

# Overuse Injuries in Children and Adolescents: Treatment & Prevention

**John P. DiFiori, M.D., FACSM, FAMSSM**

NBA Director of Sports Medicine

# Overuse Injuries in Young Athletes

- Factors contributing to overuse in youngsters
- Approach to Common Injuries
  - Diagnosis
  - Management
- 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.
- Home schooled to enable more time to train, travel and compete.
- Now has a private coach. Trains 7 d/wk,  $\geq 4$  h/session.
- Prior to this year she was practicing 2-3 times per week.



# Case History

- 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.

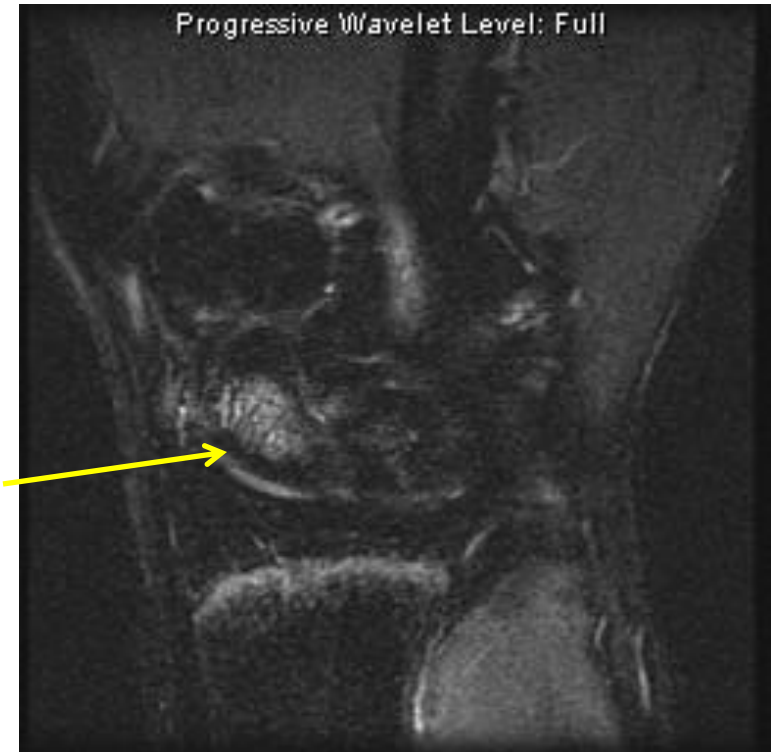


# Exam

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



# Stress Fracture Scaphoid





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graph TD; RA[Repetitive Activity] --> CTO[Cyclic Tissue Overloading]; CTO --> TF[Tissue Fatigue]; TF --> MT[Microtrauma]; MT --> ITR[Inadequate tissue repair]; ITR --> LTS[Loss of tissue strength]; LTS --> RA; OI[Overuse Injury];
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Repetitive Activity

