Bone fractures and Bone healing

Lecture: 3 (for females) / 2 (for males)

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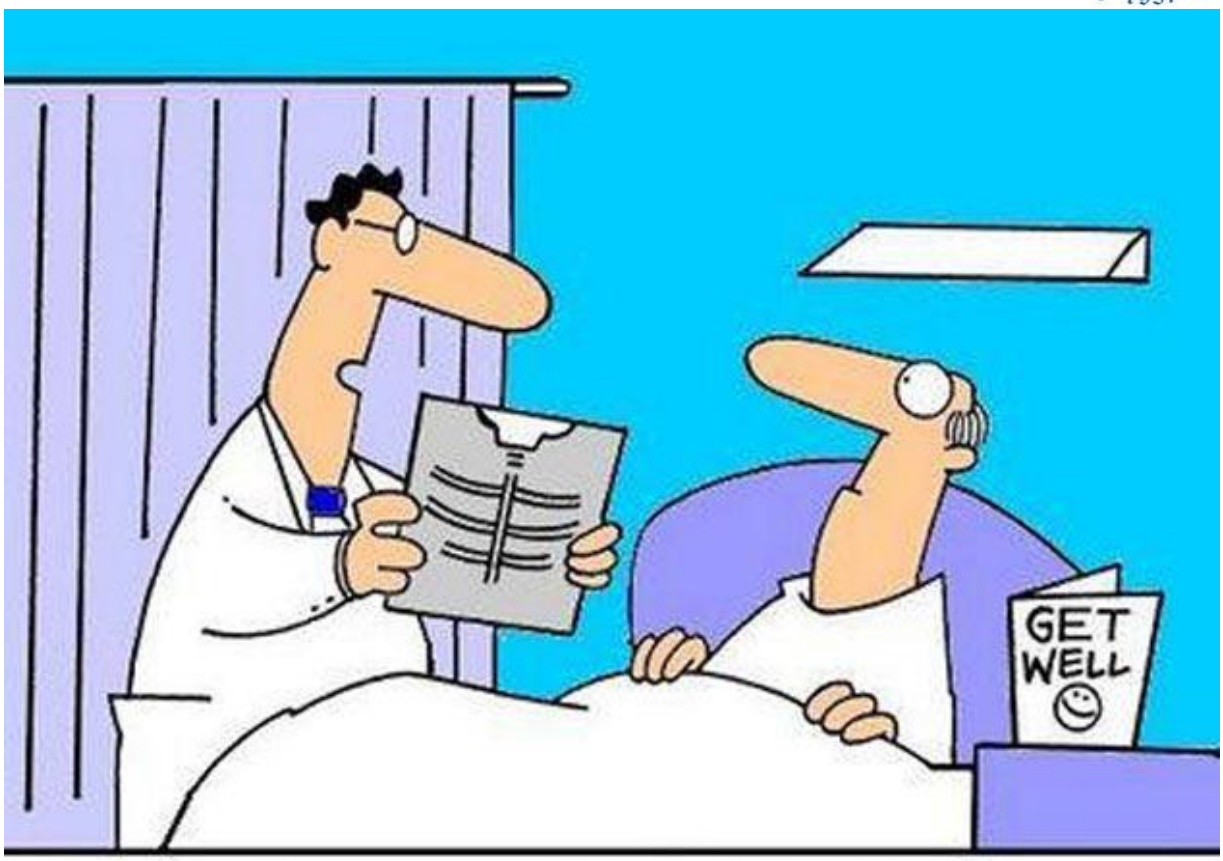


"Your x-ray showed a broken rib, but we fixed it with Photoshop."

PATHOLOGY
TEAM 433

Objectives:

- Be aware of the mechanism and stages of fracture healing and understand the difference between trauma induced and pathological fractures.
- Know the factors contributing to delayed fracture healing.

Videos to Watch:

- Both videos about bone healing.

https://www.youtube.com/watch?v=VZF3xicLtTw

https://www.youtube.com/watch?v=qVougiCEgH8

1st: Introduction.

Injuries caused by direct trauma, for example:

- Laceration to face and hands from windshield glass.
- Fracture of sternum and ribs from impacts with steering column.
- Fracture of legs from collapse of car frame or from impact of car on a pedestrian.
- Contusional damage and laceration of liver, spleen and lungs.
- Contusions of brain and fracture of neck from impact damage to head.

❖ Bones are composed of specialized collagen (Osteoid) which is mineralized by: deposition of hydroxyapatite (Ca+2).

