

# Overuse Injuries in Children and Adolescents: Treatment & Prevention

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# Overuse Injuries in Young Athletes

- Factors contributing to overuse in youngsters
- Considerations for prevention

# Benefits of Youth Sport Participation

- Provides an opportunity to develop self-esteem, self-discipline, and leadership qualities
- Offers a chance for socialization with peers
- Promotes general health and fitness and development of motor skills
- Might even be fun



# Case History

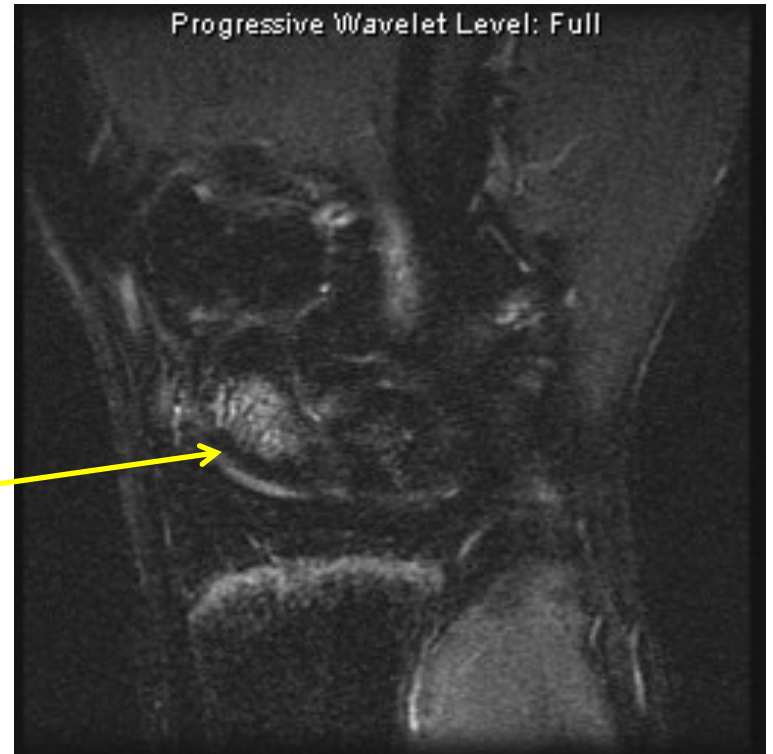
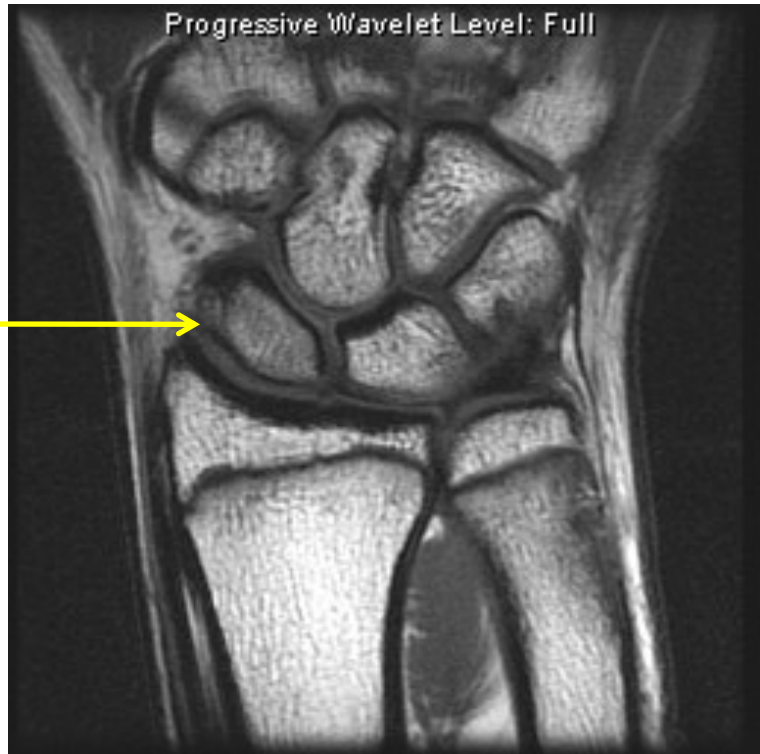
- A 14yo competitive tennis player presented with a 4 wk history of R wrist pain.
- Currently home schooled to enable her to continue to play on a more extensive basis.
- Now has a private coach. Trains 7 d/wk, 4 h or >/session.
- Prior to this year she was practicing 2-3 times per week.
- 3-4 weeks ago she began to notice soreness of the right wrist, hitting forehands or forehand volleys. No history of trauma.
- Now unable to hit forehands or forehand volleys because of pain.

# Exam

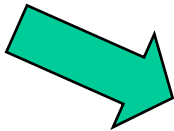
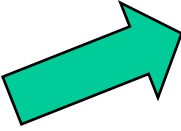
- FROM. No swelling. No TTP
- The patient localized her symptoms to the region of the anatomic snuff box and the distal radius.
- Strength normal.
- No pain with ulnar or radial deviation of the wrist.



# Stress Fracture Scaphoid



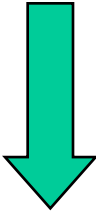
Repetitive Activity



Loss of tissue strength

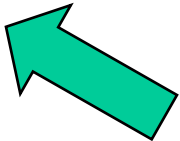
Cyclic Tissue Overloading

**Overuse Injury**

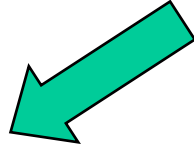


Inadequate tissue repair

Tissue Fatigue

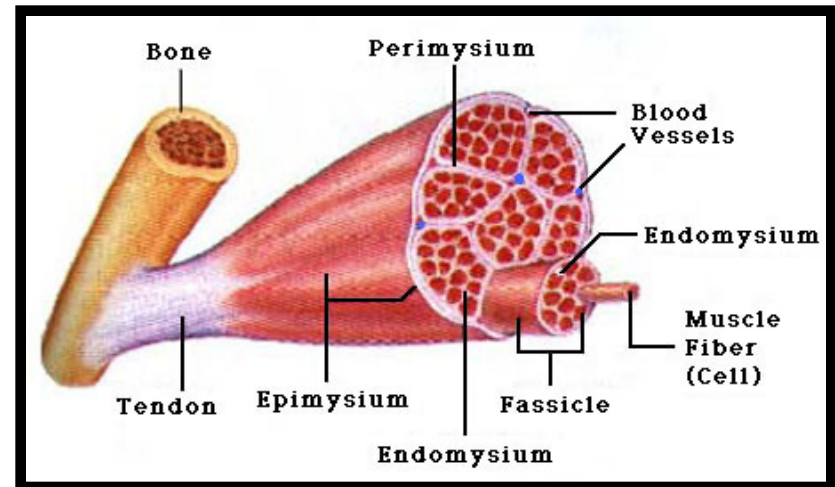


Microtrauma



# Tissues Commonly Injured Through Overuse

- Muscle-tendon unit
- Bone
- Bursa
- Nerve
- Vascular structures





# Common Types of Overuse Injuries

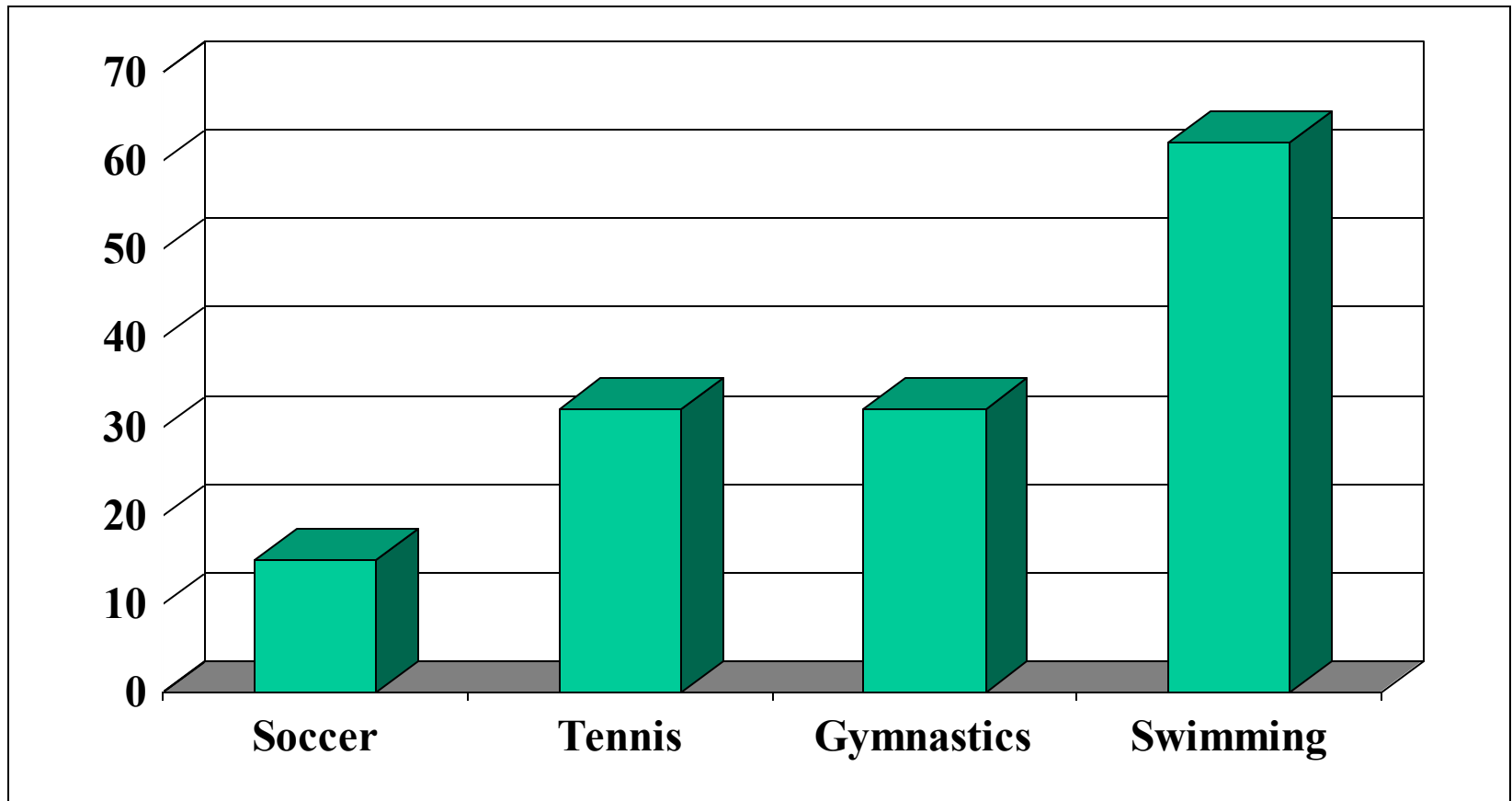
## Adults

- Tendinopathy
- Tendon rupture
- Bone stress injury
- Nerve entrapment
- Exertional compartment syndromes
- Vascular entrapment