Loss of tissue strength

Cyclic Tissue Overloading

**Overuse Injury**

Inadequate tissue repair

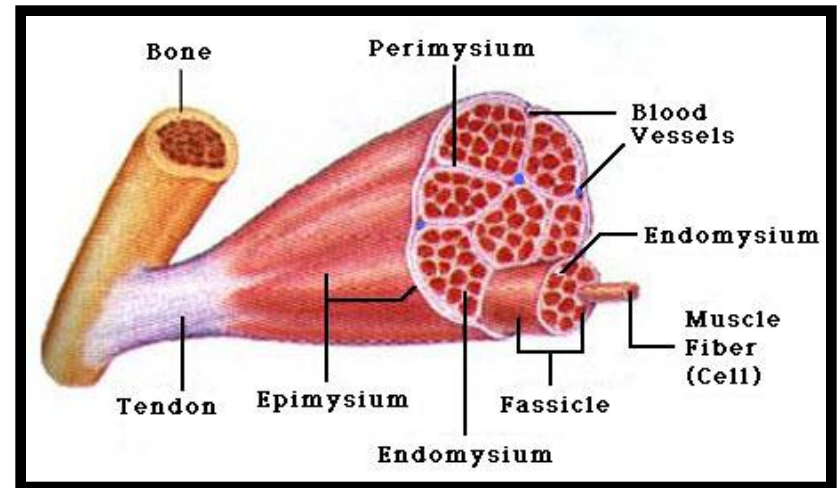
Tissue Fatigue

Microtrauma



# Tissues Commonly Injured Through Overuse

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



# Common Types of Overuse Injuries

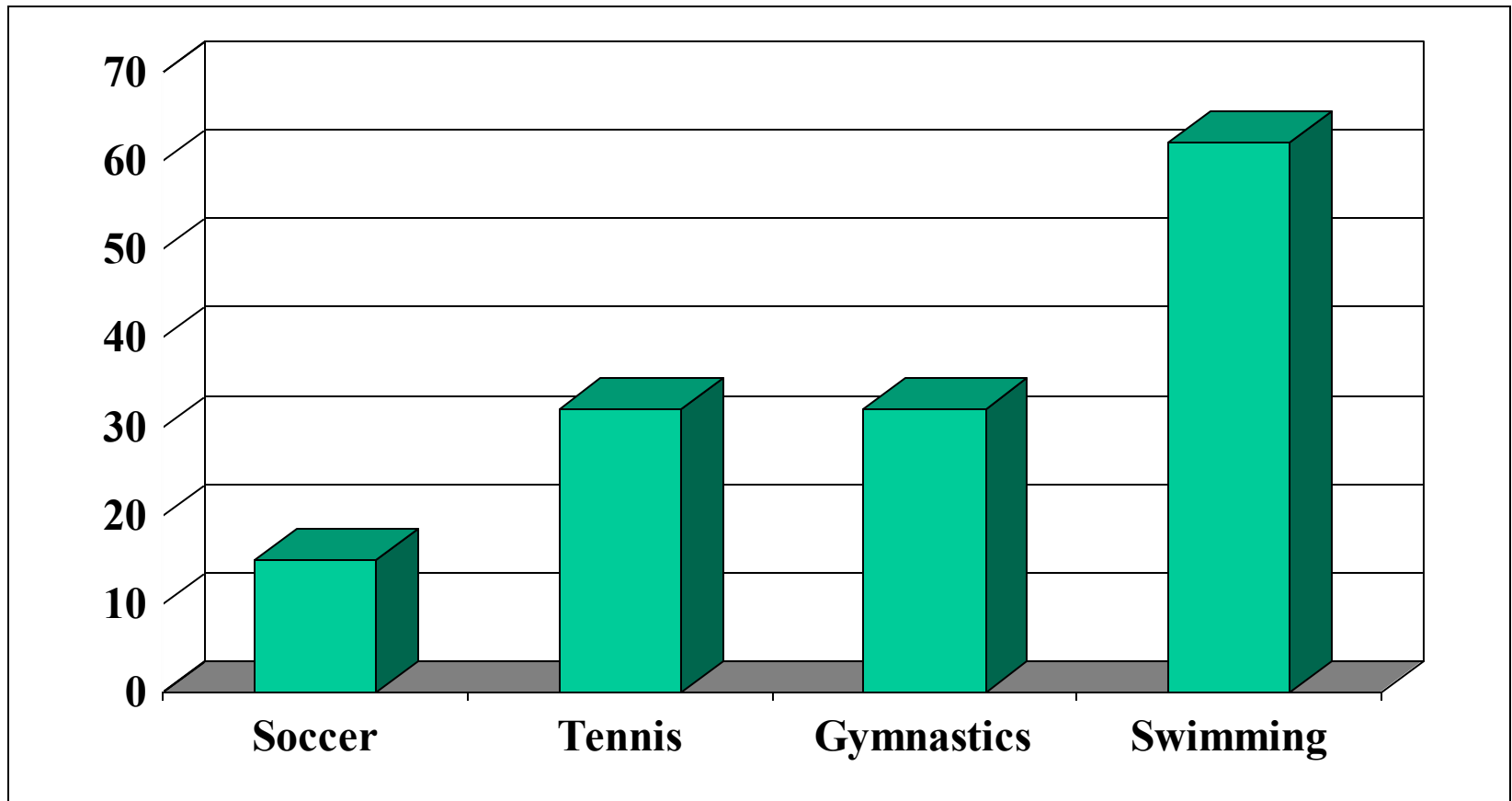
## Adults

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

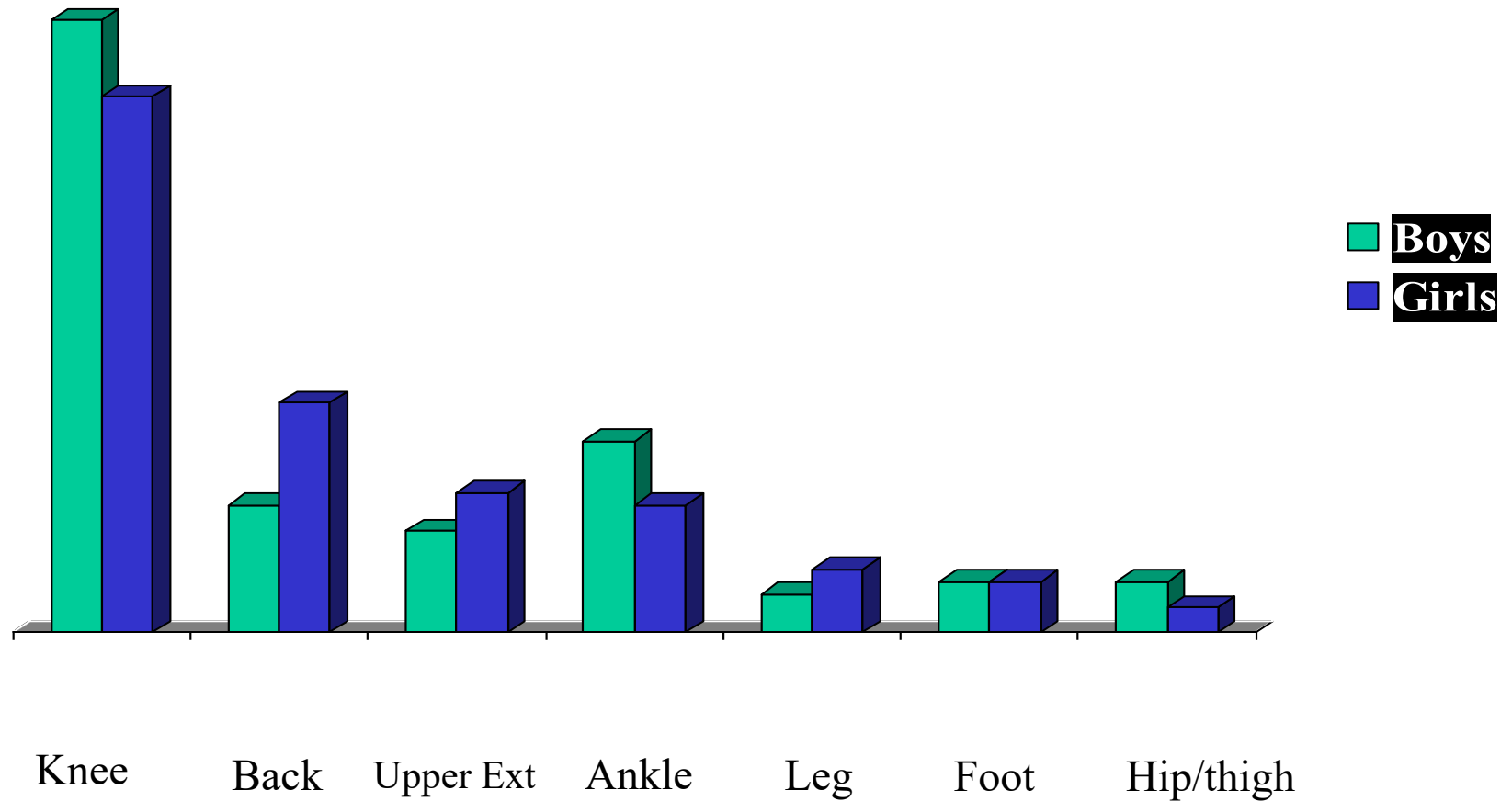
## Children and Adolescents

- 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

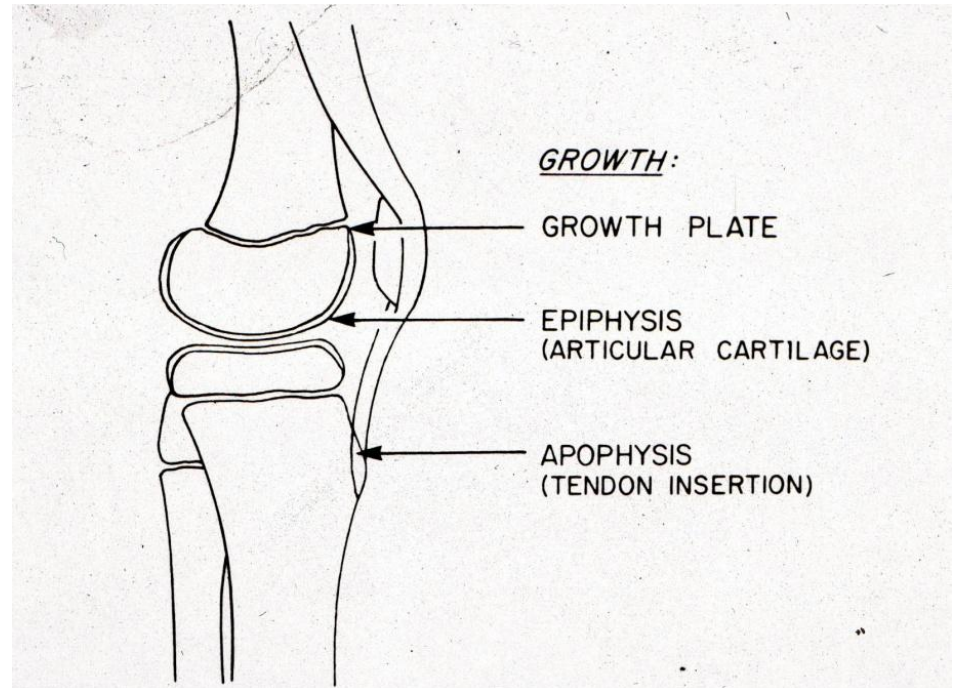


# Factors Contributing to Overuse Injury

- 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

# Common Apophyseal Injury Sites

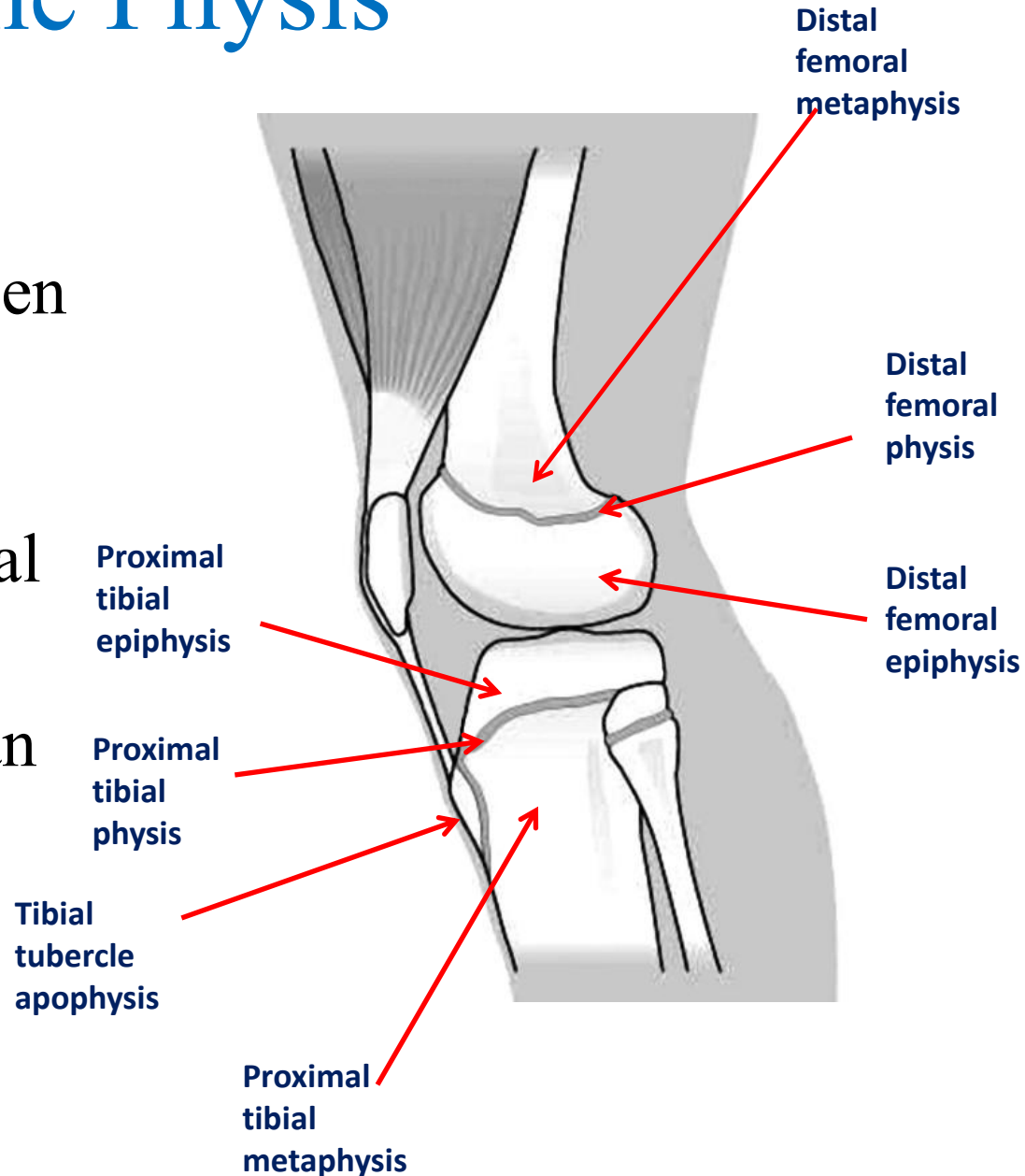
Elbow	<b>Medial epicondylar apophysitis</b>
Pelvis	<b>Ischial apophysitis</b>
Knee	<b>Tibial tubercle apophysitis</b> <b>Sinding-Larsen Johansson syndrome</b>
Foot	<b>Os calcis apophysitis</b> <b>Accessory navicular syndrome</b>





