Pediatric Overuse Injuries

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Learning objectives

Become familiar with statistics of youth sports & epidemiology of overuse injuries

- Sports specialization vs Multi-sport athlete

Become familiar with common pediatric overuse injuries

- Upper and lower extremity
- Spine and pelvis

Understand general management concepts

- Treatment
- Return to play
- Injury prevention

Learning objectives

Become familiar with statistics of youth sports & epidemiology of overuse injuries

- Sports specialization vs Multi-sport athlete

Become familiar with common pediatric overuse injuries

- Apophysitis
- Epiphysitis
- Osteochondrosis

Understand general management concepts

- Treatment
- Return to play
- Injury prevention

Benefits of youth sports

- **Medical**
  - Improved bone health and BMI
  - Improved cardio-respiratory and muscular fitness
- **Psychological**
  - Improved cognitive function
  - Reduced risk of depression, suicide, and suicidal thoughts

Benefits of youth sports

- **Life skills**
  - Develop competence, confidence, self-esteem, goal setting, time management, and work ethic
  - Academic performance
- **Social**
  - Develop interpersonal skills such as teamwork, leadership, and relationship building

Statistics of Youth Sports

- **60 million children (6 to 18 yrs) participate in organized athletics**
  - Basketball, Baseball, Football, Golf, Gymnastics, Soccer, Tennis, Volleyball, Cheerleading
- **30 million participate in organized team sports (6 to 17 yrs)**
  - Basketball > Football=Soccer > Baseball > Volleyball
- **44 million participate in more than 1 organized sport/yr**

Professionalism of Youth Sports

- Previous generations of children typically played for leisure
- Children made rules & modifications, served as the officials, administrators and refereed themselves
- Shift towards adults being “ultra-organizers” of youth sports
- Often parent’s desires differ greatly from children
  - College athletic scholarships or professional level play
- Creates culture of mental stress, burnout, and physical injury

Professional level play

- 6% of athletes progress from High School to NCAA Divisions
- 2% of NCAA athletes drafted to professional athletics
- 0.12% of HS athletes move to professional athletics
  - NBA/WNBA/MLB/MiLB/NHL/AHL/NFL/MLS/USL

HS Seniors – advancement

- **Football**
  - 6.8 % play at the NCAA level (all levels)
  - 0.1 % drafted to NFL
- **Baseball**
  - 7.1 % play at NCAA level (all levels)
  - 0.6 % drafted (MLB or MiLB)
  - 0.02 % advance to MLB
- **Basketball (M/W)**
  - 3.4/3.9 % play at the NCAA level (all levels)
  - 0.04/0.03 % drafted by NBA/WNBA

HS Seniors – advancement

- **Ice Hockey**
  - 11.7 % play at the NCAA level (all levels)
  - 0.6 % play in professional leagues (NHL/AHL)
  - 0.3 % drafted to NHL
- **Soccer**
  - 5.6 % play at NCAA level (all levels)
  - 0.8 % play in professional leagues (MLS/USL)
  - 0.08 % drafted to MLS

Pediatric Overuse Injury

- Chronic injury related to **repetitive stress** on an immature MSK system **without sufficient recovery** time

- 50% of sports injuries in children <18 y/o are overuse injuries

- Increasing problem
  - Elimination of sports "seasons"
  - Rise of club sports
  - Parental goals (scholarships)
  - **Sports specialization**

Sports Specialization

- **Intense, year-round training in a single sport with the exclusion of other sports – Increasingly common**
  - Baseball, Gymnastics, Soccer

- **Higher rates of injury, increased psychological stress, and quitting sports at a younger age**
  - Single sport athletes account for 50% of overuse injuries
  - 70-93% more likely to be injured than multisport athletes
  - Early specialization in a single sport = higher rates of adult physical inactivity and increased BMI
    - Likely from early burnout

Pediatric Skeleton

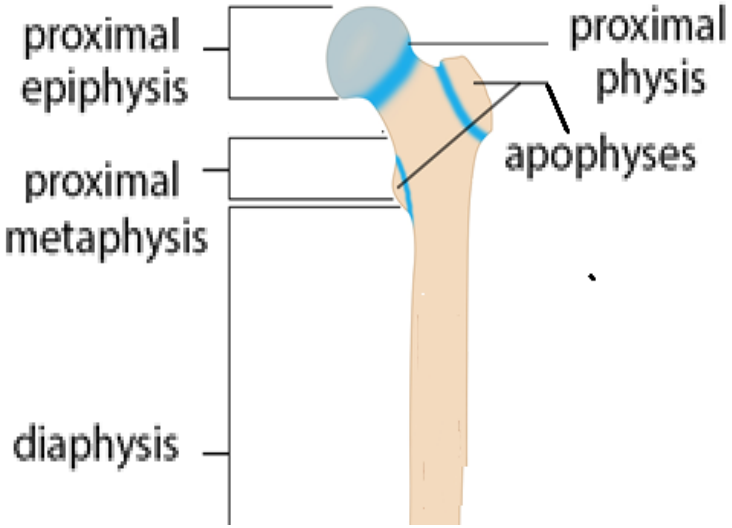
- Bone is relatively elastic and rubbery
  - Plastic deformity, buckling fractures are common
- Periosteum is thick, active, and vascular
  - Fractures are more often stable and heal quickly
- Ligaments are strong native to the bone
- Ligament injuries are rare in young children
  - Fractures or growth plate disturbances are more common
  - Kids do not typically “sprain stuff”
- Physis and apophysis are the “weak links”

