# Physeal Stress Injuries

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# Agenda

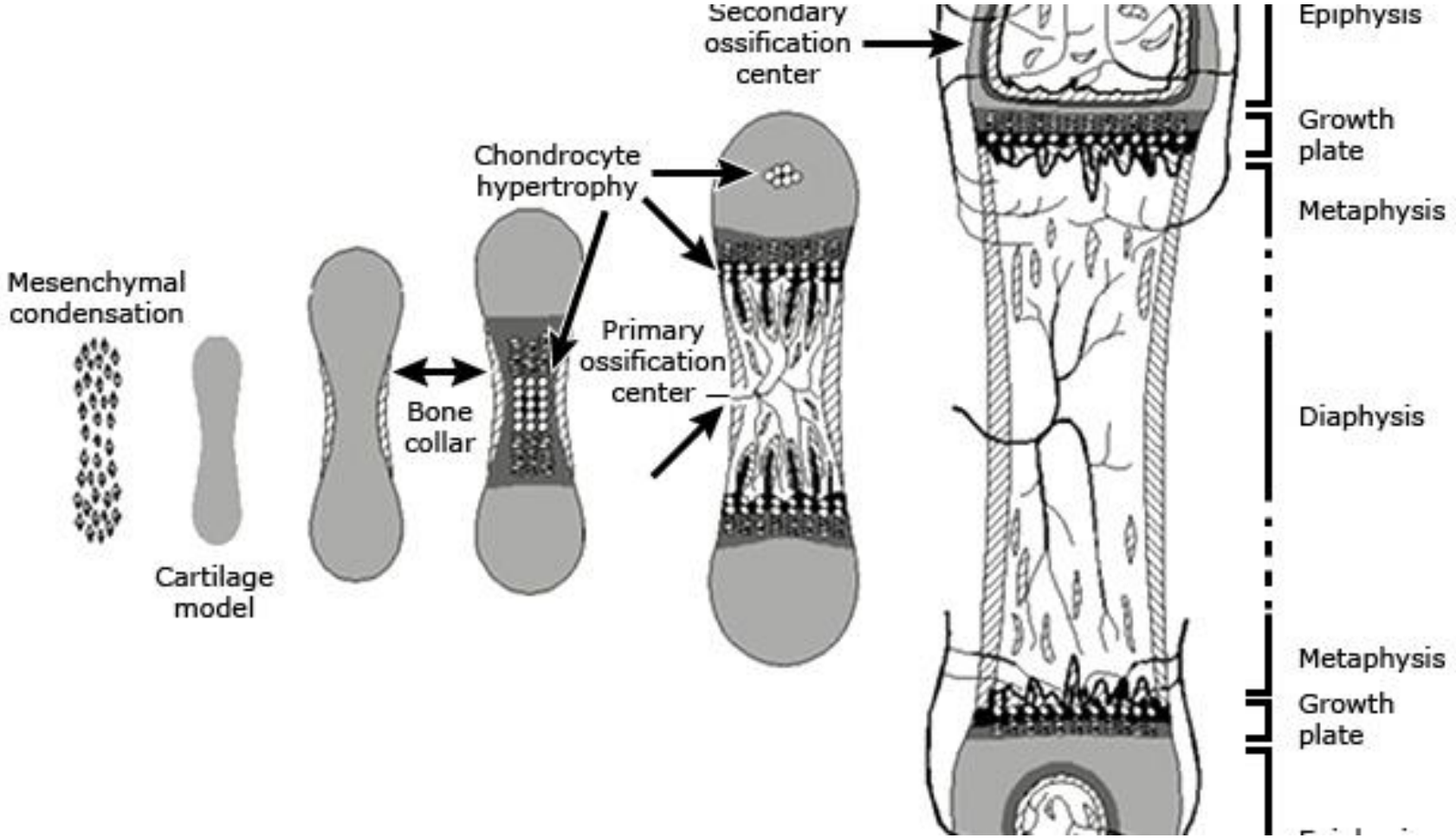
1. Physiology of skeletal maturation
2. Mechanism of physeal stress injuries
3. Specific sports related physeal stress injuries
   - Proximal humeral epiphysitis
   - Medial epicondyle apophysitis
   - Apophyseal injuries of the hip and pelvis
   - Sinding-Larson-Johansson Disease
   - Osgood-Schlatters Disease
   - Severs Disease
   - Iselin's Apophysitis

# Skeletal Maturation

- Intramembranous mesenchymal ossification
  - Intramembranous: primitive mesenchymal cells directly differentiate into membranous bone
  - Skull, clavicle, facial bones

- Endochondral ossification
  - bones first are cartilaginous and then transform into bone
  - Long bones, vertebrae, skull base
  - Primary ossification center forms first, in diaphysis of chondral precursor
  - Secondary ossification center forms in epiphysis during first 18 months of life

