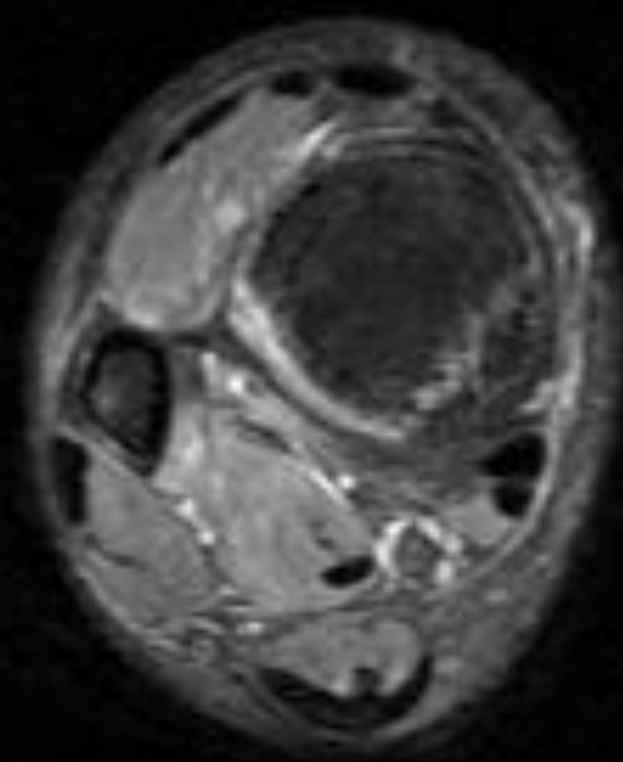
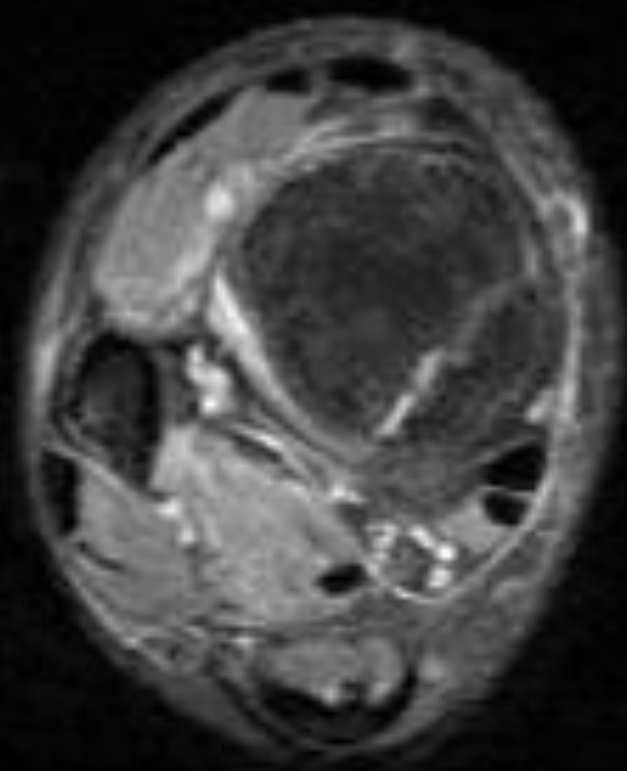
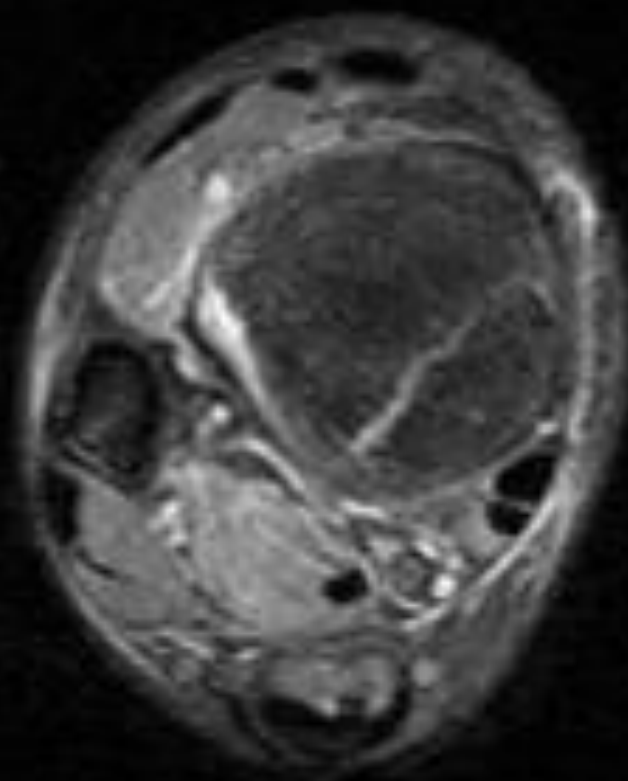