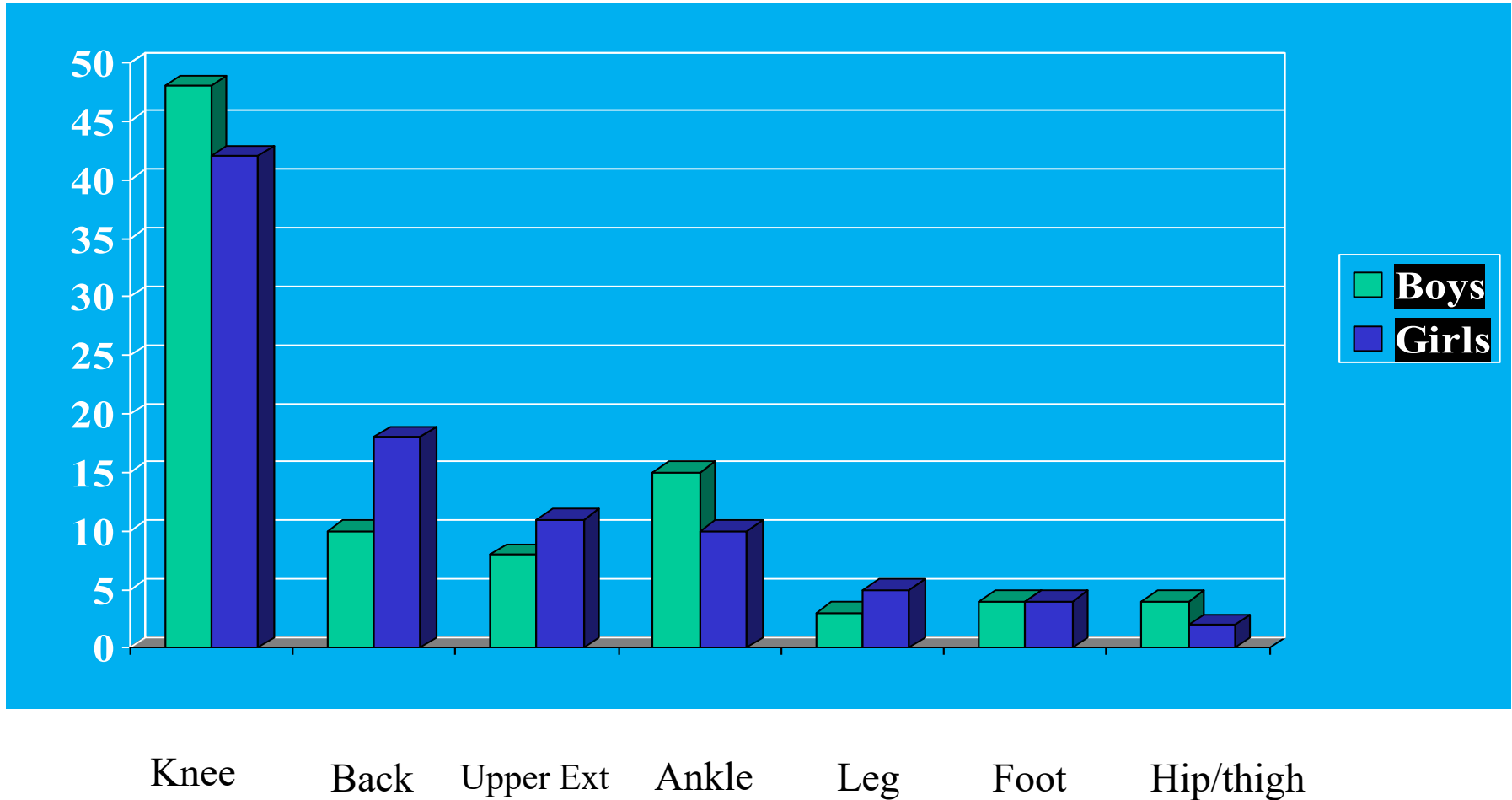
## Children and Adolescents

- Apophysitis
- Apophyseal avulsion
- Bone stress injury
- Physeal stress injury
- Nerve entrapment
- Exertional compartment syndromes
- Vascular entrapment

# Relative Frequency of Overuse Injuries by Sport (n=453)



# Common Sites of Overuse Injuries in Young Athletes

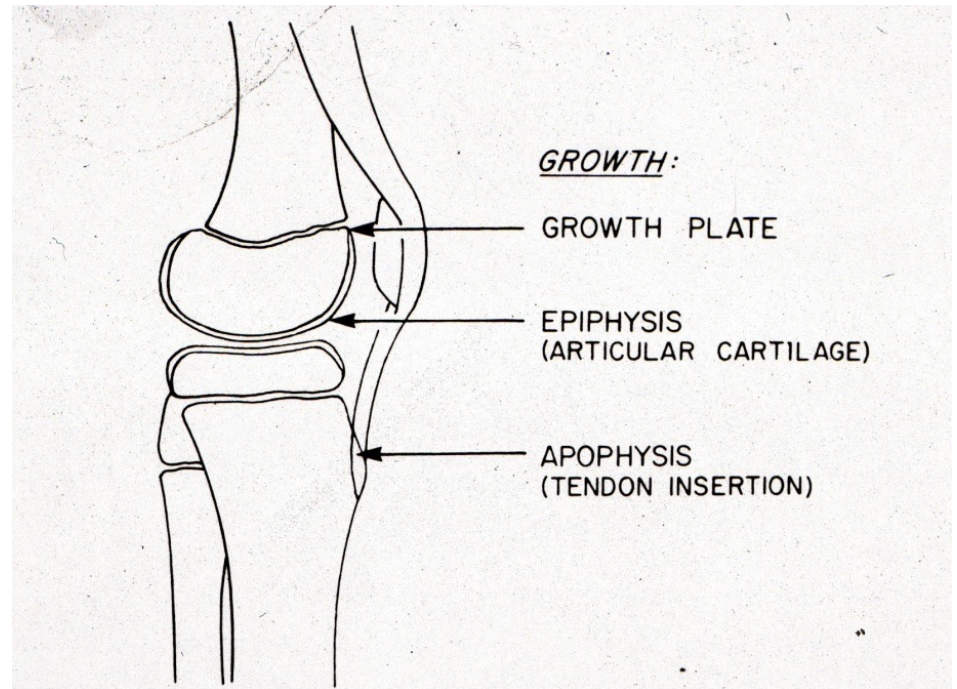


# Factors Contributing to Overuse Injury

- Growth related factors
  - Growth cartilage
  - Growth rate
- Other intrinsic factors
  - Prior injury
  - Conditioning
  - Menstrual dysfunction
  - Psychologic factors
- Extrinsic factors
  - Training progression
  - Equipment
  - Technique
  - Psychologic factors

# Growth Related Factors

- Inflexibility and muscle imbalance?
  - Asynchronous growth (Hawkins, MSSE 2001)
- Susceptibility of growth cartilage to repetitive stress



# Flexibility and Growth

- 948 high school students
- Flexibility, height and weight measured at baseline, 6 months, and 12 months
- Growth and growth rate did not affect changes in flexibility



Feldman et al . Clin. J. Sport Med.  
1999; 9(1):24

# Flachsmann et al (2000)

- Studied response to dynamic shear stress of bovine osteochondral junction
- Adolescent tissue failed at a significantly lower level of shear stress and required less energy to produce failure than either more mature or more immature specimens