Pediatric Skeleton

- Physeal zone = enlarging hypertrophic chondrocytes
  - inherent weakness – site of pathology
- Variability in timing of injuries is related to physical maturation & gender
- Decrease in bone mineralization and bone mass preceding growth velocity
  - Accounts for differences in injuries related to gender and age

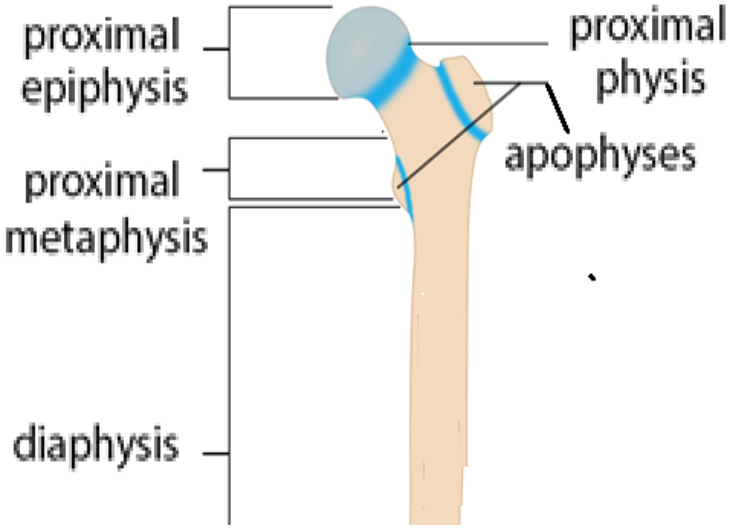
Pediatric Skeleton

- **Physis (epiphyseal plate, growth plate)**
  - Primary ossification center
  - Long bone - longitudinal growth
  - Compressive forces
  - Chronic injury = Epiphysitis
  - Acute injury = Salter Harris Fractures



Pediatric Skeleton

- **Apophysis**
  - Secondary ossification center
  - Site of Muscle/Tendon-Bone junction
  - Provides contour & shape of bone not length
  - Traction forces
  - Chronic injury = Apophysitis
  - Acute injury = Avulsion fracture



Intrinsic Risk factors

- **Non-Modifiable**
  - Age, gender, developmental maturity level, previous injury
- **Modifiable**
  - Fitness level, training & warm-up, muscle strength, flexibility, joint stability, biomechanics, balance/proprioception, nutrition, BMI

Extrinsic Risk factors

- **Modifiable**
  - Incorrect training technique
  - Higher volumes
  - Rules and regulations
  - Coaching education/training
  - Playing time
  - Playing surface
  - Equipment
  - Early specialization

Types of Overuse Injuries

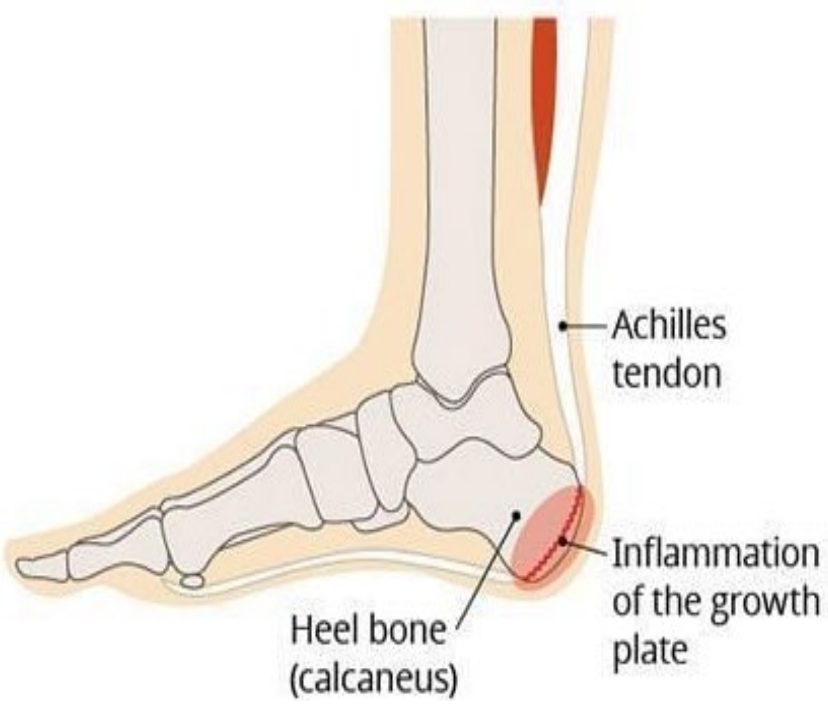
Apophysitis

- Traction injury to the cartilage and bony attachment of tendons
- Rapid growth = tight or inflexible muscle-tendon units
- Pain, swelling and TTP over apophysis
- Pain or limp that worsens with activity, improves with rest

Lower Extremities

- Inferior pole of patella = Sinding Larsen-Johansson syndrome
- Tibial tubercle = Patellar tendon = Osgood-Schlatter disease
- Calcaneus = Achilles Tendon = Sever disease
- Fifth metatarsal base = Peroneal Tendon = Iselin disease