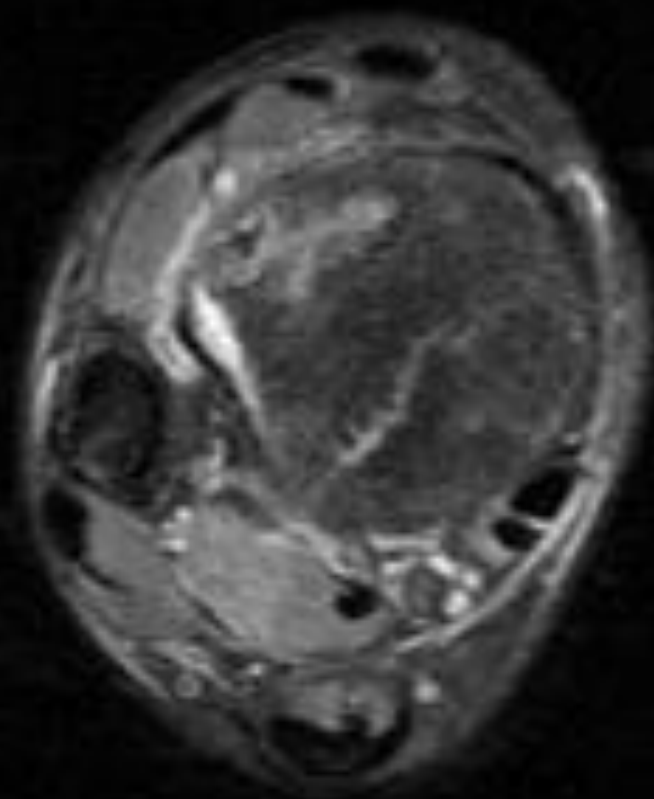


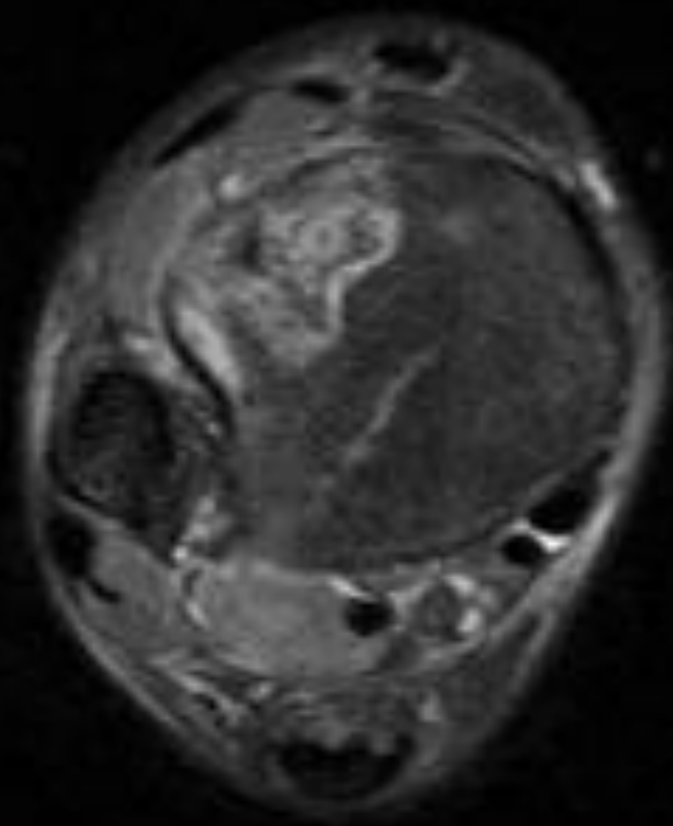
14 yo male s/p ankle fracture 4 weeks ago with increased pain