# Common Apophyseal Injury Sites

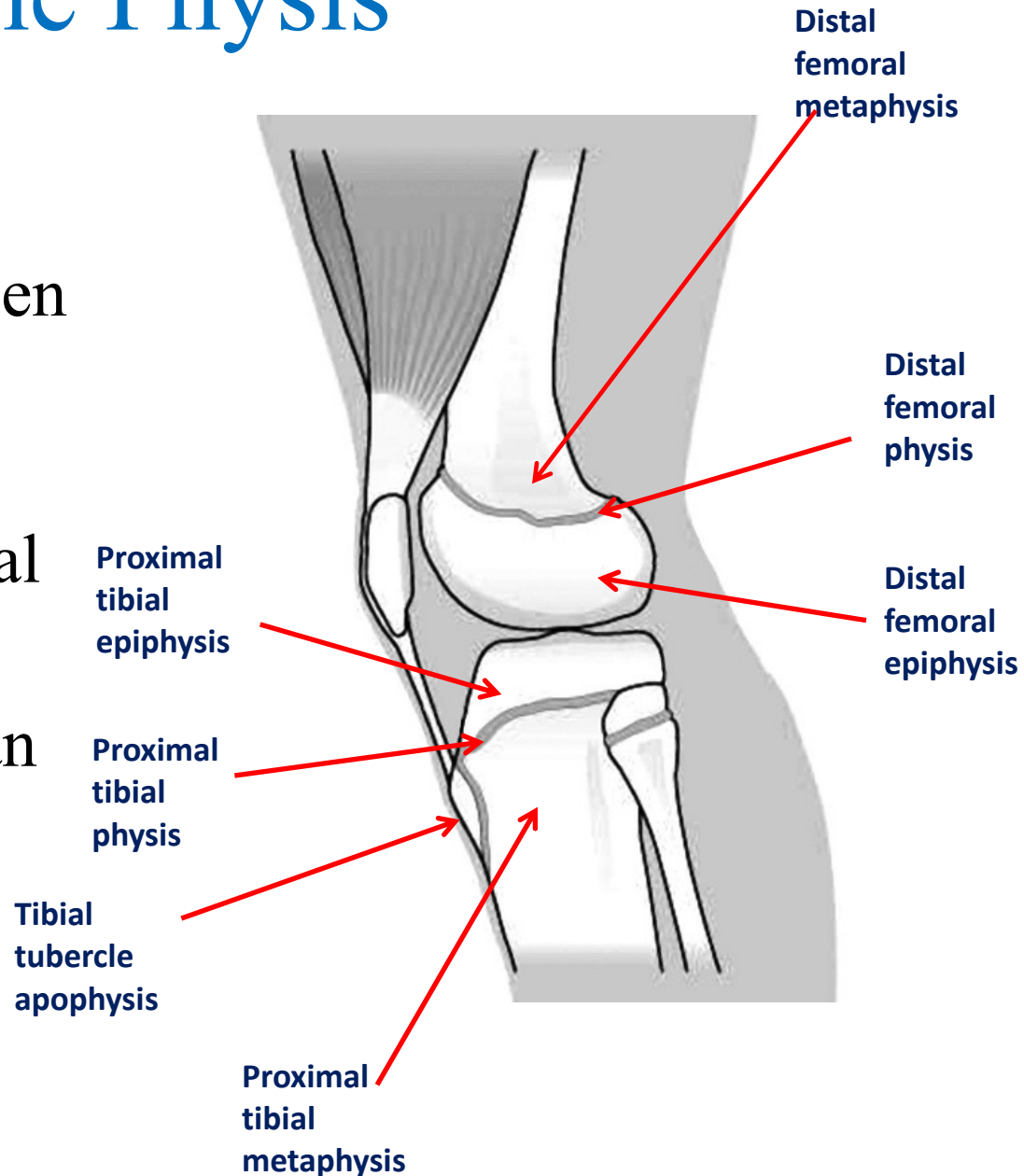
Elbow	<b>Medial epicondylar apophysitis</b>
Pelvis	<b>Ischial apophysitis</b>
Knee	<b>Tibial tubercle apophysitis</b> <b>Sinding-Larsen Johansson syndrome</b>
Foot	<b>Os calcis apophysitis</b> <b>Accessory navicular syndrome</b>





# The Physis

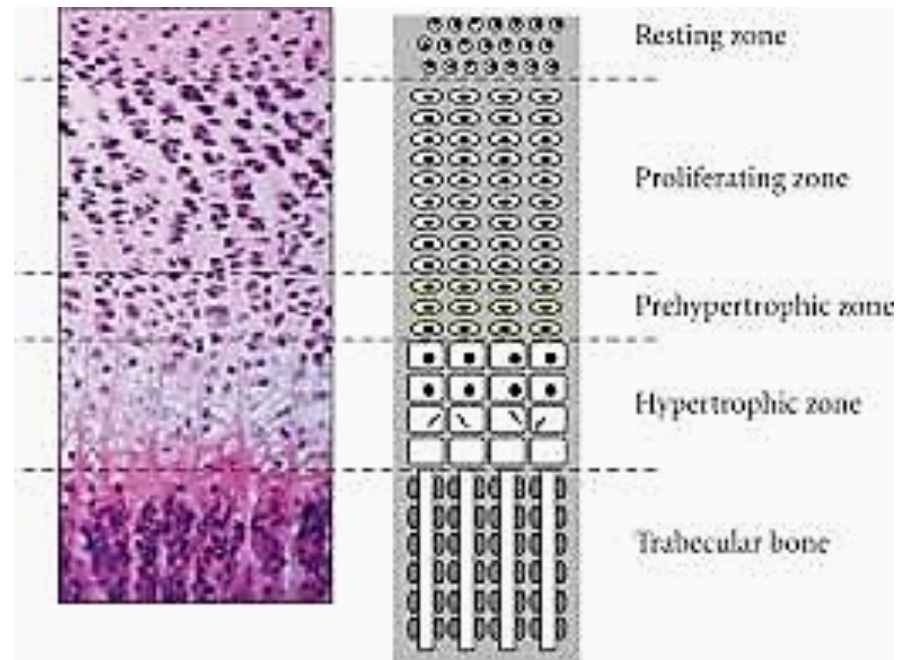
- The physis, or growth plate, is located between the epiphysis and the metaphysis
- Center of endochondral ossification
- Injury to the physis can result in growth disturbance



# Growth Plate Structure

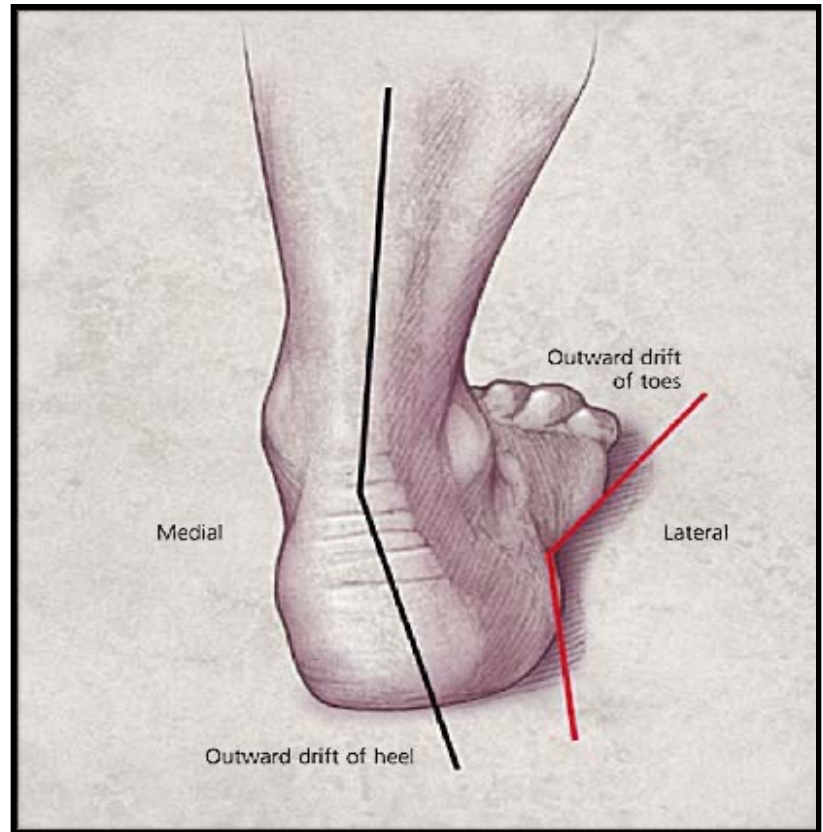
## Zones of chondrocytes:

- Germinal (resting layer)
- Zone of proliferation
- Zone of hypertrophy
  - Maturation
  - Degeneration
- Zone of provisional calcification



# Other Intrinsic Factors

- Prior Injury
- Prior level of conditioning
- Anatomic malalignment
- Joint laxity
- Menstrual dysfunction/bone health
- Psychological factors – athlete specific



# Extrinsic Factors

- Training progression
- Equipment/footwear
- Sport technique
- Surfaces

# Extrinsic Factors

- Psychologic factors – adult and peer influences
- Team vs. individual sports



# Patellofemoral Syndrome

- Perhaps most common overuse injury seen in the primary care setting.
- Can usually be diagnosed clinically without the need for imaging studies.
- The great majority of cases can be successfully treated non-surgically.

# “Patellofemoral Syndrome”

- No clear consensus on terminology
- Often used interchangeably with “Anterior Knee Pain”, chondromalacia patella, runner’s knee
- Clinically: PFS commonly used when peripatellar or retropatellar pain presents without any other identifiable cause

