

Bone healing

Principles of fracture treatment:

1. Reduction

- Anatomical reduction >> for intra-articular fractures, minimize the risk of secondary osteoarthritis.
- Functional reduction >> restoring the acceptable: (1) Length, (2) Rotation, (3) Alignment.

2. Immobilization (stability)

- Absolute stability >> no movement at all at fracture site.
E.g. Leg screw, compression plates, tension band wiring.
- Relative stability >> allow minimal movement at the fracture site.

3. Rehabilitation (mobilize)

- To avoid joint stiffness.

For a fracture to heal properly it needs:

1. Good blood supply.
2. Stability at the fracture site.
3. Good bony apposition (no soft tissue between fracture pieces).

Type of fracture healing:

1. Primary bone healing (direct):

- Gap less than 2mm, no callus formation, need absolute stability to happen.

2. Secondary healing (indirect):

- Healing with callus formation, seen in relative stability.
- 4 stages:
 - ✓ Hematoma & inflammation: granulation tissue is produced
- PMN cell is the first inflammatory cell arrive at site of bone healing.
 - ✓ Soft callus: fibrous tissue is **replaced** by cartilage (fracture become sticky).
 - ✓ Hard callus: cartilage is **replaced** by bone (woven bone).
 - ✓ Remodeling: mineralization of the woven bone then replaced by lamellar bone.

Notes:

- Intra-articular = absolute stability = anatomical reduction = primary healing.
- Extra-articular = relative stability = functional reduction = secondary healing.
- These types of bone healing are observed in cortical and in cancellous bone.
- Bone healing between fracture ends resembles endochondral ossification.

Complication of fracture healing:

1. Malunion

- Good healing but inappropriate site >> impaired function.
- Treatment: osteotomy (surgically breaking the bone) and fixation in the correct position.

2. Nonunion, 2 types:

A. Hypertrophic

- Due to inadequate stability at the fracture site.
- There is a callus formation but no union (healing).
- Elephant foot or horse hoof appearance of the fracture ends.
- Treatment: surgical stabilization of the fracture.

B. Atrophic

- Due to inadequate vascularity at the fracture site.
- No callus formation.
- Pencil-like appearance of the fracture ends.
- Treatment: debridement of the necrotic bone ends, bone grafting, and fixation.



**Hypertrophic
nonunion**



**Atrophic
nonunion**

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