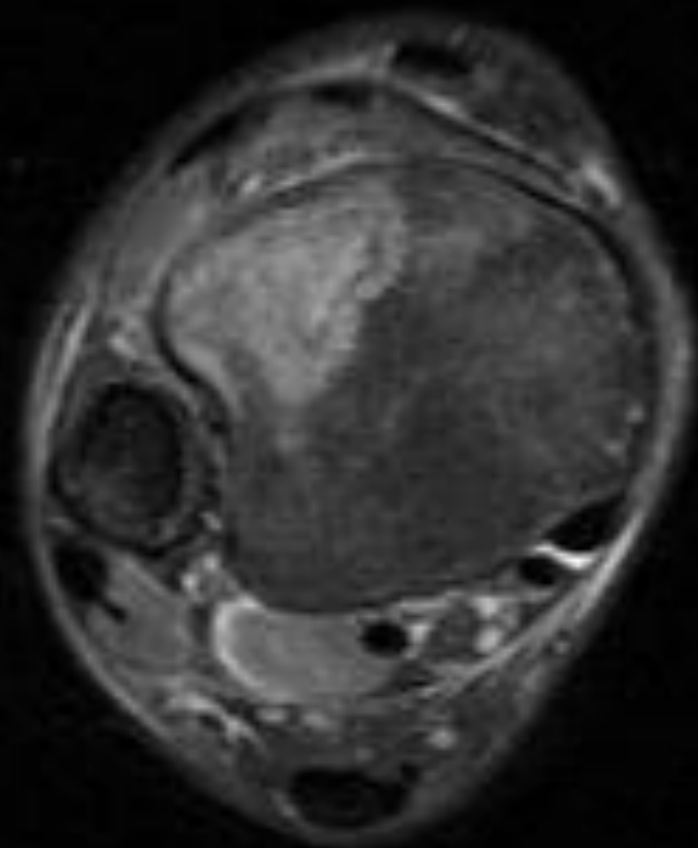


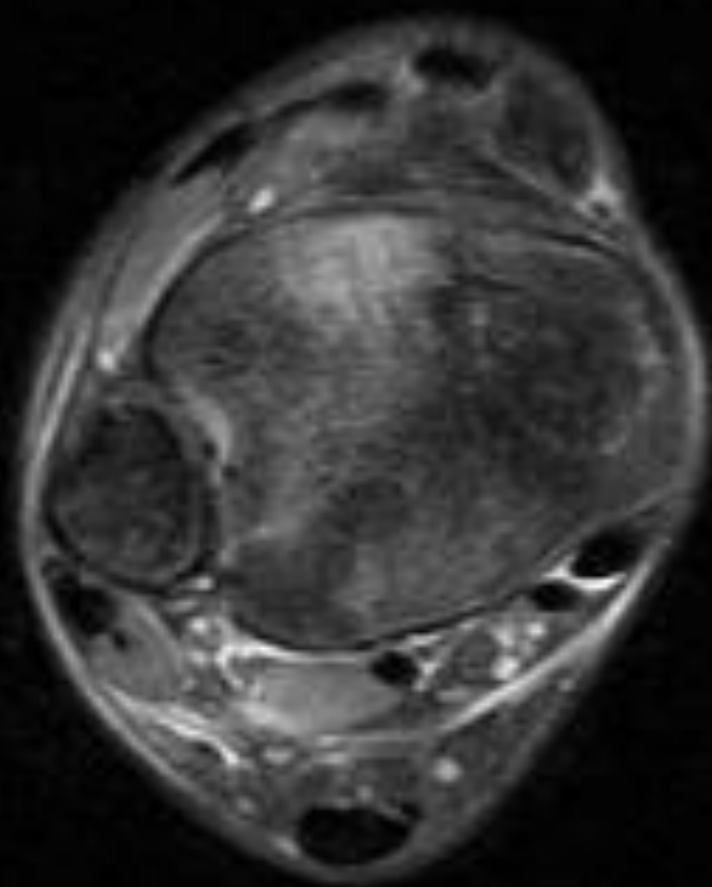




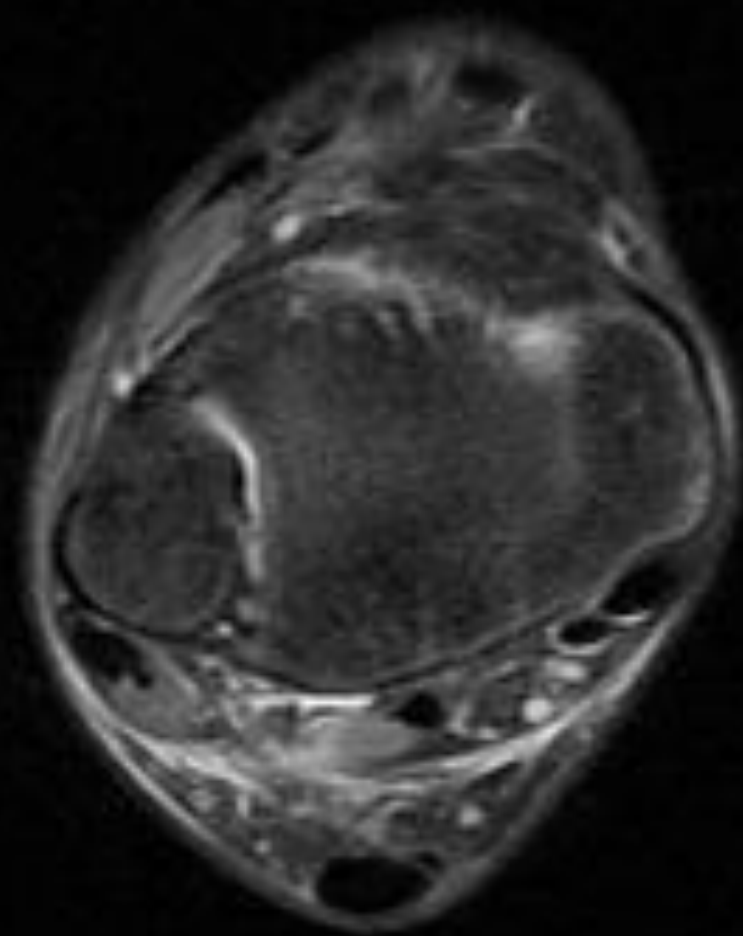


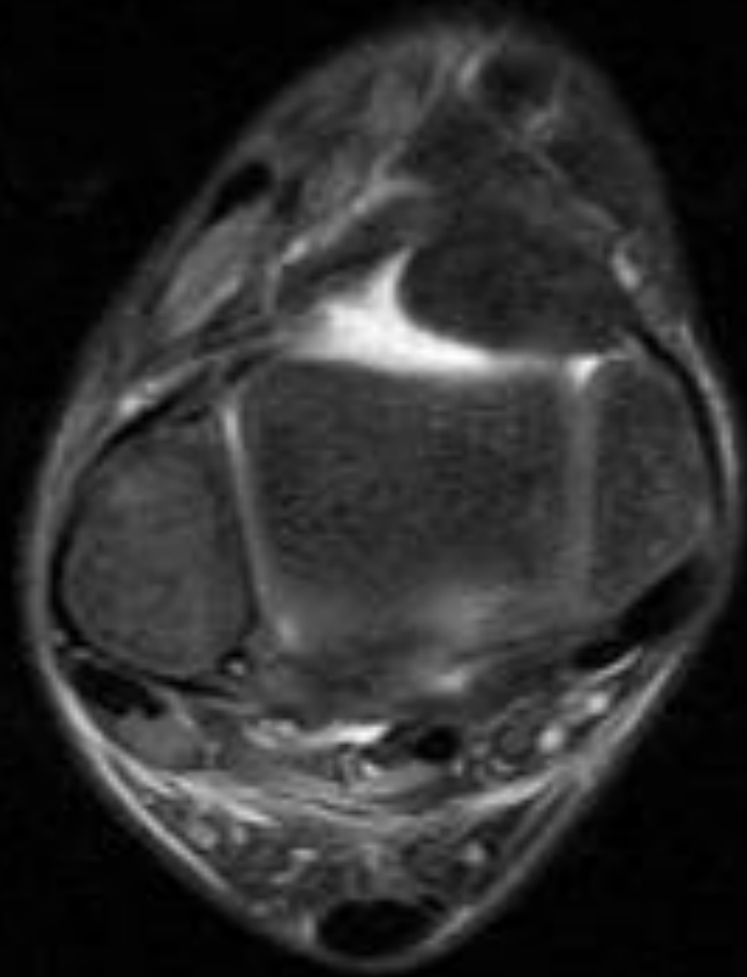


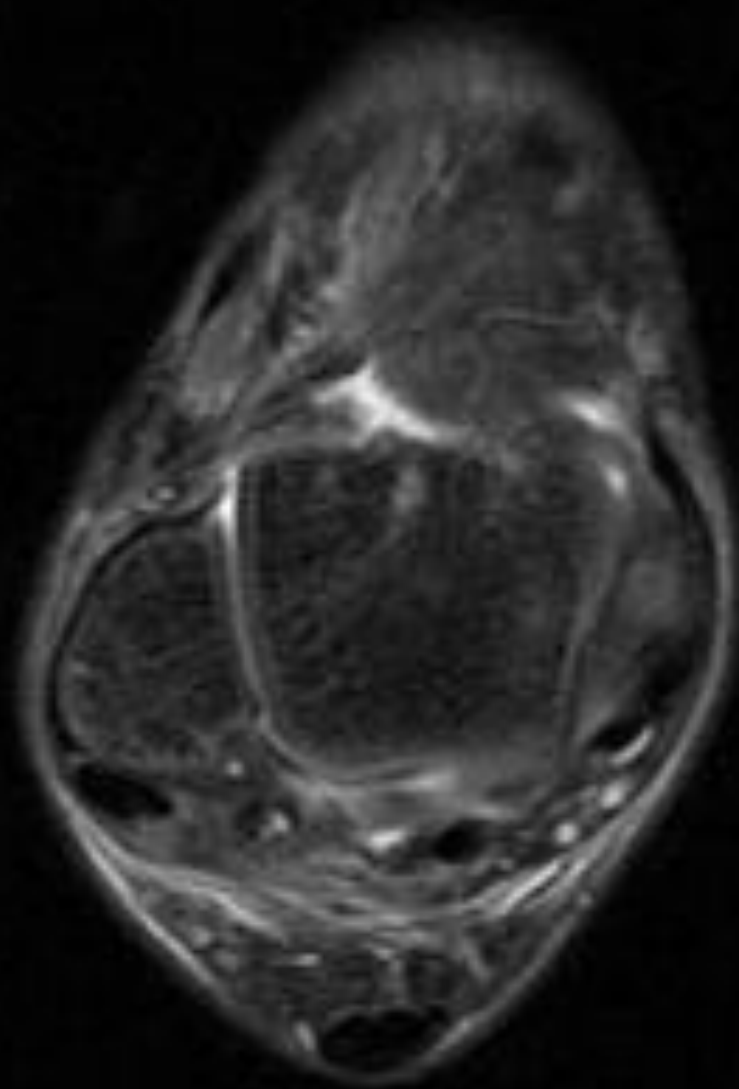


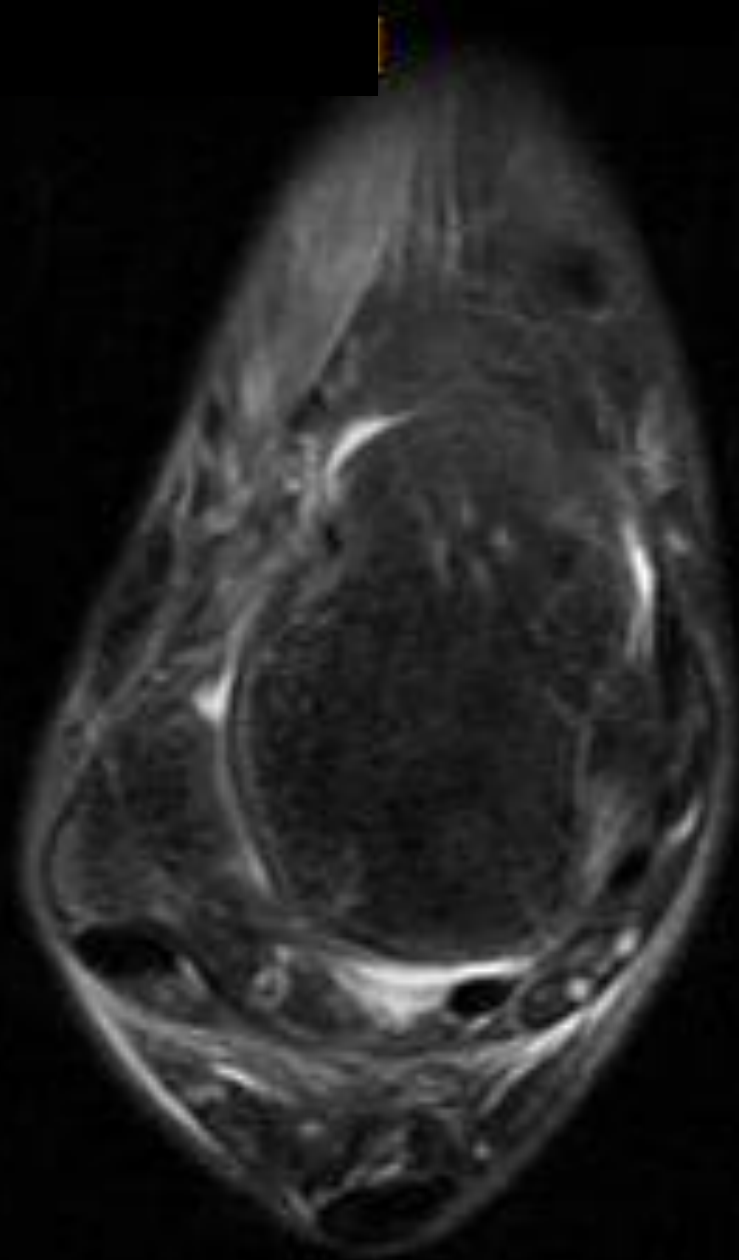


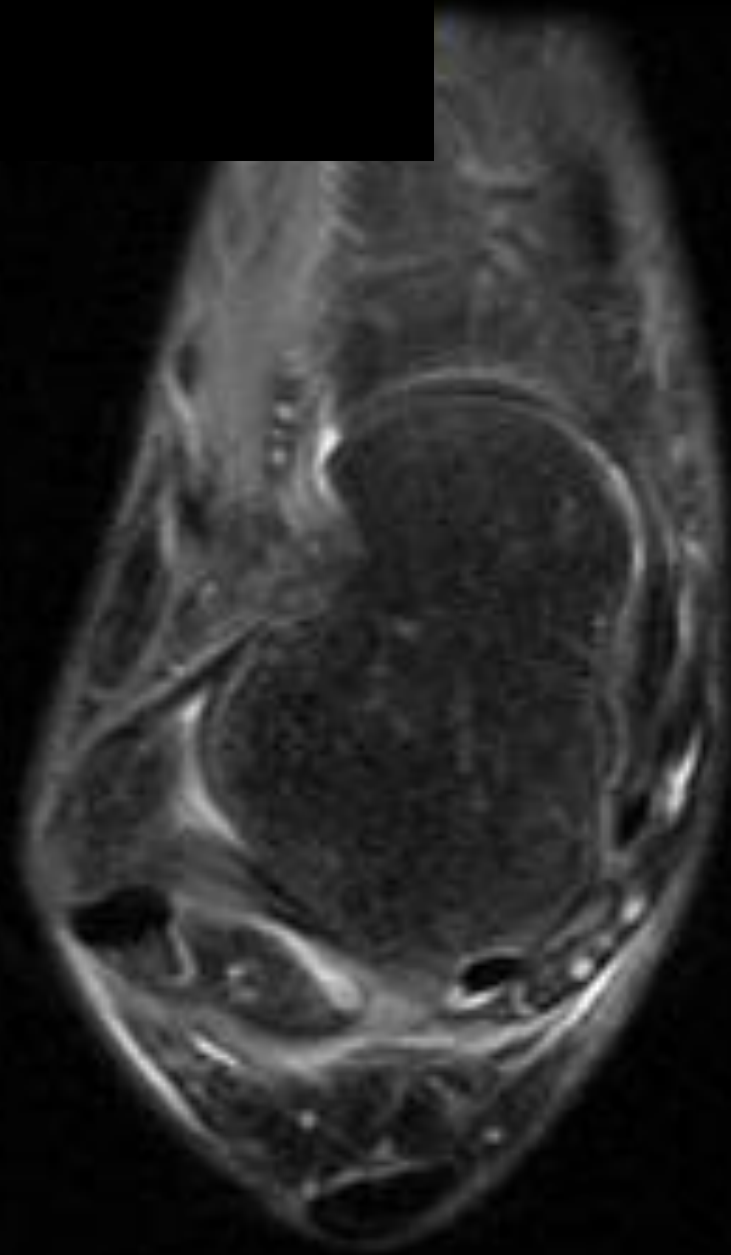