# Skeletal Maturation

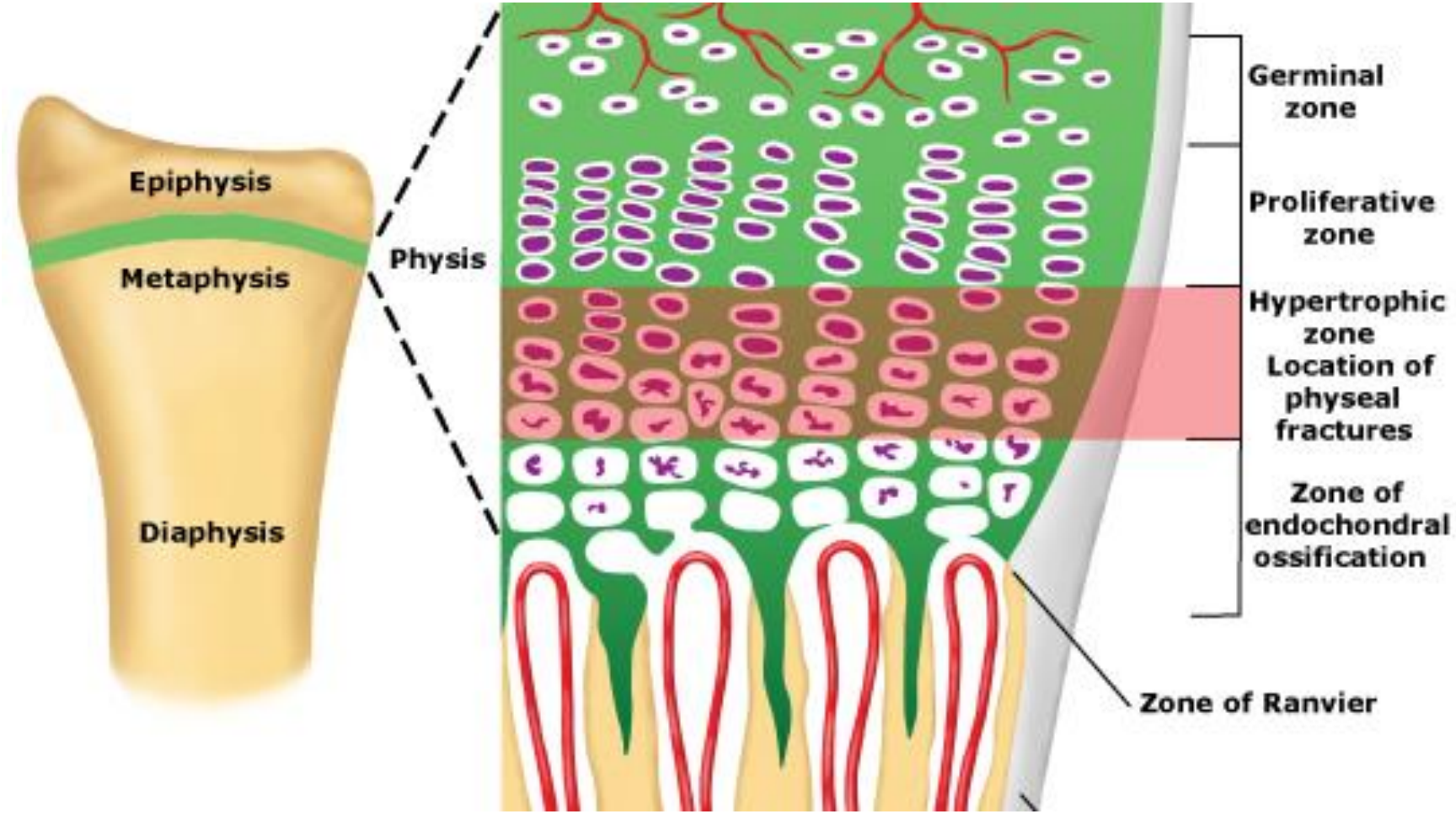


# Skeletal Maturation

- Physis:
  - growth center for long bones
  - Found on either side of joints
  - Made of columns of chondrocytes in various stages of differentiation into bone
  - Contributes to length of bone
  - Injury has potential to stunt growth

- Apophysis:
  - Ossification center protruding from bone.
  - Does not articulate with moveable joint nor contribute to linear growth.
  - Usually site of tendon and ligament attachment to bone.