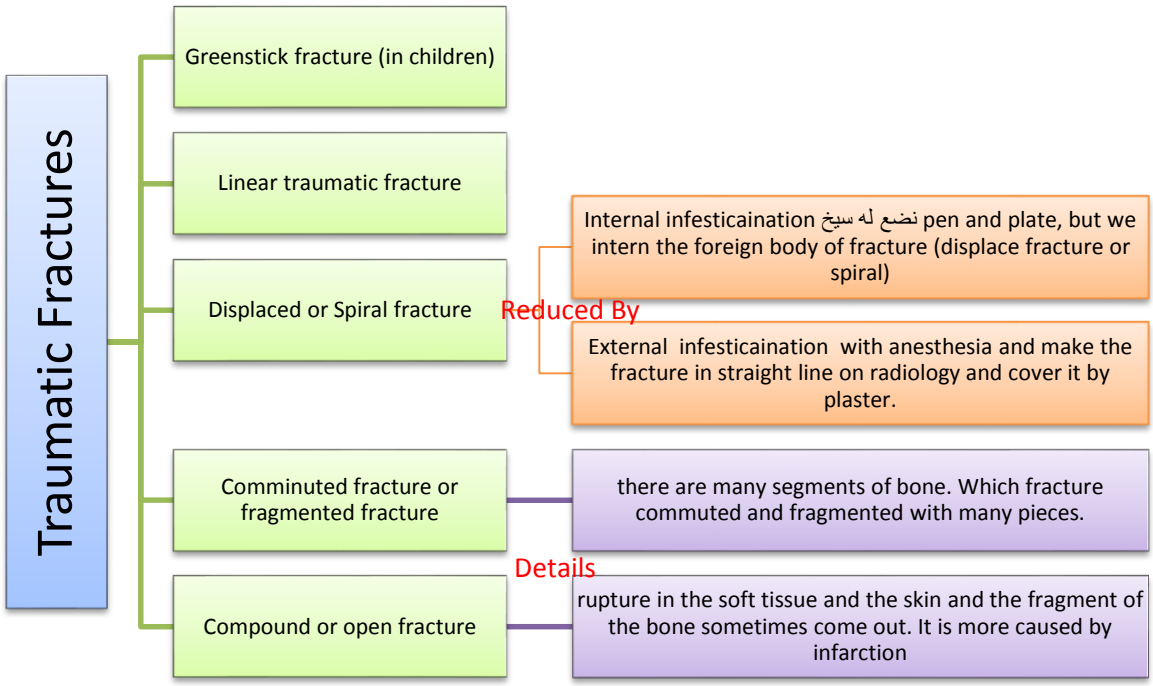
- In normal woven bone (Spongy or Trabecular), the osteoblasts deposit osteoid collagen in a haphazard or random pattern. With its random arrangement of osteoid collagen fibers, this woven pattern is far less efficient and much weaker than lamellar bone and has greater tendency to fracture under stress.

❖ Bones are constantly being refashioned by osteoblastic new bone formation and osteoclastic removal of old bone (Bone remodeling).

Increase in osteoclastic activity leads to destruction of the bone.
"Feature of some metabolic bone diseases"

2nd: Bone Fracture.

Fracture: Break in the continuity of bone
We have **two kinds** of fractures: **Pathological** and **Traumatic** (Pathological, already explained in the previous lecture)



3rd: Bone Healing Process.

1-Reactive Phase:

Fracture and inflammatory phase:

1- Bone fracture, leading to **ruptures of associated blood vessels**.
2- The resulting blood clot **(hematoma)** from the fractured bone, and surrounding tissue **recruit inflammatory cells, fibroblasts, and endothelium.**
3- Swelling of fracture area **(inflammation)**. This stage begins the day you fracture the bone and lasts about 2 to 3 weeks.

- **Granulation tissue formation:**

  The healing of this blood clot (hematoma) occurs **by granulation tissue** (Blood vessels formation).

2-Reparative Phase:

A- Callus formation:

Soft callus: This soft tissue callus can hold the ends of the fractured bone in apposition but is non-calcified and cannot support weight bearing.

- Cannot be seen on x-rays
- Between 2 - 3 weeks after the injury, the pain and swelling will decrease. At this point, the site of the fracture stiffens and new bone begins to form.
- This stage usually lasts until 4 to 8 weeks after the injury.

Hard callus: soft callus converts to bony callus (Hard callus).

- The fractured ends are bridged by a bony callus.
- Between 4 - 8 weeks, this bony bridge can be seen on X-rays.
- By 8 - 12 weeks after the injury, new bone has filled the fracture.

B- Lamellar bone deposition: **"The cartilage woven are gradually replaced by lamellar bone".**

Woven bone: which is characterized by haphazard organization of collagen fibers and is mechanically weak.

Lamellar bone: which has a regular parallel alignment of collagen into sheets (lamellae) and is mechanically strong.