Severs Apophysitis



Severs Apophysitis

- Apophysis of calcaneus
  - Insertion of achilles tendon
- Repetivie gastrosoleus contraction
- High impact sports
  - Gymnastics
  - Cross country

Osgood Schlatter Dx

Osgood Schlatter Dx

- Traction at tibial tubercle
- Site of patellar tendon attachment
- Forceful repetitive quradriceps contraction
  - Running, jumping, cutting
- Lack of full leg extension can indicate avulsion injury

Sinding Larson-Johansson

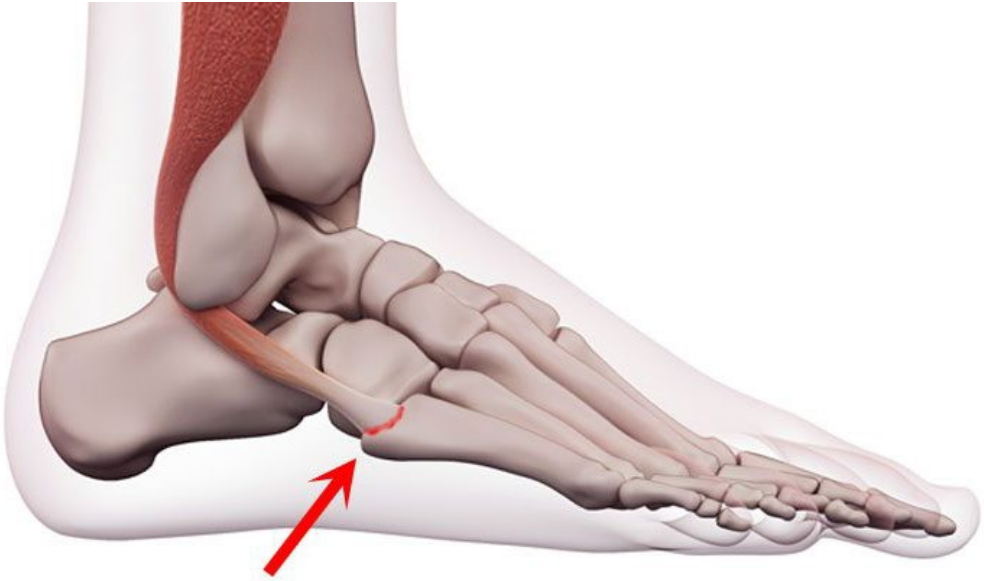
Sinding Larson-Johansson

- Traction at inferior patellar pole
- Site of patellar tendon origin

- Forceful repetitive quadriceps contraction
  - Running, jumping, cutting

- Lack of full extension can indicate a patellar sleeve fracture

Iselin's Disease



Iselin's Disease

- Apophysis at base of 5th metatarsal
- Chronic contraction of peroneal brevis tendon
- Plain film x-rays typically normal
  - Clinical diagnosis
- Dancers, ballet, cheerleaders