# Skeletal Maturation

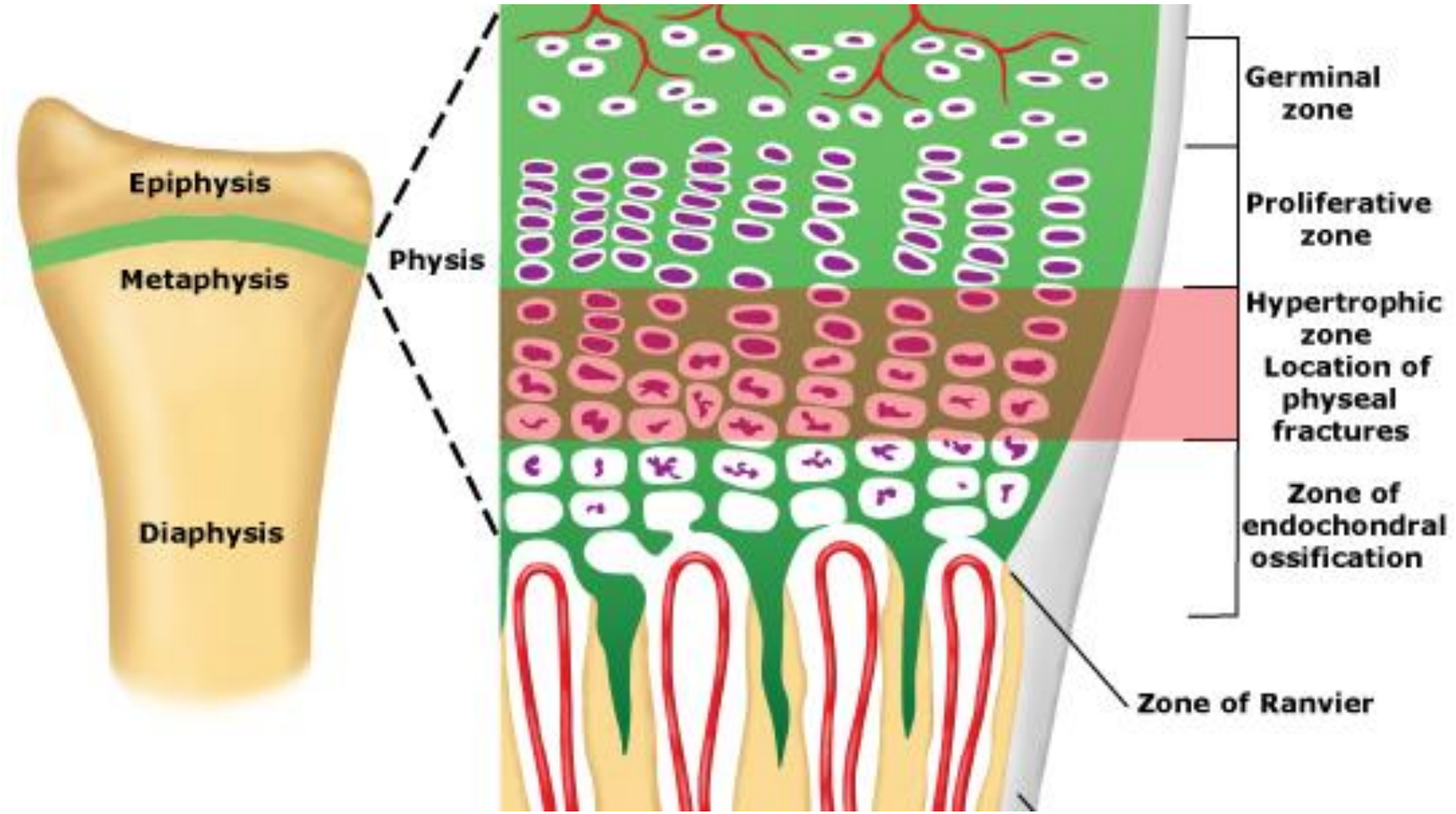



Picture credit: UpToDate

# Physeal Stress Injuries

- Physis is weakest part of growing bone
- Diaphyseal cortex is relatively thick and strong
- Muscle and tendon growth lags behind bone growth
- Injuries tend to occur during periods of rapid growth
- Fractures therefore occur at the metaphyseal-physeal junction
  - Repetitive loading disrupts metaphayseal perfusion
  - Inhibits ossification of chondrocytes in zone of provisional calcification
  - Widening of physis develops as chondrocytes continue to transition from germinal to proliferative zone
    - Widening can be seen radiographically

# Physeal Stress injuries

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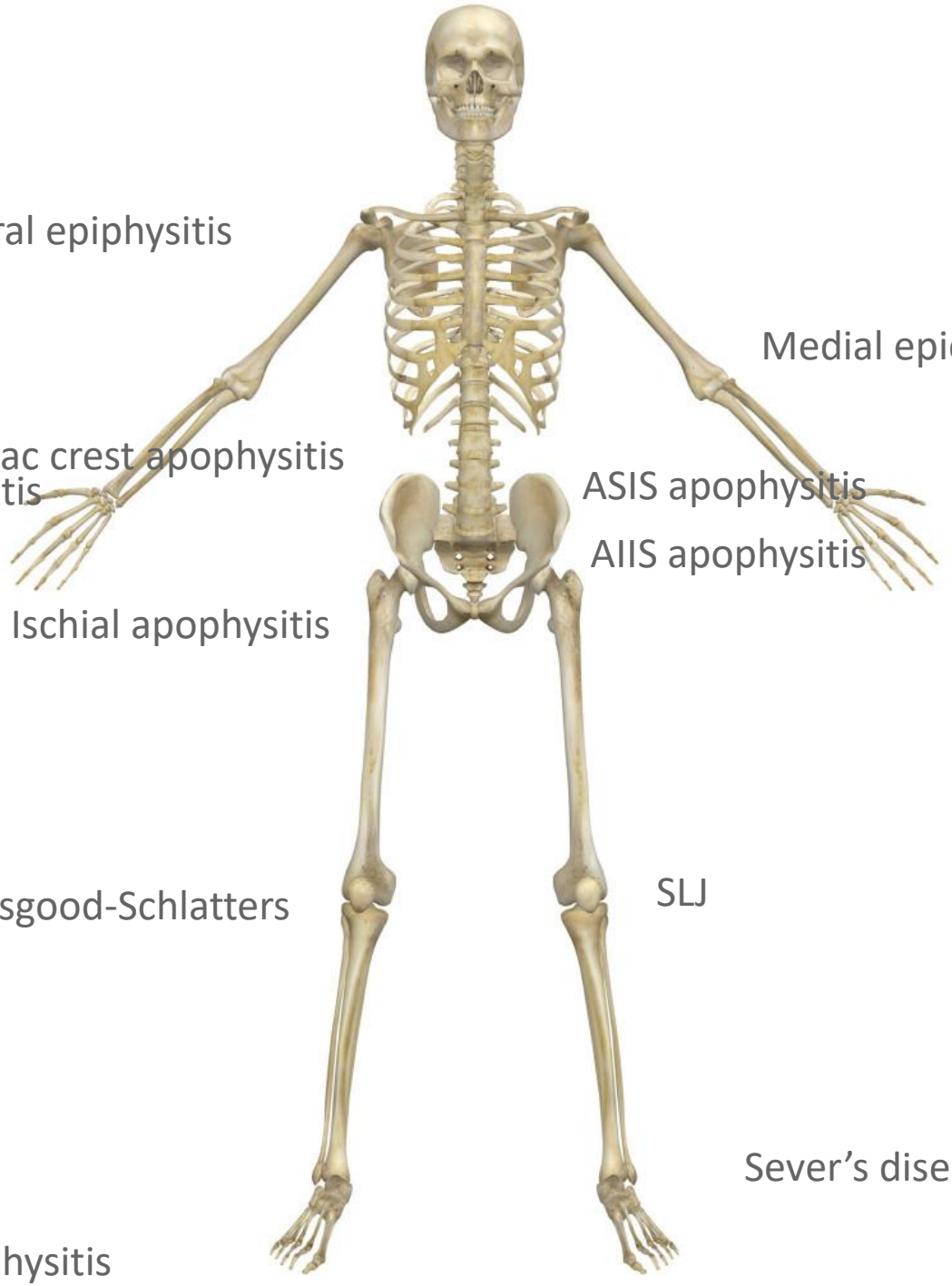

Proximal humeral epiphysitis
Medial epicondyle apophysitis
Iliac crest apophysitis
Distal radial epiphysitis
ASIS apophysitis
AIIS apophysitis
Ischial apophysitis
Osgood-Schlatters
SLJ
Sever's disease
Iselin's apophysitis

