The Lower Extremity: Femoral Neck Fractures Fractures

a quick-hit lecture series based on content from...

Orthopaedic Surgery Clerkship: A Quick Reference Guide for Senior Medical Students
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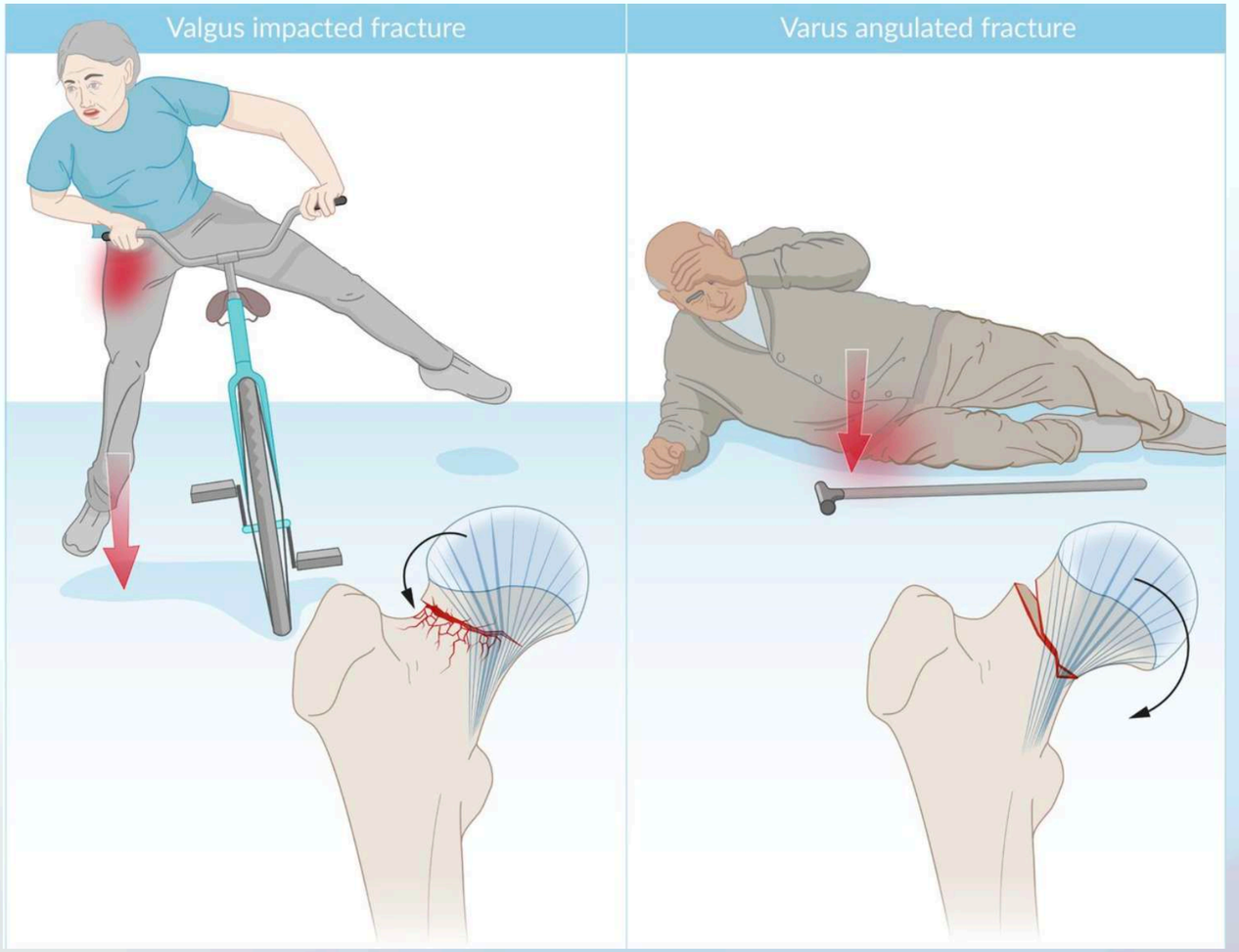
presented by Underground Ortho

Epidemiology & Etiology

- Common, increasing incidence due to aging population
- Overall mortality rate 25% at 1yr and loss of independence in 50%
- **Risk factors** include:
  - Female gender
  - Increasing age
  - Low estrogen levels
  - Prior/frequent falls
  - Prior fractures
  - Tobacco and alcohol use
- Bimodal distribution
  - Majority low-energy falls in elderly
  - Minority high-energy mechansm in youth



- 6-9% of femoral shaft fractures assoc/w femoral neck fractures, neck treated before shaft

Histology

- Periosteum surrounds all bone cortex except at sites (known as entheses) of ligament and tendon attachment, and for portions which are intra-articular, the latter instead covered by cartiliage or synovial membrane. Periosteum will thus overlie metaphysis + diaphysis, but not epiphysis.