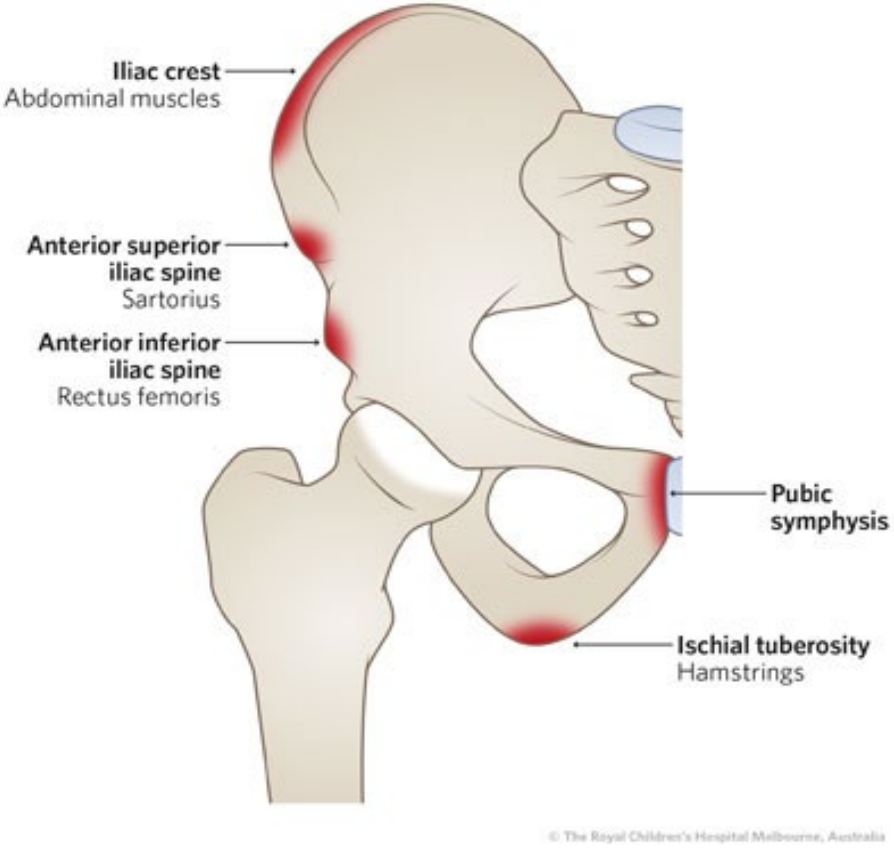
Types of Overuse Injuries

Apophysitis

Hip/Pelvis

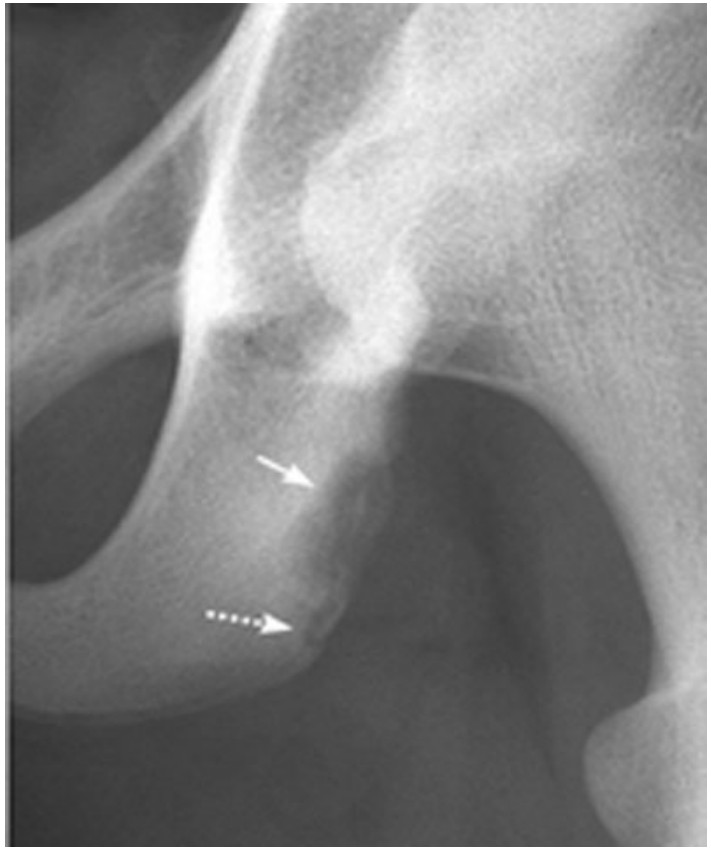
- ASIS = Sartorius
- AIIS = Rectus femoris
- Ischial tuberosity = Hamstrings
- Illiac crest = Oblique abd/Latissimus/Quadratus

Hip & Pelvic Apophysitis



- Typically in adolescents
- ASIS most common, followed by AIIS and Illiac crest
  - Hip flexion
  - Trunk and pelvis rotation
- Runners, sprinting, soccer, ice hockey and dancers
- Tenderness at bony insertion
  - Distinct from tendonitis

Hip & Pelvic Apophysitis



Plain film imaging

- Fragmentation or “fluffy” appearance at muscle attachment
- If pain continues despite relative rest, repeat imaging to ensure no avulsion has developed

Typical timing of Apophysitis

- Sever's Disease: 7-10 years
- Iselin's Disease: 9-11 years
- Osgood Schlatter Disease/SLJ: 11-15 years
- ASIS/AIIS: 12-18 years
- Iliac crest: 10-20 years
- Ischial tuberosity: 11-23 years

Apophysitis treatment principles

- Evidence based treatment protocols lacking in literature
- Further imaging recommended for:
  - Concern for acute avulsion fracture
  - Severe symptoms (limping, loss of motion) outside of sports
- **Treatment** in general consists of:
  - Rest from painful activity
    - ~ 2-4 weeks
  - Protect the apophysis from further injury
    - Heel cups, minimal immobilization/NWB for severe cases only
  - Short course of anti-inflammatory of choice 7-10 days w/ icing

Apophysitis treatment principles

- Evidence based treatment protocols lacking in literature
- Further imaging recommended for:
  - Concern for acute avulsion fracture
  - Severe symptoms (limping, loss of motion) outside of specific activity
- **Treatment** in general consists of:
  - Modifiable risk factors (flexibility, training patterns, etc)
    - Home exercise plan, formal therapy, school ATC involvement
  - Activity or position may be modified to allow continued participation
  - Gradual return to play
    - Use PE, PT progress to guide athlete back
    - Sport specific drills/activities encouraged early

Prevention principles

- Warm up
  - 10-15 mins light jog, cycling, formations
  - Increases circulation to muscles, increases muscle pliability, decreases stress on apophyses
- Stretching
  - Post warm up/pre activity: light pain-free stretching recommended
  - For muscular problem areas, can apply heat to aid circulation
  - Ensure proper stretching mechanics
    - Static, Dynamic, Ballistic, Myofascial release, Proprioceptive neuromuscular fascilitation (PNF)
- Recovery
  - Pain free stretching
  - Ice and deep tissue massage over problem areas
  - Nutrition
  - Rest days (low impact)

