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
1. Superior epiphyseal artery

2. Superior metaphyseal artery

3. Periosteal vessels

4. Diaphyseal or feeding arteries

5. Periosteal vessels

6. Inferior metaphyseal artery

6. Inferior epiphyseal artery
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...
References