# Causes of Anterior Knee Pain

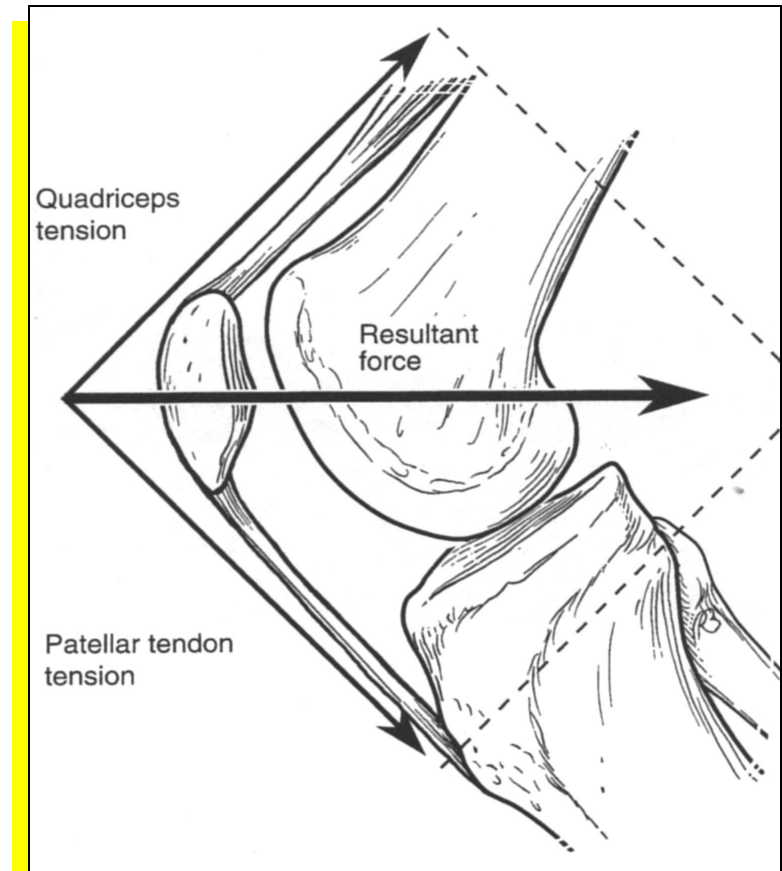
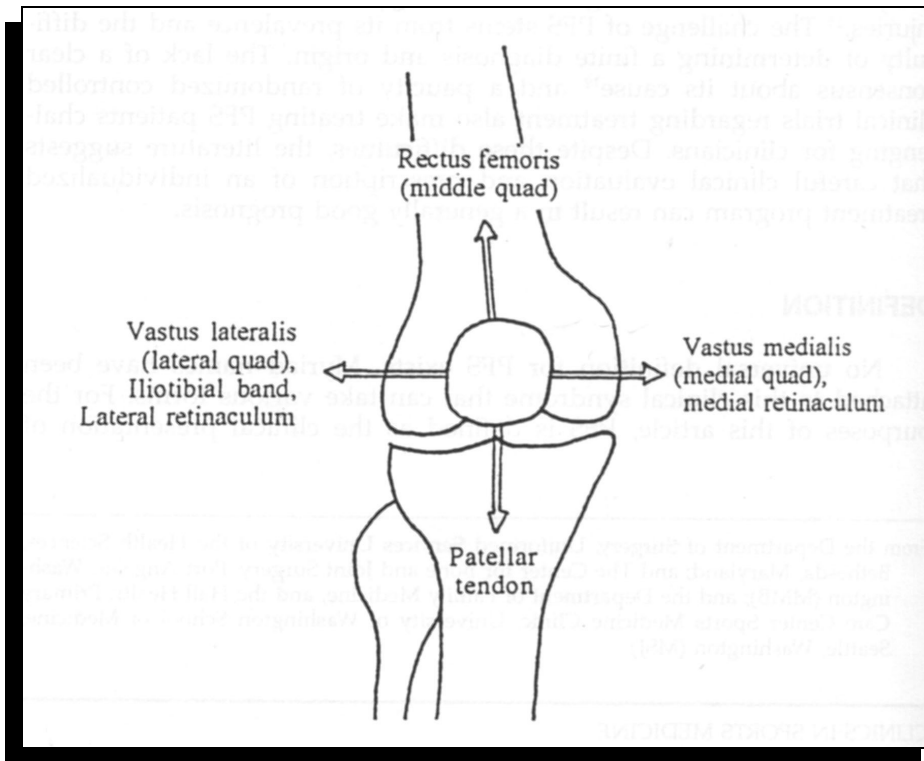
- Patellofemoral pain syndrome
- Patellar instability/subluxation
- Patellofemoral osteoarthritis
- Osteochondritis dissecans
- Articular cartilage injury
- Chondromalacia patella
- Loose bodies
- Patellar stress fracture
- Symptomatic bipartite patella
- Prepatellar bursitis
- Quadriceps tendinopathy
- Synovial plica
- Patellar tendinopathy
- Sinding-Larsen-Johansson syndrome
- Hoffa's fat pad syndrome
- Osgood-Schlatter disease
- Pes anserine bursitis
- Bone tumors
- Referred pain from hip joint pathology



# How Common is PFPS ?

- Most common cause of knee pain among adolescents and young adults in the office setting
- 11.3% of musculoskeletal complaints in the family practice setting
- 25-42% of runners presenting to sports medicine clinics
- Baquie and Brukner (1997): Most common dx in a multidisciplinary sports medicine clinic

# Patellofemoral Biomechanics



# Biomechanics

PF joint reaction forces

Walking:  $0.5 \times BW$

Stair Climbing:  $3-4 \times BW$

Squatting:  $7-8 \times BW$



# History

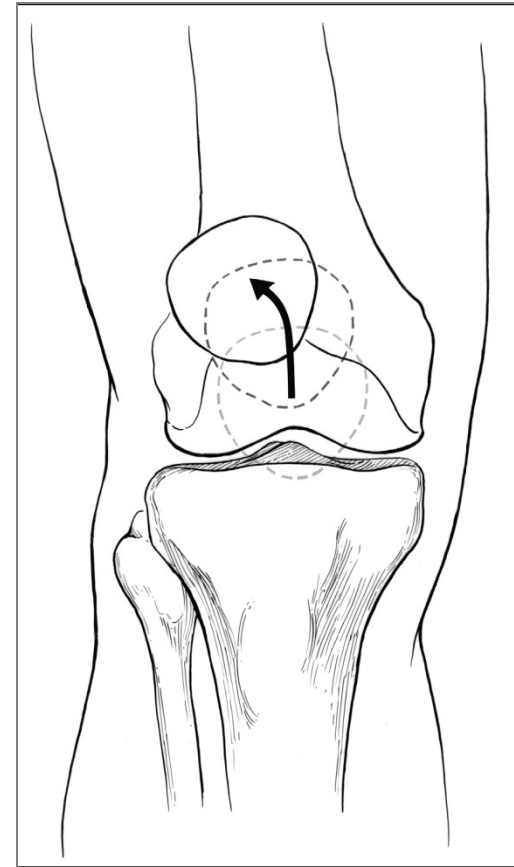
- Pain behind or around patella (circle sign)
- Gradual onset
- Stiffness with prolonged sitting
- Change in activity/training
- Pain with activities that load the PF joint: stairs, squatting, running
- May be bilateral
- Prior knee injury or surgery

# Exam

- Assess alignment, flexibility, muscle tone/strength
- Inspection for effusion
  - If an effusion is present, PFPS is not the diagnosis!
- ROM, crepitance?
- Measurement of quad girth, VMO present?

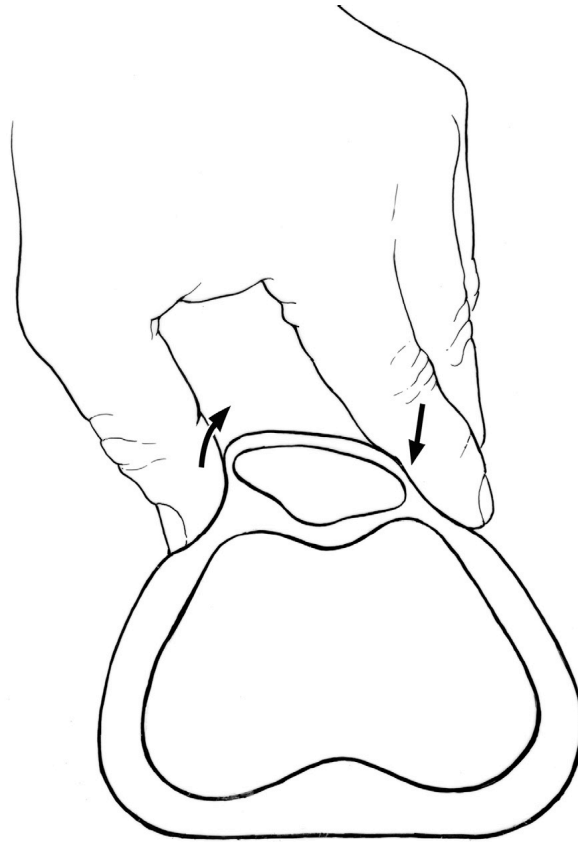
# Exam

- Patellar compression often painful
- Palpation of surrounding structures
  - Retinaculum, facets, quad and patellar tendons, pes anserine bursa, ITB, plica
- Patellar motion may be restricted due to tight lateral structures: Tilt, glide, position
- Patellar tracking, single leg squat

