft






At the end of your exam, you must comment on: (imp) Skin is intact or not, Neurovascular status is intact or not, Compartments of limbs are soft are not .

Investigations

- Start with basics and proceed to more specific tests:
- Basic blood works (because he may go for surgery).
- X-rays of interest.
- Advanced radiological exams if needed.
- X-rays should be adequate and this means them containing
 - At least 2 orthogonal (perpendicular) views: AP and lateral
 - Joint above and below the area should be visible
 - Special views: specific for the region of interest

If fracture does hurt, splint the patient's injured limb before you send him to x-ray and if there is gross deformity, re-align, splint and then send for images to relief the pain.

Fractures can be obvious on images (bone discontinuity). Sometimes, careful assessment of radiographs is needed (i.e. stress fracture or non displaced fracture)

Secondary signs of fracture on X-ray				
Soft tissue swelling	Fat pad signs (Capsule filled with blood)	Periosteal reaction	Joint effusion	Cortical buckle
				

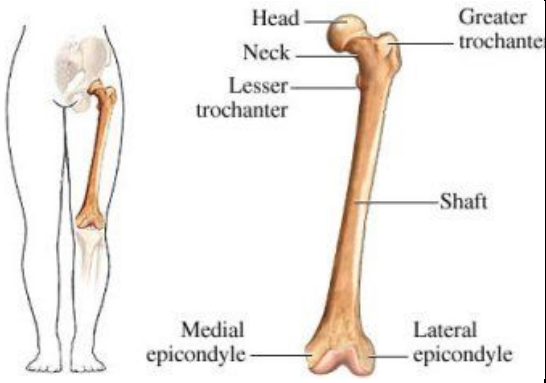
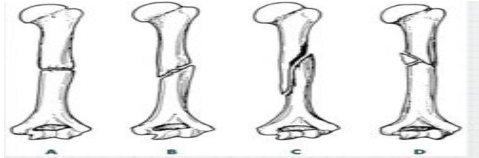


Advanced radiological images should be considered:

- If fracture extends to joint -> obtain CT scan
- If fracture is suspected but not seen on x-ray -> MRI

HOW TO DESCRIBE A FRACTURE?

1. Clinical parameters

- Open vs. closed
- ANY break in the skin in proximity to the fracture site is OPEN until proven otherwise
- Neurovascular status
- Presence of clinical deformity

2. Radiographic parameters		
Location	<p>Which bone? Which part of the bone? Epiphysis intraarticular? Metaphysis – intraarticular? Diaphysis – divide it into 1/3 (upper, lower and mid thirds) use anatomic landmarks when possible. (e.g. medial malleolus, ulnar styloid, etc...)</p>	
Pattern	<p>Simple vs. comminuted. Complete vs. incomplete. Orientation of fracture line (A: transverse, B: oblique, C: spiral).</p>	
Displacement	<p>(translation/angulation/shortening/rotation) Displacement is the opposite of apposition. We call the displacement of the fragment that is distal in relative to the proximal. It's expressed as a percentage.</p>	
Angulation	<p>Angulation is the deviation from normal alignment. It's described depending on its apex (The apex of both fragments defines direction of angulation). It's expressed in degrees.</p>	

Treatment

Note! :If the injured limb is grossly deformed, simple realignment and splinting should be initially.

Treatment Principles

A. Reduction

- To maximize healing potential
- To ensure good function after healing

Reduction is indicated when a fracture is displaced. It's meant to **re-align** fracture fragments and to minimize soft tissue injury. It can be considered definitive if fragments' position is accepted. An open reduction takes place at OR.

Important points to remember:

1. Take consent from patient prior to reduction (1st & most imp step).
2. Patient must receive adequate analgesic 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 (before and after reduction).

B. Immobilization

- To relieve pain
- To prevent motion that may interfere with union
- To prevent displacement or angulation of fracture

Immobilization is done to hold reduction in position, to provide support to broken limb, to prevent further damage, and most importantly, **control the pain**. Most fractures require an immobilization of joint above and below.

