Fractures and Healing of fractures.

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Learning objectives

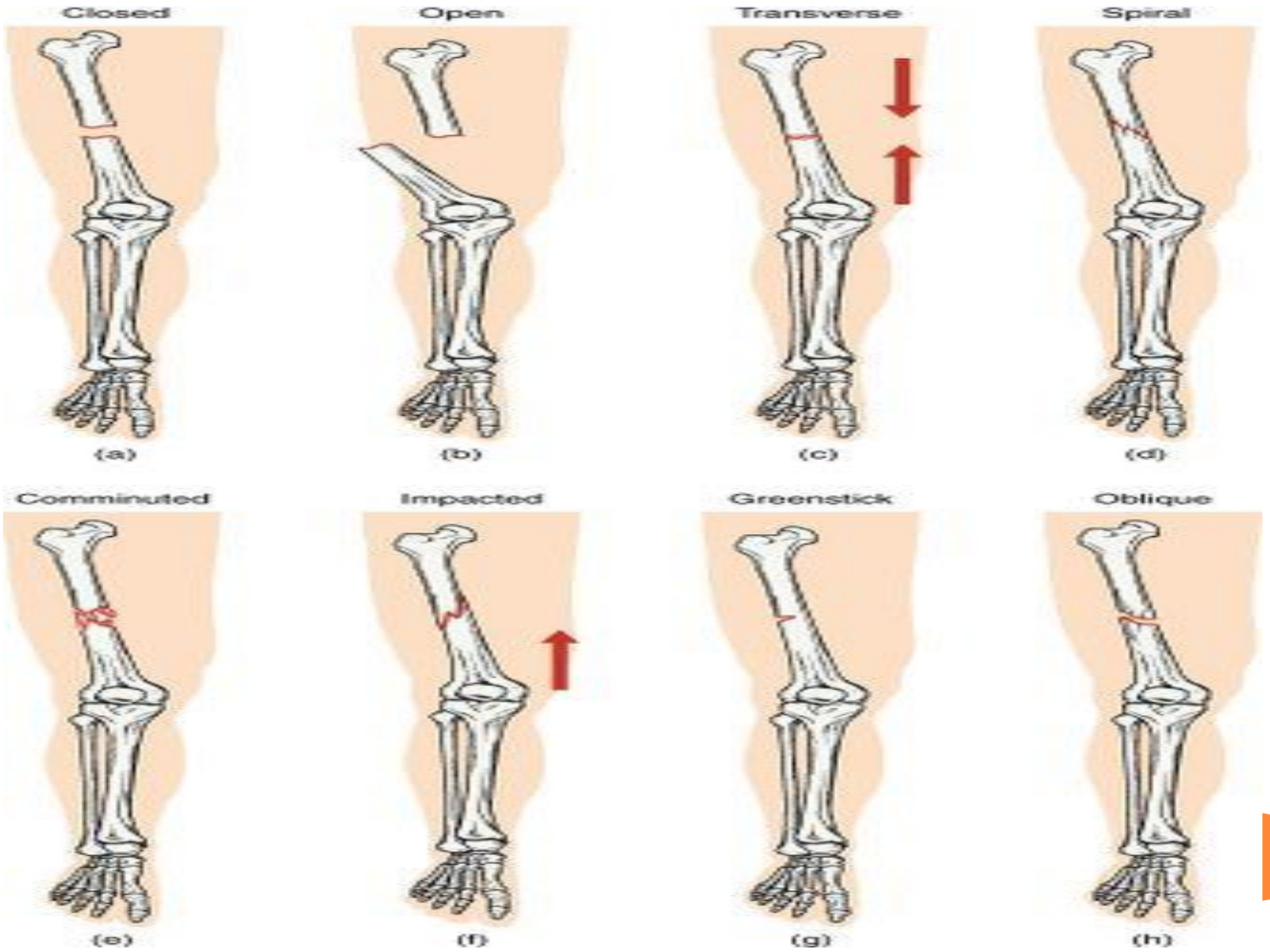
- Classify fractures and describe healing process in fractures.
- Enlist etiology of osteonecrosis.
- Describe clinical features and morphological findings in osteonecrosis.