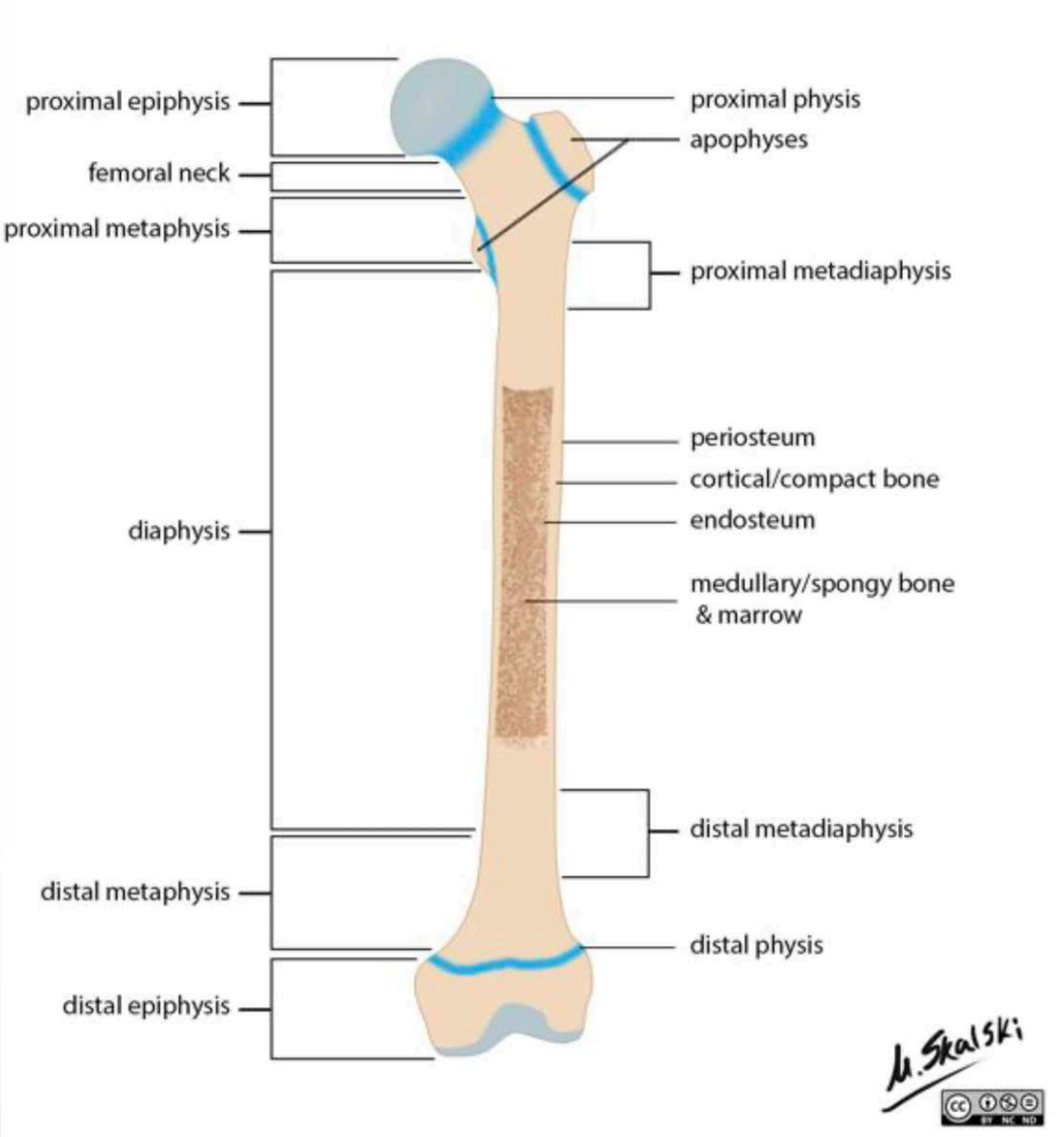
- Periosteum consists of two layers:

  - Outer fibrous membrane, subdivided into superficial vascular and deep fibro-elastic layers