# 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



# Adolescents at Higher Risk

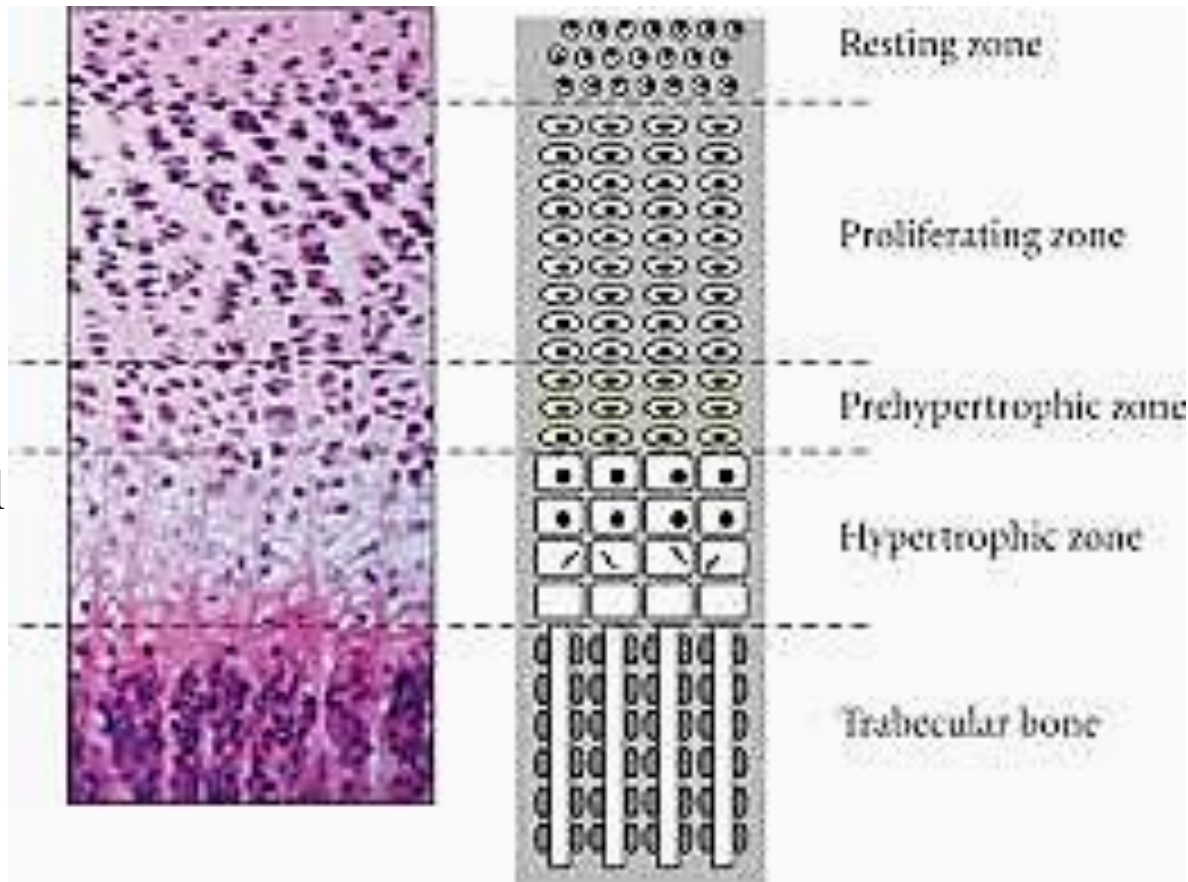
- Studied response to dynamic shear stress of bovine osteochondral junction
- Adolescent tissue failed at a significantly lower level of shear stress and required less energy to produce failure than either more mature or more immature specimens

Flachsmann et al (2000)

# Growth Plate Structure

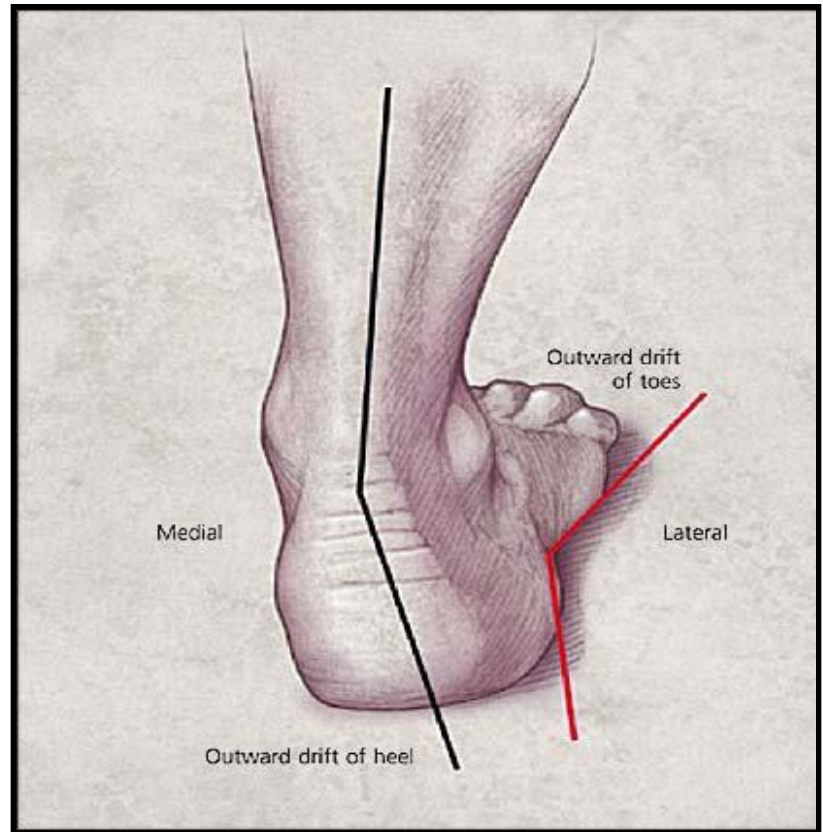
## Zones of chondrocytes:

- 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



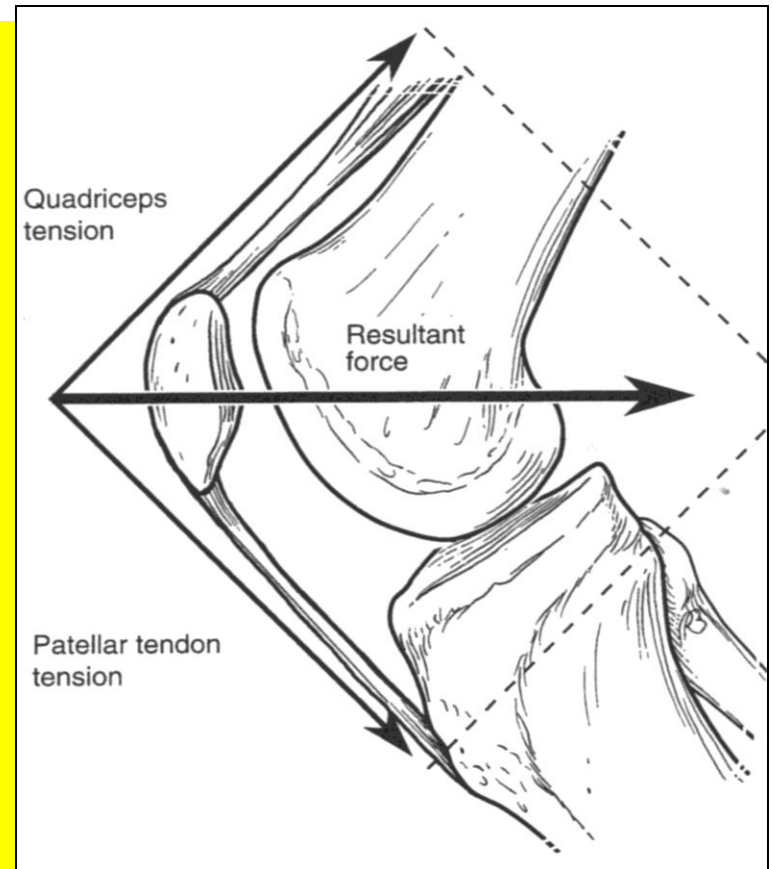
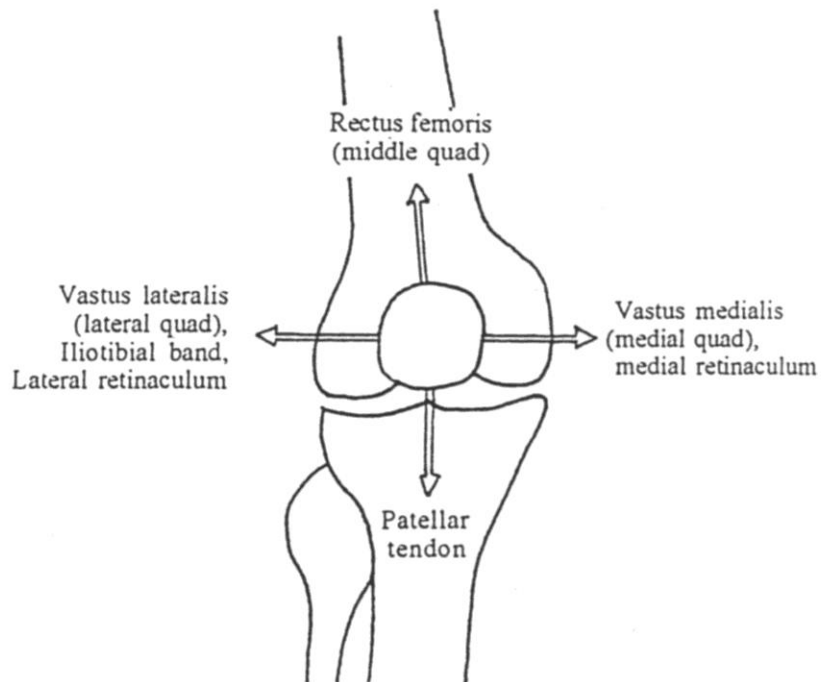
# Causes of Anterior Knee Pain

- 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

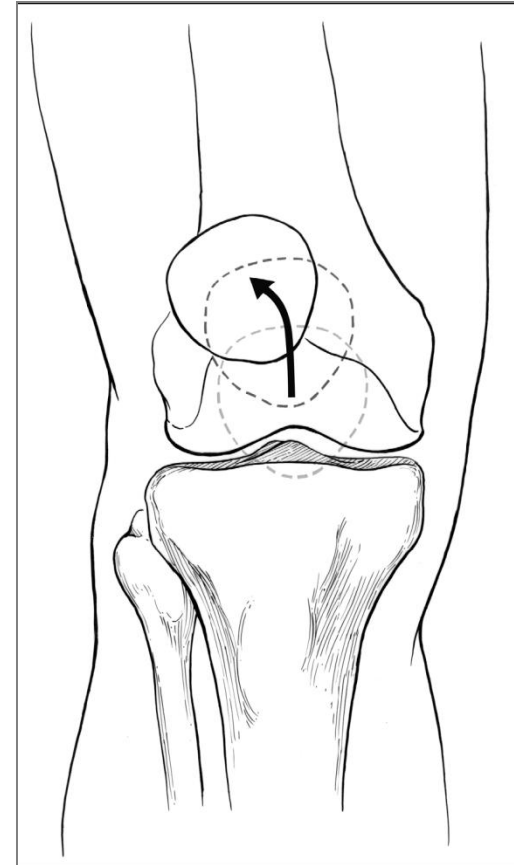
- Pain behind or around patella (circle sign)
- Gradual onset
- Stiffness with prolonged sitting
- Change in activity/training
- Pain with activities that load the PF joint: stairs, squatting, running
- May be bilateral
- Prior knee injury or surgery