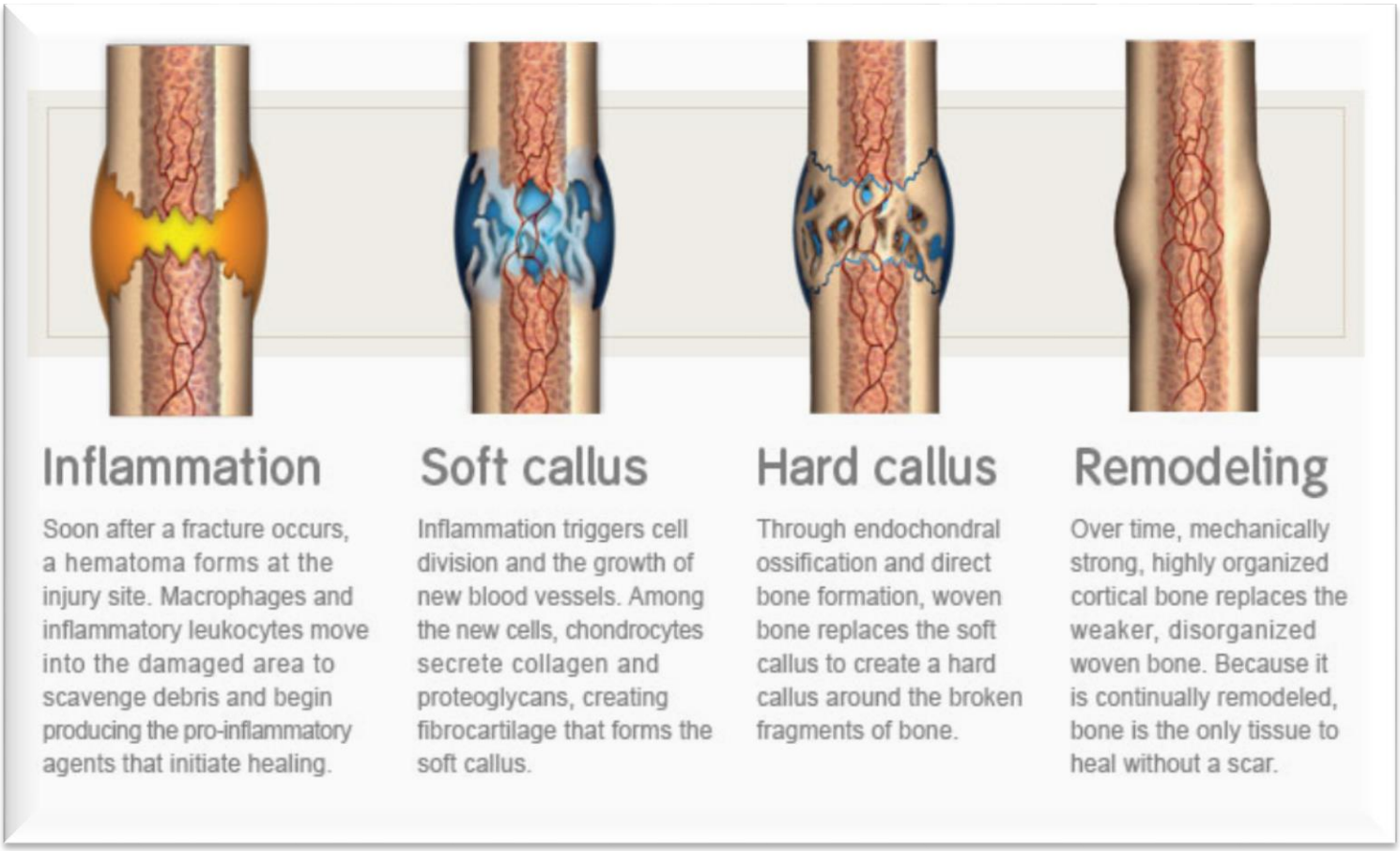
3-Remodeling Phase

Remodeling to original bone contour:

- The new bone can be remodeled so that the anatomy can return to close to normal.
- Fracture site remodels itself, correcting any deformities that may remain as a result of the injury. ***"Remodeling phase can last up to several years".***
- The rate of healing and the ability to remodel a fractured bone vary tremendously for each person and **depends on the age**, **your health**, **the kind of fracture**, **and the bone involved.**

For example: Children are able to heal and remodel their fractures much faster than adults.

Note: The degree of fracture can vary widely from simple crack in the cortical bone to complex multiple fractures with fragmentation and displacement of bone pieces, associated with severe damage to the surrounding soft tissue and sometime exposure of the bone fragment to the exterior through a large gaping wound.



4th: Factors disrupting healing process.

