

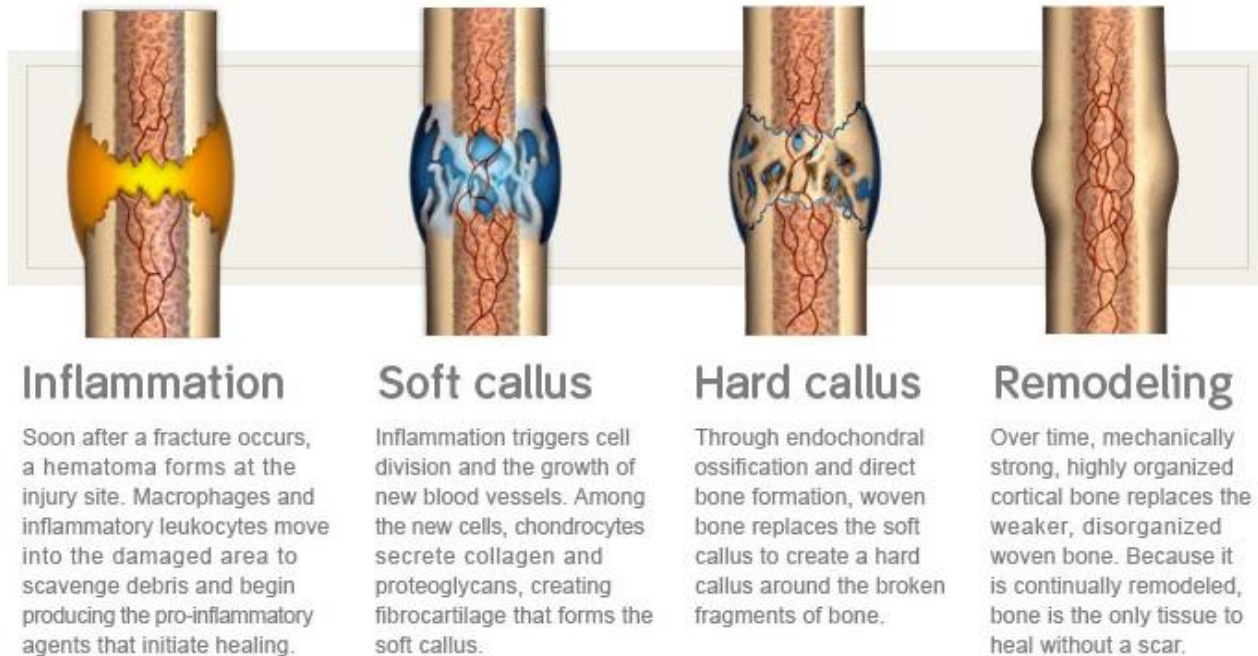
Unit VII – Problem 2 – Pathology: Fracture Healing



- **Definition of a fracture:** discontinuity of a bone.
- **Fracture healing:**
 - **Primary** healing of a bone following osteotomy (cutting of a bone).
 - **Secondary** healing of a bone following fracture.
- **Type of fractures:**
 - **Traumatic fracture:** following a trauma (direct force applied on the bone and breaking it).
 - **Stress (fatigue/march) fracture:** repeated microfractures resulting in a true fracture. It occurs in joggers, skiers and ballet dancers. Callus forms before fracture radiologically resembles a tumor.
 - **Pathological fracture:** the presence of a disease which leads to the weakening of bones and eventually resulting in fractures.
- **Complications of fractures:**
 - Impairment of movement and function.
 - Soft tissue and muscle necrosis (especially if a vessel is injured or the fracture is compressing on a specific area).
 - Hemorrhage might also result and develop into hypovolemic shock (which is an emergency situation).
 - Bone & cartilage necrosis.
 - Nerve damage (example: damage to the axillary nerve when a fracture occurs in the surgical neck of the humerus).
 - Tears of tendons and ligament (example: a fracture in the clavicle can lead to a tear in coracoclavicular ligaments).
 - Fat and bone marrow embolism (especially if the fracture occurs in long bones).
- **Repair of bone fractures: this process is composed of 3 phases (see the figure below):**
 - **Inflammatory phase (1-7 days with the appearance of callus at day 7):**
 - ✓ When a fracture occurs, there will be hemorrhage followed by clot formation and neovascularization (formation of new blood vessels within the clot).
 - ✓ Standard inflammatory reactions will occur (i.e. exudation of fluid and cellular infiltration).
 - ✓ Bone death (bone necrosis) will occur and will be manifested by the absence of osteocytes and empty osteocytes lacunae.
 - ✓ Then, osteoprogenitor pluripotential cells will differentiate into:
 - ❖ Osteoblasts: which will synthesize osteoid and woven bone.
 - ❖ Chondrocytes: which will produce cartilage.
 - ✓ Woven bone (bone scar) will form at the periphery of a clot where vascularization is greatest. Trabeculae of reactive bone will form at periosteal and endosteal surfaces near fracture ends. Cartilage formation (by chondrocytes) and resorption by endochondral ossification (conversion of a cartilage to a solid bone) will occur.
 - ✓ What is a callus (نسيج لين)? It is a specialized type of specific granulation tissue occurring in fracture repair and containing woven bone + cartilage formed by osteoblasts and chondrocytes. There are 2 types of a callus:
 - ❖ External (periosteal).
 - ❖ Internal (endosteal).
 - **Reparative phase (starting at the end of the 1st wk of a fracture & extending to months!):**
 - ✓ External and internal callus grow into fracture site.
 - ✓ Cortical cutting cones will reach the rough fracture ends which will be remodeled by osteoclasts into smooth ends.



- **Remodeling phase (occurring wks after a fracture and extending to months!):**
 - ✓ Reconstruction of the fractured bone to restore full mechanical strength.
 - ✓ Woven bone is resorbed and replaced by lamellar bone.
 - ✓ Medullary callus is removed to restore medullary cavity.



- **Factors affecting cell renewal / tissue repair (modifying factors):**

- Age of the patient (i.e. healing of a fracture occurs faster in children than in adults).
- Vascularity of a tissue (i.e. healing of a fracture occurs faster if there is good blood supply to the area).
- Impairment of lymph drainage.
- Early movement of affected part (i.e. for a fracture to heal, the affected part must not be moved).
- Fixation to underlying tissue (i.e. fractures occurring in the scapula will heal fast because it is fixed and surrounded by muscles).
- Presence of foreign body and irritant substances.
- Infection.
- Denervation.

- **Primary healing of bone:**

- No bone displacement.
- No soft tissue reaction.
- No external callus.
- Internal callus grows directly into fracture site.
- Rapid constitution of cortex including Haversian system.

- **Notes:**

- **Malunion (سوء الالتئام):** dysfunctional fracture repair.
- **Non-union:** fracture never heals.
- **Pseudoarthrosis:** pluripotential cells become histologically indistinguishable from synovial cells and they secrete synovial fluid.