# 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?

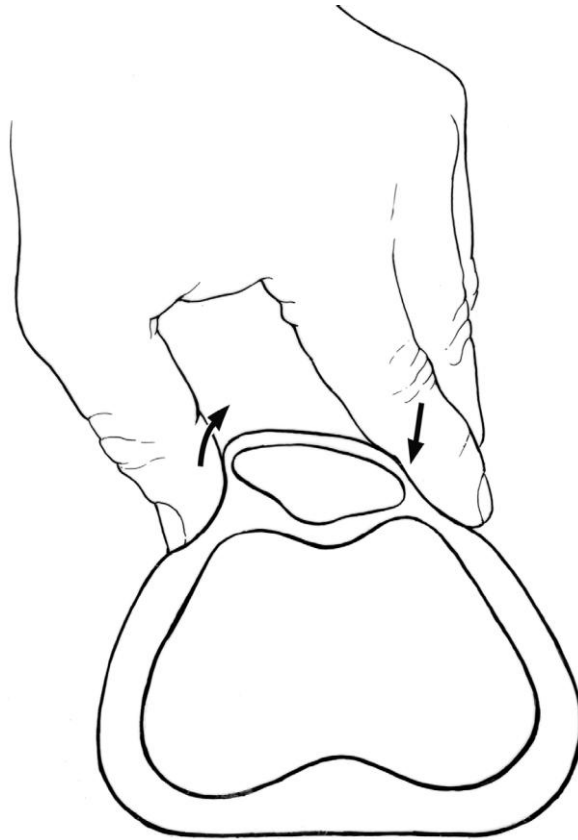
# Exam

- 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



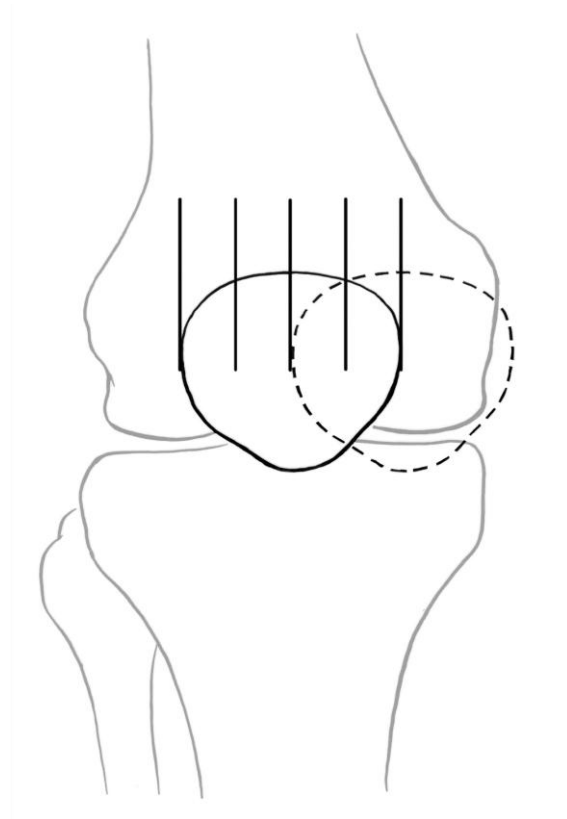
Lateral Patellar Tracking

# Patellar Tilt





# Medial Glide



# Patellar Compression



# Patellar Grind



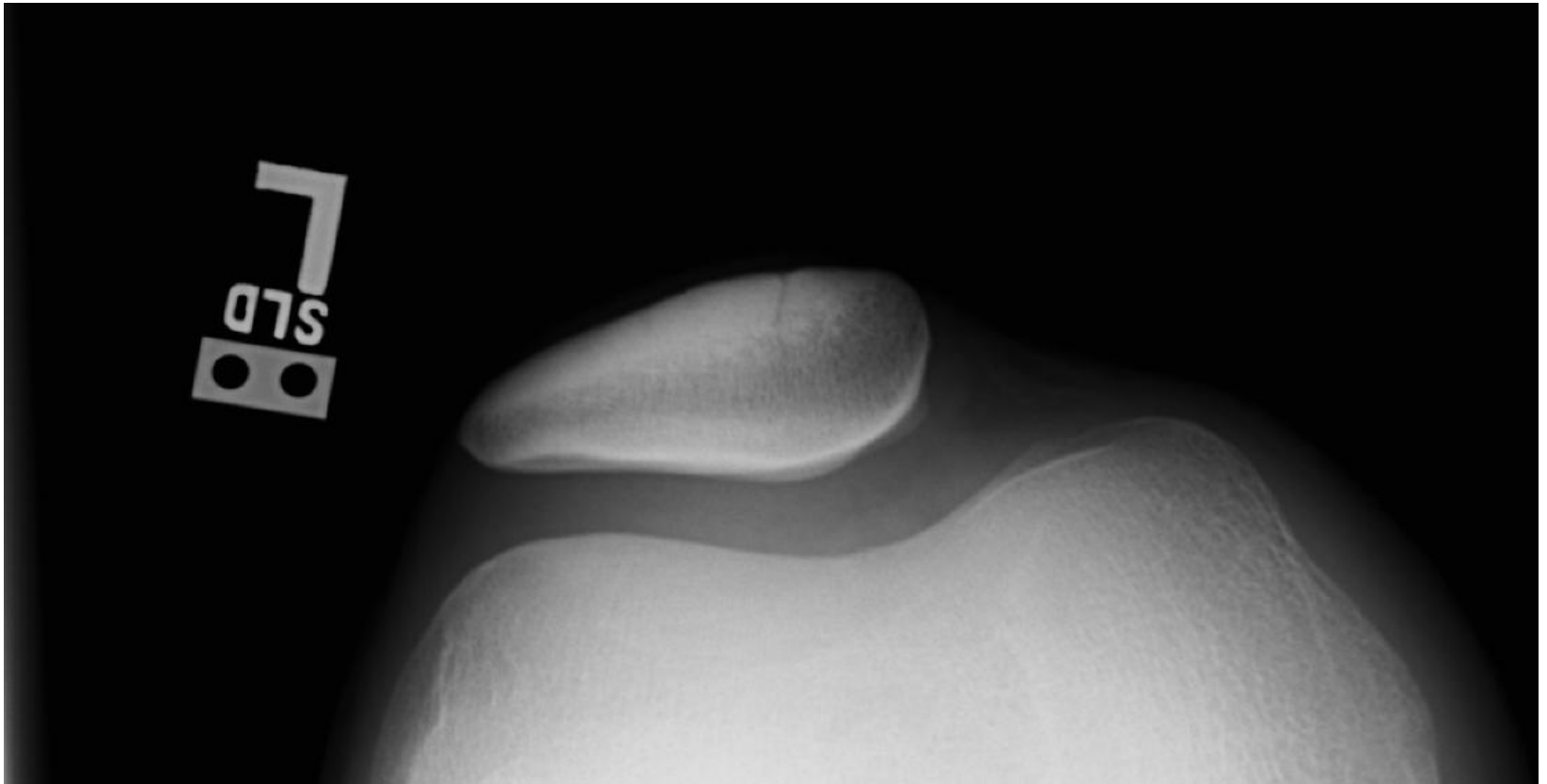
# When to Consider Radiographs

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

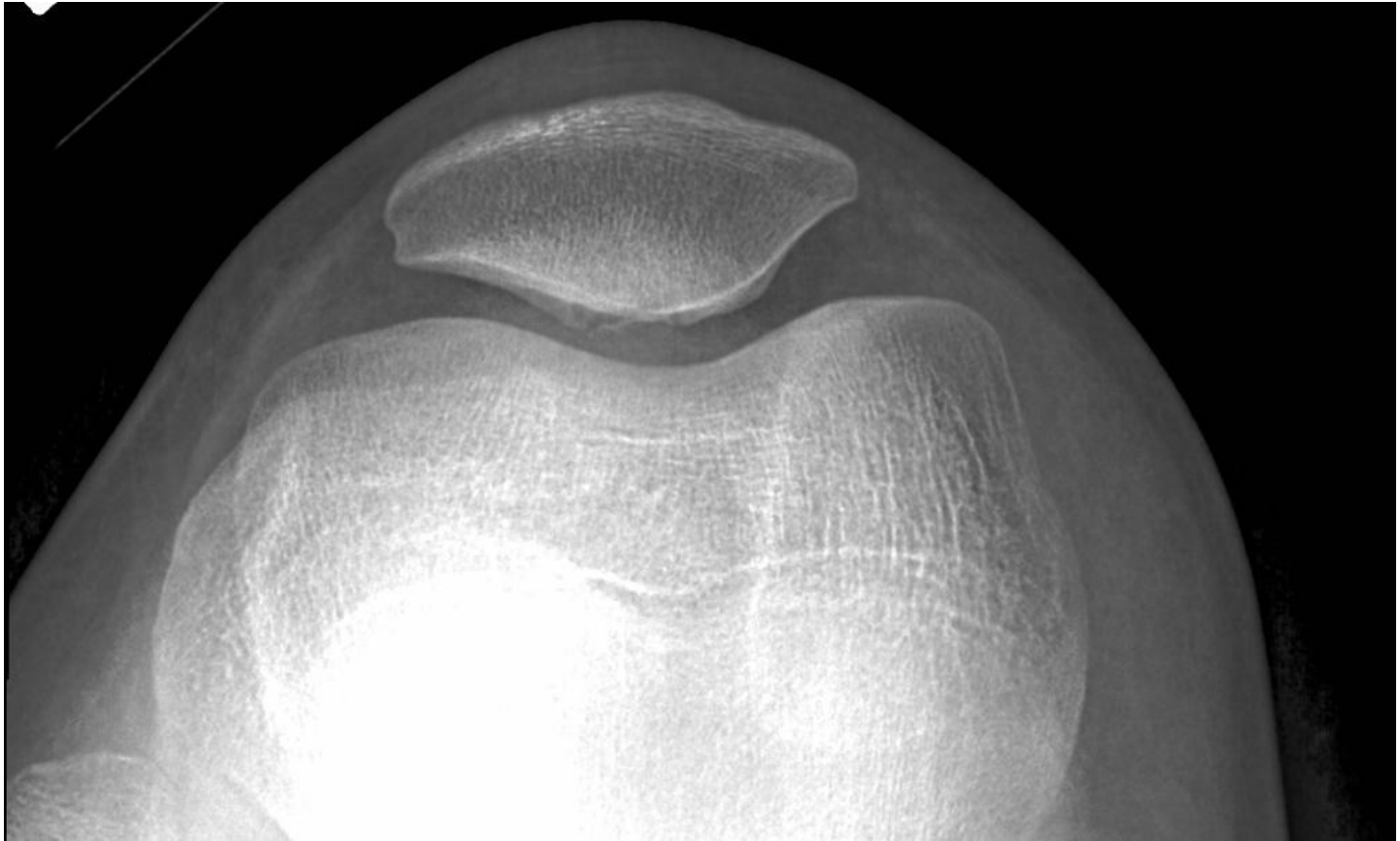
# Imaging

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

# Sunrise View



# Anterior Knee Pain – Adolescent



# OCD Patella



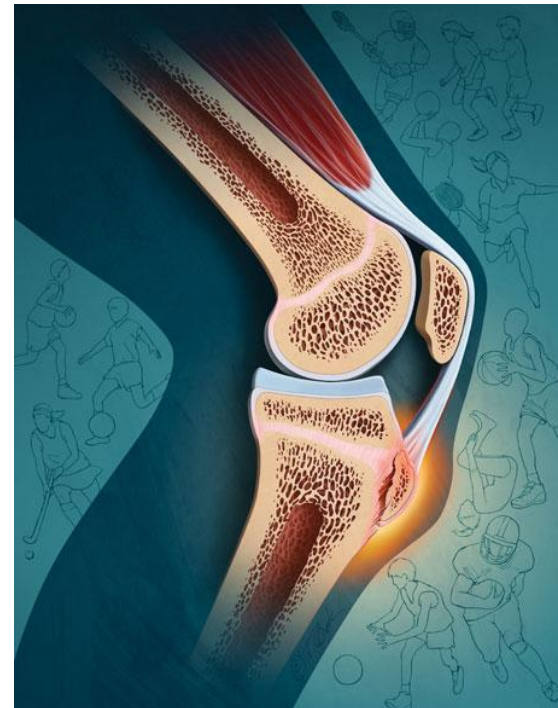


# Treatment

- Relative Rest
  - Reduction in training intensity, frequency, volume
  - Alternative activities: cycling, swimming, elliptical
