The Children's Hospital of San Antonio
CHRISTUS Health

Baylor College of Medicine

Knee Injuries in Skeletally Immature Athletes

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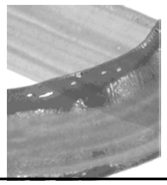


No Disclosures

Topics

- Distal Femur Fractures
- Proximal Tibia Fractures
- Tibial Tuberosity Fractures
- Tibial Eminence Fractures
- Pediatric ACL Tears
- Patellar Dislocations

General Concepts

- Increased rate and ability of healing
- Higher strength of ligaments compared to growth plates
- Continued growth
- Children are NOT just small adults

Growth Around the Knee

- Distal Femoral Physis
  - 1cm growth per year
  - 70% growth of the femur and 37% growth of the lower limb
- Proximal Tibial Physis
  - 0.7cm growth per year
  - 55% growth of the tibia and 25% growth of the lower limb

Evaluation

- Injury mechanism
  - Contact vs. Non-contact
- "Pop" or "snap"
- Able to continue playing
- Displacement or spontaneous reduction of patella
- Presence of Effusion
- Ligamentous laxity
  - Apparent varus/valgus laxity may be due to a physeal injury

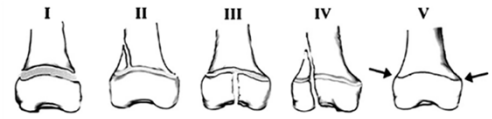
Distal Femur Fractures

- 7% of physeal injuries of the lower extremities
- Complex shape of the physis results in increased risk of focal physeal injury
- High-velocity trauma in younger juvenile patients
- Low-energy sports injuries, usually hyperextension, in adolescents

Complications

- Growth Arrest (40-90%)
  - 64% for type IV
  - 58% for type II
  - 49% for type III
  - 36% for type I
- Leg Length Discrepancy (22%)
- Angular Deformity (24%)
- Repeat X-rays every 6-12 months
- Consider MRI to detect physeal bar

Classification



- Plain radiographs may be equivocal for type I fractures
  - Oblique Xray, contralateral films or consider MRI/CT
  - Stress radiographs have fallen out of favor
- Salter-Harris II fractures account for 54% of these injuries

Proximal Tibia Physeal Fractures

- 3% of lower extremity physeal injuries
- Metaphyseal attachment of ligaments
- Hyperextension Mechanism
- Apex posterior angulation of metaphysis can cause injury to popliteal artery
- May auto-reduce to innocuous position

Treatment

- Nondisplaced – Immobilization for 4 to 6 weeks
- Displaced – Gentle closed reduction (90% traction, 10% manipulation) or Percutaneous pin/screw fixation
- Intra-articular extension of fracture – ORIF

Management

- High index of suspicion for concomitant injuries
  - Vascular injury (5-7%)
  - Anterior compartment syndrome
  - Peroneal nerve injury
  - Ligamentous and meniscal injuries
- Classification and treatment similar to distal femoral fractures
  - Pes anserinus may be interpositioned into fracture site for type II fractures

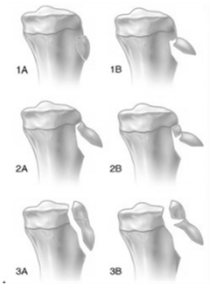
Tibial Tuberosity Fractures

- Salter Harris Type III proximal tibia fractures
- 14-15% of proximal tibia fractures
- Violent contraction of the quadriceps or sudden passive flexion of the knee against a contracted quadriceps
- 90% are sports related
- Occur near end of growth - average age is 15
- Differentiate from Osgood-Schlatter's disease

Clinical Findings

- Patella Alta
- Knee held flexed at 20 to 40 degrees
- Unable to actively extend leg
- Anterior compartment swelling
  - Anterior compartment syndrome
  - Injury to the anterior tibial recurrent artery

Ogden Classification



Treatment

- Most require operative fixation with k-wires or cancellous screws
- Anterior compartment fasciotomy may be indicated
- Immobilize in LLC or HKB for 4-6 weeks
- Return to sports requires 3 to 5 months
- Growth concerns not as common
  - genu recurvatum may develop in younger patient

Tibial Spine Fractures

- ACL insersetion at chondroepiphysis, which is weaker than ACL
- 2% of knee injuries in children
- 8 to 14 years of age
- Usually associated with a plastic deformity or partial tear of ACL as well