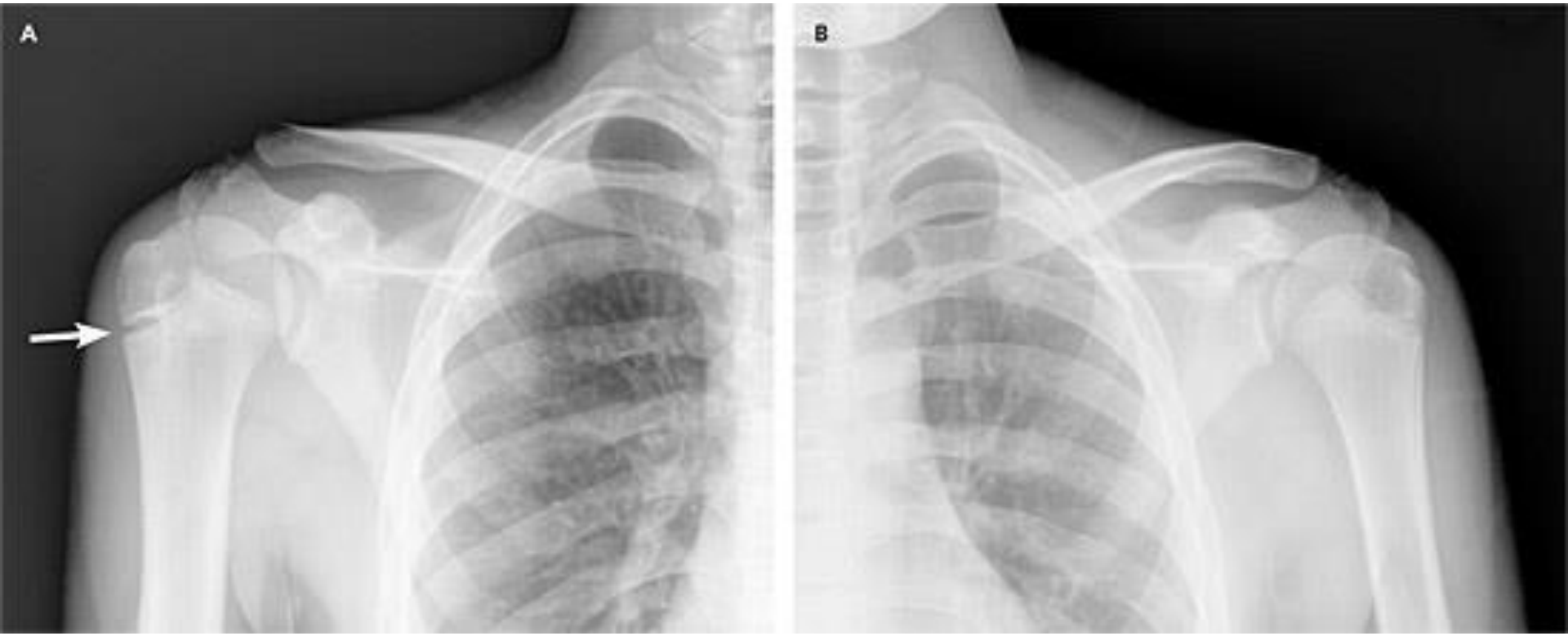
# Physeal Stress Injuries: Proximal Humeral Epiphysitis

- AKA “Little League Shoulder”
- Repetitive microtrauma leads to failure or stress fracture through proximal humeral physis
- Most commonly via repetitive rotational and compressive forces applied to humerus during throwing
- Most commonly affects boys age 11-14 years in throwing sports
- Gradual onset pain, often with superimposed subacute episode
- Physis closes at age between 14-17 in girls and 16-18 in boys

- Physical exam:
  - Unremarkable inspection
  - Tenderness over epiphysis
  - Restricted ROM due to pain
  - Pain with most RC testing

# Physeal Stress Injuries: Proximal Humeral Epiphysitis

- Imaging:
  - AP in ER and IR
  - Comparison view




Picture credit: AAFP

# Physeal Stress Injuries: Proximal Humeral Epiphysitis

- Treatment
  - Rest:
    - Refrain from all throwing and overhead activity until asymptomatic with ADLs
  - Rehab
    - Special focus on core and lower extremity strengthening and stability

- Return to play
  - Usually after 8-12 weeks
  - Throwing protocol w/gradual increase in amount, frequency and velocity of pitching

- Complications – rare
  - Displacement of proximal humeral physis requiring reduction and internal fixation
  - AVN of the phyysis
  - All reported in high level males 11-13yo

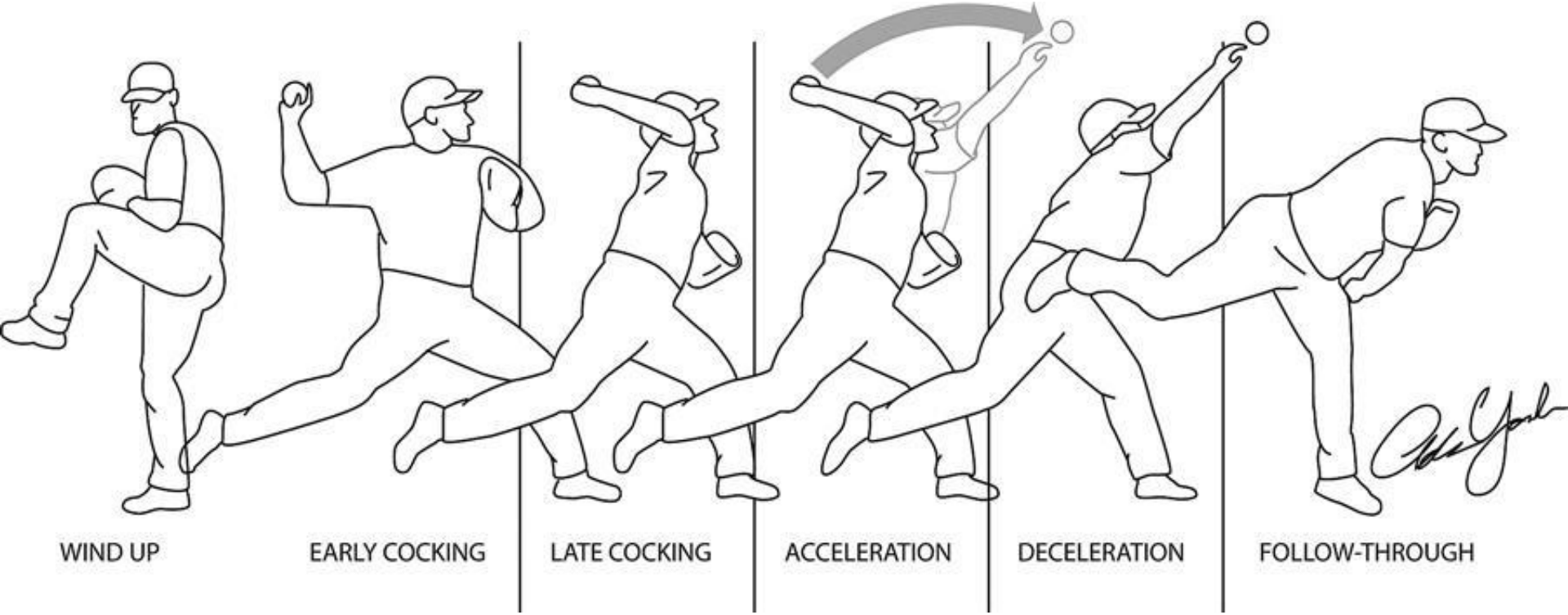
# Physeal Stress Injuries: Medial epicondyle apophysitis