Definition

- A fracture is defined as loss of bone integrity due to mechanical injury and/ or diminished bone strength

Classification of Fractures

- **Simple**: the overlying skin is intact.
- **Compound**: the bone communicates with the skin surface.
- **Comminuted**: the bone is fragmented.
- **Displaced:** the ends of the bone at the fracture site are not aligned.
- **Stress**: a slowly developing fracture that follows a period of increased physical activity in which the bone is subjected to repetitive loads
- "**Greenstick":** extending only partially through the bone, common in infants when bones are soft
- **Pathologic**: involving bone weakened by an underlying disease process, such as a tumor


Closed
Open
Transverse
Spiral
(a)
(b)
(c)
(d)
Comminuted
Impacted
Greenstick
Oblique
(e)
(f)
(g)
(h)

Healing of Fractures

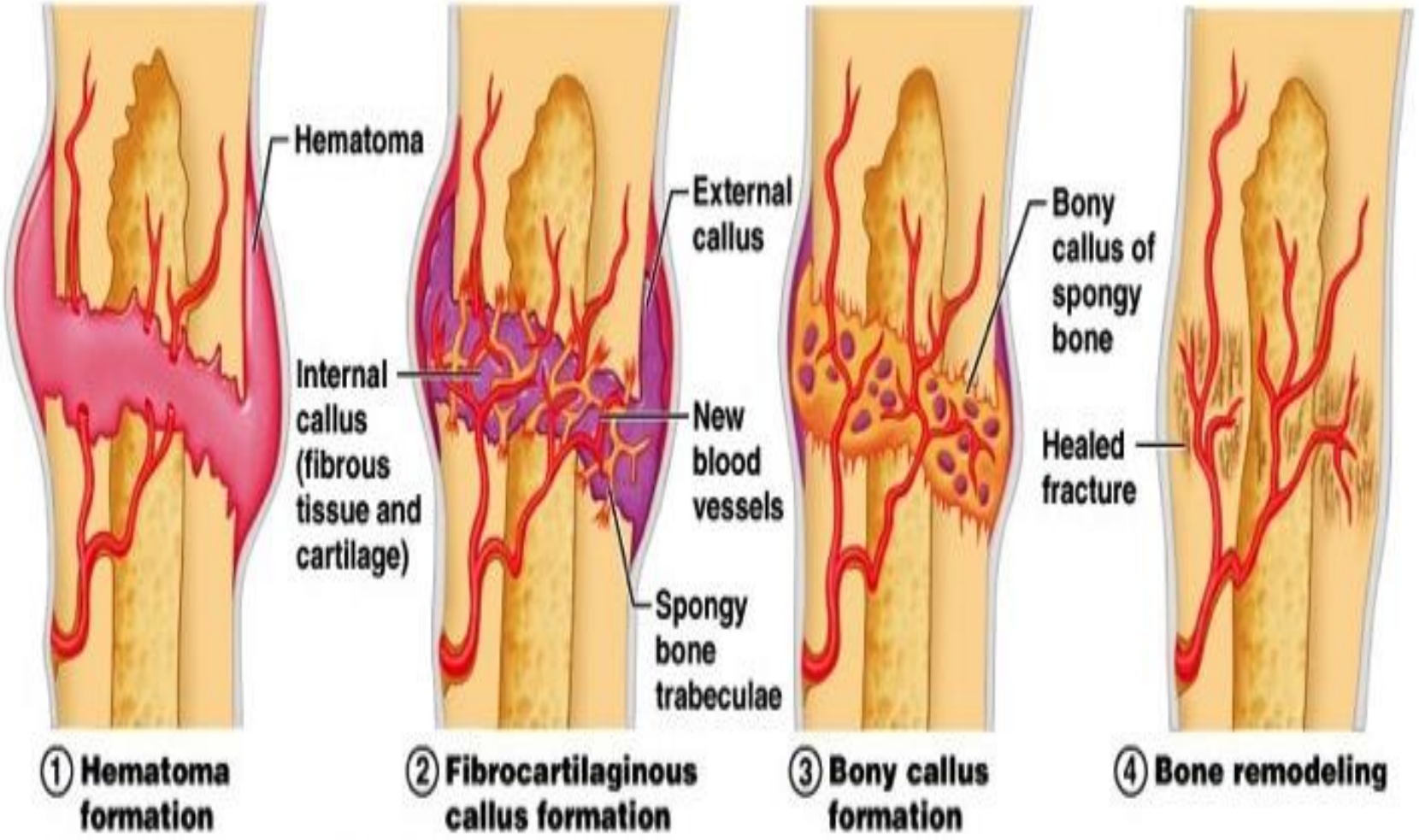
Immediately after fracture, rupture of blood vessels → a hematoma, It fills the fracture gap and surrounds the area of bone injury. The clotted blood → fibrin mesh, → sealing off the fracture site and creates a framework for the → influx of inflammatory cells and in growth of fibroblasts and new capillaries.

