



# Fracture Healing<sup>Dr</sup>

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# Osteology – Healing of Fractures

- 5 histologic stages of fracture healing:
  1. Fracture
  2. Formation of granulation tissue around fractured bone ends
  3. Replacement of granulation tissue by callus
  4. Replacement of callus by lamellar bone
  5. Remodeling of bone to normal contour

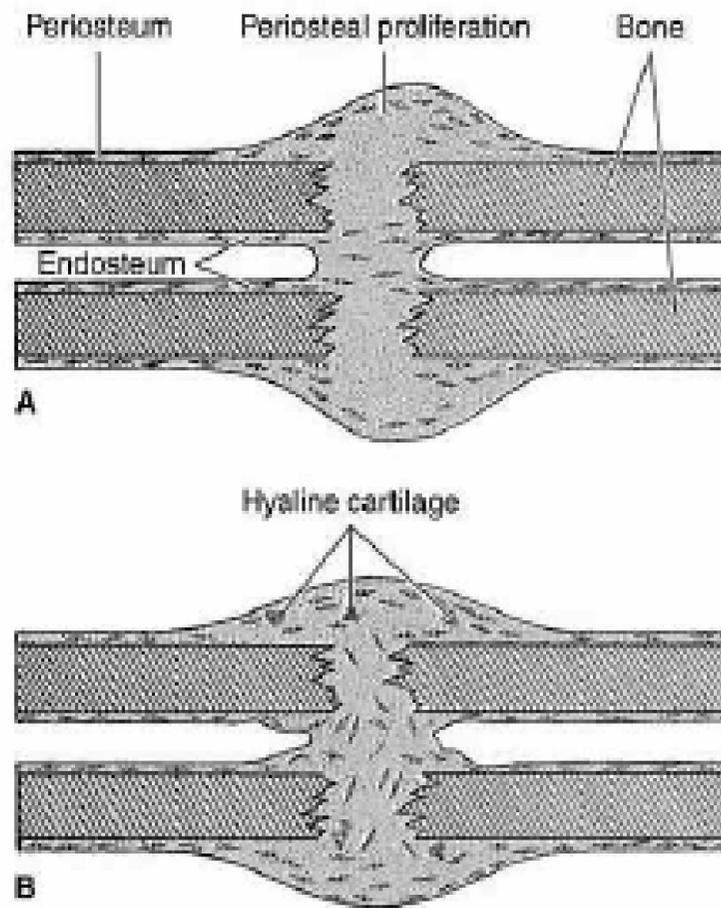
# Osteology – Healing of Fractures

- |  |   |                  |
|--|---|------------------|
| 1. Fracture                                    | } | Reactive phase   |
| 2. Formation of granulation tissue             |   |                  |
| 3. Replacement of granulation tissue by callus | } | Reparative phase |
| 4. Replacement of callus by lamellar bone      |   |                  |
| 5. Remodeling of bone to normal contour        | } | Remodeling phase |

# Osteology – Healing of Fractures

- Fracture causes haemorrhage and tissue destruction; blood clot forms (hours)
- Proliferating fibroblasts and capillary sprouts grow into blood clot in injured area, forming granulation tissue, in response to cytokines released by tissue damage (days)