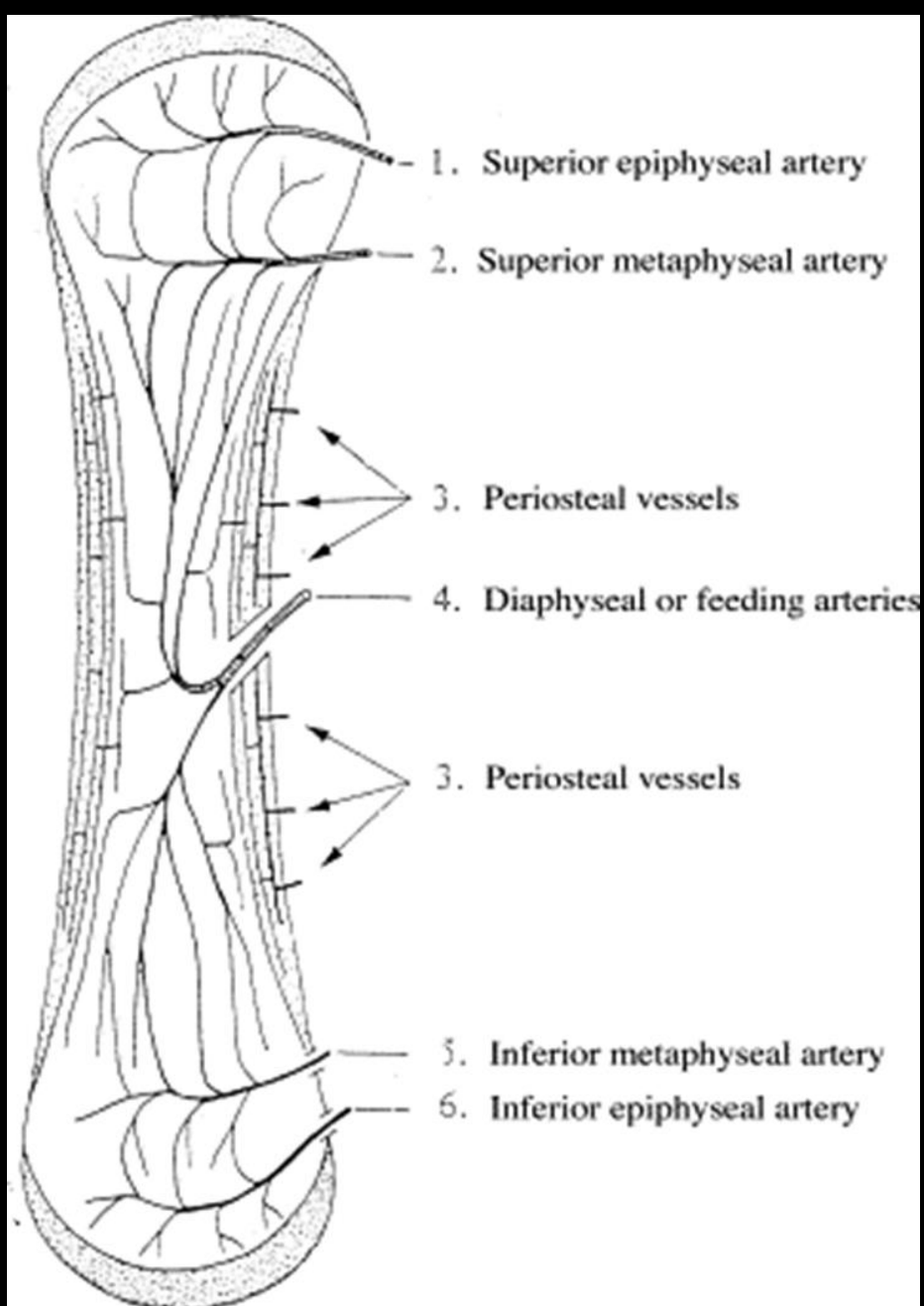




# Metaphyseal osteonecrosis after fracture

- Unusual as bone usually has extensive collateral circulation
- Long bones have 3 sources:
  - Nutrient artery system
  - Metaphyseal-epiphyseal system
  - Periosteal system





Laroche, M. Intraosseous circulation from physiology to disease.