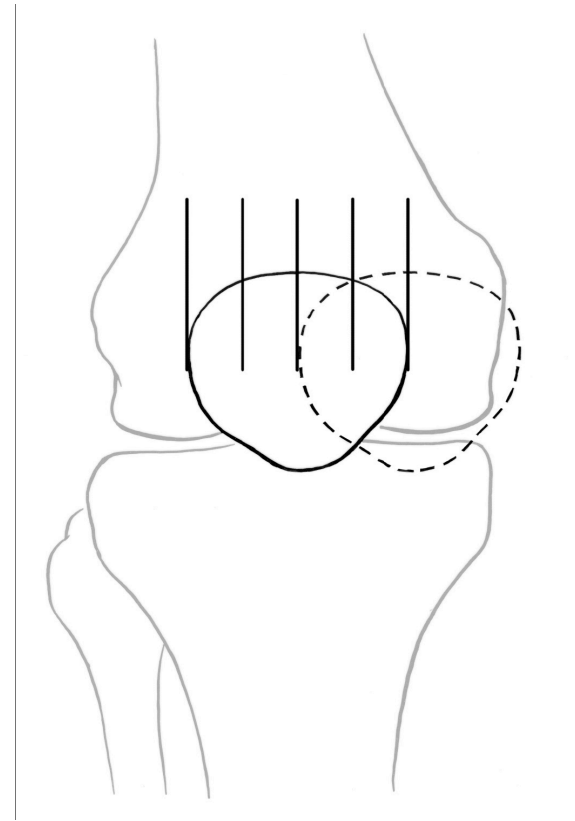


Lateral Patellar Tracking

# Patellar Tilt



# Medial Glide





# Patellar Compression



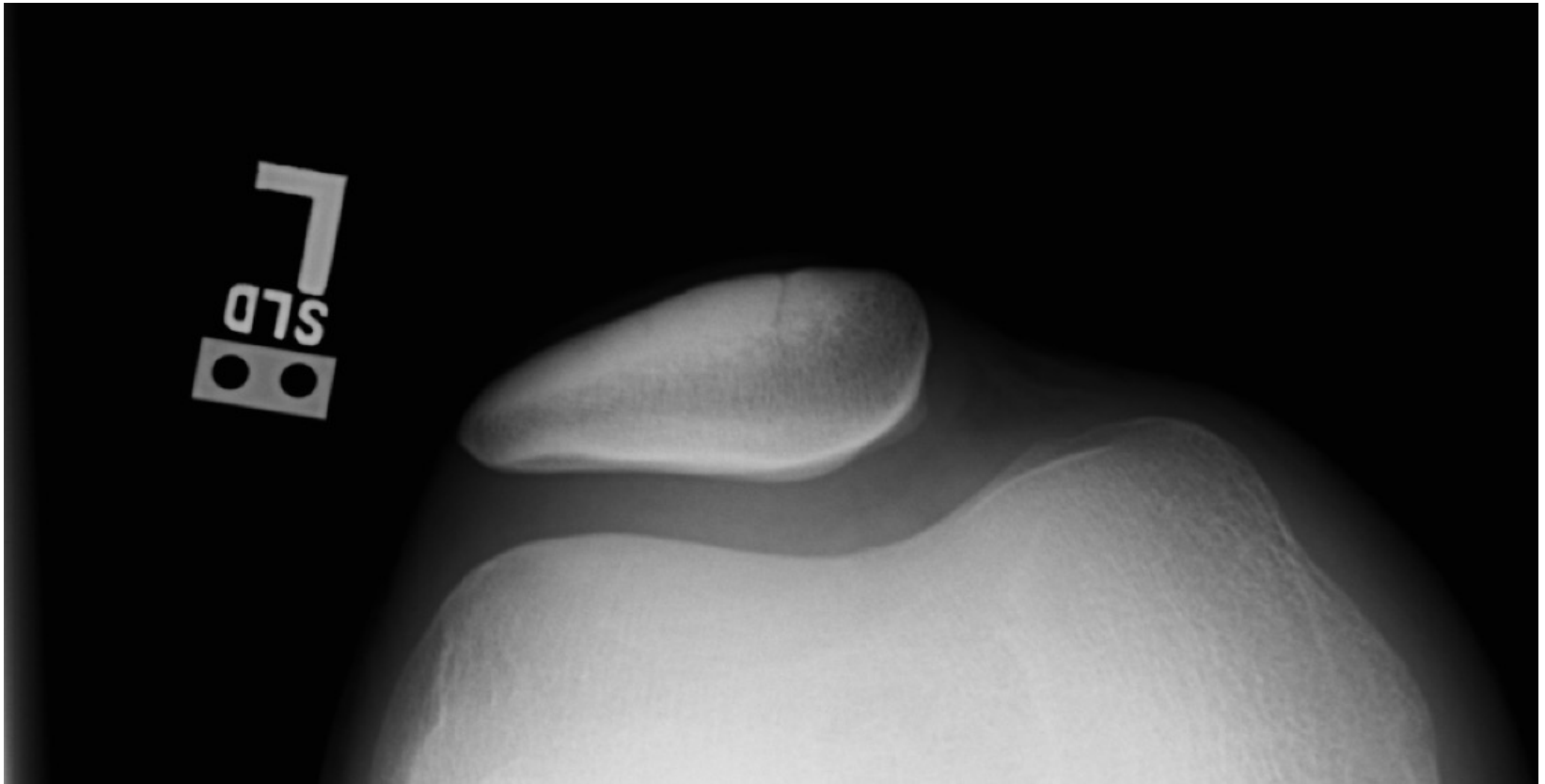
# Patellar Grind



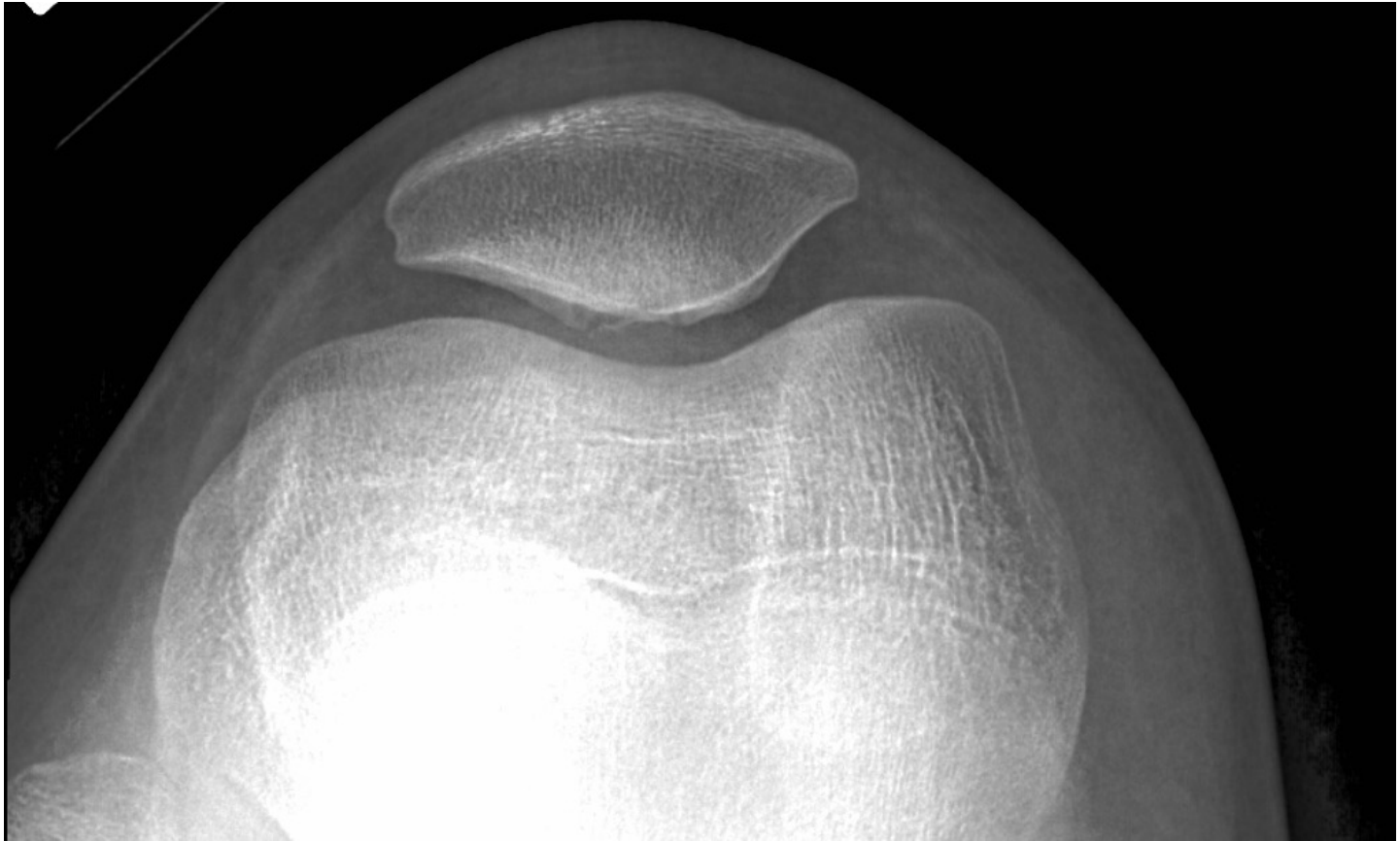
# Imaging

- Radiographs: PA, lateral, axial (Merchant, sunrise others)
- CT
- MRI

# Sunrise View



# Anterior Knee Pain – Adolescent



# OCD Patella



# When to Consider Radiographs

- Trauma, previous surgery
- Pain that does not improve with treatment
- Unable to clinically diagnose

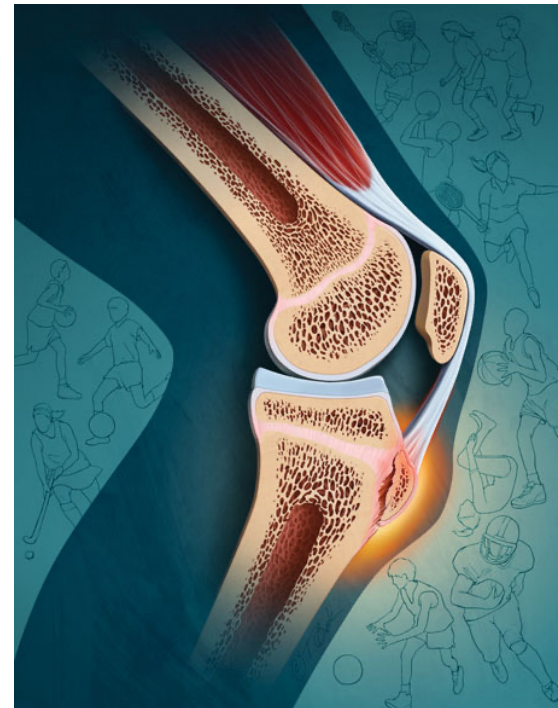
# Treatment

- Relative Rest
  - Reduction in training intensity, frequency, volume
  - Alternative activities: cycling, swimming, elliptical
- Pain Reduction – ice, modalities if needed
- PT – strengthening, flexibility and dynamic stabilization



# Osgood-Schlatter Disease

- Tibial tubercle apophysitis, first described by Dr. Robert Osgood in 1903
- Traction force of patellar tendon on tibial tubercle with micro-avulsion injury
- Pain, and often swelling over tibial tubercle



# Osgood-Schlatter Disease

- Average age 10-14 years; typically resolves by age 15 in girls, 16 in boys – closure of apophysis
- Relative rest, ice, quadriceps / hamstring strengthening and flexibility
- X-ray usually does not alter management



# Sever's Disease (Calcaneal Apophysitis)

- May be more of a metaphyseal stress injury  
(Ogden *J. Pediatr. Orthop.* 2004; )
- History
  - Pain during/after activity- running/jumping
- PE
  - + “squeeze test”
  - TTP posterior, medial, lateral calcaneus)

# Sever's Disease

- X-ray
  - Does not change management
  - Fragmentation
  - Sclerosis
  - Increased density of apophysis



(in a symptomatic patient!)