- AKA “Little League Elbow”
- Most common in 9-12 year olds who participate in throwing sports
  - Pitchers and quarterbacks
- Throwing puts valgus traction force on medial elbow and compression laterally

- Physical exam:
  - TTP over medial epicondyle
  - Flexion contracture, often greater than 15 degrees
  - Valgus alignment
  - Make sure to also assess ulnar nerve, ligamentous stability, distal biceps tendon

  - Differential diagnosis:
    - Medial epicondylitis, medial epicondyle avulsion, ulnar neuritis, Panners disease, osteochondritis dissecans of the capitellum, UCL injury

# Physeal Stress Injuries: Medial epicondyle apophysitis




Picture credit: Orthobullets

# Physeal Stress Injuries: Medial epicondyle apophysitis

- Imaging
  - AP, lateral, comparison

- Treatment
  - Rest: abstinence of throwing usually 4-6 weeks
  - Posterior splint in severe cases
  - Range of motion at 6 weeks

- Return to play
  - Throwing program usually started at 8 weeks
  - Focus on proper mechanics

Complications

growth disturbance around the elbow, persistent pain, avulsion fractures, ocd, valgus instability after physeal closure

# Physeal stress injuries: Distal radial epiphysitis

- AKA “Gymnast Wrist”
- Repetitive compressive stress at the physis leads to injury
- Most common ages 10-14, boys and girls
  - Dorsal wrist pain worse with weight bearing
- Can lead to growth disturbance
- Distal radial physis closes progressively from ulnar to radial

- Physical Exam:
  - Pain difficult to reproduce on exam – may have dorsal wrist tenderness
  - No provocative tests – may have pain with axial loading
  - Loss of wrist extension possible in chronic cases

# Physeal stress injuries: Distal radial epiphysitis

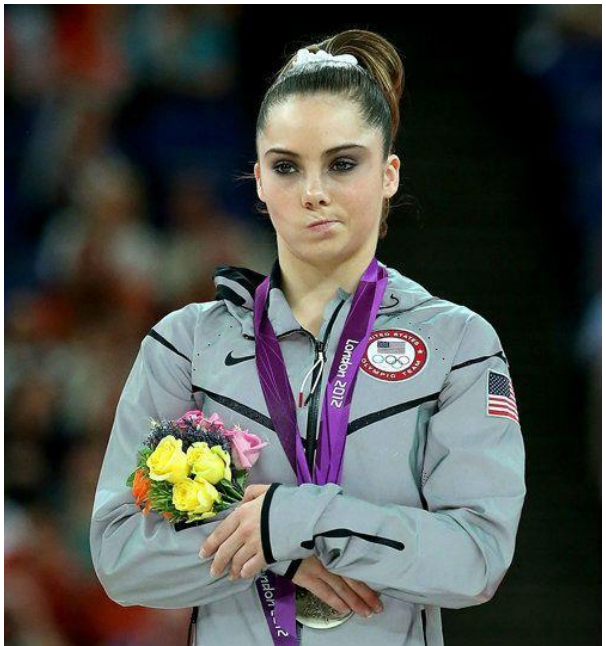
- Imaging:
  - May be normal or show physeal widening, sclerosis, beaking, haziness, or irregularity
  - Premature physeal closure may be seen in severe cases
  - MRI shows edema on both metaphyseal and epiphyseal ends of the physis, cartilage extension into the physis, and vertical fractures

  - Treatment
    - Healing happens only with cessation of offending activity
    - Immobilization to decrease acute symptoms (and prevent participation) however prolonged immobilization not advised
    - Surgical treatment may ne needed if premature closure

# Physeal stress injuries: Distal radial epiphysitis

- Return to play:
  - Begin after being symptom free for four weeks
  - Start at 25% of compressive loading activity and increase every 1-2 weeks
  - Full RTP 10-12 weeks after diagnosis

- Complications:
  - Growth arrest with abnormal development of radial height and inclination, and positive ulnar variance



# Physeal stress injuries: hips and pelvis

- Iliac crest apophysitis
- ASIS apophysitis, AIIS apophysitis, ischial tuberosity apophysitis
- Boys and girls 15-18 year old

- Risk factors:
  - Tight, imbalanced muscles of hip, lower extremity malalignment, overuse training errors
  - Sports with kicking, rapid acceleration and deceleration, jumping

- Imaging: AP pelvis, unilateral oblique view
  - widening of physis, potential avulsion

- Treatment: 4-6 weeks of rest with aggressive rehab, NSAIDs

- Complications rare

# Physeal stress injuries: Sinding-Larson-Johansson Disease

- Apophyseal injury at the inferior pole of the patella
- Most common in boys 10-13 years old
- Running, jumping, stairs

- Imaging:
  - Lateral most helpful
  - Physis may be calcified or ossified

- Treatment:
  - Activity modification, ice NSAIDs
  - PT focusing on eccentric quadriceps loading and lower extremity stretching

Return to play:
  - Self limited process
  - May take 10-12 months for symptoms to totally resolve

# Physeal stress injuries: Tibial tubercle apophysitis

- AKA “Osgood-Schlatter’s Disease”
- Forceful contraction of quadriceps leads to repetitive traction injury of tibial tuberosity and adjacent tibial physis
- Girls 10-13yo, boys 12-14yo
- Bilateral in 20-30% of cases
- Worse with running, jumping, stairs, rising from squat
- Associated with tight quadriceps and hamstrings

- Physical exam:
  - TTP and swelling over tibial tubercle
  - No limitation in ROM except with forced flexion

- Imaging:
  - lateral most helpful
  - Separation and fragmentation of tibial tubercle apophysis, possible enlargement of tubercle