# Bone Blood Supply

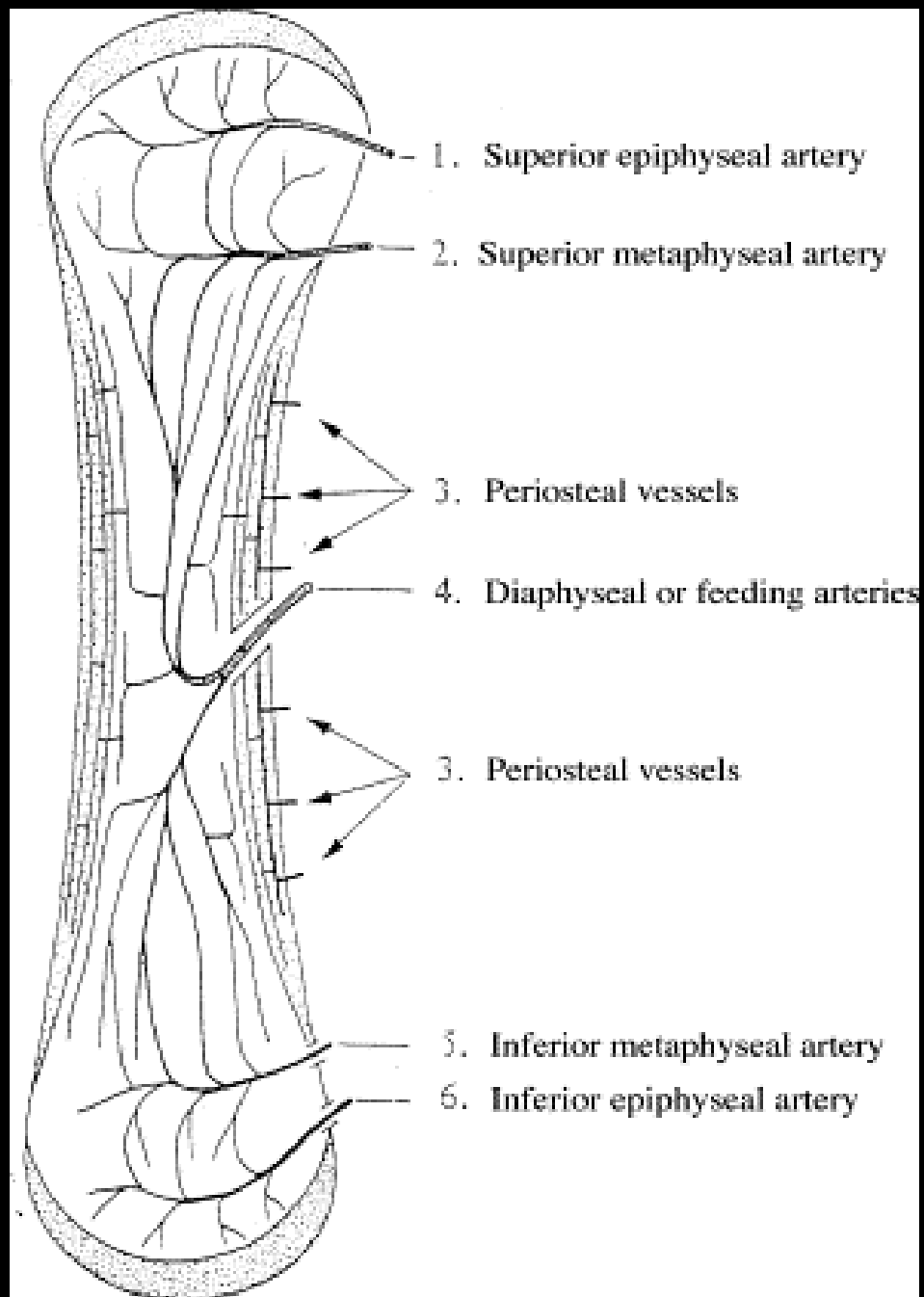
- Nutrient artery system
  - From major systemic arteries
  - In case of tibia, tibialis anterior, tibialis posterior, and fibularis artery
  - High pressure
  - Supplies inner 2/3

# Bone Blood Supply

- Metaphyseal-epiphyseal system
  - Arteries that enter at the level of the growth plate
  - Extensive anastomosis between the metaphyseal and epiphyseal systems
  - Supplied by major branch vessels
  - Distal tibia
    - Metaphyseal – tibialis anterior
    - Epiphyseal – tibialis anterior, tibialis posterior, fibularis

