Growth Plate Injuries

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- No relevant financial relationships
Objectives

- Review anatomy of growth plates
- Review pathology of the apophysis
- Discuss clinical cases of apophysitis and avulsions
- Highlight management / Return to play
The Unique Pediatric Patient

- Anatomy
- Physiology
- Psychology
- Pathology
- Injury patterns
- Healing patterns
Growing Pediatric Bone

“E”piphysis vs “A”pophysis
Epiphysis

Definition

- Site of long bone longitudinal growth
- Epiphyseal plate is the primary center of ossification
Epiphyseal Injuries

- Salter Harris injuries
- Fracture/dislocation “slip” injuries
- Stress (overuse) injuries
- Age and physeal dependent
- Focus of next talk
Apophysis

Definition

- Secondary centers of ossification
- Site of muscle-tendon unit insertion
- Provide contour and shape to growing bones (without adding length)
- Age dependent closure of each apophysis
Apophysis
Definition

- Weak link in the musculoskeletal chain at given age ranges
- Apophysis is less resistant to tensile forces than soft tissues surrounding that area
- Chronic (overuse) injuries = Apophysitis
- Acute injuries = Avulsion fractures
Apophysitis

Definition

- Chronic (overuse) injury resulting from
  - Traction of a tendon at its insertion
  - Microavulsions at the bone-cartilage junction
- Common during periods of rapid growth
Apophysitis
Mechanism--OVERUSE

Too much activity

Inadequate healing time

Incomplete tissue repair

PAIN
The 4 Stages of Overuse Injury

(1) Pain in the affected area after physical activity
(2) Pain during the activity, without restricting performance
(3) Pain during the activity that restricts performance
(4) Chronic, unremitting pain even at rest

<table>
<thead>
<tr>
<th>Apophysis</th>
<th>Age</th>
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</thead>
<tbody>
<tr>
<td>Calcaneus</td>
<td>8 TO 12</td>
</tr>
<tr>
<td>Inferior Pole Patella</td>
<td>8 TO 11</td>
</tr>
<tr>
<td>Base of 5&lt;sup&gt;th&lt;/sup&gt; MT</td>
<td>9 TO 12</td>
</tr>
<tr>
<td>Medial Epicondyle</td>
<td>10 TO 12</td>
</tr>
<tr>
<td>Tibial Tubercle</td>
<td>11 TO 15</td>
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<tr>
<td>Pelvis</td>
<td>14 TO 22</td>
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Apophysitis
The Athlete at Risk

- Age dependent patterns
- Rapid increase in activity
- Elite, fit, driven
- Biomechanical deficits
Apophysitis Management

- Rest and Rehab (address bio-mechanics)
- Alleviating measures (Ice, OTC pain relief)
- Benefits of cross-training and varied sports participation
  - Reduce overuse injury (and potential for burnout)
  - Improved performance in primary sport!
Apophysitis Management

- Relative Rest
  - Pain free activities allowed
- Correct muscle length/strength imbalances
- Correct “biomechanical” factors
- Consider orthotics, heel cups, bracing prn

GRADUAL RTP
Apophysitis
Inappropriate Management

- Forbid sports
- Complete immobilization
- Exclusive REST/RICE
- No discussion of timeline
- Certain Rehab Techniques not helpful
  - Thermal modalities
  - Transverse friction
Avulsion Fractures

- Most commonly involve apophysis (weak link)
- Acute MOI
- Pop, swelling, bruising, severe disability
- MSK chain is “broken”
- Often preceded by apophysitis
Not ALL Apophyses are created Equal!