  - Inner cellular (or inner cambium) layer, osteogenic and richly vascular

- Femoral head + neck are intracapsular structures, thus lack periosteal layer

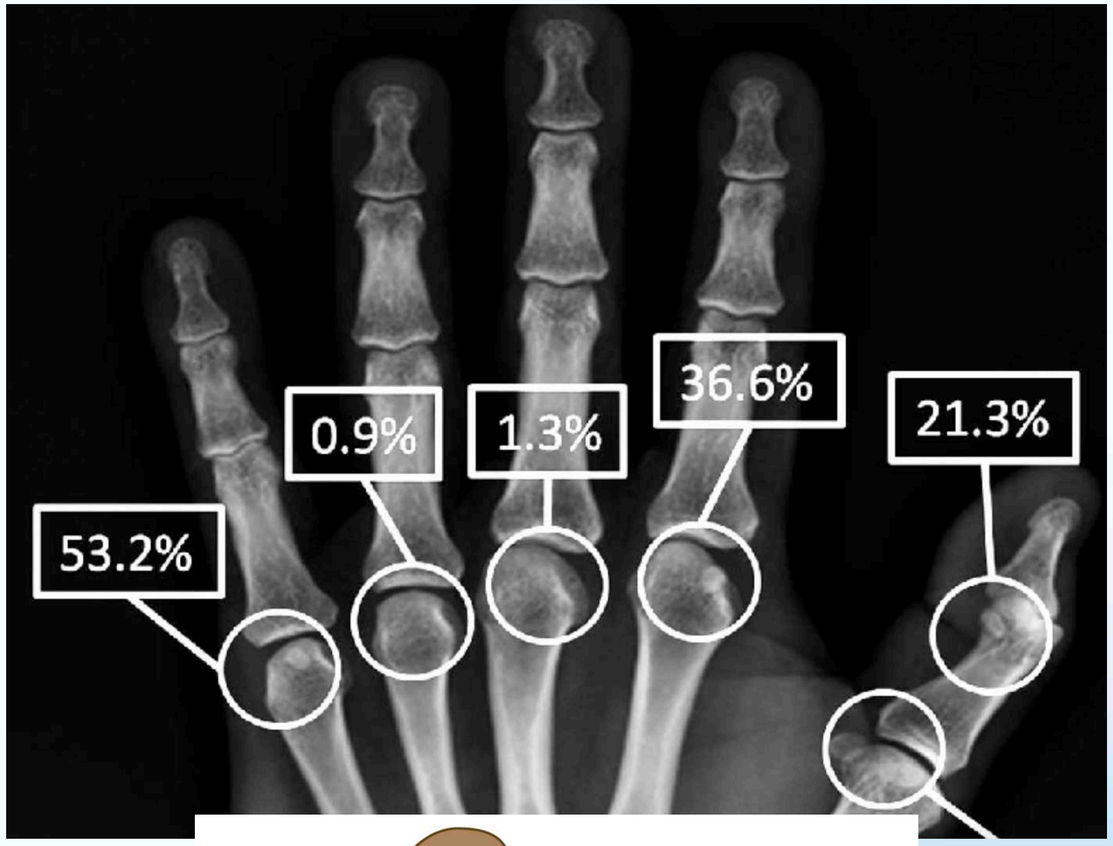
- Thus, callus formation sp femoral neck fracture is limited, relying solely on endosteal bone formation, affecting healing