# Sever's Disease

- Treatment
  - Relative rest
  - Heel cups/lifts – short term only
  - Strengthening
  - Orthotics rarely needed
  - For recalcitrant cases:
    - Dorsiflexion splint at night
    - Walking boot
    - Consider additional imaging

# Little League Elbow

- Apophysitis at medial epicondyle
- May lead to avulsion of medial epicondyle
- Due to valgus forces (baseball)

# Little League Elbow

- Symptoms
  - Medial pain
  - Pain with resisted wrist flexion
  - Soft tissue swelling
- Signs
  - TTP over med. epicondyle
  - Ecchymosis if acute avulsion
  - Pain w/ valgus stress
  - No effusion

# Little League Elbow

- Imaging
  - X-rays: fragmentation or avulsion of medial epicondyle
    - Get comparison views





# Little League Elbow

- Treatment
  - Apophysis widening
    - Rest from throwing
    - Functional rehab
  - Avulsion <5mm
    - Immobilize 2 wks
    - Functional rehab
  - Avulsion >5mm
    - ORIF



# Clinical Features - OCD

- Adolescent age group
- Sports setting
- Mechanical symptoms
  - Intermittent locking
- Pain, swelling, stiffness
- TTP, effusion, decreased ROM
- Sites
  - Medial femoral condyle
  - Talus
  - Capitellum
  - Patella



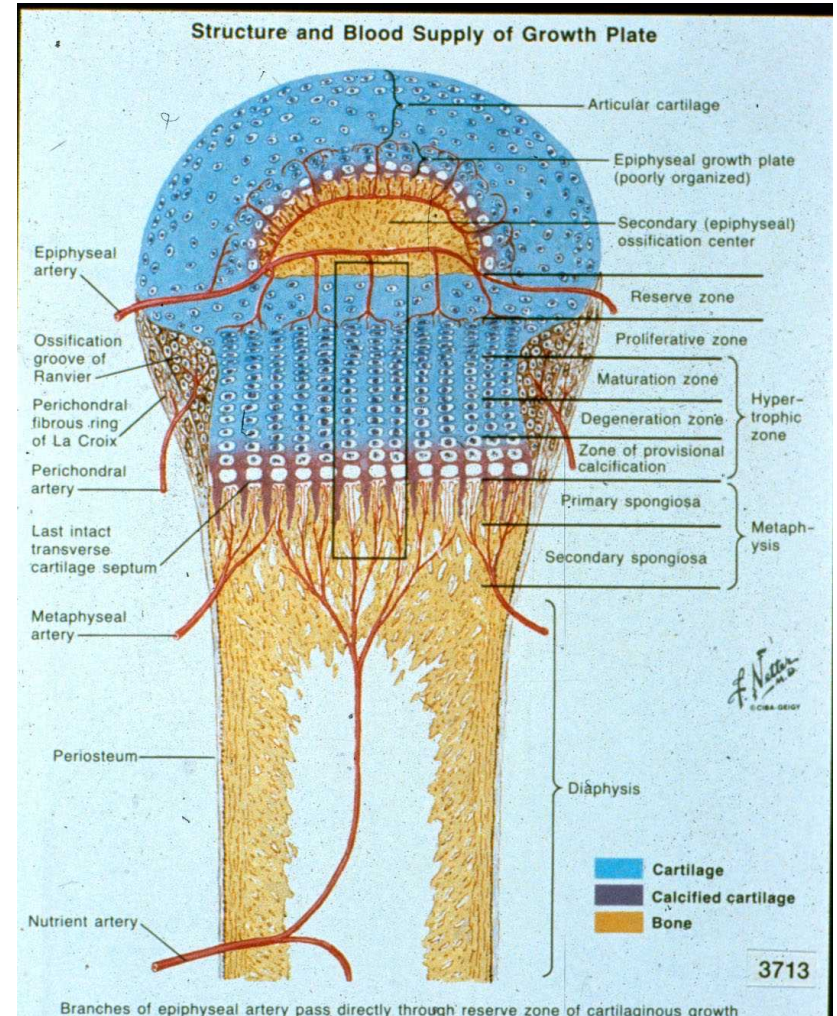
# Treatment - OCD

- Consultation peds ortho in most cases
- Tx depends on site and stage
  - Stage with MRI
    - Stage I – thickening of articular cartilage
    - Stage II – low signal rim = fibrous
    - Stage III – high signal behind fragment = fluid – unstable
    - Stage IV – loose fragment
  - If stable – rest, observe
  - Unstable – arthroscopy -removal of loose fragments, debridement



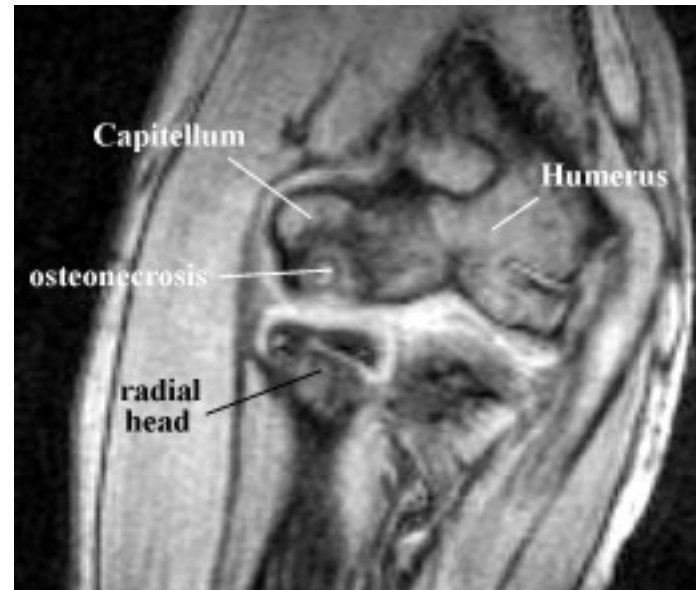
# Osteochondroses

- Thought to represent disorder of endochondral ossification
- Endochondral ossification
  - Mechanism in which cartilage is transformed into bone.
  - Chondrocyte proliferation, matrix production, calcification, ossification
- However, normal endochondral ossification may not be uniform



# Pathogenesis

- Early necrosis – condensation
- Revascularization with bone deposition and resorption – fragmentation
- Bone healing- reorganization
- Residual deformity



## Panner's

- 7-12y (peak 9y)
- +/- Sports related
- Full ROM
- No locking, catching
- Flattening and patchy sclerosis of most of capitellum
- No loose bodies
- Self limited
- No long term sequelae

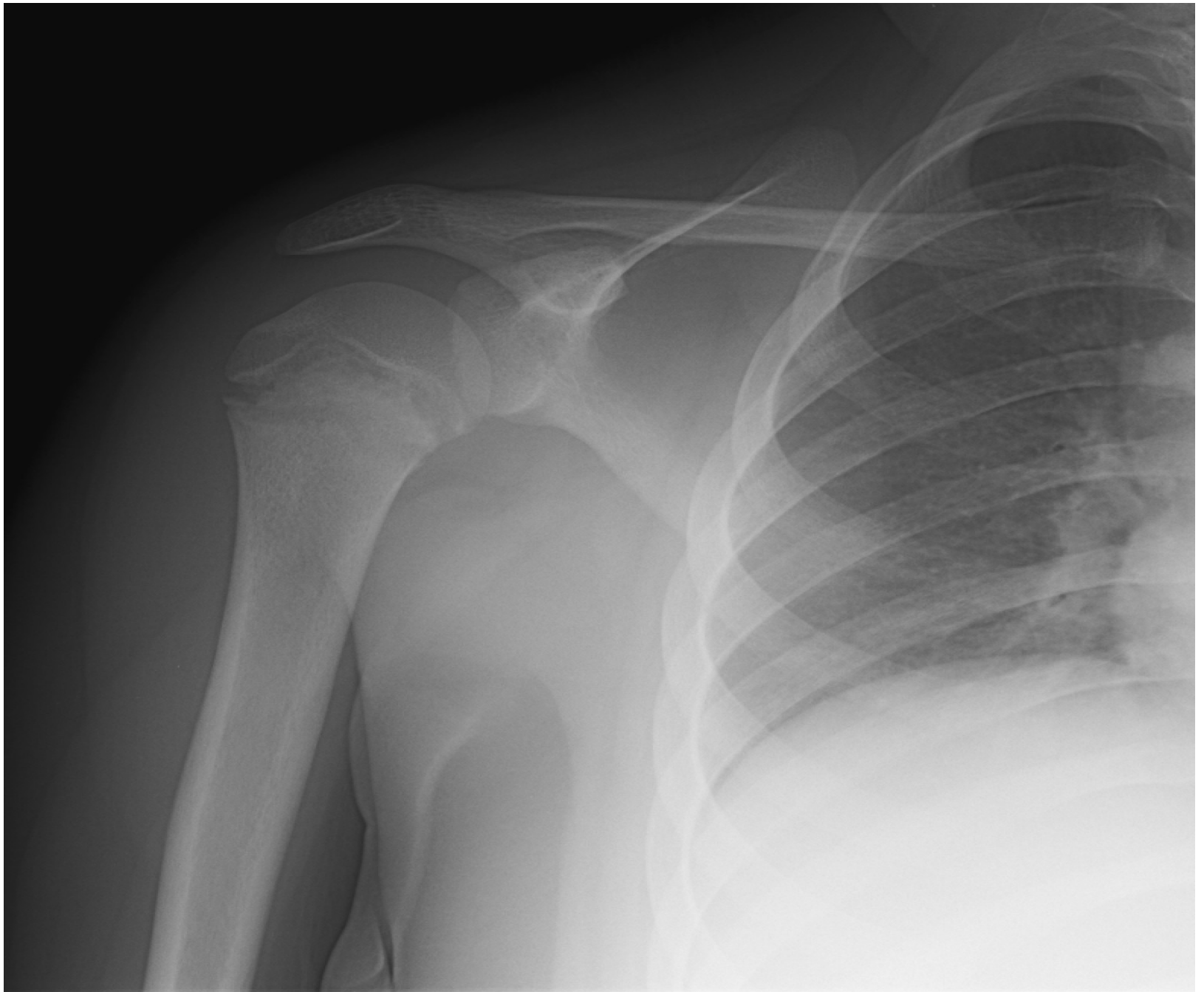
## OCD Capitellum

- 11-16y
- Gymnasts, pitchers
- Limited ROM
- Catching/locking can occur
- Focal lesion
- Loose bodies
- May require intervention
- Residual deformity/disability

# History

A 13 yo right hand dominant pitcher complains of a 2 month history of right shoulder pain. No history trauma. No paresthesias of the extremity. Pain only occurs when throwing. He rested for 2 weeks, but the pain recurred when he resumed throwing.

The exam is unremarkable.