# Periosteal System

- Extensive network of vessels covering entire length
  - All sorts of supply
    - From adjacent muscles (musculoperiosteal)
    - From adjacent fascia (musculofascial)
    - From bone itself (cortical capillary anastomosis)
    - From dedicated vessels (intrinsic periosteal)
- Relatively low pressure
- Supplies about outer 1/3

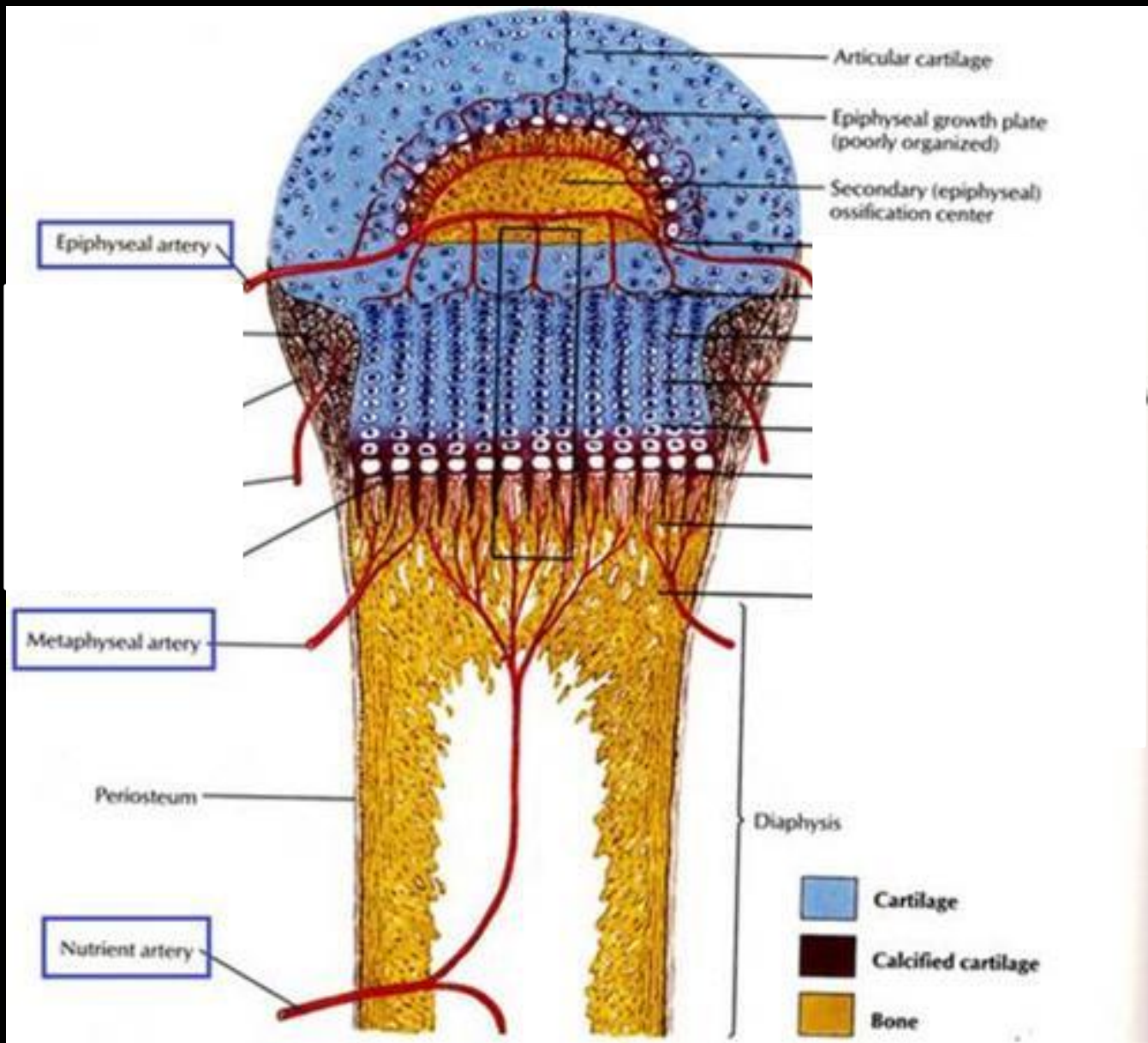


# Arterial Supply in Adults

- Direction of flow is centrifugal
  - INSIDE to OUTSIDE
  - Endosteum to periosteum
- Extensive collateralization, especially at epiphysis and metaphysis