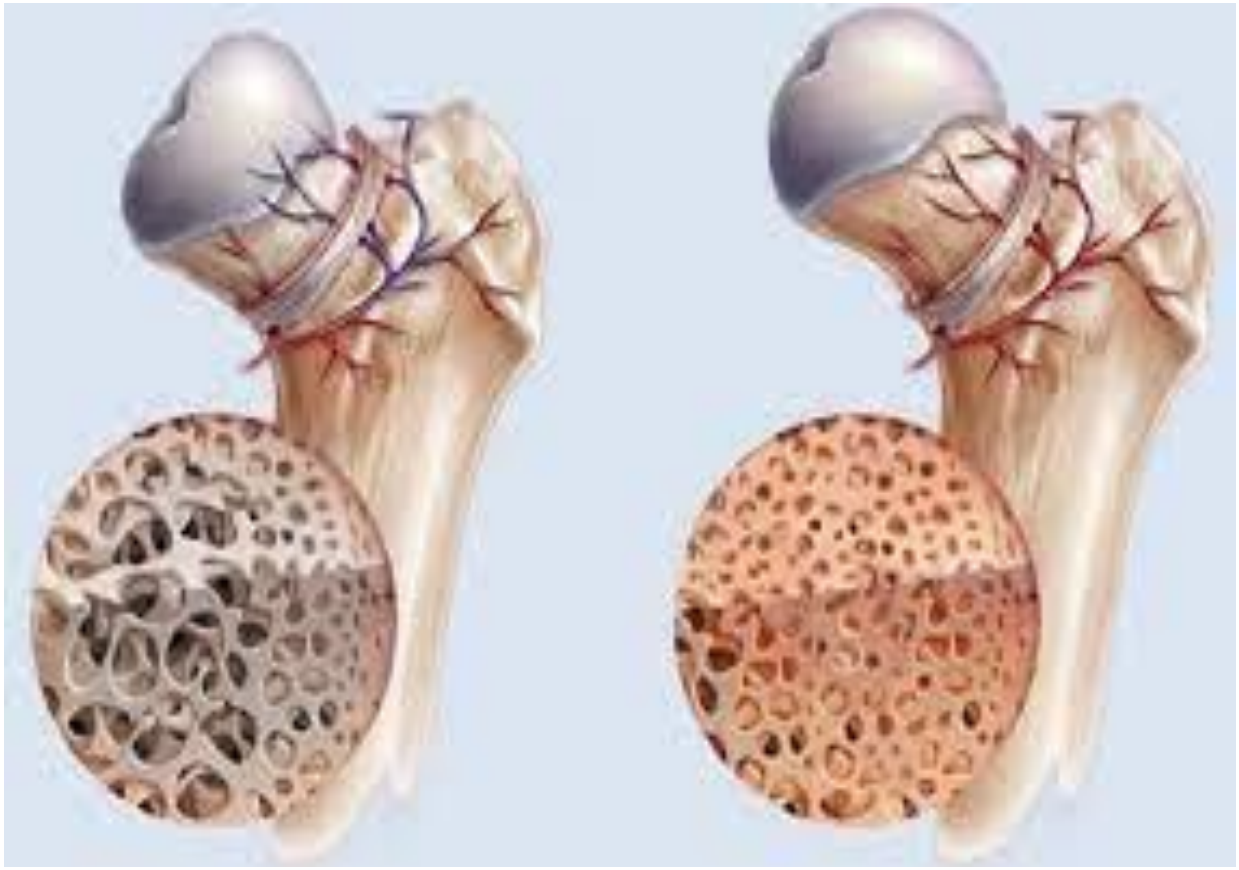
- PDGF, TGF-, FGF, and other factors, secreted by platelets and infalamatory cells activate → osteoprogenitor cells → osteoclastic and osteoblastic activity.
- By the end of the **first week**, the major changes are organization of the hematoma,
- matrix production in adjacent tissues,
- This fusiform and predominantly uncalcified tissue called soft tissue **callus or procallus-** provides some anchoring but not structural rigidity for weight bearing.