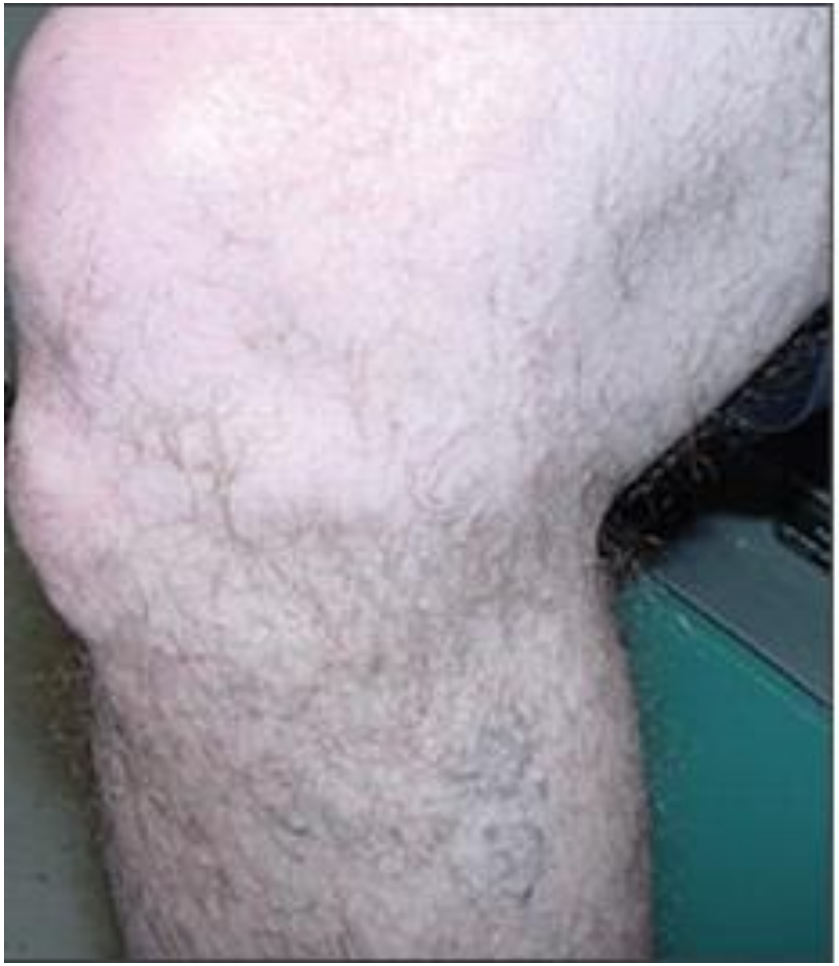
# Physeal stress injuries: Tibial tubercle apophysitis

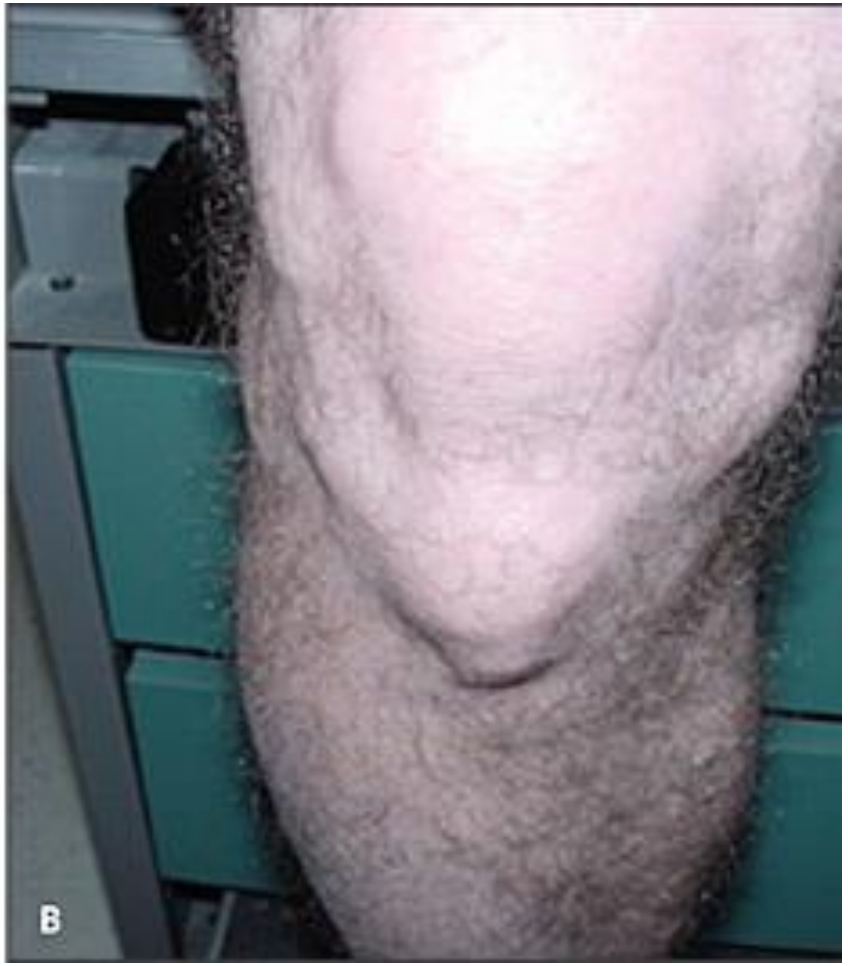
- Treatment:
  - Activity modification, ice
  - Stretching and strengthening:
  - quadriceps, hamstrings, IT band
  - Infrapatellar strap may provide symptomatic relief

- Return to play:
  - Self limited condition – return when symptoms resolved, rehab goals achieved
  - Usually achieved in 2-3 weeks

- Complications:
  - Persistent pain after closure of apophysis
  - Formation of separate ossicle – may need surgical excision