- **Upper extremities**
  - LL elbow, coracoid, LE

- **Pelvis**
  - IT, AIIS, ASIS, LT, IC, AT

- **Lower extremity**
  - Osgood Schlatter’s, Sever’s, SLJ, Islen’s

* Variable Avulsion and Arrest Risks
Avulsion fracture

Management

- Non-displaced: immobization followed by PT
- Displaced: may need surgical fixation
- Varying degrees of acceptable displacement
- Apophyseal dependent
Case 1
KNEE PAIN

- 12 y.o. male, basketball
- Intermittent L knee pain, no trauma
- Pain worse with jumping and kneeling
Knee Exam

- Inspection - Enlarged tibial tuberosity
- ROM - Normal, tight hamstrings
- Palpation - Localized tenderness over tibial tuberosity
- Neurovascular - Intact
- Special Maneuvers - no ligamentous laxity
Knee Exam

- Popliteal Angle measures hamstring flexibility
Osgood-Schlatter Apophysitis
Osgood-Schlatter

- Traction apophysitis of tibial tubercle
- Forceful, repetitive contractions of quads
  - Jumping, running, cutting
- Athletes 11-15 years old, females younger
- More common unilateral
Tibial Tuberosity Apophysitis

Treatment

- Active rest, RTP as tolerated
- Ice massage, OTC pain control
- Rehab-Stretch Hamstrings/Quads
- Cho-Pat Straps
Osgood-Schlatter gone bad

Avulsion fracture (acute)

Heterotopic ossification (chronic)
Sinding-Larsen-Johannsson

- Apophysitis of Inferior Pole of Patella “SLJ”
- Ages 10-12
- Similar presentation and treatment to Osgood’s, but less common
Case

- 10 year old girl slipped and fell onto hyperflexed knee
- Felt “pop”, immediate pain and large swelling
- Unable to walk
Exam

- **Inspection** - Large effusion, high riding patella
- **Palpation** - Max pain over distal patellar pole w/ 2cm gapping
- **ROM** - Guarding at 30 deg flexion
- **Neurovascular** - Unable to straight leg raise
- **Special maneuvers** - Deferred
Patellar sleeve fracture
Treatment

- Straight leg knee immobilizer
- Non-weight bearing, elevation, pain control
- NPO and surgical referral made
Post-Op films
Case

HEEL PAIN

- 11 y.o. boy, track athlete
- 2 month hx of R heel pain
- No injury, Pain activity related
Foot/Ankle Exam

- **Neurovascular**: Intact
- **Inspection**: No swelling, normal arches
- **ROM**: Normal, tight heel cord
- **Palpation**: Localized tenderness over calcaneus
- **Special Maneuvers**: No ligamentous laxity, positive calcaneal squeeze test
Sever’s Disease
Radiographs

- Normal
- Varying degrees of sclerosis and fragmentation of aphophysis
Sever’s Disease

- Traction apophysitis of ossification center of calcaneus
- Repetitive contractions of gastroc-soleus complex
  - Impact sports especially when running and cleats or without shoes
- Ages 9-12 yrs, earlier in girls
- Bilateral in 60%; Avulsion risk very low
SEVER’S Disease

Treatment

- Relative Rest, RTP as tolerated
- Gastrocnemius-soleus stretching and eccentric strengthening
- Viscelastic heel cups in all shoes
Case

• 12 yo twists R foot while playing soccer
• Inversion type injury with immediate swelling
• Unable to put weight on his R foot
• X-rays?
PE

- Tender at the marked site
- Pain with passive inversion
- Pain with resisted eversion

:(}
X-rays

- Soft tissue swelling
- Normal apophysis
- Avulsion Fx of the base of the 5th metatarsal
Pediatric base of 5th metatarsal fracture

- Must be differentiated from a normal apophysis
  - Tenderness
  - Apophysis lies parallel to the long axis of MT
  - Fracture is almost always transverse
  - Comparison views in needed
Base of 5\textsuperscript{th} metatarsal fracture

- **Treatment**
  - Non-surgical in most cases with good outcome
  - Short-leg walking cast or boot for 3 weeks
  - Ortho referral with displacement >3 mm
Iselin’s Disease

- Traction apopysitis at ossification center at base of 5th MT
- Chronic contractions of peroneus brevis tendon
- Athletes 10-12 years old, females younger
- More common unilateral
- Xrays typically normal
Case

- 15 yo female, Track runner
- Chronic lateral B/L hip pain
- Atraumatic, worse with running/hurdles
- No popping/mechanical symptoms
Hip Exam