- **After 2 weeks**, callus is transformed into a bony callus. The activated osteoprogenitor cells deposit subperiosteal trabeculae of woven bone that are oriented perpendicular to the cortical axis and within the medullary cavity.
- The bony callus reaches its completion at the end of the second or third week and helps to stabilize the fracture site.

Newly formed cartilage along the fracture line undergoes **endochondral ossification**, forming a continuous network of bone with newly deposited bone trabeculae in medulla and beneath periosteum.

- With the pessage of time the callus is reduced in size by absorbtion of extra tissue restoring the shape and outline of the fractured bone as **lamellar bone**. The healing process is complete with restoration of the medullary cavity.


Hematoma
Internal callus (fibrous tissue and cartilage)
External callus
New blood vessels
Spongy bone trabeculae
Bony callus of spongy bone
Healed fracture
① Hematoma formation
② Fibrocartilaginous callus formation
③ Bony callus formation
④ Bone remodeling



Osteonecrosis

Definition

Reduced vascular supply to the bone resulting in progressive and painful degeneration of the bone is called osteonecrosis.

Epidemiology

- Incidence
  - typically occurs in the anterolateral femoral head
- Demographics
  - dependent on the cause of osteonecrosis
    - *e.g.*, systemic lupus erythematosus associated with osteonecrosis is more likely to be seen in women

Etiology

- **traumatic**
  - fractures
    - *e.g.,* femoral head, femur, and scaphoid bone
  - dislocation
    - *e.g.,* slipped capital femoral epiphysis
- **atraumatic**
  - idiopathic (Legg-Calve-Perthes disease)
  - alcohol use
  - corticosteroids
  - think of disorders that use corticosteroids such as
    - systemic lupus erythematosus
    - acute lymphoblastic leukemia
    - transplantation
  - Gaucher disease
  - sickle cell disease
  - bisphosphonate therapy
  - thromboembolism

