Foot and Ankle Problems in the Pediatric Athlete

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Overview

- Developmental Problems
  - Pes Planus
  - Tarsal Coalition
  - Adolescent Bunion
  - Accessory Ossicles
    - Os Trigonum
    - Accessory Navicular
    - Medial Malleolus Ossification Center
  - Acute Injuries
    - Fractures/Sprains/Tendon Subluxation
  - Overuse Injuries
    - Stress Fractures/OCD
    - Tendonitis/Apophysitis

Developmental Problems

- Pes Planus
  - Flat foot common in children until age 6
  - Said to be “flexible” if arch reconstitutes when the child stands on their toes
  - Reported in up to 15% of the population
  - For athletes who are symptomatic an arch support to prevent excessive pronation is often helpful

Developmental Problems

- Tarsal Coalition
  - Fibrous, cartilaginous, or bony connection of two (or more) bones in the midfoot or hindfoot with presentation common during adolescence
  - Most are bilateral, but is reported to occur in <1% of the population
  - Most common are calcaneonavicular and talocalcaneal
  - Present with a history of multiple ankle sprains and vague pain that is insidious in onset

Tarsal Coalition

- Symptoms typically begin or are exacerbated during athletic training. Hence, a high occurrence is encountered in the young athlete
  - PE will show limited subtalar motion
  - Generally seen on plain radiographs
    - C sign for talocalcaneal
    - Oblique view for calcaneonavicular
  - CT scan for perioperative planning

Disclosures

Grant Hogue, M.D., has no financial relationships to disclose.

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**Tarsal Coalition – Treatment**
- Conservative management with orthotics and temporary immobilization is often successful
- Resection may be necessary for recalcitrant cases in order to restore mobility and decrease pain
- Not necessary to wait until skeletal maturity for resection

**Developmental Problems- Adolescent Bunion**
- Most common in female dancers
- Initial treatment includes wider shoes, bunion pads, orthotics
- If pain persists then boney realignment is necessary with osteotomy choices similar to the adult population
- Simple bunionectomy has an exceedingly low success rate

**Accessory Ossicles**
- **Os Trigonum**
  - Posterior talus has a separate ossification center that generally ossifies and fuses 1 yr after appearance (8-10 girls, 11-13 boys)
  - If fusion does not occur an os trigonum is formed
  - Present in ~10% of the population and generally asymptomatic
  - Can become symptomatic in athletes who actively plantarflex their ankle — ballet, gymnastics, ice skaters, occ soccer players

**Os Trigonum**
- Will present with posterolateral ankle pain secondary to posterior impingment between the tibia and calcaneus
- Repetitive impingment can also cause hypertrophic capsulitis
- Pain reproduced with plantarflexion on exam
- If patient has concurrent posteromedial pain then a concurrent FHL tendonitis should be suspected

**Os Trigonum**
- Sports
  - Dance
  - Gymnastics
  - Competitive cheering
  - Martial arts

**Os Trigonum - Treatment**
- Rest, NSAIDs, avoidance, PT, BUT pain usually returns once sporting is resumed. Especially with ballet dancers
- Resection often necessary in the competitive young athlete
- Medial or lateral approach to the posterior ankle
  - Use medial approach if addressing concurrent FHL tendonitis

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Accessory Ossicles- Accessory Navicular

- Most common accessory bone in the foot and occurs on the medial, plantar border of the navicular
- Insertion site of posterior tib tendon
- Reported in 4-14% of the population but <1% symptomatic
- Present in the adolescent athlete due to pressure over the bony prominence, tear in the synchondrosis, or posterior tib tendonitis

Accessory Navicular- Treatment

- Conservative tx with orthotics and trial of casting is usually quite successful however resection is necessary in recalcitrant cases
- After resection/excision it is important to repair posterior tib insertion on the navicular proper

Accessory Ossicles- Medial Malleolus Ossification Center/Os subtibiale

- Medial Malleolus ossification center appears b/t 1-2 yrs of age and fuses by age 11-12
- Persistence into adulthood is uncommon, but can be a source of pain from microtrauma at the chondro-osseous jxn in young athletes

Os subtibiale -Tx

Usually unites
Traumatic vs. developmental
- Can become symptomatic after trauma or repetitive use
Treatment:
  - Rest, time
  - Rarely more
- Micheli: rest x 3 weeks → cast x 3 weeks → re cast → scope excision

Os subtibiale

Arthroscopic resection
- Accessory portal

Arthroscopic resection
- Pre-op
- Post-op

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**Acute Injuries- Physeal Fractures**

- Distal tibial and fibular physes form a "plane of weakness" about the ankle
- Ligaments often stronger than physeal cartilage leading to increased risk of physeal injury over ligamentous sprain
- Goldberg: 31/53 fractures of the distal tibial physis occurred during sporting activity