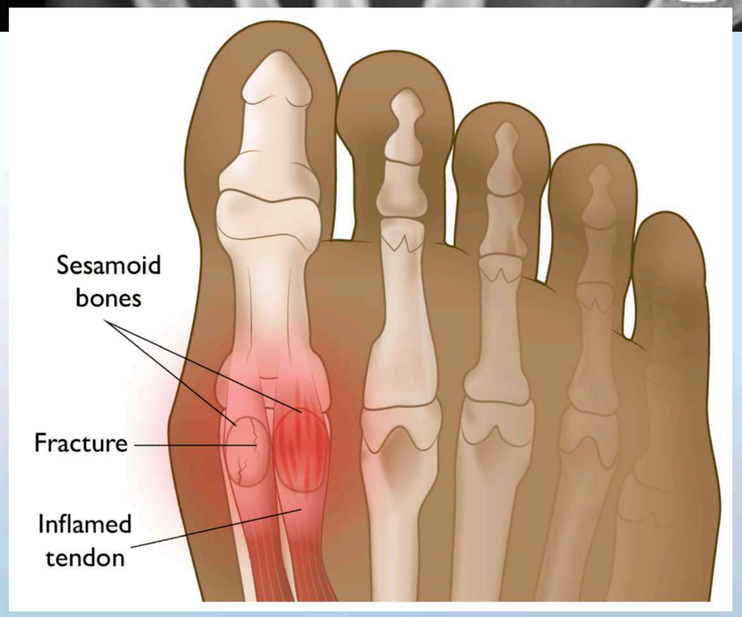


Aside

Sesamoid bones

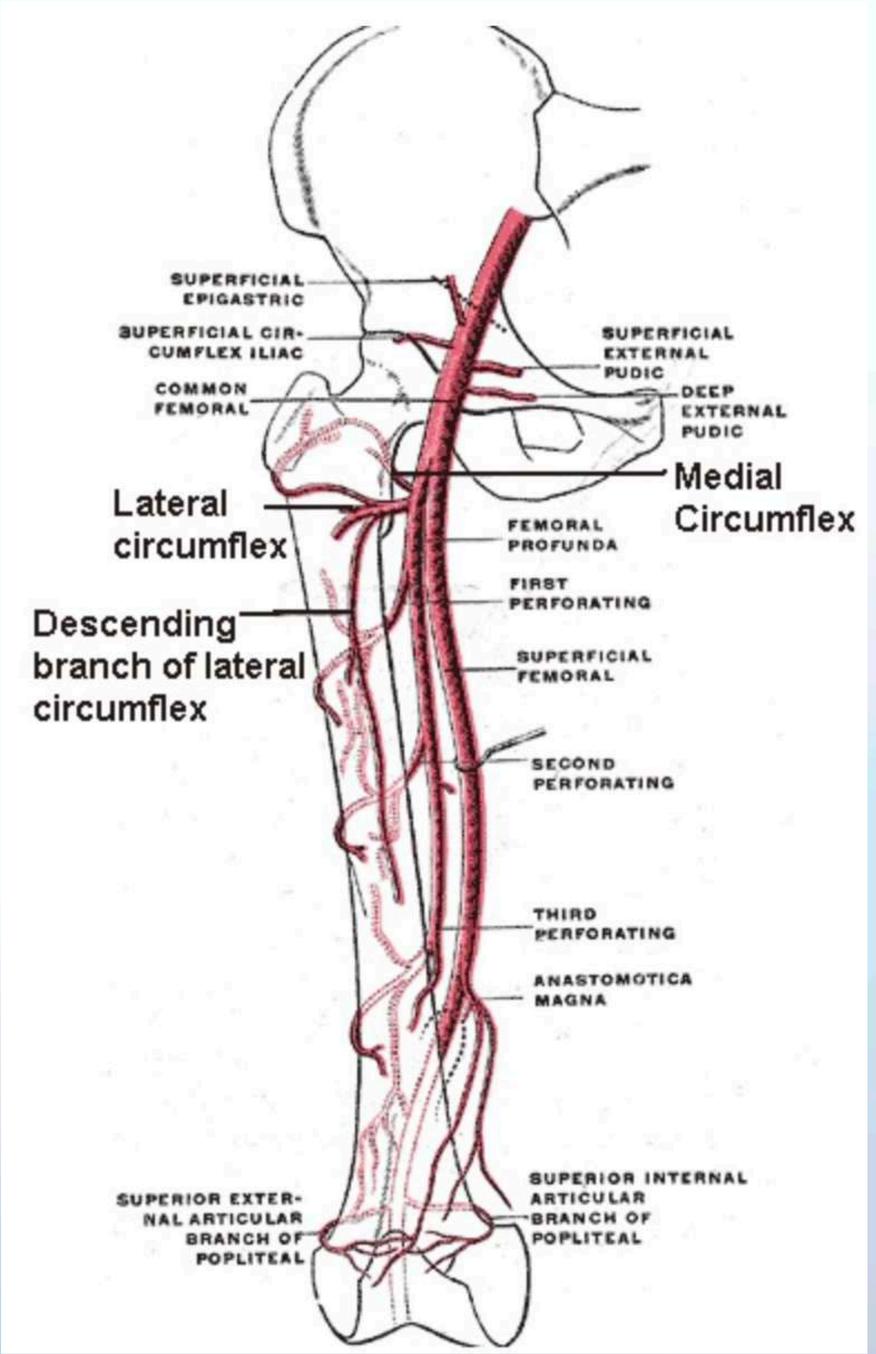
- Periosteum is a medium for attachment of muscles, tendons and ligaments to bone
- Mature periosteum is present in long and flat bones, although absent in vertebrae, carpal and tarsal bones, including sesamoid bones. The patella is the largest sesamoid.
- Sesamoid bones are small focal areas of ossification commonly found embedded within muscle or tendon near joint surfaces functioning as a pulley to alleviate stress on the respective muscle or tendon
- Largely they do not articulate with other bones
- Sesamoiditis or sesamoid fractures have lengthy recovery times, with multiple weeks or months of wearing a cast + NWB on the affected foot