Types of Overuse Injuries

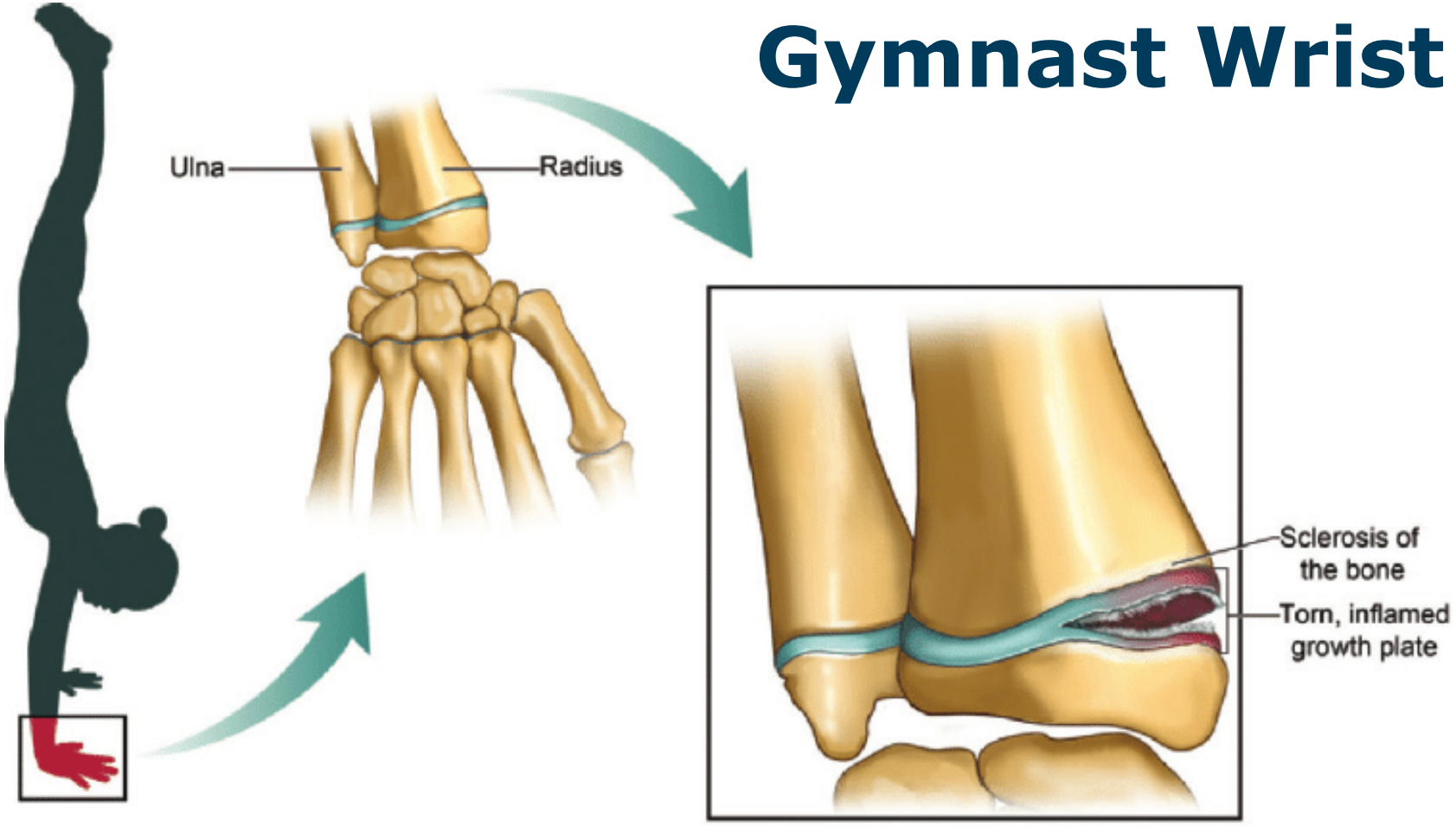
Epiphysitis

- Repetitive compression, torsional, distractive or shear injury to physis
- Salter Harris type I chronic physeal stress injury

Upper Extremities

- Distal Radius = Gymnast Wrist
- Proximal Humerus = Little League Shoulder

Gymnast Wrist



Gymnast Wrist

Pathophysiology

- Supra-physiological loads
- Physeal inflammation / stress injury
- SH type 1 fracture

Diagnosis

- Tenderness at distal radius
- Radiographs:
  - Widened distal radial physis
  - Ill defined borders