1. **D**isplaced and comminuted fractures “poor apposition of the fractured bone”.
2. **I**nfection: particularly in open fractures and it's comminuted.
3. **I**nadequate minerals and vitamins, protein malnutrition.
4. **I**nadequate immobilization: **Too much motion along the fracture gap** (as in nonunion) causes the central portion of the callus to undergo cystic degeneration.
5. **I**nfections.
6. **V**ascular insufficiency: Poor blood supply to the affected area. This is important in certain areas such as the scaphoid bone in the wrist and the neck of the femur, both of which can be associated with avascular necrosis of fracture fragments.

Notes:

- The aim of treatment in fractures is **to ensure apposition of the bone ends** followed by firm immobilization so that the fractured ends cannot move during the formation of granulation tissue and callus.
- When fractured bone ends are not closely apposed, or if any of the above local complicating factors are present, ossification of the callus does not occur and the two bone ends are joined by **Fibrous tissue** (fibrous ankylosis) which is unstable.

The difference between children and the elderly people in the healing process:

Adults and children they usually don't get abnormal fractures because of **perfect reconstitution**, but when fractures occur with **osteoporosis**, repair frequently is **less than** optimal without orthopedic intervention.

Note:

Bone formation in children **>** Bone resorption, and if the fracture was transverse it will take **longer healing time than spiral.**

5th: Complications of Bone Healing.

I. Compartment Syndrome:
- Severe swelling after a fracture can put so much pressure on the blood vessels that not enough blood can get to the muscles around the fracture.
- The decreased blood supply can cause the muscles around the fracture to die, which can lead to long-term disability.
- Compartment syndrome usually occurs only after a severe injury.

II. Delayed union: A fracture that takes longer to heal than expected is a delayed union.

III. Nonunion: A fracture that fails to heal in a reasonable amount of time is called a nonunion (pseudarthrosis).

IV. Delayed union & non- union which caused by:
- Nutrition
- Bone Disease
- Old Age

V. Malunion**:** A fracture that does not heal in a normal alignment.
- Primary Neglected.
- After Reduction! Watch X-Ray After 10 Days

VI. Neurovascular injury

VII. Infection: open fractures can become infected.

VIII. Post-traumatic arthritis: Fractures that extend into the joints (intra-articular fractures) or fractures that cause the bones to meet at an abnormal angle in the joint can cause premature arthritis of a joint.

IX. Growth abnormalities**:** A fracture in the open physis, or growth plate, in a child, can cause many problems. Two of these problems are:

Premature partial or **incomplete closure of the physis**. This means that one side of a bone or the whole bone stops growing before it naturally would.

NOTE: For normal bone to fracture, the causative trauma usually has to be severe. In contrast, weak trauma may cause fracture when the underlying bone is abnormal **(pathological fracture).**

6th: Causes of Pathological Fracture.

I. Osteoporosis (particularly in the femur and the vertebral column in the elderly).

II. Osteomalacia (the fractures are often small microfractures without displacement).

III. Paget's disease of bone (the pagetic bone being structurally weak despite the increase in bulk).

IV. Primary or metastatic tumor (Bone metastasis from carcinoma of the breast, bronchus, thyroid and kidney produce bone destruction "osteolytic metastasis" which predisposes to fracture)

V. Congenital bone disorders (the most important disorder is osteogenesis imperfect, in which multiple fractures occur, often in utero and in infancy with minimal trauma)

7th: MCQs

1- Which one of the following fractures may cause infection?

A. Complete fracture.
B. Open fracture.
C. Fracture dislocation.

2- In which phase of healing, callus formation happen?

A. Reactive phase
B. Reparative Phase
C. Remodeling phase

3- spirl fracture of upper limb takes ….. to consolidation?

A. 6 weeks
B. 3 weeks
C. 1 week

4- A fracture that takes longer to heal than expected is a delayed union it known as :

A. Complicated fracture
B. Comminuted fracture
C. Delayed union of fracture

5- the causes of delayed union or non-union are?

A. Nutrition
B. Old age
C. Both of them

6- A 90-year-old Caucasian female (CF) was directly admitted to the hospital after she slipped and fell at home.

Past medical history (PMH)

In a relatively good health for a 90-year-old, working part-time as an optometrist, independent, drives her own car. Remote history of (h/o) uterine and colon cancer. She was complaining of pain in the right side of the body. A series of X-rays were done -- head, neck, shoulders, elbows, hands, hips, pelvis, knees, and ankles.

A. According to the case & pictures above, the women suffer from :
B. pelvic bone fracture
C. spiral fracture in her lower limb
D. combination of injuries

1- B.
2- B.
3- C.
4- C.
5- C.
6- B.