# What about in kids?

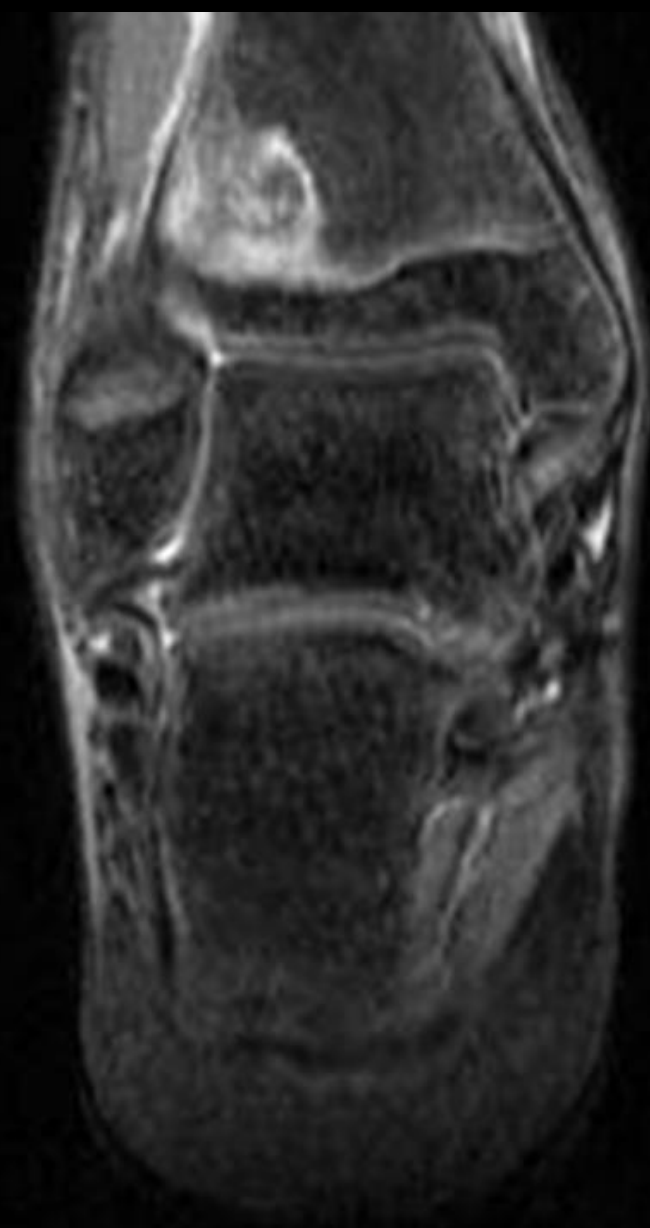
- Periosteal system dominates, so blood flow is centripetal
  - OUTSIDE to INSIDE
- Growth plates separates epiphyseal and metaphyseal circulation
  - Growth plate supplied by perichondrial artery
- Extensive metabolic activity





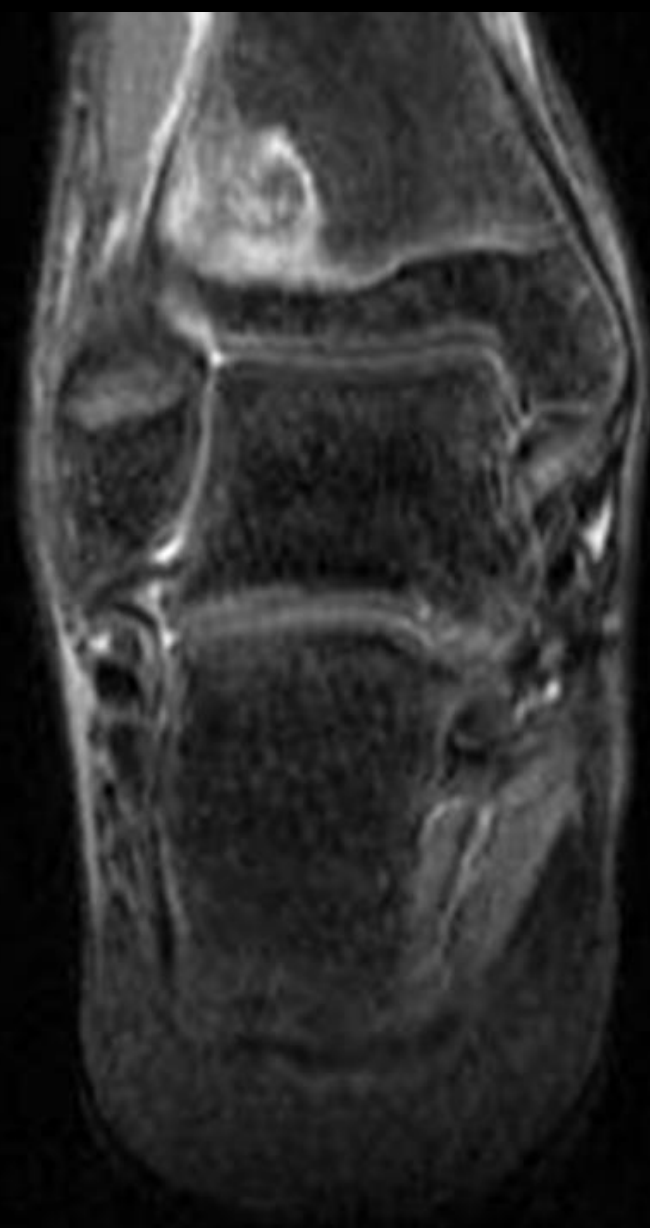
# Fractures and Blood Flow

- After a fracture...
  - Initially:
    - Decrease in blood flow overall
      - Increased intraosseous pressure
      - Because nutrient system/metaphyseal system is disrupted
    - Periosteal system is favored
  - Later:
    - Increased blood flow (regional acceleration)
    - Peaks at 2 weeks, back to normal at 3-5 months



# Putting it all together

- In pediatric patients:
  - Distal metaphysis is supplied by nutrient and metaphyseal arteries along with the periosteal system
    - Physis inhibits collateral flow from the epiphysis
  - Fracture may disrupt larger vessels and increases intraosseous pressure, decreasing flow overall
  - Periosteal disruption cuts off the main blood supply
  - Children have an overall increased metabolic demand
- If the hemorrhage extends subperiosteally, can end up with osteonecrosis



# Natural progression...



3 months



18 months

# References

1. Bhattacharjee, A, Singh, J, Mangham, D and Freeman, R. Osteonecrosis of the distal tibial metaphysis after Salter–Harris type-2 injury: a case report. *Journal of Pediatric Orthopaedics B* 2015, 24:366–369.
2. Laroche, M. Intraosseous circulation from physiology to disease. *Joint Bone Spine*. 2002 May. Vol 69(3); 262-269.
3. Simpson, A. The blood supply of the periosteum. *J Anat*. 1985 Jun; 140(Pt 4):697-704.
4. Wheeless, C. Osseous circulation. [www.wheelessonline.com/ortho](http://www.wheelessonline.com/ortho).
5. Woon, C. Bone Circulation. Retrieved from [www.orthobullets.com/basic-science/9005/bone-circulation](http://www.orthobullets.com/basic-science/9005/bone-circulation).