Gymnast Wrist

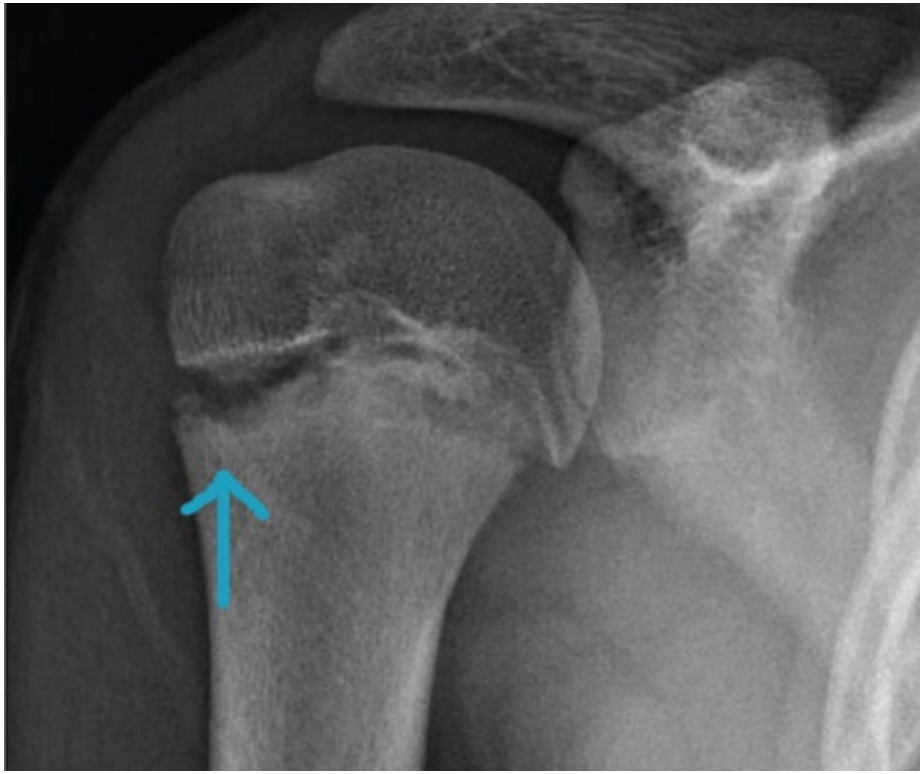
Non-operative treatment

- NSAIDS
- Immobilization 4-6 weeks
- PT/OT
- Modification of routine

Complications

- Premature physeal closure
- Ulnar overgrowth
  - Ulnar impaction syndrome

Little League Shoulder



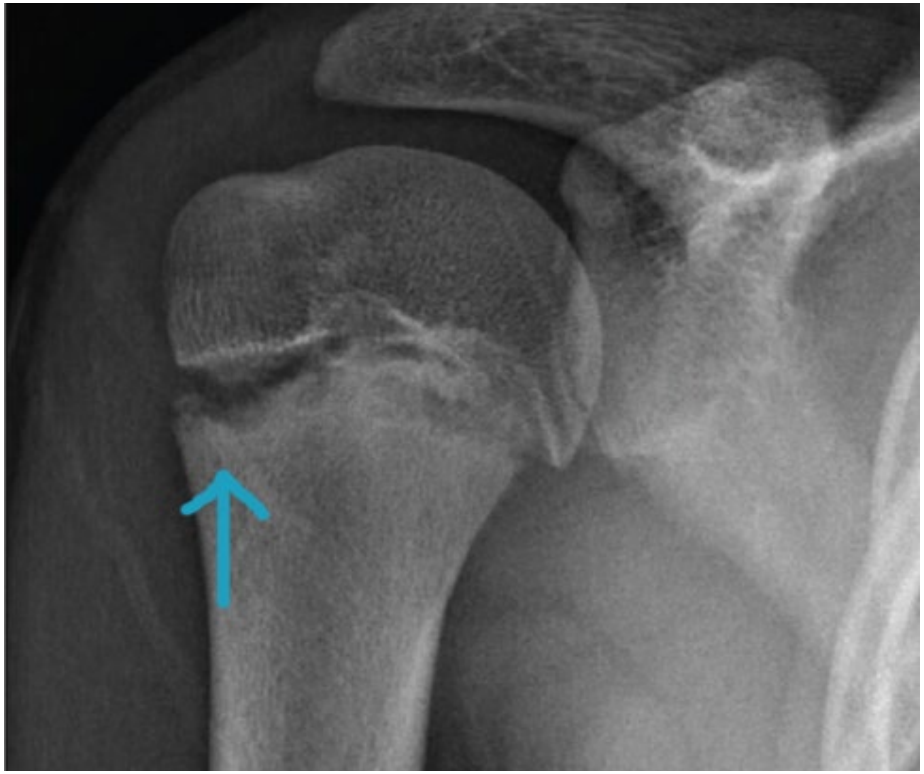
Pathophysiology

- Repetitive torsional and distractive stress w/ pitching
- Physeal inflammation / Salter Harris 1 stress injury

Diagnosis

- Pain w/ throwing
- TTP at lateral proximal humerus
- Pain with shoulder rotation

Little League Shoulder



Pathophysiology

- Repetitive torsional and distractive stress w/ pitching
- Physeal inflammation / Salter Harris 1 stress injury

Diagnosis

- Widened proximal humerus physis – compare contralateral
- ~17% w/ normal xrays
- MRI if diagnosis unclear