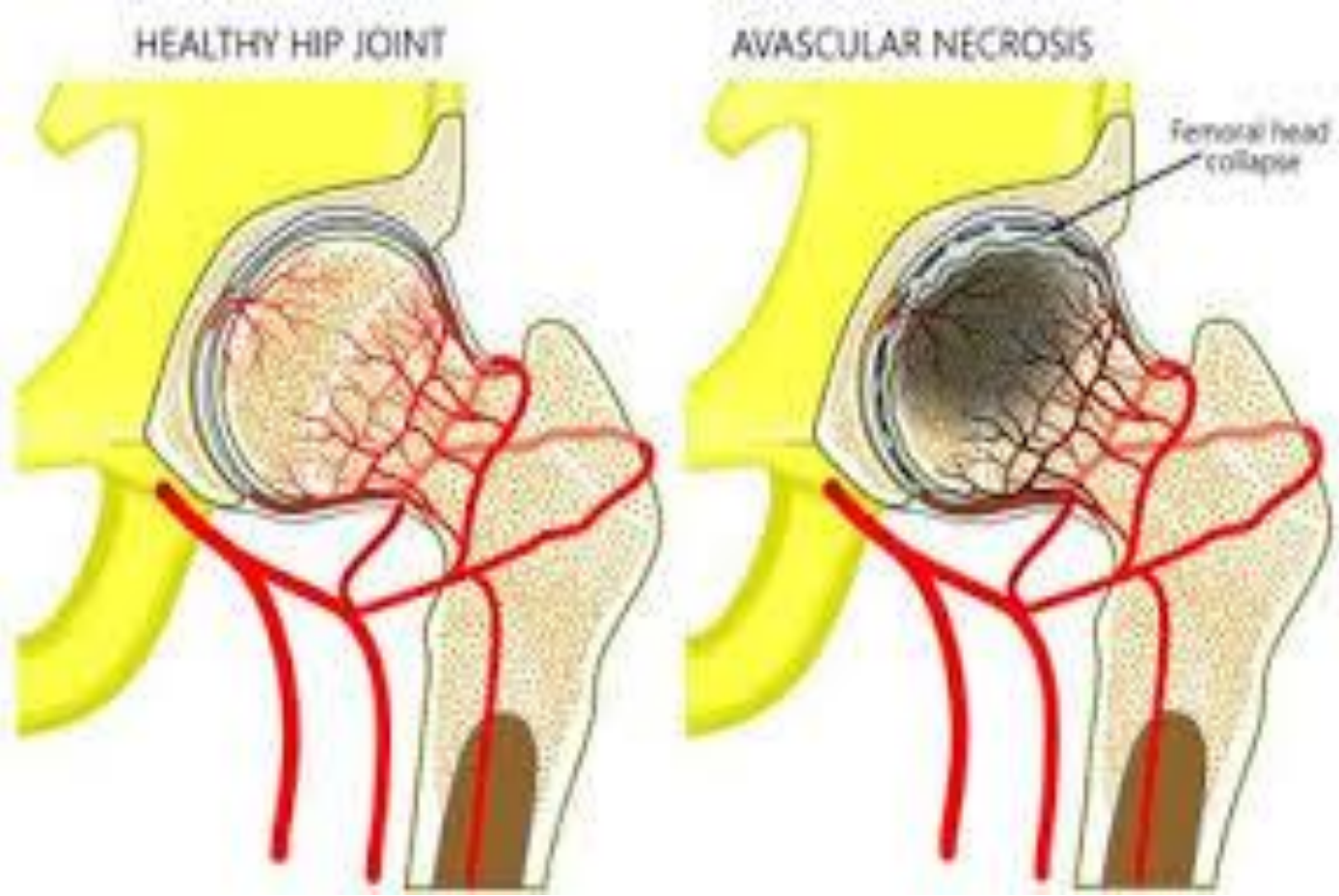
Pathogenesis

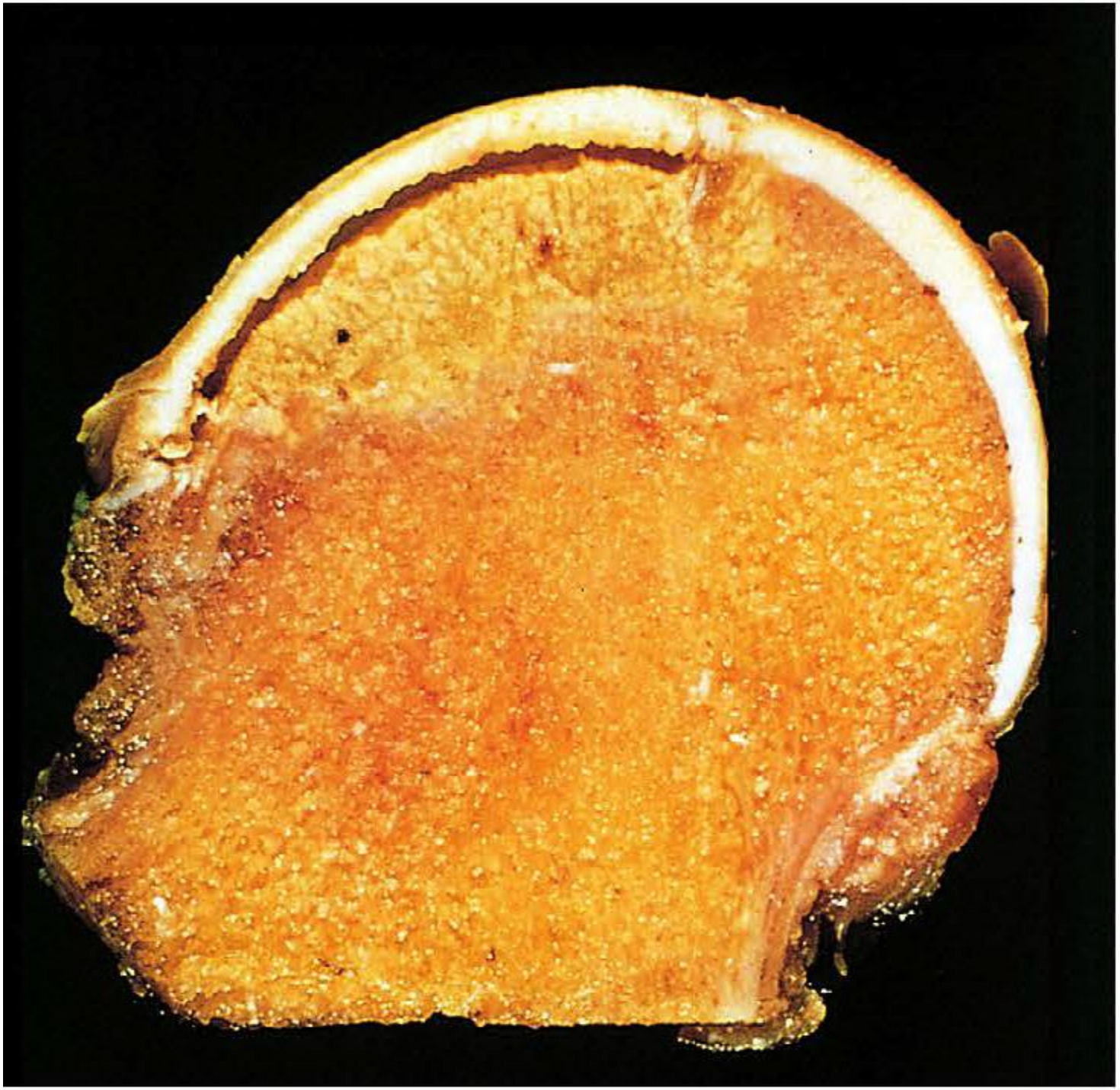
Impaired blood supply leads to infarction of the associated bone and bone marrow vascular insufficiency can result form

- mechanical blood vessel injury
- blood vessel compression
- venous occlusion

Morphology

Regardless of etiology, medullary infarcts effects the trabecular bone and marrow. The cortex is usually not affected because of its collateral blood flow. In subchondral infarcts, a triangular or wedge-shaped segment of tissue , undergoes necrosis. The overlying articular cartilage remains viable, as it can access nutrients that are present in synovial fluid. Microscopically, dead bone is recognized by empty lacunae surrounded by necrotic adipocytes that frequently rupture. The released fatty acids bind calcium and form insoluble calcium soaps that may persist for life. In the healing response, osteoclasts resorb the necrotic trabeculae. Trabeculae that remain act as scaffolding for the deposition of new bone in a process known as creeping substitution .In subchondral infarcts the pace of this substitution is too slow to be effective, so there is collapse of the necrotic bone and distortion, fracture, and even sloughing of the articular cartilage.


HEALTHY HIP JOINT
AVASCULAR NECROSIS
Femoral head collapse



Clinical course

- asymptomatic
  - seen in a small portion of patients
- pain
  - groin pain suggests osteonecrosis of the femoral head
    - thigh and buttock pain is also suggestive
  - pain in weight bearing joints
  - pain can occur at rest and at night
- Subchondral infarcts often collapse and may lead to severe,secondary osteoarthritis

thanks