**Physeal Closure**

Distal tibia physis closes:
- About age 12-15 yrs girls
- About age 13-17 yrs boys

Medial malleolus extension appears ~ 10 yrs
Asymmetric closure over ~ 18 months
- Tibia physis closes in center first then medially and posteriorly.
- Anterolateral portion of physis is the last to close
Closure of the distal fibula physis follows distal tibia physeal closure by ~12-24 months

**Distal Tibial Physeal Closure**

**Age / Fracture Pattern**

**Classification Anatomic**

- Salter-Harris
  - High interobserver correlation
  - Correlated with outcomes
  - Higher number correlates with greater chance of growth disturbance

**Classification - Ankle Fractures; Dias-Tachdjian**

Mechanism of injury:
- Supination-Inversion
- Pronation-Eversion
- External Rotation
- Supination-Plantar-Flexion
- Supination-External Rotation


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**13yo M SH IV of tibia, SH I of fibula**

Football injury. Supination-inversion type. Attempted to practice for 2 DAYS before seeing a physician.

**“transitional fractures”**

- Triplane and tillaux
  - Triplane
    - Fracture appears to be in multiple planes
  - Tillaux
    - Fracture of the anterolateral epiphysis

**Triplane Fractures**

Combination of Salter II and III fractures: usually near end of growth (Complex type IV fracture)

Anterior epiphyseal fracture with large posteromedial metaphyseal fragment...fibula may also be fractured

**Triplane Fractures**

Displaced Triplane Fractures (>2 mm)
- Anatomic reduction required
- If closed reduction successful
  - Cast: consider a long leg cast with 30° of knee flexion and foot internally rotated, if unstable
  - If closed reduction unsuccessful => ORIF
- Reduction/Internal fixation done in step-wise fashion with small fragment or 4.0 cannulated screws
- Postop - SLC x 3-4 wks, then SLWC x 3 wks

**Adequate Imaging Helps**

CT gives 3D visualization of fracture patterns
Essential for planning

**Triplane Fracture**

Surgical Correction

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“Transitional” Fractures

Juvenile Tillaux fractures
- Patients tend to be older than those with triplane fx
- Fibula prevents marked displacement: may be subtle
- Local tenderness at anterolateral joint line
- Mortise view essential
- May need CT scan
- Although literature based on small series, excellent results with anatomic reduction noted

Tillaux Fracture Example

CT shows a Salter III (“Tillaux”) fracture of the distal tibia
- Tillaux fractures occur near the end of growth as medial portion of distal tibial physis closes before the lateral side closes

Tillaux Fractures Treatment

Non-displaced
- Cast (NWB) x 3 wks, then SLWC x 3-4 wks
- CT scan after cast placement may be needed to assure no displacement
- Radiographs in cast to assure no re-displacement in cast
- Follow-up x-rays obtained every 6-12 months for 2 to 3 yrs to assess for growth arrest

Tillaux Fractures Treatment

Displaced (>2mm) Tillaux fxs
- Anatomic reduction required
- If closed reduction achieved
  - Long leg cast with knee flexed 30 degrees and foot internally rotated if unstable
- If closed reduction unsuccessful
  - Attempt closed reduction under anesthesia
  - If still unsuccessful, may use k-wires to joystick Tillaux fragment (percutaneously or open)
  - Fixation with small fragment or 4.0 cannulated screws
- Postop - SLC x 3-4 wks, then SLWC x 3 wks

Tillaux Fracture Example

Child with ankle pain:
- Fracture difficult to see

Tillaux Fracture Example

Post-operative and healed x-rays after hardware removal: no residual deformity
**Sprains**
- Ankle sprains reported to make up as much as 25% of athletic injuries
- High grade ankle sprains unusual in the skeletally immature (ligament stronger than bone/physis)
- Physisal fracture until proven otherwise
- Most common is similar to adults
  - Inversion-plantarflexion with sprain of the ATFL and calcaneofibular ligaments
- These lower grade ankle sprains respond well to conservative mgmt with treatment mimicking adults models

**Treatment options**
- Ankle sprains:
  - Non-operative care
  - RICE
    - Rest
    - Ice
    - Compression
    - Elevation
  - Immobilization
    - Lace-up ankle brace
    - Stirrup brace
    - Fracture-boot
    - Possibly more recurrence than lace-up brace
    - Cast
    - Physical therapy – early

**Sprains**
- Operative mgmt
  - Surgical techniques
    - Brostrum
      - Direct late repair of lateral ankle ligaments
    - Gould modification of Brostrom
      - Mobilization and reattachment of lateral portion of extensor retinaculum to fibula after imbrication of ATFL and CFL
      - Provides additional stability
      - Gold standard – 85-95% successful
    - Modified brostrum + Split Evans
      - Augment brostrum repair with anterior 1/3 slip of PB (gard, FAI 1999)