Little League Shoulder

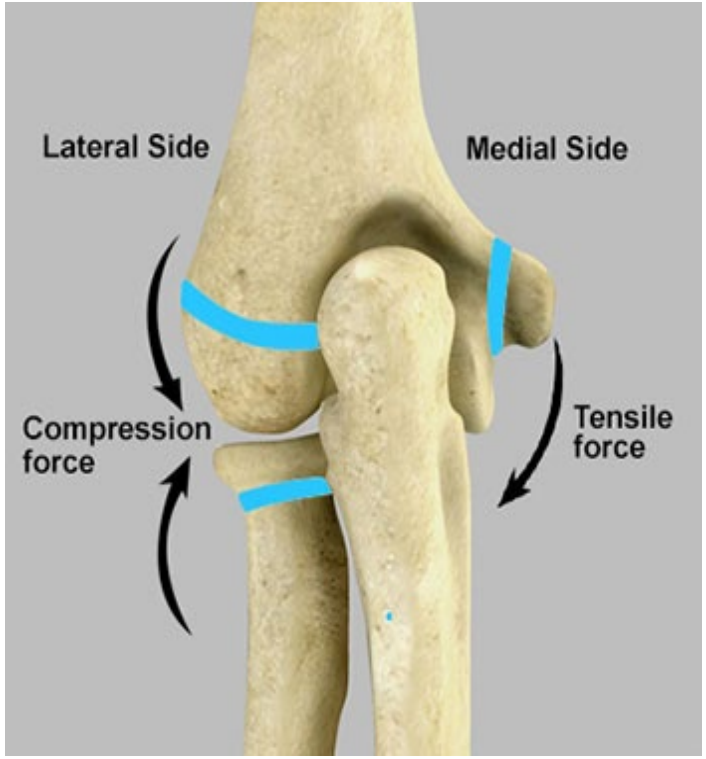
Nonoperative treatment

- Cessation of pitching
  - 3 months
- Physical Therapy
  - Rotator cuff and core
- Progressive throwing program
  - Guided by PT/Coach/ATC

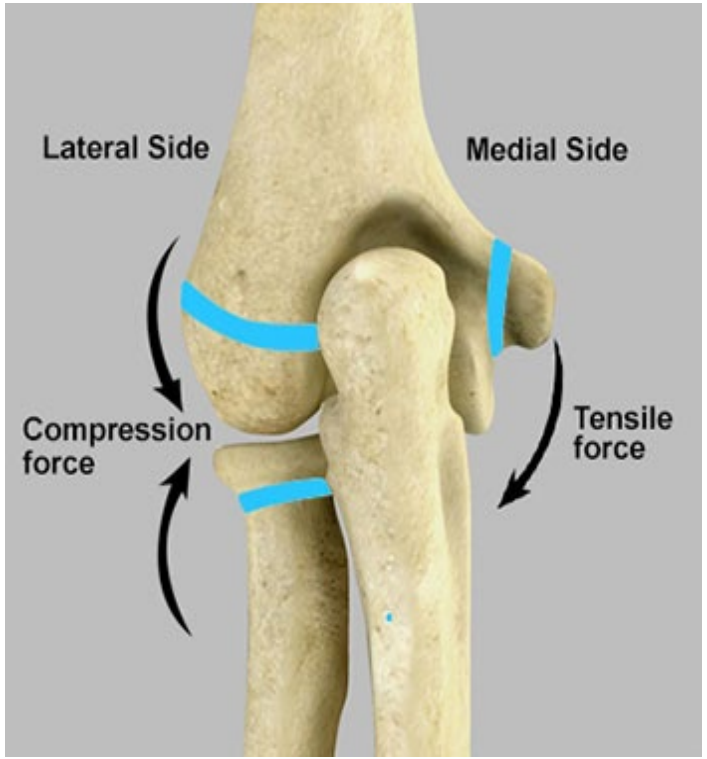
Complications

- Premature physeal closure
- Angular Deformity

Little League Elbow



Little League Elbow



Potential sites of injury

- Medial epicondyle apophysis
  - Apophysitis or avulsion
- Ulnar collateral ligament (UCL)
  - older adolescents
- Flexor-pronator mass strains
  - older adolescents
- Physis compression injury
  - Proximal radius physis
  - Humeral Capitellum physis

Little League Elbow

Risk Factors

- Greater than 80 pitches/game
- > 8 months of pitching/year
- Fastball speed > 85mph
- Pitching despite arm fatigue/pain
- Participating in showcases

Symptoms

- Medial elbow pain
- Decreased speed, accuracy, and/or distance

Exam

- TTP medial elbow > lateral
- pain with valgus stress
- instability with valgus stress notes more severe involvement

Little League Elbow

Acute phase: Weeks 1-4 treatment protocol

- Rest from throwing (min 4 weeks), Limit immobilization
- Initiate ROM immediately with core/posture exercise program
- Anti-inflammatories of choice, 7-10 days
- Ice 20 mins 1-2x daily
- Initiate Upper extremity PT once pain improves

Little League Elbow

Recovery phase: Weeks 5-8 treatment protocol

- Start recovery phase
  - Full, non-painful ROM, no TTP, symmetric UE strength, good core stabilization and balance
- Initiate biomechanical pitching/throwing analysis
  - Experienced PT, ATC, coach
- Return to throwing program
  - Guided program
    - Start with throwing every second or third day and progress
  - Progress levels based on pain AND performance

Little League Elbow

Prevention and Maintenance phase

- General principles for warm up, stretching and recovery
- Pitch counts by age
  - Different organizations have different guidelines
  - Often difficult to enforce
    - Private pitching coaches in addition to league play

Pitch Count and Required Rest Limitations

Age	Daily Max (Pitches)	Required Rest (Pitches)	Required Rest (Pitches)	Required Rest (Pitches)	Required Rest (Pitches)	Required Rest (Pitches)
		0 Days	**1 Day**	**2 Days**	**3 Days**	**4 Days**
7-8	50*	1-20	21-35	36-50	N/A	N/A
9-10	75*	1-20	21-35	36-50	51-65	66+
11-12	85*	1-20	21-35	36-50	51-65	66+
13-14	95*	1-20	21-35	36-50	51-65	66+
15-16	95*	1-30	31-45	46-60	61-75	76+
17-18	105	1-30	31-45	46-60	61-75	76+

Little League Elbow

Prevention and Maintenance phase

- General principles for warm up, stretching and recovery
- Pitch counts by age
  - Different organizations have different guidelines
  - Often difficult to enforce
    - Private pitching coaches in addition to league play
- Cross training with lower extremity sport
  - Encourage off season

Types of Overuse Injuries

Osteochondrosis

- Temporary disruption of vascular supply at bone-cartilage complex of a joint – Aseptic avascular necrosis (AVN)
- Rare, etiology unknown but thought to be multifactorial
  - Repetitive mechanical trauma
  - Vascular abnormalities
  - Hormonal imbalances
  - Genetic component ?