# Physeal stress injuries: Tibial tubercle apophysitis






Picture credit: AAFP

# Physeal stress injuries: Calcaneal apophysitis

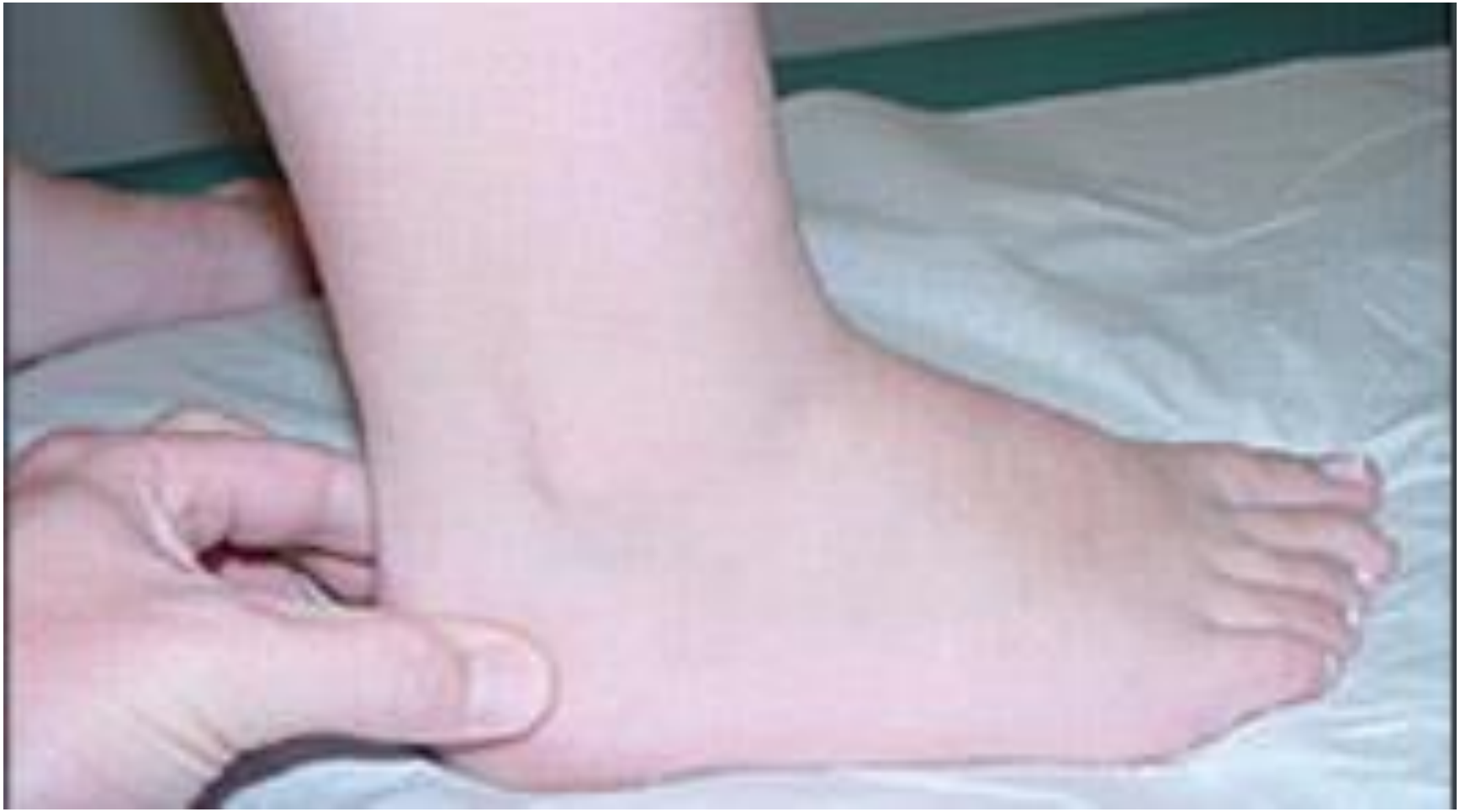
- AKA “Sever’s Disease”
- Athletes 8-12 years old
- Unilateral or bilateral heel pain worse with activity, better with rest
- Local tenderness with lateral and medial compression of the calcaneus, but not with palpation of plantar surface of heel
- Associated with heel cord contraction and weakness of dorsiflexors

- Imaging:
  - Os calcis view, lateral
  - May show fragmentation and sclerosis of calcaneal apophysis

- Treatment:
  - Relative rest, stretching and strengthening gastrocs and soleus, heel cups, NSAIDs

- Return to play:
  - Usually 3-6 weeks

# Physeal stress injuries: Calcaneal apophysitis



Picture credit: AAFP

# Physeal stress injuries: Iselin's apophysitis

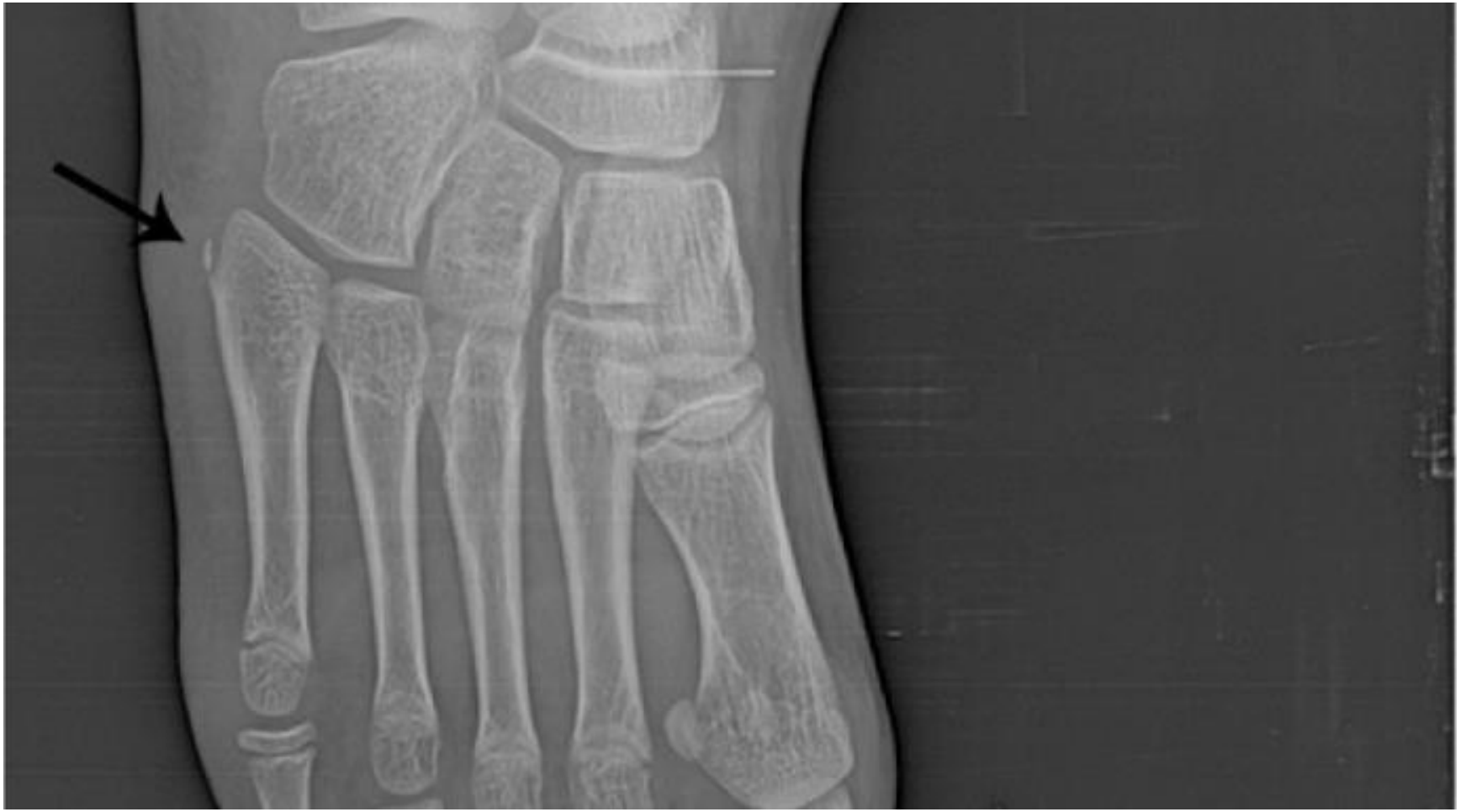
- Traction apophysitis of tuberosity of fifth metatarsal
- Boys and girls 8-13 years old
- Associated with repetitive inversion stress, repetitive traction of peroneus brevis on its insertion
- Lateral foot pain worse with activity, better with rest
- Tenderness and swelling over base of 5$^{th}$
- Pain with resisted eversion and plantarflexion