- **Inspection** - No swelling
- **ROM** - Normal, symmetric IR/ER/AB, Pain with resisted hip abduction and trunk rotation
- **Palpation** - Localized tenderness over iliac crest bilaterally
- **Neurovascular** - Intact
- **Special Maneuvers** - negative FADIR
Iliac Crest Apophysitis

- Traction apophysitis
  - Ossification center of iliac crest
- Chronic contraction of abdominal muscles
  - Running sports-arm swing/trunk rotation
- Ages mid to late teens
Hip Apophysitis

- Abdominals
- Sartorius
- Rectus Femoris
- Gluteus Medius
- Iliopsoas
- Hamstrings
- Adductors
Case

- 15yo boy tries 50 yard FG attempt
- Suddenly feels a loud pop and falls to the ground in severe pain
- Pain in the right anterior hip region
- Taken to the ED were x-rays were completed
Pelvic Avulsion Fx at AIIS
Pelvic Avulsion Fx

- Acute presentation
- Tender apophysis after forceful contraction and “pop” >> think avulsion fracture
- Pain and weakness elicited when activating associated muscle
Treatment

- Rest, Ice, protected movement, crutches 3-4 wks
- Begin early ROM when pain subsides.
- Formal physical therapy to regain ROM, strength, and flexibility.
- Gradual return to play when pain free with functional testing.
Pelvic Avulsion Fracture
Ischial Tuberosity
Pelvic Avulsion Fracture
ASIS
Pelvic Avulsion Fracture
Iliac Crest
Normal?

- 13 y/o felt pop in buttock during sprint in football
- Pain, unable to continue running
- X-rays read normal
Not Normal!

- Avulsion injury of un-ossified apophysis
- Callus formation can be seen 10-14 days out
- Trust your clinical picture!
Case 7
ELBOW PAIN

- 12 y.o. male, baseball pitcher, RHD
- 6 weeks R medial elbow pain, no injury
- No locking, catching, motion deficit
- Pain activity-related, no pain at rest
Elbow Exam

- **Inspection**- No swelling, no atrophy
- **ROM**- Full, pain with wrist flexion
- **Palpation**- tenderness over medial epicondyle
- **Neurovascular**- intact
- **Special Maneuvers**- No instability
ELBOW XRAY
Elbow Anatomy

- Multiple ossification centers (6)
- CRITOE
- Appear every 2 years
- All close at different times
Little Leaguer’s Elbow

Definition

- Related to the stress of repetitive throwing in youth
- Medial Epicondylar Apophysitis
  - Medial epicondyle weakest structure in elbow, last to close
  - Stress reaction of medial epicondyle apophysis
  - X-ray can be normal or slightly irregular
Little Leaguer Elbow

Medial Epicondylar Apophysitis

- Tenderness over medial epicondyle
- Radiographs can show
  - Separation/widening of apophysis
  - Fragmentation
- MRI usually not necessary
- Clinical Diagnosis!
Elbow Pain in Throwers

- Most common complaint in younger thrower
  - AGE IS IMPORTANT RISK FACTOR
- Pitch counts, rest days are a significant consideration
Forces on the elbow

- Common site of injury
- Traction injuries - medial side
- Compression – lateral side
Medial elbow pain
A look at biomechanics

- Large valgus loads with rapid elbow extension = high tensile stress on medial elbow
  - Medial epicondyle apophysitis
  - Ulnar collateral ligament injury
  - Flexor-pronator mass tendinitis
  - Ulnar neuritis
Little Leaguer’s Elbow

*Treatment*

- NO THROWING until symptoms improve
  - Usually 1 to 3 months
- Rehabilitation, biomechanics, kinematics
- Interval Throwing Program--SLOW return, consider switching position
- Pitch counts, types of pitches, rest days
- Never throw with a FATIGUED arm!!!
Acute Throwing Injury...
ME Avulsion Fracture

- Often acute on chronic
- Preceded by MEA
- Pop, severe pain, swelling, disability
- Surgical >3-5mm displaced

AP and Stress views:
Fracture or Growth plates?

- Trust clinical picture!
- Remember CRITOE
- If lateral condyle is ossified, then…
Great PCSM References

http://www.wheelessonline.com
http://www.radiologyassistant.nl
www.uahealth.com/pedssportsmed
Questions?