- Pain Reduction – ice and 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

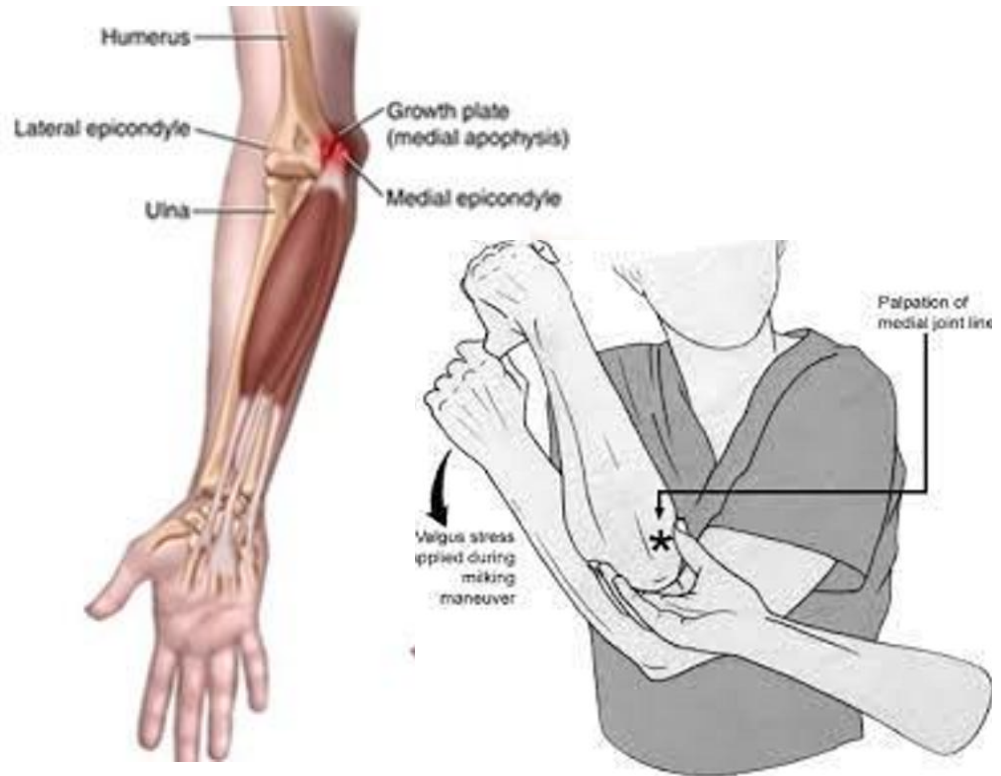
# Medial Epicondylar Apophysitis (Little League Elbow)

- Apophysitis at medial epicondyle
- May lead to avulsion of medial epicondyle
- Mechanism: Valgus stress



# 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



# Medial Epicondylar Apophysitis



# 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

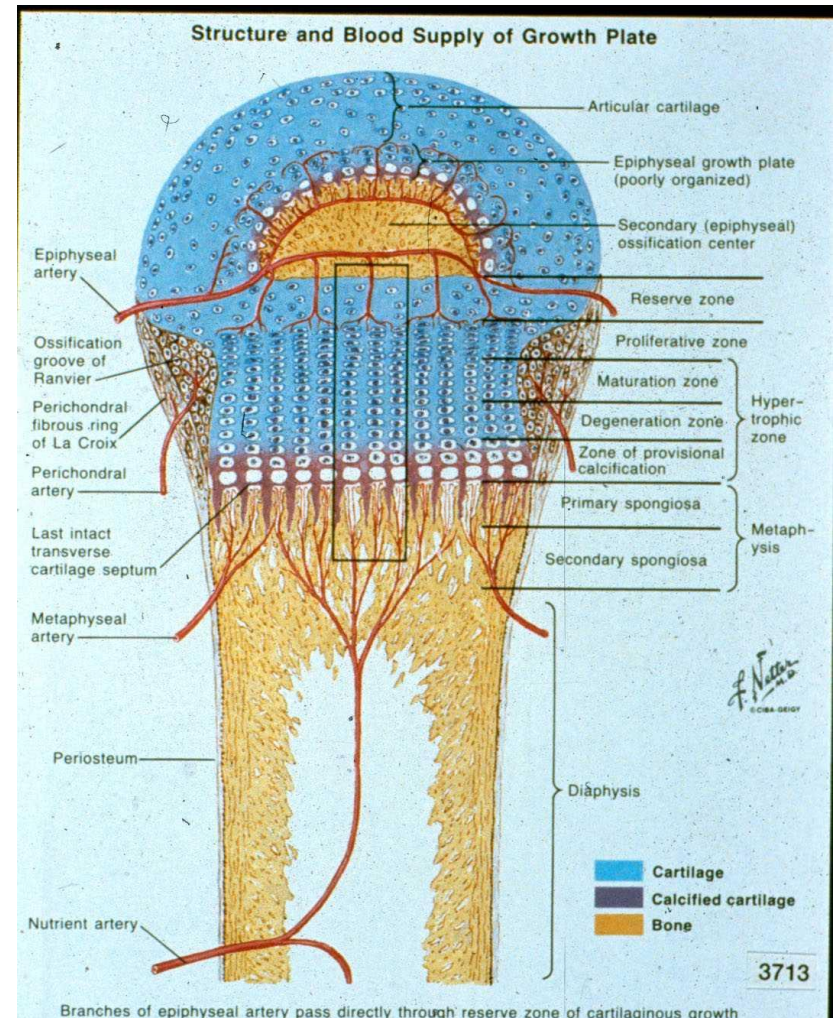
- Consultation peds ortho in most cases
- Tx depends on site and stage
  - Stage with MRI
    - Stage I – thickening of articular cartilage
    - Stage II – low signal rim = fibrous
    - Stage III – high signal behind fragment = fluid – unstable
    - Stage IV – loose fragment
  - If stable – rest,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