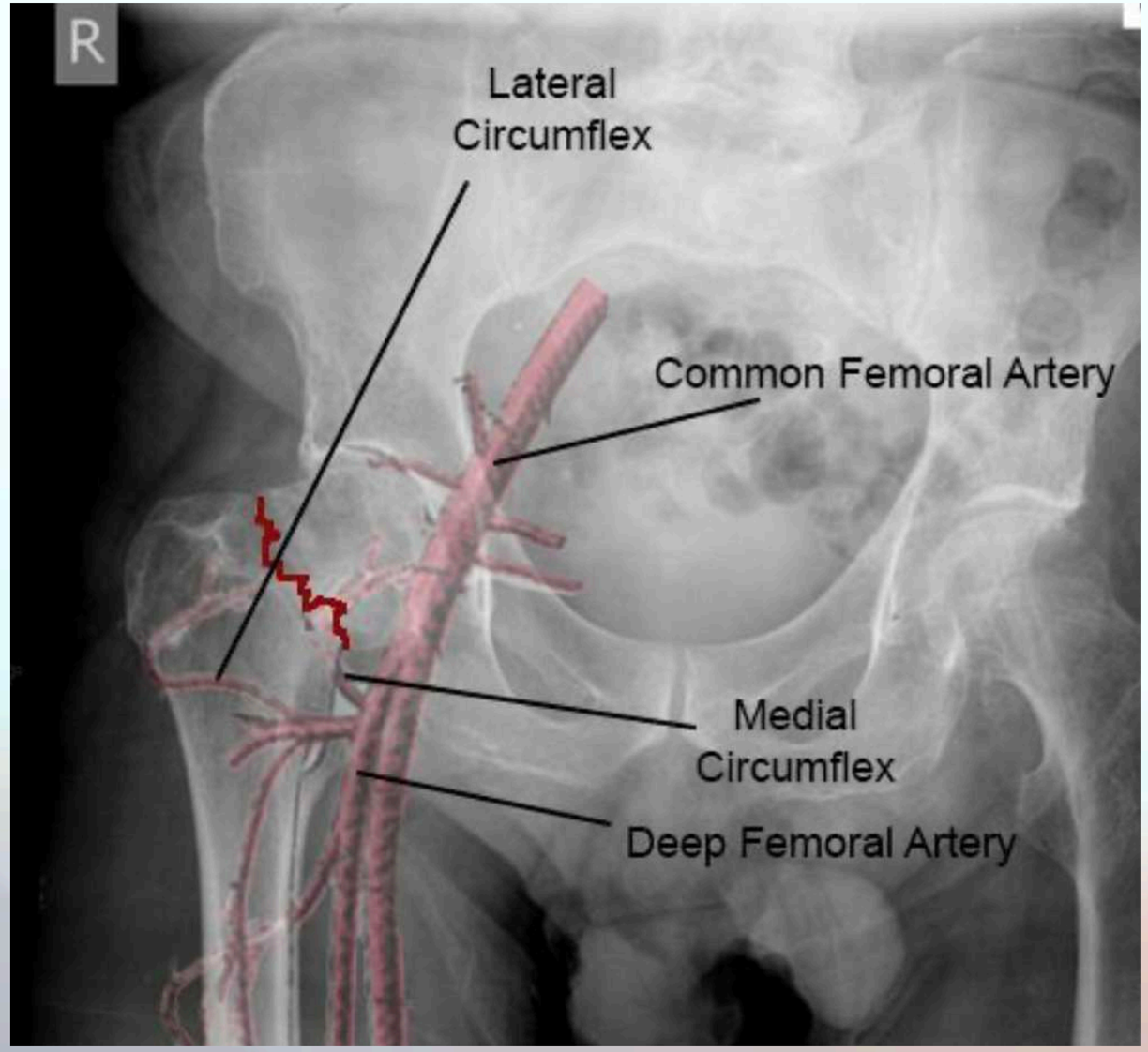


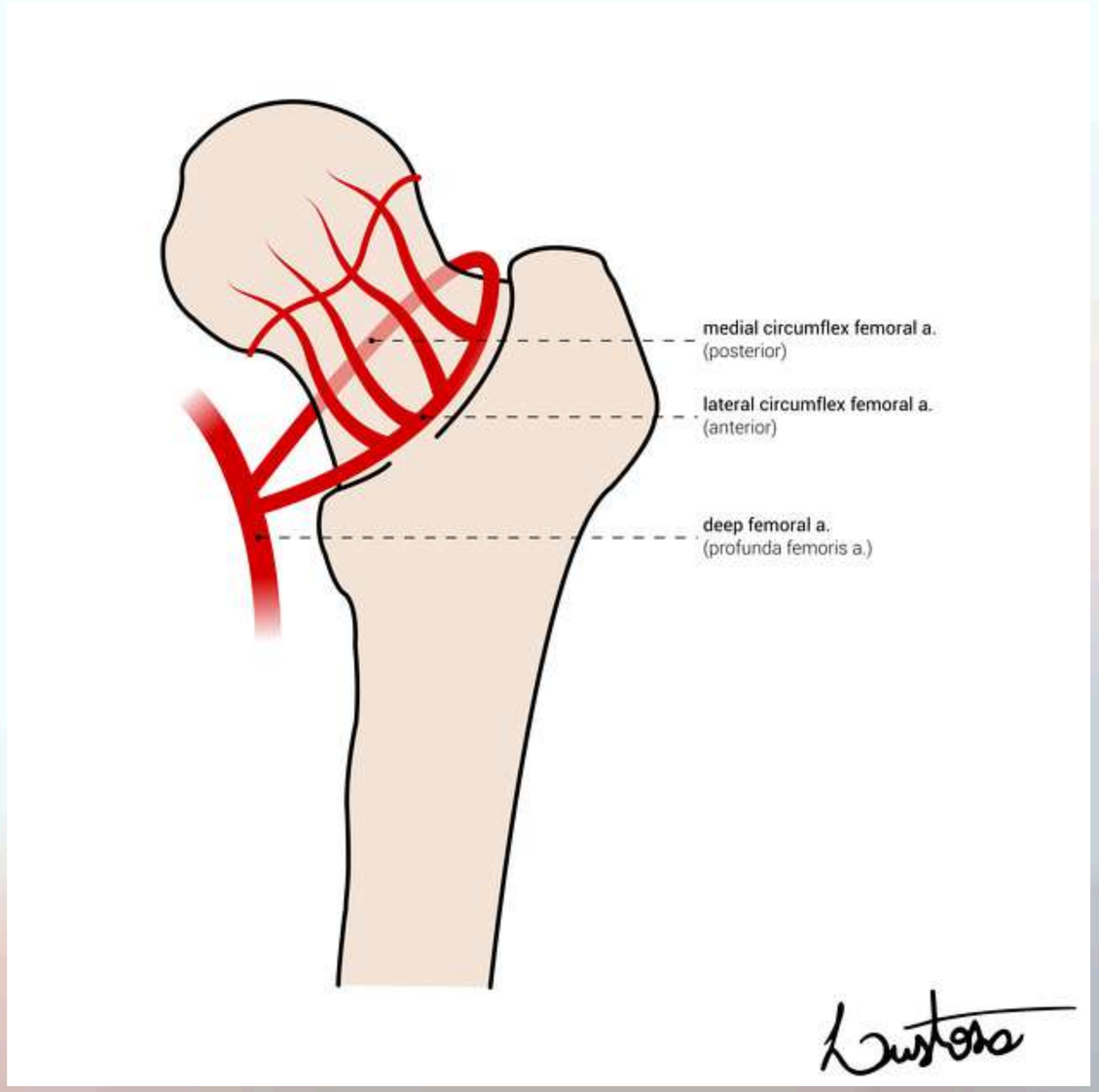


Anatomy

- Normal neck-shaft angle 130 +/- 7 degrees
- Normal neck anteversion relative to shaft 10 +/- 7 degrees
- **Blood supply** to femoral head:
  - Major contribution from (lateral epiphyseal branch of) medial femoral circumflex artery + (ascending branch of) lateral femoral circumflex artery
    - Common iliac —> external iliac —> femoral —> profunda femoris (or deep femoral)
    - Capsular vessels, penetrate capsule and supply femoral head as retinacular arteries
    - Circumflex arteries anastomose at base of femoral neck
    - Tenuous vasculature, vulnerable to AVN + intracapsular hematoma
  - Minor contribution from inferior gluteal arteries
  - Negligible contribution from foveal artery through ligamentum teres, commonly disrupted w/dislocations, main blood supply to femoral head in children




R
Lateral
Circumflex
Common Femoral Artery
Medial
Circumflex
Deep Femoral Artery


medial circumflex femoral a.
(posterior)
lateral circumflex femoral a.
(anterior)
deep femoral a.
(profunda femoris a.)

A 25-year-old man sustains the fracture seen in Figure A and is seen in pre-op holding prior to surgery. What position of his lower extremity would result in the lowest intracapsular hip pressure?

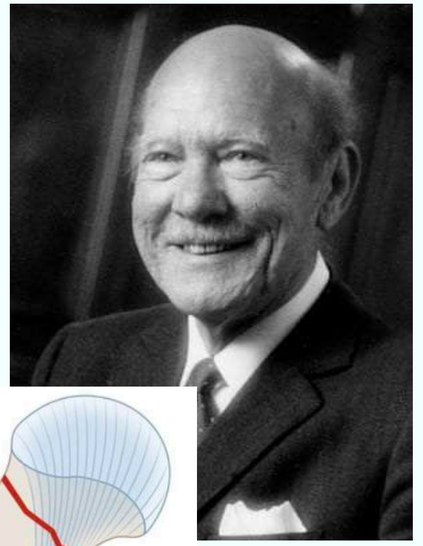
1. Neutral rotation and flexion
2. External rotation and flexion
3. Internal rotation and extension
4. External rotation and extension
5. Internal rotation and flexion

The femoral neck fracture seen in Figure A is considered by most to be a surgical emergency in a 25-year old due to the at risk blood supply of the femoral head. Due to the intra-capsular hematoma and hemarthrosis that occurs, the involved extremity is often found to be in external rotation and flexion as the intra-capsular volume is the highest in this position. Debate exists of the significance of the pressure caused by the fracture hemarthrosis as it is believed by some to cause a local compartment syndrome adding further insult to the already tenuous blood supply. Advocates of early fixation have proposed that reduction maneuvers without capsulotomy can compromise the circulation of the femoral head by increasing the hip joint pressure. Maruenda et al showed in their study of 34 consecutive patients with femoral neck fractures that the mean intracapsular pressure was the highest with the hip in extension and internal rotation.

Bonnaire et al in their prospective study of 55 patients with intracapsular femoral neck fractures found the lowest pressure to be at 70 degrees of flexion. Both Maruenda and Bonnaire's studies showed no significant intracapsular pressure difference based on fracture displacement.

Corollary to adult fracture patients, it is also noted that pediatric patients with a septic hip hold their hip in a flexed and externally rotated position to maximize intracapsular volume as shown in Illustration A.