Myers and McKeever Classification

Treatment

- Closed Management of Type I and reducible Type II with cast immobilization at 10 degrees for 6 weeks
- Open or arthroscopic treatment to achieve anatomic reduction with sutures or screws
- Inter-meniscal ligament or anterior horn of medial meniscus may be interposed
- Pull of attached anterior horn of lateral meniscus may be impediment to reduction

Complications

- Arthrofibrosis
  - Begin early ROM exercises at 4 weeks
  - Extension block from malunion or prominent hardware
- Residual laxity or instability
  - Up to 64% of patients at 4 years follow-up
  - Much less likely in children under 10

Pediatric ACL Tears

- Increased incidence due to growth in popularity of youth sports, especially for females
  - Athletes participating in high-school sports has doubled in past 40 years (1972 Title IX legislation)
- National Survey of Athletic Trainers in 2012
  - Female soccer players tore ACL 14.08 per 100,000 exposures
  - Male football players tore ACL13.87 per 100,000 exposures

Pediatric ACL Tears

- History and exam is similar to adults
  - Non-contact injuries associated with a "pop" and effusion
  - Poor neuromuscular control and landing mechanics
- Older thinking was that tibial eminence fractures were pediatric equivalent of ACL tears
  - Narrower notch width is associated with higher likelihood of tearing ACL vs. tibial eminence fracture

Work-Up

- Plain X-rays and MRI
  - Assess growth plates and additional injuries
  - Standing long-leg films
    - pre-existing LLD or alignment abnormality
- Assessment of maturity (chronologic, skeletal and physiologic age)
  - Tanner stage
  - PA hand and wrist X-ray for assessing bone age

Treatment

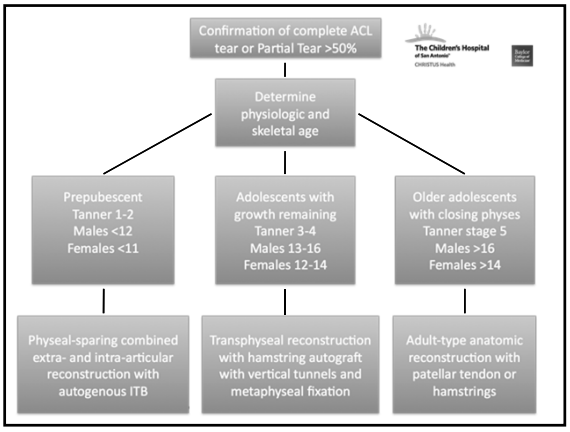
- Non-operative treatment indicated for partial tears <50% and in select cases of complete tears
  - Poor compliance limits success of treatment
  - Overall incidence of meniscal tears 4% for operative vs. 67% for nonoperative
  - Nonoperative patients unlikely to return to play

Surgical Management

- Concern for physeal damage leading to growth arrest or angular deformity
  - Few reports of this in literature with use of proper techniques
- Alternative fixation techniques
  - Physeal-sparing with combined intra-articular and extra-articular reconstruction using ITB
  - All-epiphyseal
  - Partial or complete transphyseal

Surgical Management

- Minimize tunnel diameter
- More central and vertical tunnel drilling
- Soft tissue grafts that occupy <5% of the cross-sectional area have not been shown to cause growth arrest
- Quadrupled hamstring autograft is best choice
- Metaphyseal fixation



Patellar Dislocation

- Non-contact injury that presents with acute hemarthrosis
- Patient may self-describe the dislocation and subsequent reduction
- Predisposing anatomy
  - Genu valgum, Femoral Anteversion, External tibial torsion, Patella Alta, Trochlear dysplasia, Hypermobility, Weak VMO

Evaluation

- If not reduced on presentation, gentle knee extension with medial force to achieve reduction
  - Aspiration of hemarthrosis may be considered
- Assess for patella alta, tenderness over medial retinaculum and apprehension on lateral patellar translation
- Plan X-rays (merchant view) and MRI
  - Osteochondral fractures and loose bodies
  - MPFL, VMO and concomitant injuries

Treatment

- Nonoperative management
  - Preferred for most first-time dislocations
  - Immobilization for 3 weeks with rehab program focusing on strengthening of VMO
- Operative management
  - Indicated in setting of osteochondral fracture or loose body, recurrent dislocations, significant injury to medial stabilizers with VMO retraction
  - MPFL repair vs. reconstruction
  - Distal realignment may be indicated
  - Lateral release rarely, if ever, indicated

Thank You