# Fracture Healing



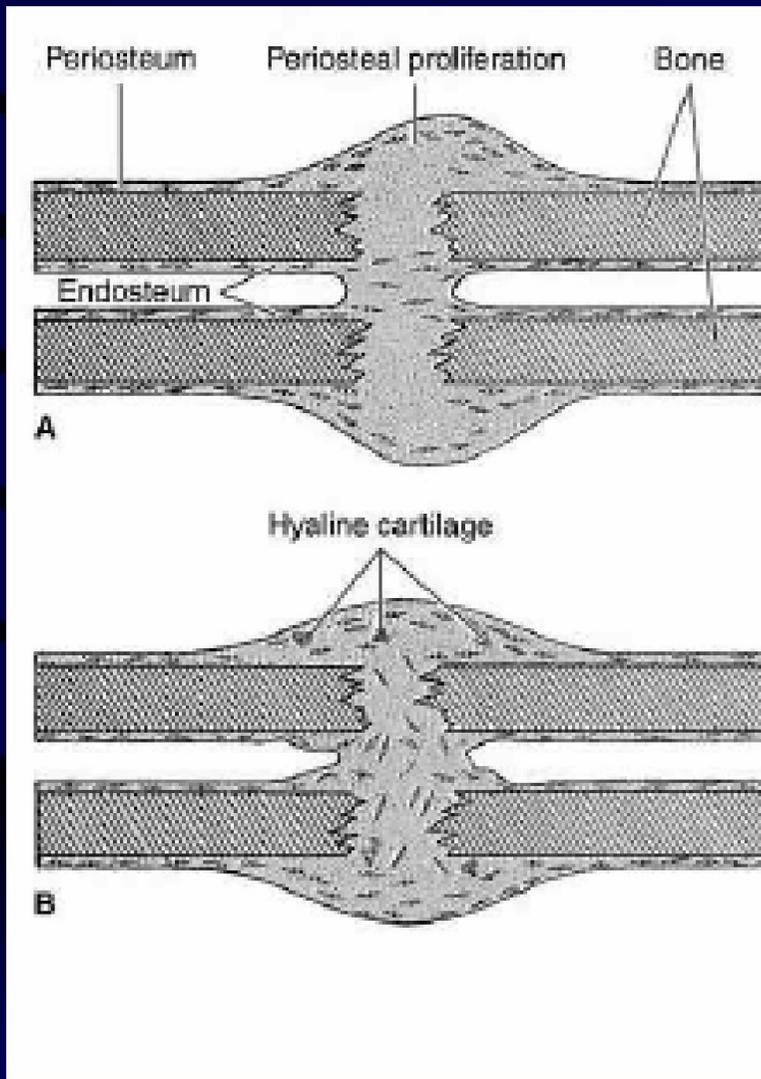
Haemorrhage

Tissue destruction

Proliferating fibroblasts and capillary sprouts grow into blood clot in injured area, forming granulation tissue