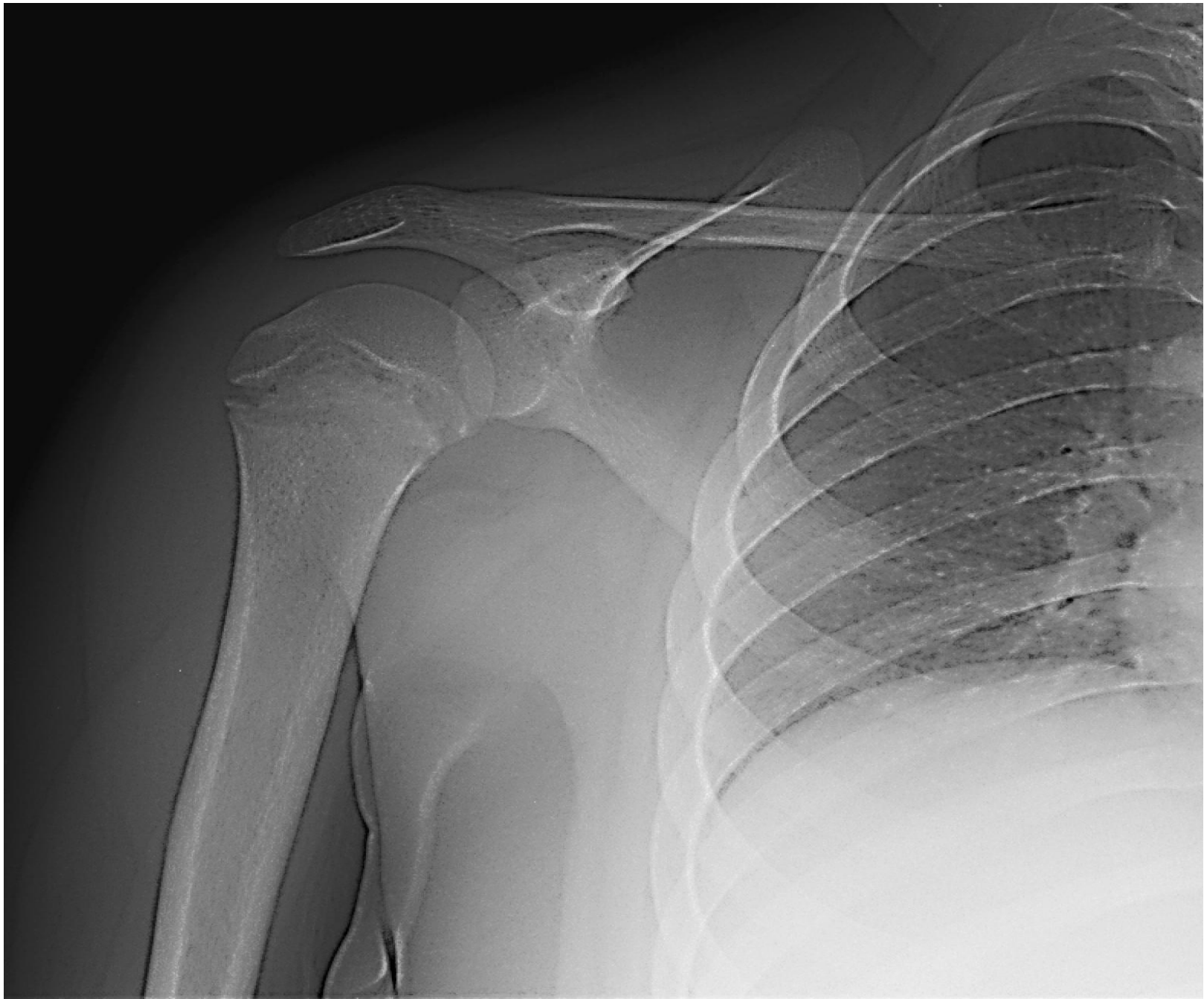
- 11-16y
- Gymnasts, pitchers
- Limited ROM
- Catching/locking can occur
- Focal lesion
- Loose bodies
- May require intervention
- Residual deformity and disability can occur



# 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.

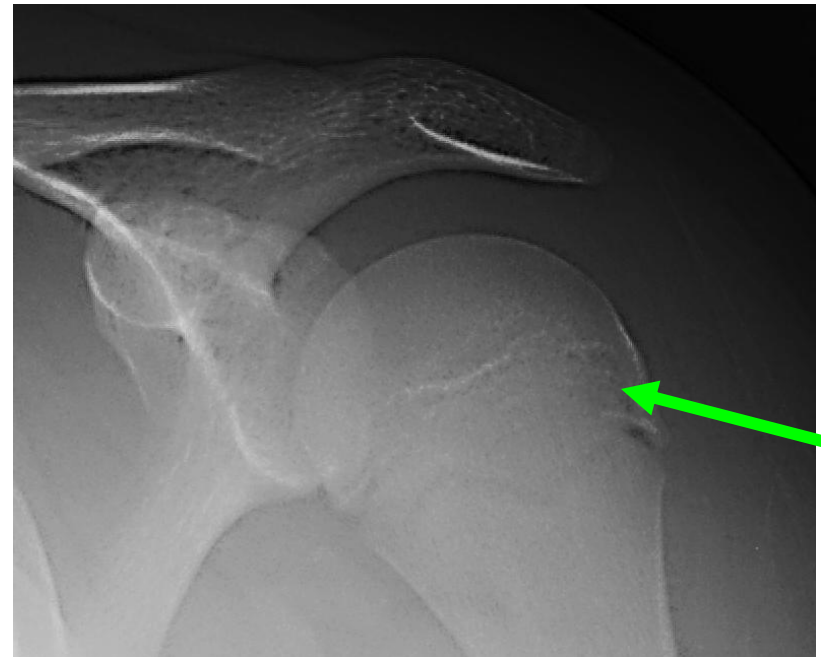
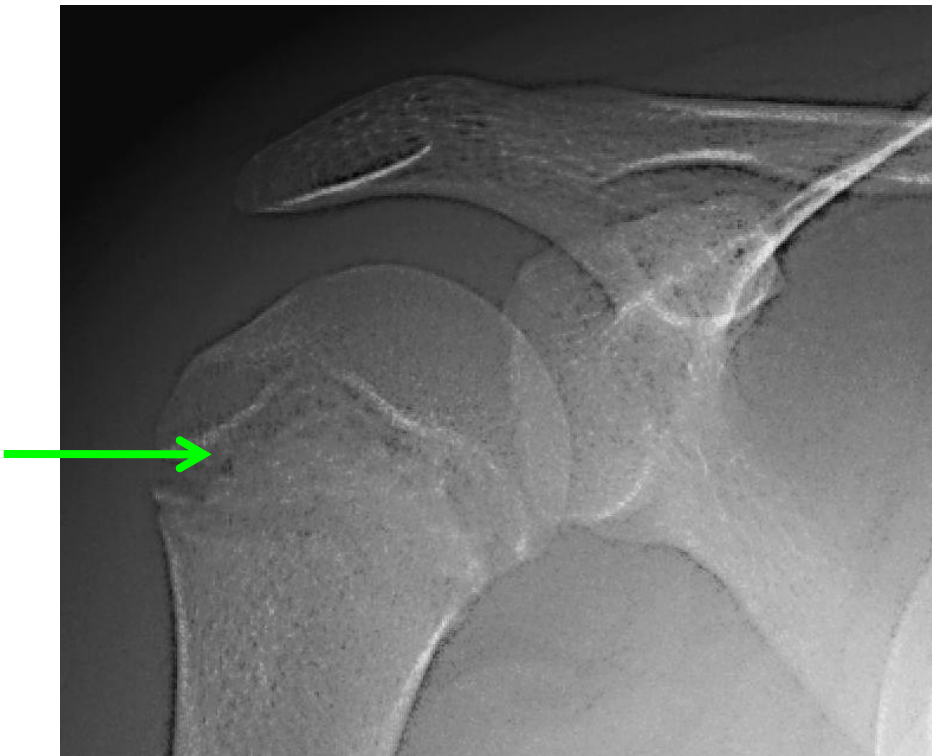
The exam is unremarkable.