Classification



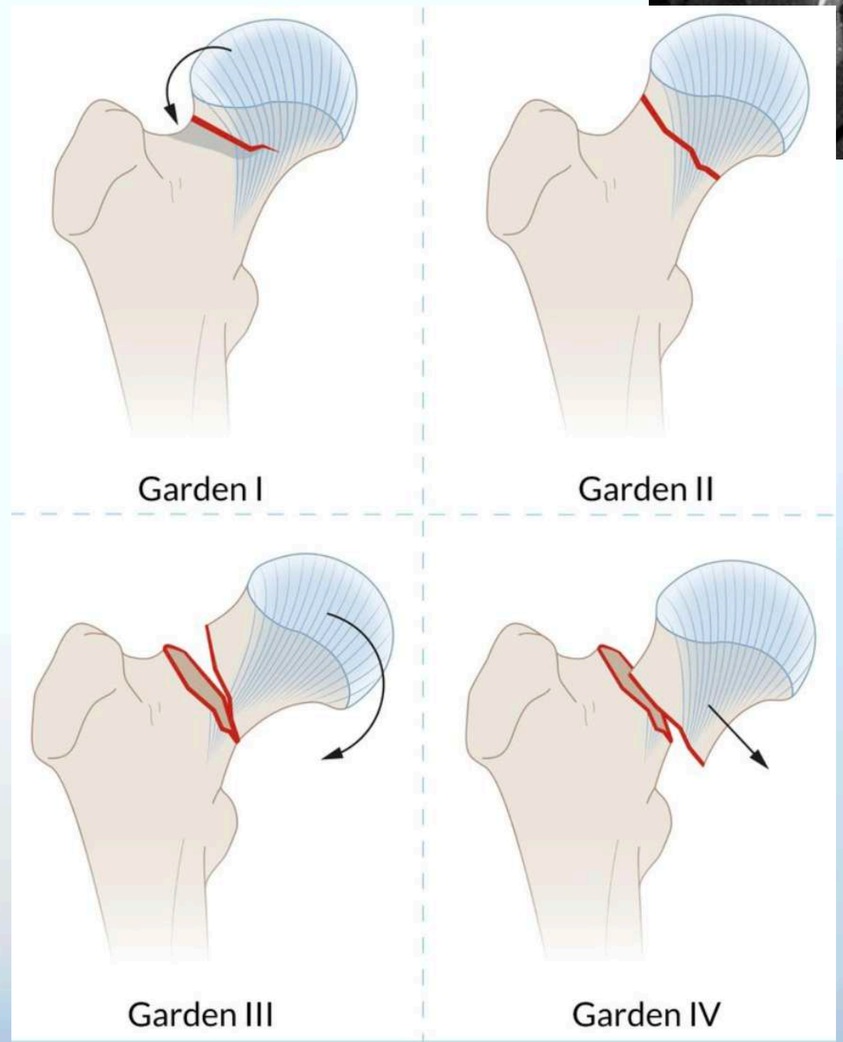
- Robert Garden, Scottish orthopaedic surgeon (1961)
- Garden classification describes fracture completeness and displacement, and relationship to bony trabeculae in femoral head and neck
- Utility in low-energy fragility-type fractures, cf Pauwel classification in high-energy fractures

Garden Classification (based on AP radiographs and does not consider lateral or sagittal plane alignment)	
Type I	Incomplete fx (valgus impacted)
Type II	Complete fx, nondisplaced
Type III	Complete fx, partially displaced
Type IV	Complete fx, fully displaced

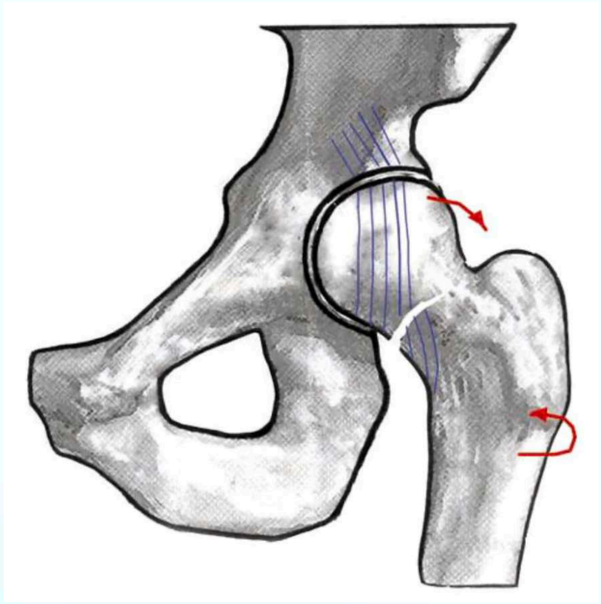
The **Garden classification** of subcapital femoral neck fractures is the most widely used. It is simple and predicts the development of osteonecrosis [1,2]. Garden described particular femoral neck and acetabular trabeculae patterns which can assist in recognizing differences within this classification system [2].