Modified from Junqueira

# Fracture Healing



Invaded by neutrophils,  
macrophages which  
phagocytize debris

Granulation tissue  
becomes denser

Cartilage forms

Modified from Junqueira

## Fracture Healing

Connective tissue

+

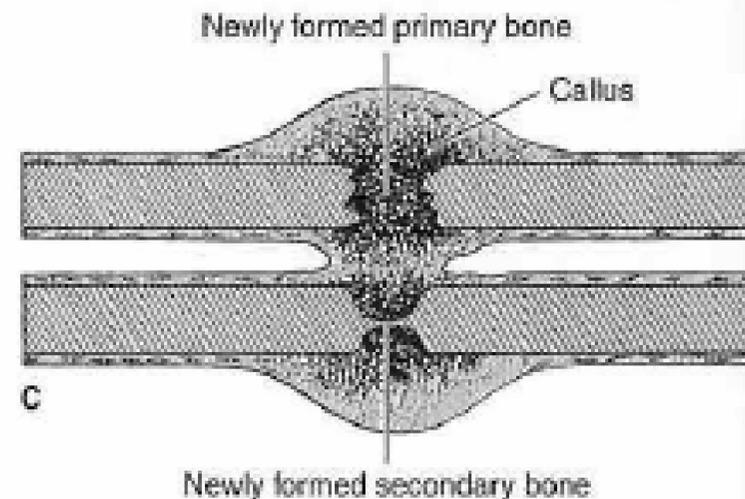
Cartilage tissue

=

Callus

Callus temporarily binds  
and stabilizes bone

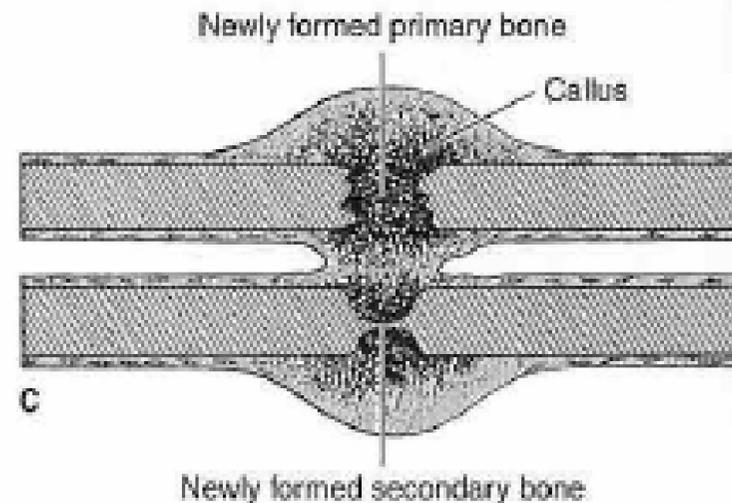
Dormant osteogenic cells of  
periosteum enlarge, become  
osteoblasts, deposit osseous  
material on outside of bone  
centripetally



Modified from Junqueira

## Fracture Healing

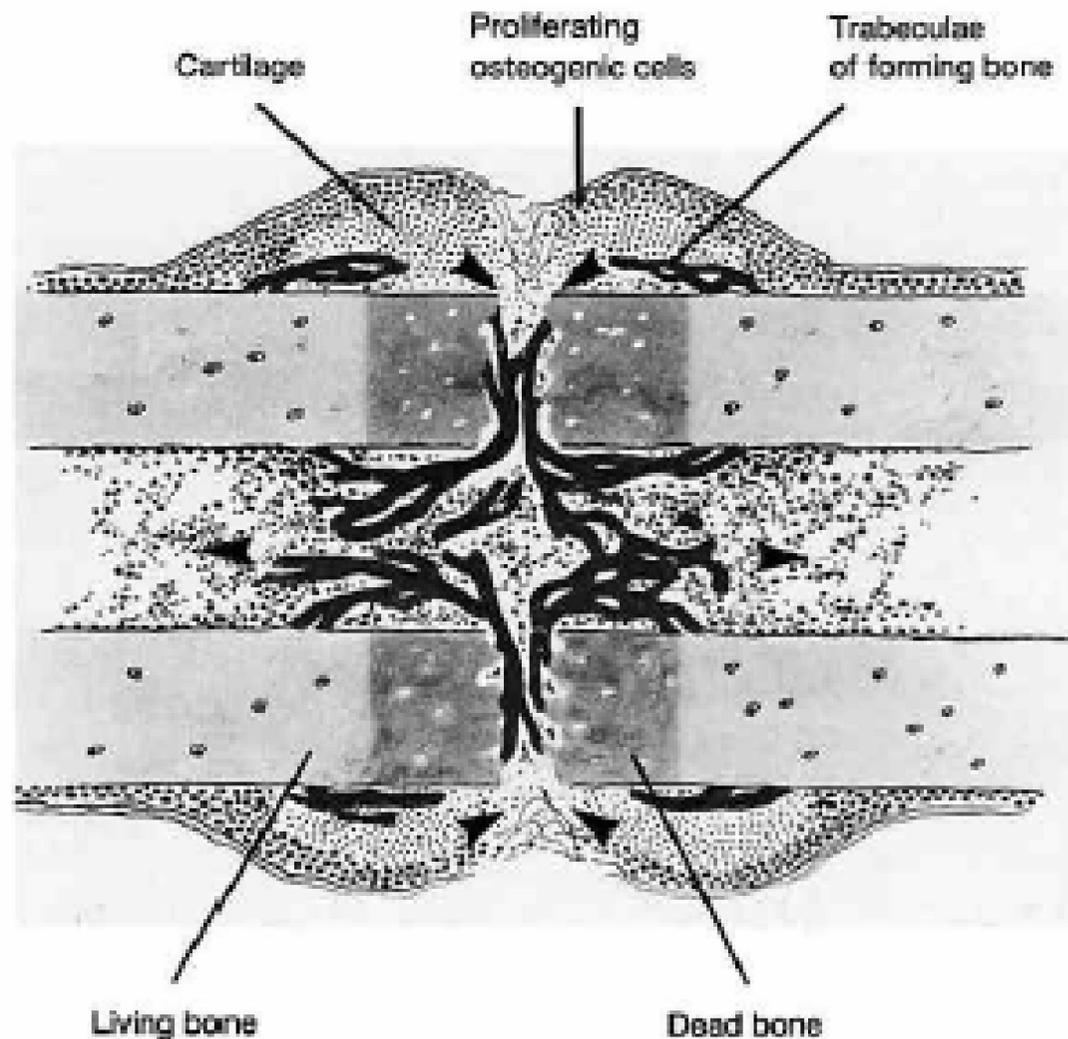
Sheath of bone is formed over fibrocartilaginous callus; osteogenic buds invade this callus and replace it with bony callus; in replacement of this callus, cartilage undergoes calcification and absorption same as in intracartilaginous bone formation