## 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



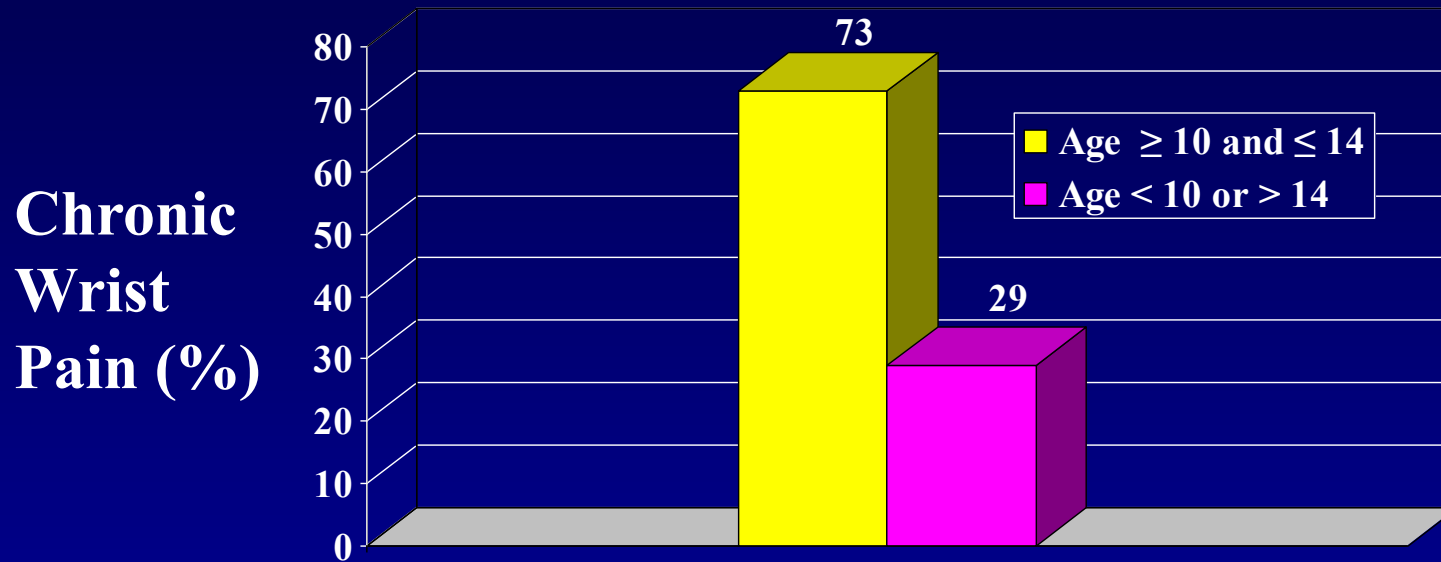
# Follow Up



# Distal Radial Physeal Injury



# Relationship between Adolescent Age and Chronic Wrist Pain



$P = 0.03$ , adjusted for ht, wt, yrs of training, age that training began, and training intensity.  
DiFiori et al. Clin J Sports Med 12:348, 2002.

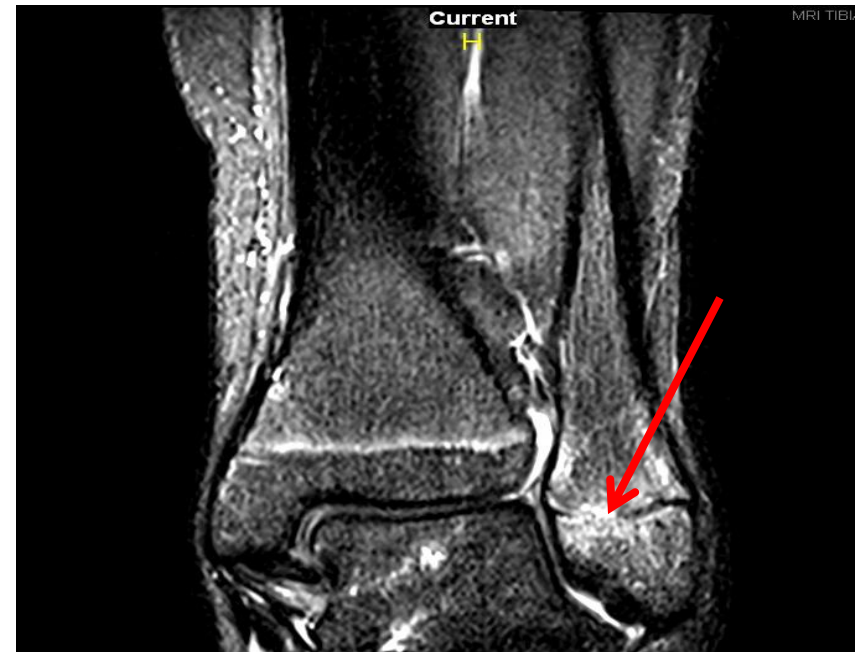


# Physcal Injury – Long Term Effects



# Lower Extremity Physical 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**



# 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

## PPE PREPARTICIPATION PHYSICAL EVALUATION

5th Edition

American Academy of Family Physicians

American Academy of Pediatrics

American College of Sports Medicine

American Medical Society for Sports Medicine

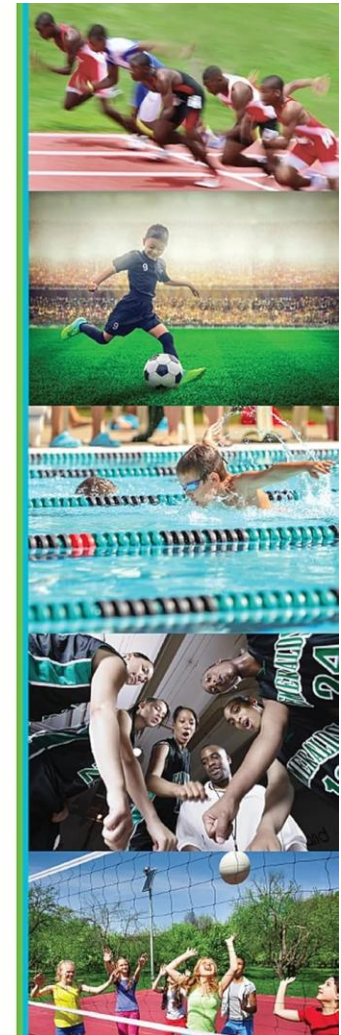
American Orthopaedic Society for Sports Medicine

American Osteopathic Academy of Sports Medicine

American Academy  
of Pediatrics



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# 3. Coaching and Supervision

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



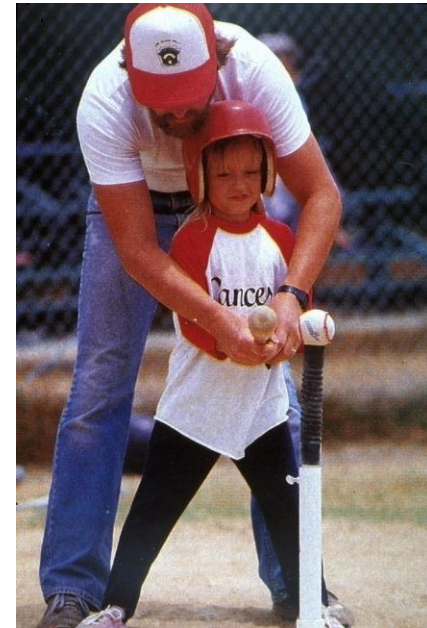
## CIF Spreads the Word on New Training

■ **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
- Balance commitments - sport, school, community, family.



# 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
- Chronologic age vs. physical development vs. cognitive maturation

Gradual training progression

- Short term (1-3 months) and long term planning (1 year)
- Carefully monitor volume when mastering a new skill
- 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



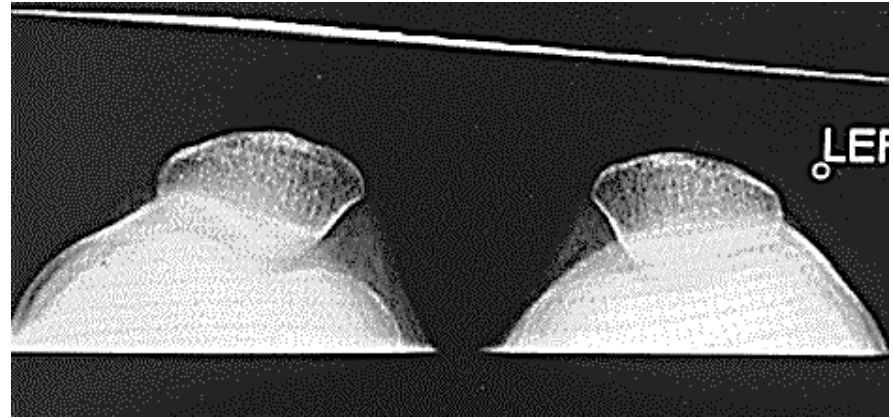
# Case History

- 15 y.o. male presenting with 5-day history of left anterior knee pain. He states he was running at a soccer practice 5 days ago and developed the abrupt onset of anteriorly located left knee pain.
- He has had difficulty attempting do any running since then. He has pain with walking at times as well.
- He has not noticed any swelling.
- He denies any previous symptoms or prior injuries.

# Case History

- Key Exam Findings
  - FROM
  - no effusion
  - There is soft tissue swelling over the proximal medial aspect of the tibia.
  - There is tenderness at the pes anserine bursa, however there is also tenderness more medially along the proximal tibia as well.
  - lig intact
  - no masses posteriorly
  - skin clear

# Case X-rays



# Case MRI



# Thank You