Types of Overuse Injuries

Osteochondrosis

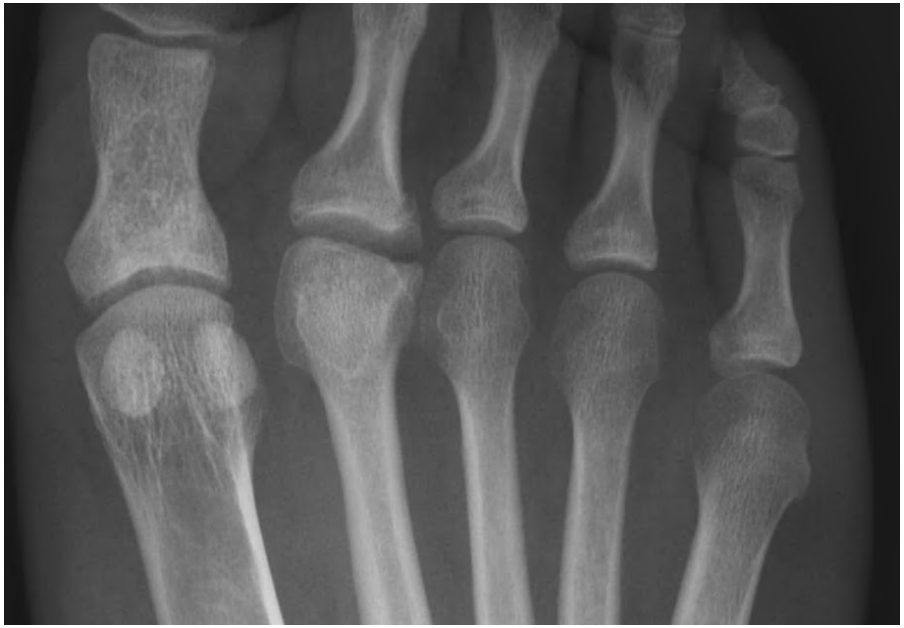
Lower extremities

- Freiburg disease – AVN of the second digit metatarsal head
- Repetitive forefoot micro-trauma and osteonecrosis
  - dancers, gymnastics

Freiburg Disease

Epidemiology

- Age 10-15 years
- F:M = 3:1
- Most symptomatic during rapid growth
- Bilateral in 6% of cases



Freiburg Disease

Stages of disease

	Smillie Classification
Stage 1	Subchondral fracture visible only on MRI
Stage 2	Dorsal collapse of articular surface on plain radiographs
Stage 3	Collapse of dorsal MT head, with plantar articular portion intact
Stage 4	Collapse of entire MT head, joint space narrowing
Stage 5	Severe arthritic changes and joint space obliteration

Treatment for early stages 1-3

- Walking cast or boot for 4-6 weeks
- Transition to stiff soled shoe after casting
- Modified footwear, custom orthotics

Types of Overuse Injuries

Osteochondrosis

Upper extremities

- Panner disease – AVN of capitellum of humerus
- Repetitive valgus compression of lateral elbow
  - Pitching, gymnastics, wrestling
  - 90% males,
  - Age <10 years

Panner's Disease

Panner's Disease

Treatment

- No specific evidence based recommendations
- Immediate cessation of activity
  - 3-6 weeks minimum
- Progress back to activity between 6-12 weeks as tolerated
- Xrays will show "smoothing" contour of capitellum

Injury Prevention

- Use 10% rule
  - Do not increase activity > 10% per week
    - mileage, pace, weight

- Incorporate strength training, Increase flexibility and core stability
  - Focus on modifiable risk factors

Modifiable Risk factors

- Intrinsic
  - Fitness level
  - Training & warm-up
  - Muscle strength
  - Flexibility
  - Joint stability
  - Biomechanics
  - Balance/proprioception
  - Nutrition
  - BMI
- Extrinsic
  - Incorrect training technique
  - Higher volumes
  - Rules and regulations
  - Coaching education/training
  - Playing time
  - Playing surface
  - Equipment
  - Early specialization

Injury Prevention

- Use 10% rule
  - Do not increase activity > 10% per week
    - mileage, pace, weight

- Incorporate strength training, Increase flexibility and core stability
  - Focus on modifiable risk factors

- REST AND RECOVERY (AAP and Council on Sports Medicine)
  - OFF at least 1 day off per week from organized sports
  - 2 to 3 months off (entire season) from a specific sport every year
  - Multisport athletics should be encouraged over specialization

Learning objectives

Become familiar with statistics of youth sports & epidemiology of overuse injuries

-Sports specialization vs multi-sport athlete

Become familiar with common pediatric overuse injuries

- Apophysitis
- Epiphysitis
- Osteochondrosis

Understand general management concepts

-Treatment

-Return to play

-Injury prevention

Questions / Comments