Modified from Junqueira

## Summary diagram of bone healing

**Fig. 12-43.** Summary diagram of healing rib fracture. New cancellous bone is shown in black; cartilage is indicated in light stipple. Arrowheads indicate the direction of growth of trabeculae of new bone in the external and internal callus. For details, see text.



From Cormack

# Fracture Healing

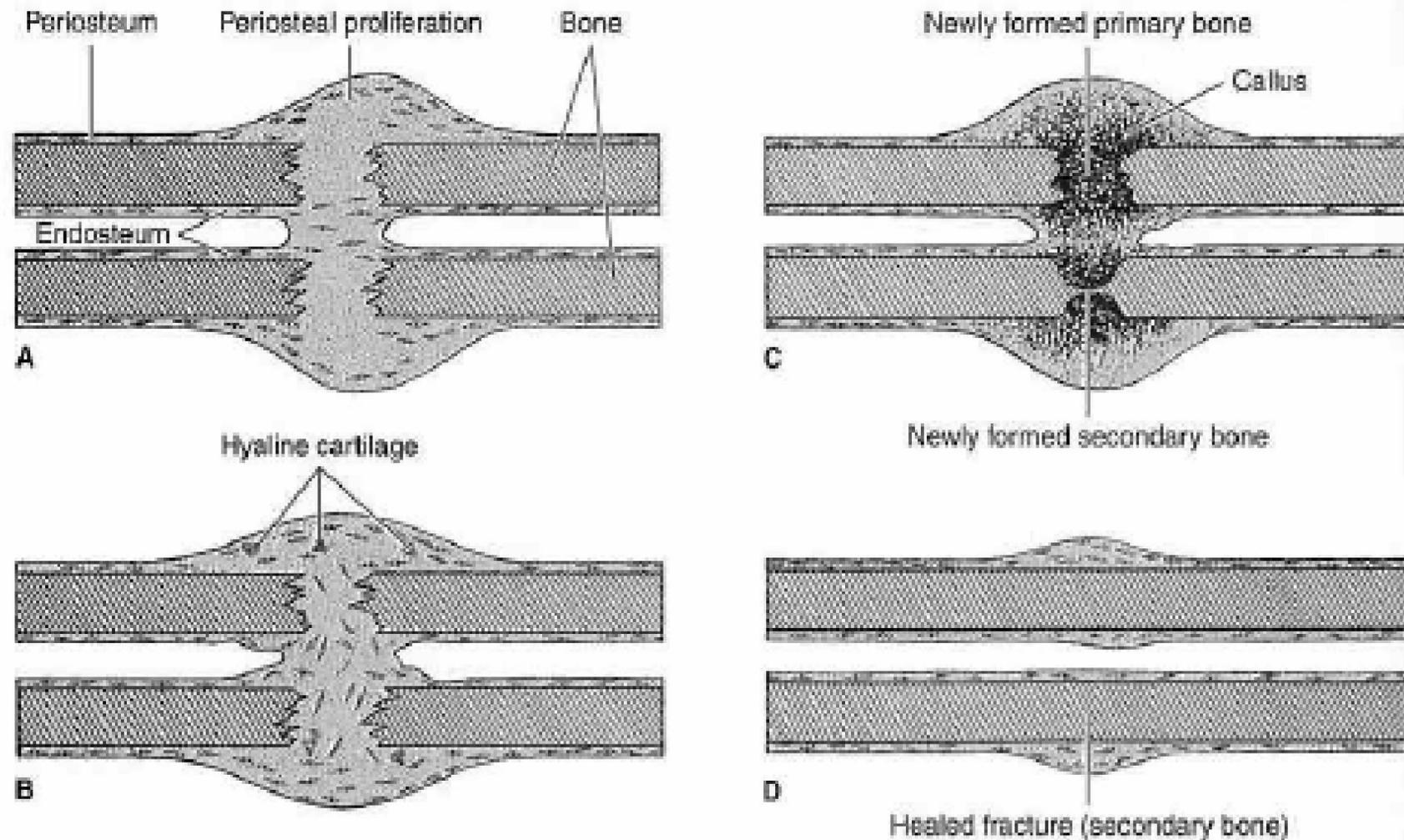


Figure 8-17. Repair of a fractured bone by formation of new bone tissue through periosteal and endosteal cell proliferation.

# Factors Affecting Fracture Healing

- | Both local and systemic variables influence the rate and degree of fracture healing. When normal healing occurs, but at a slower rate than usual, it is termed **delayed union**. A complete cessation of the healing process, in which fibrous tissue is never replaced by bony matrix, is termed **non-union**

# Systemic Factors Affecting Fracture Healing

- | **Age:** Young patients heal rapidly and have a remarkable ability to remodel and correct angulation deformities. These abilities decrease once skeletal maturity is reached.
- | **Nutrition:** A substantial amount of energy is needed for fracture healing to occur. An adequate metabolic state with sufficient carbohydrates and protein is necessary

# Systemic Factors..cont

- | **Systemic Diseases:** Diseases like osteoporosis, diabetes, and those causing an immunocompromised state will likely delay healing. Illnesses like Marfan's syndrome and Ehlers-Danlos syndrome cause abnormal musculoskeletal healing.
- | **Hormones:** Thyroid hormone, growth hormone, calcitonin, and others play significant roles in bone healing. Corticosteroids impede healing through many mechanisms.