**Peroneal Tendon Subluxation**
- Uncommon but potentially disabling in young athletes
- Often overlooked as a cause of persistent lateral ankle pain after trauma
- Among reported cases in the skeletally immature >90% are the result of athletics
- Skiing, skating, basketball, soccer, football

**Peroneal tendon instability**
- Superior peroneal retinaculum

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Peroneal tendon instability

**Mechanism**
- Ankle dorsiflexed
- Hindfoot everted

**Acute presentation:**
- Very similar to lateral ankle sprain

**Chronic presentation**
- Visible
- Audible Snap
- Palpable snap

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Peroneal tendon instability

**Non-operative Care**
- Recognize the acute injury
- Immobilize
- Therapy
- 50% successful?

**Surgery**
- Repair
- Reconstruction

Ferran et al. Sport Med 2006

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Peroneal tendon instability

**Anatomic repair**
- Deepen peroneal groove
  - If growth plate closed

Oliva, F Bull Hosp Joint Dis 2006

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Peroneal tendon instability

**Pediatric reconstruction:**
- Modified Chrisman-Snook
  - Split peroneus brevis
  - Through the epiphysis
  - Into the calcaneus

Forman & Micheli. Foot & Ankle. 2000

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Overuse Injuries

- Repetitive, un repaired microtrauma manifests as “overuse” injuries
- In the growing athlete the bones may grow more swiftly than the muscle-tendon units, resulting in poor flexibility and overuse injuries
- Stress fractures, tendonitis, muscle strains, and apophysitis all have a common denominator: the structure involved is stressed beyond the limits of its ability to repair.

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Overuse Injuries - Stress Fractures

- Present with mechanical pain that increases with activity and decreases with rest
- Risk factors
  - Female
  - Caucasian
  - Sudden increase in training intensity
  - Menstrual irregularity
  - Tibia vara and dec hip ROM
  - Tibia, femoral neck, distal fibula, calcaneus, and metatarsals

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**Overuse Injuries- Stress Fractures**

- **Diagnosis**
  - Clinical diagnosis backed up with advanced imaging
    - MRI or Bone Scan
- **Treatment**
  - Conservative mgmt is the mainstay of treatment
  - Rest and immobilization as needed

**Overuse Injuries- Tendonitis**

- **Overuse tendonitis occurs in the tendons spanning the ankle joint for several reasons**
  - Training errors
  - Imbalance
  - Footwear
  - Growth spurt
  - Sudden increase in training intensity
- **Most common**
  - FHL
  - Peroneals
  - Achilles

**Sever’s disease/Aphophysitis**

- **Calcaneal apophysitis**
  - 8% of all overuse injuries in children and adolescents
  - Typically 8-12 yo
  - Open apophysis required
- **Sever’s disease**
  - 8% of all overuse injuries in children and adolescents
  - Typically 8-12 yo
  - Open apophysis required

**Sever’s disease**

- Typical history
  - Pain brought on by activity
  - Improves with rest, ice, NSAIDs
  - Returns with activity
  - No pain at rest
  - When pain resolves has no pain with weight bearing

**Sever’s disease**

- Differential diagnosis of heel pain:
  - Calcaneal tumor
  - Benign and malignant
  - Calcaneal stress fracture

- Radiographs
  - Pain with weight bearing
  - Parent’s request
  - Findings: nothing
  - Sclerosis and fragmentation vs. normal development of the apophysis

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**Sever’s disease**

**Treatment**
- Rest, ice, NSAIDs
- Activity modification
- Achilles tendon stretching
- Pad the shoe cleat
- Temporary use of heel cups if desperate
- Tuli’s heel cups
- Tuli’s cheetahs

Have to get serious to improve the pain
- Many wait to finish the season

Recurrence possible/common until skeletally mature

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**Osteochondral Lesion of the Talus (OLT)**

- Osteochondritis dissecans (OCD) of the talus
- Injury to the surface of the talus
- Cartilage and subchondral bone
- Conservative treatment not very successful
- Prolonged
- Risks cartilage

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**Osteochondral Lesion of the Talus (OLT)**

**Medial (70%)**
- 64% trauma
- Deep
- Posterior
- Plantarflexion, inversion, ER

**Lateral (20%)**
- 100% trauma
- Shallow/wafer
- Anterior
- Dorsiflexion, inversion, IR

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**Osteochondral Lesion of the Talus (OLT)**

**Berndt and Hardy Classification**

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**OCD**

Keep it simple

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Osteochondral Lesion of the Talus (OLT)

Cartilage surface intact
  • Retroarticular drilling

6 weeks post-op

Osteochondral Lesion of the Talus (OLT)

Cartilage NOT intact
  • Debridement
  • Marrow stimulation (microfracture)

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Osteochondral Lesion of the Talus (OLT)

Cartilage NOT intact
• Debridement
• Marrow stimulation (microfracture)

18 months post-op

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