- **Garden stage I:** undisplaced incomplete, including valgus impacted fractures
  - medial group of femoral neck trabeculae may demonstrate a greenstick fracture
- **Garden stage II:** undisplaced complete
  - no disturbance of the medial trabeculae
- **Garden stage III:** complete fracture, incompletely displaced
  - femoral head tilts into a varus position causing its medial trabeculae to be out of line with the pelvic trabeculae
- **Garden stage IV:** complete fracture, completely displaced
  - femoral head aligned normally in the acetabulum and its medial trabeculae are in line with the pelvic trabeculae

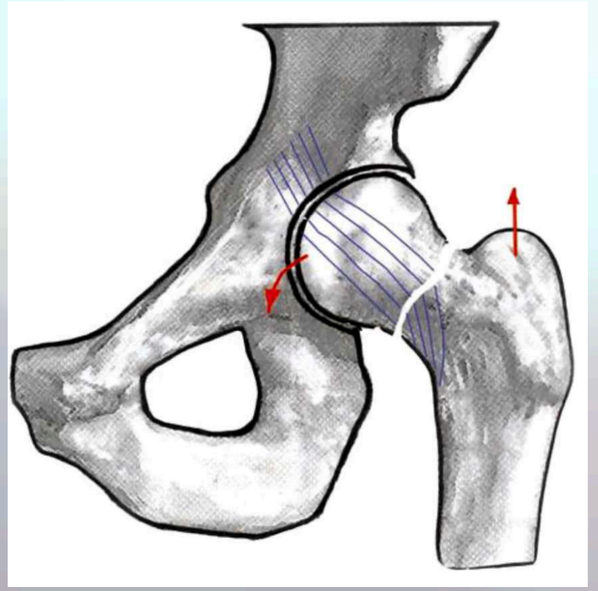
In general, stage I and II are stable fractures and can be treated with internal fixation (head-preservation), and stage III and IV are unstable fractures and hence treated with arthroplasty (either hemi- or total arthroplasty) [3].



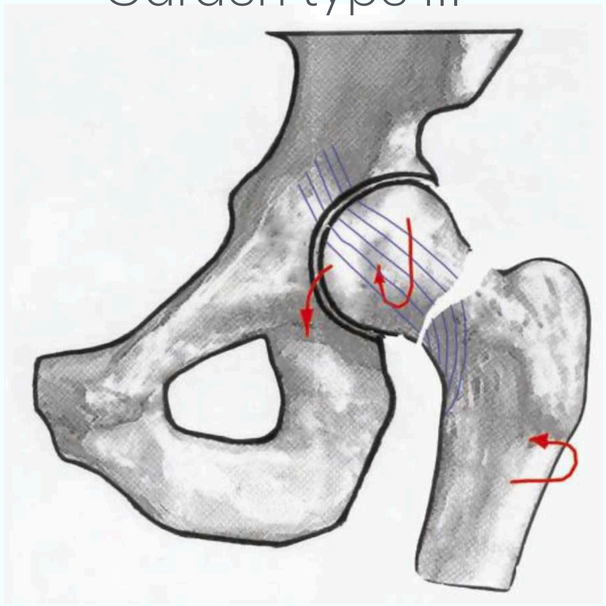
Garden type I



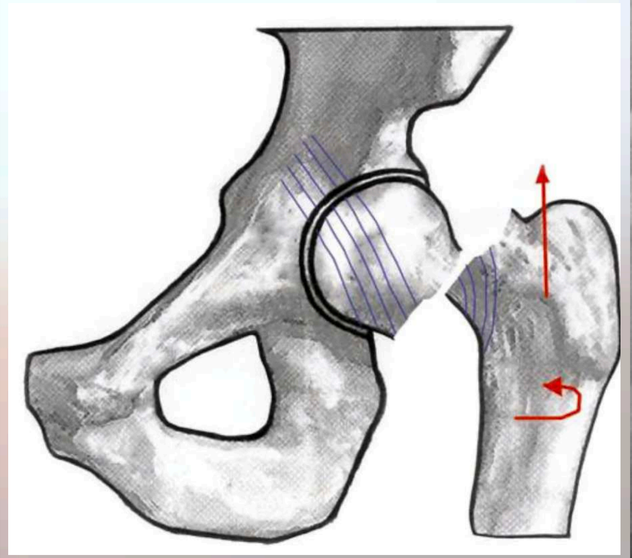
Garden type II



Garden type III



Garden type IV



Presentation

- Impacted and stress fractures (ie non-displaced, Garden type I + II)
  - Pain in groin or referred along medial side of thigh/ knee
  - No obvious clinical deformity
  - Minimal bruising (fracture is intracapsular)
- Displaced, Garden type III + IV
  - Pain in entire hip region
  - Lower extremity in external rotation, abduction and flexion, with shortening
  - Minimal bruising