# Local Variables Affecting Fracture Healing

- | **Type of bone:** Cancellous (spongy) bone fractures are usually more stable, involve greater surface areas, and have a better blood supply than do cortical (compact) bone fractures. Cancellous bone heals faster than cortical bone.
- | **Degree of Trauma:** The more extensive the injury to bone and surrounding soft tissue, the poorer the outcome. Mild contusions with local bone trauma will heal easily, whereas severely comminuted injuries with extensive soft tissue damage heal poorly.

## Local Variables..cont

- | **Vascular Injury:** Inadequate blood supply impairs healing. Especially vulnerable areas are the femoral head, talus, and scaphoid bones.
- | **Degree of Immobilization:** The fracture site must be immobilized for vascular ingrowth and bone healing to occur. Repeated disruptions of repair tissue, especially to areas with marginal blood supply or heavy soft tissue damage, will impair healing.

# Local Variables..cont

- | **Intraarticular Fractures:** These fractures communicate with synovial fluid, which contains collagenases that retard bone healing. Joint movement will cause the fracture fragments to move, further impairing union. When intraarticular fractures are comminuted, the fragments tend to float apart owing to loss of soft tissue support.
- | **Separation of Bone Ends:** Normal apposition of fracture fragments is needed for union to occur. Inadequate reduction, excessive traction, or interposition of soft tissue will prevent healing.

## Local Variables..cont

- | **Infection:** Infections cause necrosis and oedema, take energy away from the healing process, and may increase the mobility of the fracture site.
- | **Local Pathology:** Any disease process that weakens the musculoskeletal tissue, like osteoporosis or osteomalacia, may impair union.

Thank you