Examples of immobilization methods



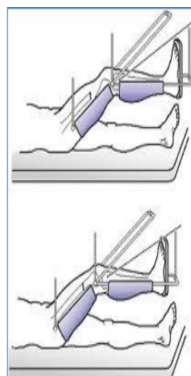
BACK SLAB



BRACE



SKIN TRACTION



SKELETAL TRACTION



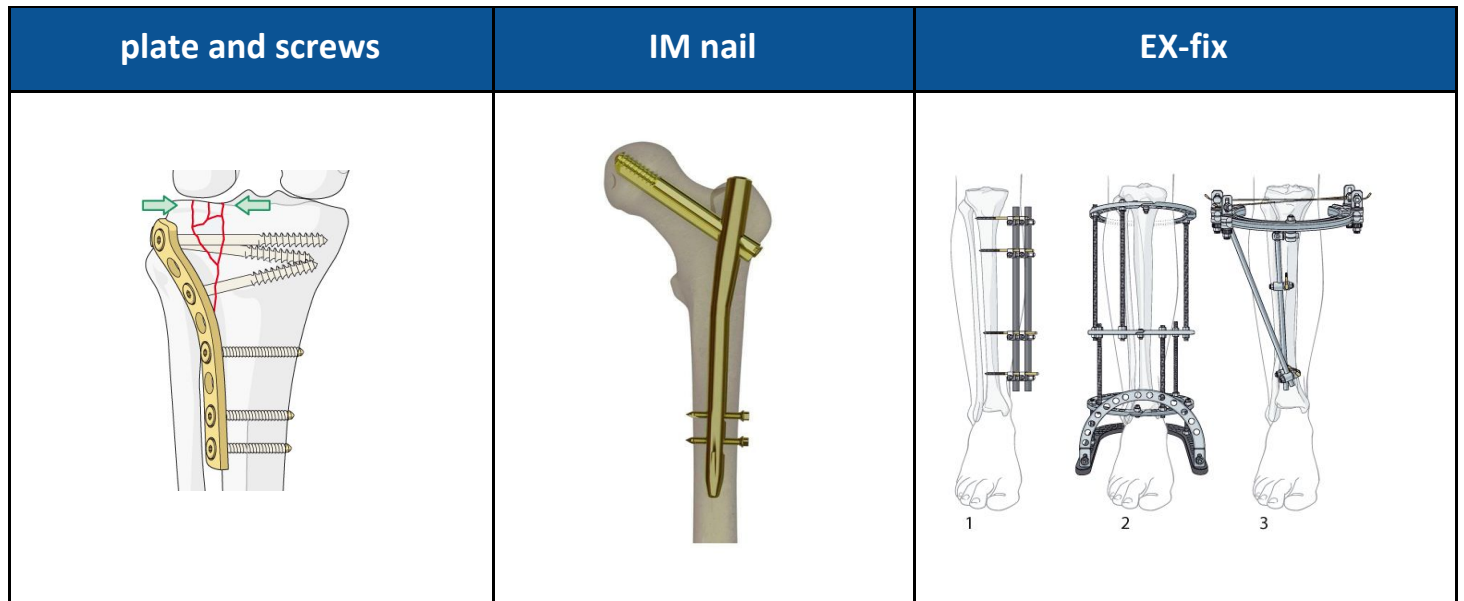
SLING



COMPLETE CAST

C. Definitive treatment

It's indicated when reduction cannot be achieved or held at initial stage. Reduction can be attempted closed or open (surgery). Immobilization can be achieved with plate and screws, IM nail, EX-fix (Surgical techniques).



D. Rehabilitation

- To ensure return to function

Initiating motion should be attempted as early as possible **without jeopardizing maintenance of reduction**. Weight bearing restriction for short period (6-8 weeks). Move unaffected areas immediately.

- **Multiple Trauma**

It's a multi-disciplinary approach. Trauma Team Leader (TTL) at the ER runs it. Orthopedic is part of the team. Each institute or hospital has their own trauma protocol, so follow it based on the hospital you're in. **Treatment is prioritized toward life threatening conditions** then to limb threatening conditions. **Save the patient's life -> save the patient's limb -> save the limb's function.**

Complications

If fracture extends into joint or close:

- OA (osteoarthritis)
- Stiffness

Fracture healing:

- Nonunion: Doesn't heal after double the expect time
- Malunion: Healed with Malalignment

Fracture specific: AVN (Avascular necrosis) after femur neck fracture.

Medical complications: Lower limbs fractures may be associated with venous thrombus event (VTE).

Surgical related: Infection, hardware failure.

A great Summary done by 434team