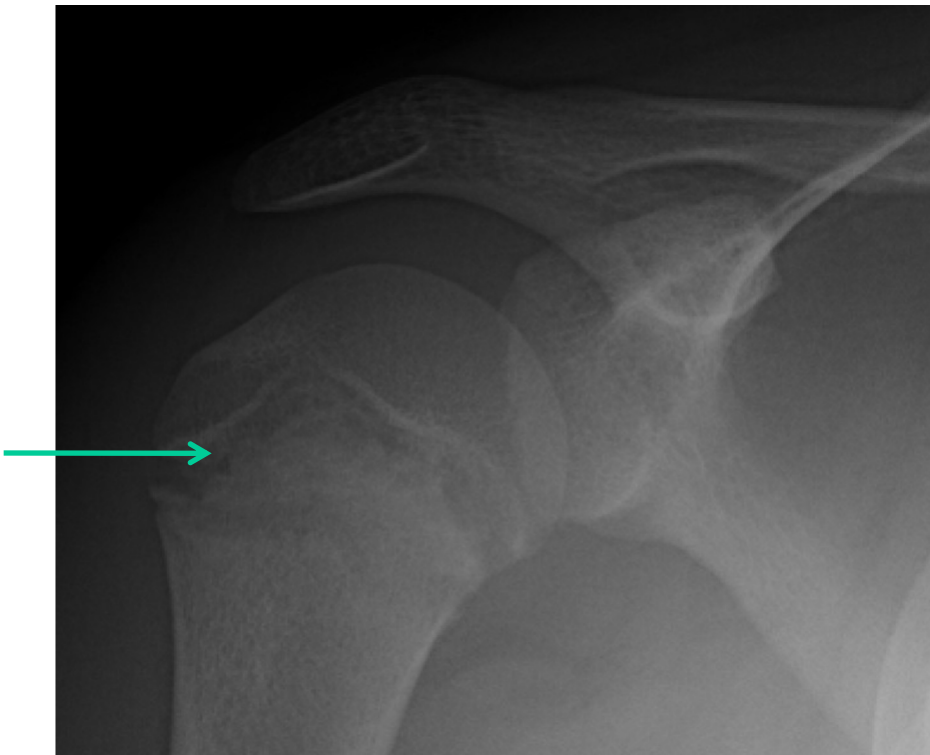




## Which of the following is appropriate?

- A. Obtain an MRI to rule a rotator cuff injury
- B. Begin physical therapy to strengthen the rotator cuff
- C. Obtain comparison x-rays of the left shoulder
- D. Order a bone scan to assess the growth plate

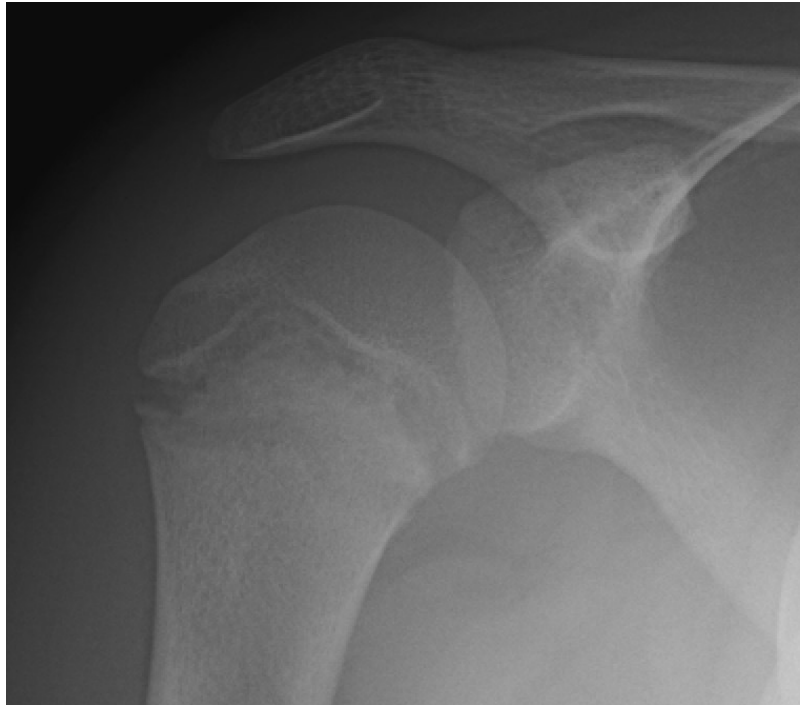
# Proximal Humeral Physeal Stress Injury – Little Leaguer’s Shoulder



# Treatment

- Rest from all throwing for at least 6 weeks
- Repeat radiographs to assess healing
- Address issues underlying overuse injuries
  - Excessive throwing
  - Biomechanics/strength
  - Unrealistic expectations
  - Injury prevention education

Initial

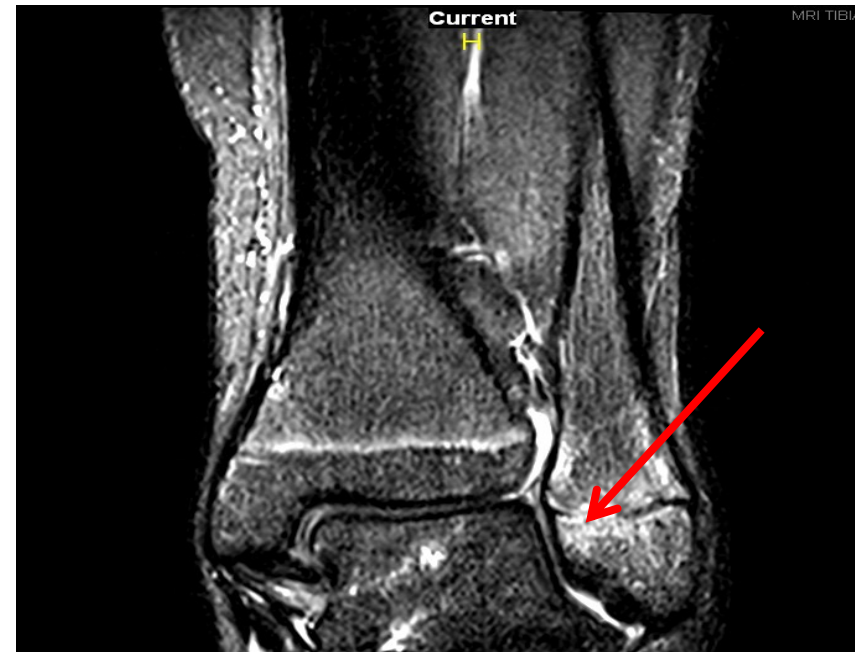


Follow Up



# Lower Extremity Physeal Injuries

- Sites involved
  - Distal femoral and proximal tibial physes most commonly reported
- Sports:
  - Distance running, basketball, tennis, soccer, baseball, basketball, gymnastics, football, rugby



12 yo girl with 1 yr hx of ankle pain

# 11 yo Tennis Player with Knee Pain



# Consequences of Physical Stress Injury

11y 6mo



17 y



# Case History

- A 14yo competitive tennis player presented with a 4 wk history of R wrist pain.
- Currently home schooled to enable her to continue to play on a more extensive basis.
- Now has a private coach. Trains 7 d/wk, 4 h or >/session.
- Prior to this year she was practicing 2-3 times per week.
- 3-4 weeks ago she began to notice soreness of the right wrist, hitting forehands or forehand volleys. No history of trauma.
- Now unable to hit forehands or forehand volleys because of pain.

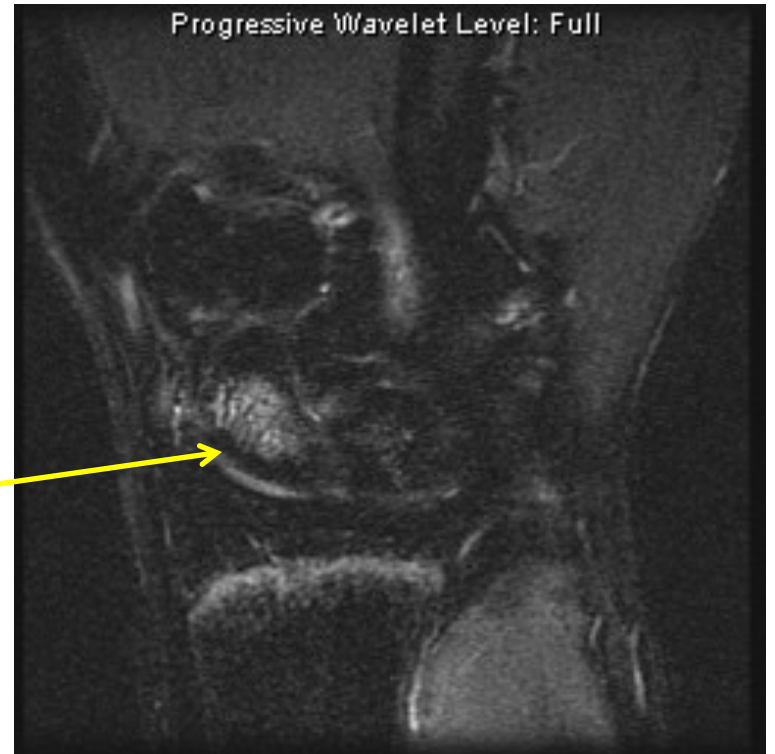
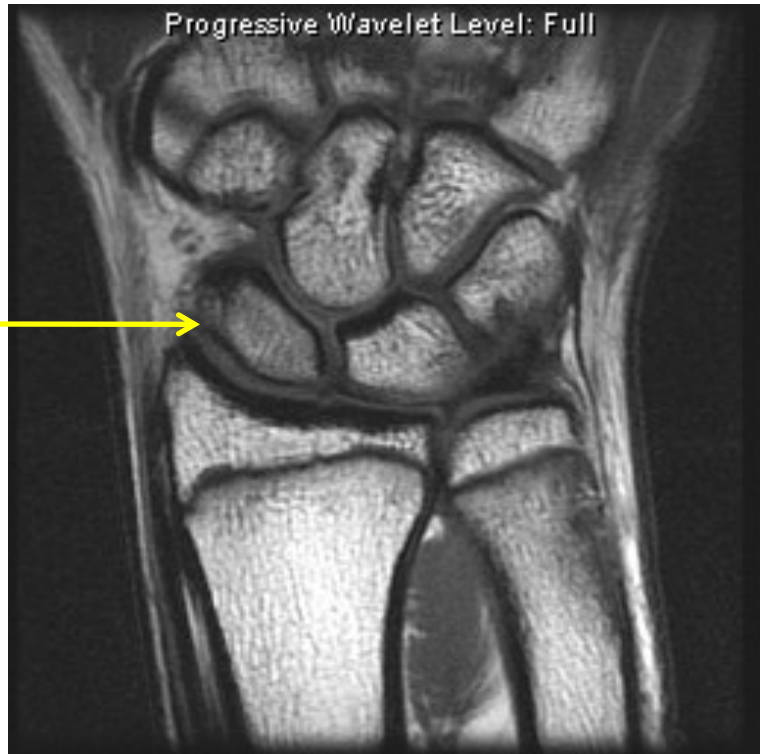


# Exam

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- Strength normal.
- No pain with ulnar or radial deviation of the wrist.