- Imaging:
  - May show widened apophysis and fragmentation

- Treatment:
  - Rest/activity modification, ice, stretching
  - Cast, surgical excision in severe cases

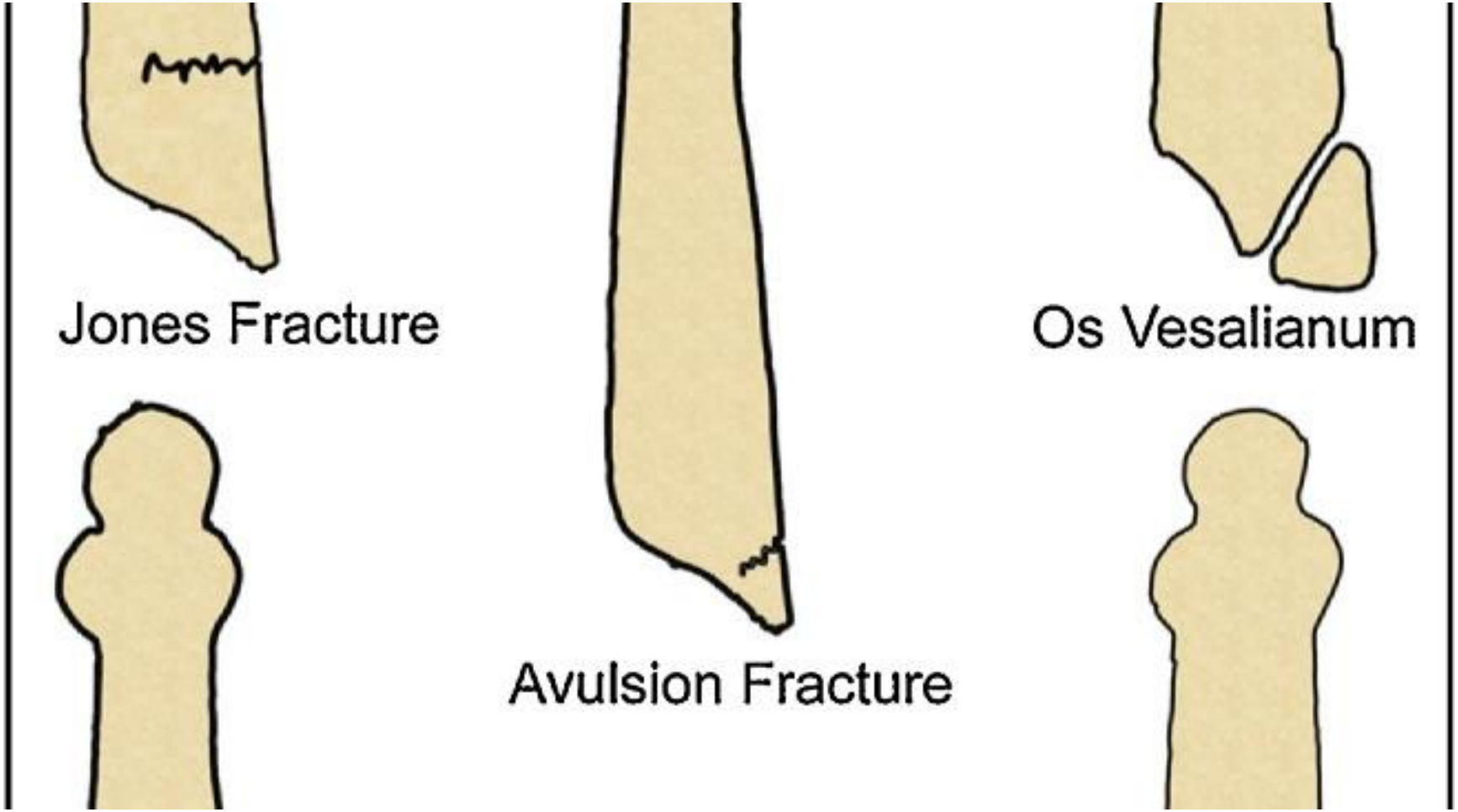
- Complications:
  - Nonunion - rare

# Physeal stress injuries: Iselin’s apophysitis



Picture credit: Iselin's disease: Traction apophysitis of the fifth metatarsal base, a rare cause of lateral foot pain.

# Physeal stress injuries: Iselin's apophysitis

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# Thank you!