# Stress Fracture Scaphoid



# Preventive Considerations

Overuse injuries in children and adolescents are largely preventable.



## Prevention – First Step

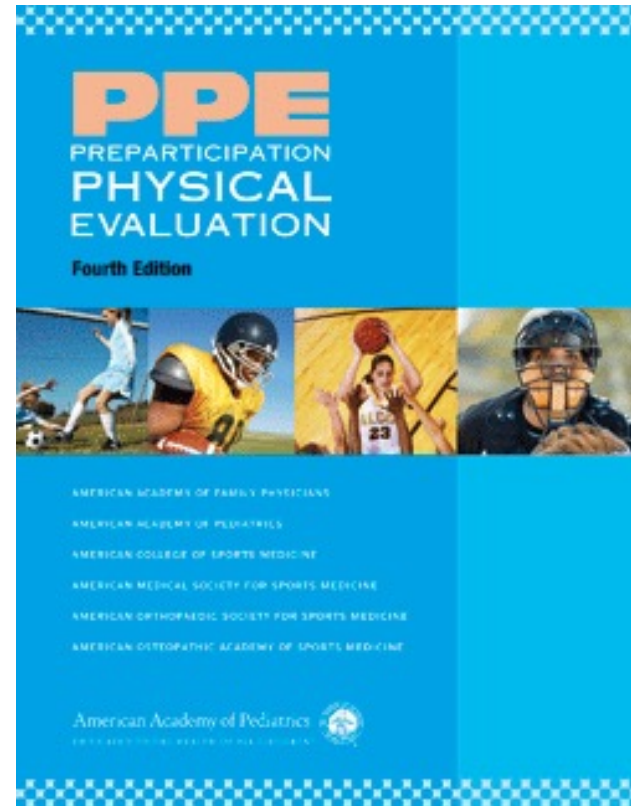
# Address the Underlying Cause of Any Overuse Injury!

- Review potential risk factors
- Include parents, coaches, trainers
- Re-educate: training, rest, technique, equipment
- Evaluate menstrual dysfunction/bone health



# 2. Preparticipation Screening

- Appropriate preparticipation screening
  - Prior injuries
  - Maturation
  - Skill level
  - Motivation



# 3. Coaching and Supervision

- Proper supervision and coaching
- Ensure coaches are knowledgeable
- Local physicians, ATCs, PTs and others can assist

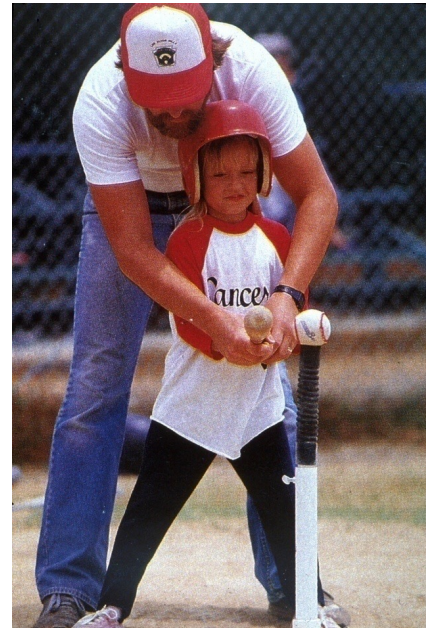


## CIF Spreads the Word on New Training

■ **Matching funds:** State to provide grants for coaching program on issues from ethics to rule adherence.

# 4. Sport Readiness

- Children should participate at a level consistent with their ability AND interest
- Recognize sport readiness/cognitive development
- Cognitive development is variable within age ranges



DiFiori J, Benjamin H, Brenner J et al. Overuse Injuries and Burnout in Youth Sports:

A Position Statement from the American Medical Society for Sports Medicine. Clin J Sport Med 2014;24:3–20)

# 5. Equipment

- Adequately fitted and maintained equipment
- Leagues should review and update yearly
- Rule changes that address safety





# 6. Training - Changing the Culture

- Training programs should emphasize general fitness and avoid excessive training volume
  - One size does not fit all
  - Must allow for growth and development
  - Carefully monitor volume when mastering a new skill
- Gradual training progression
  - Short term (1-3 months) and long term planning (1yr)
  - 10% rule of training progression ?
  - Periodization of training
    - Systematic cycling of training volume and intensity (Bompas and others)

# 7. Rest and Recovery

- Ensure 1-2 days of rest from sport each week
- Watch for signs of “burn out”, loss of interest
- Provide/encourage time away from specific sport each year



# Preventive Considerations

- Rest and recovery alone is not adequate treatment for overuse injuries
- Those involved in intense training should be regularly monitored including:
  - Nutritional status
  - Sleep
  - Signs of emotional stress



## 8. Sport Sampling

- Encourage sport diversification
  - Provide opportunity to try other sports
  - Encourage free play, unsupervised pick up games
  - Avoid limiting participation based upon a preconception
- Delay single sport specialization
  - Age may vary depending upon sport
  - In general, preferably to mid-late adolescence (14y or older)

# Early Specialization Sports

- Gymnastics
- Rhythmic Gymnastics
- Figure Skating
- Diving
- Swimming



## 9. Avoid Overscheduling

- Caution parents about more than one team or sport in same season
- Provide a transition between sports/seasons
- It is OK to miss a game for a family or school event!

# 10. Training - Changing the Culture

Training programs should emphasize general fitness and avoid excessive training volume

- One size does not fit all
- Must allow for growth and development
- Carefully monitor volume when mastering a new skill

Gradual training progression

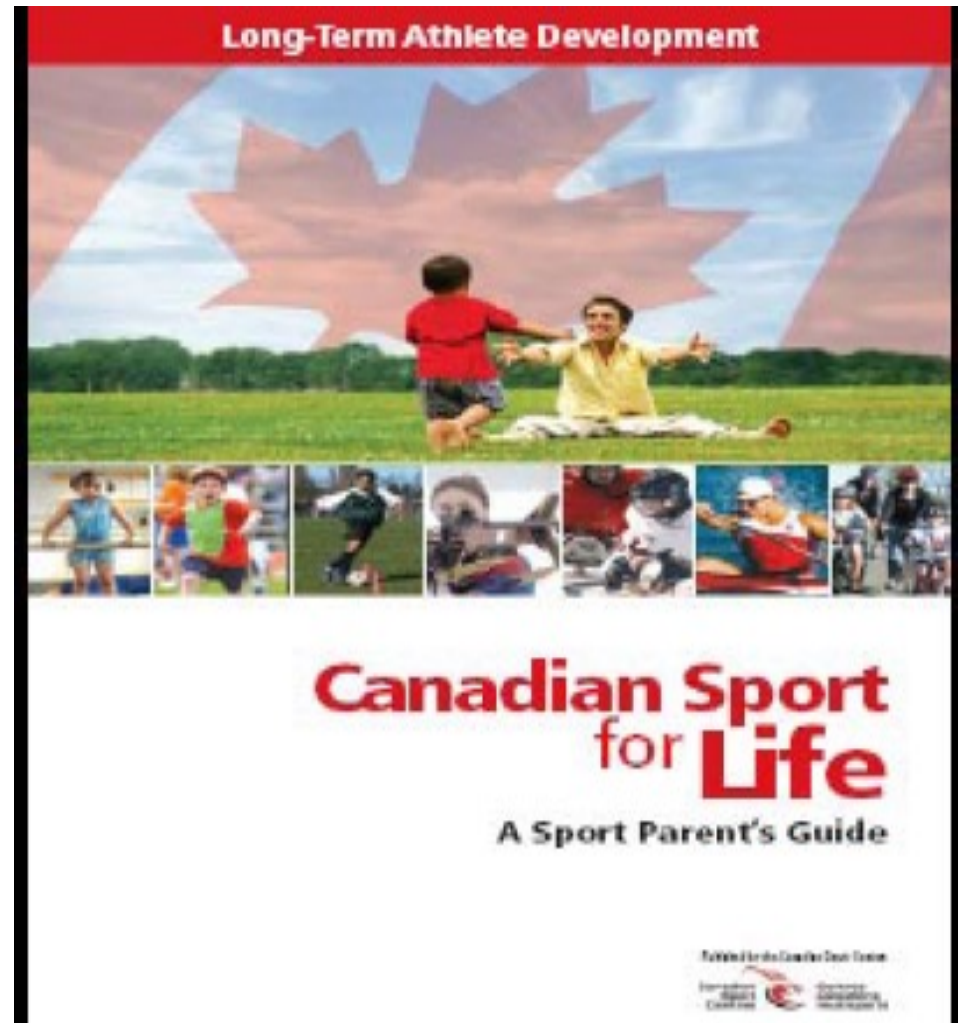
- Short term (1-3 months) and long term planning (1 year)
- Acute:chronic load ratio ??? Not described in adolescents
- Periodization of training

Systematic cycling of training volume and intensity

# Long Term Activity

## Long Term Athlete Development

- Physical literacy
- Active start
- FUNdamental
- For some:
  - Learning to train
  - Training to train
  - Training to compete
  - Training to win
- Active for life





# Thank You

