Adolescent Knee Injuries

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Sports Symposium – Athletic Injuries of the Knee

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Adolescent Knee Injuries

TOPICS
- Tibial Spine Avulsion
- Growth Plate Fractures
- Discoid Meniscus

Tibial Spine Avulsion

- Adolescent ACL tear
- Skeletally immature at risk – failure of incompletely ossified tibial eminence
- Forceful hyperextension injury
- Traction on ACL leads to avulsion

Tibial Spine Avulsion

- Traditionally…fall from a bicycle
- Recent reports – non-contact sports
  - soccer
  - Rugby
  - skiing
- Low-energy mechanisms, such as in athletic injuries, typically occur through forced knee flexion with the tibia in an internally rotated position.
  - 40% are associated with additional intraarticular pathology

Meyers and McKeever, modified by Zariczny
- Based on fracture pattern and guides treatment
  - Type 1 – non-displaced
  - Type 2 – anterior cortical displacement, intact posterior hinge
  - Type 3 – completely displaced
  - Type 4 - comminuted
Tibial Spine Avulsion – Exam / XR

- Pain, swelling / hemarthrosis
- Positive Lachman
- XR - Fracture line in the tibial eminence; useful in determining the degree of displacement
- Contralateral radiographs
  - normal anatomy
  - Non-displaced fractures

Tibial Spine Avulsion – MRI

- MRI…
  - Important if planning non-op care
  - Assess degree of displacement
  - Evaluate for concomitant injuries
    - intra-substance ACL and PCL injuries
    - MCL tears
    - retinacular tears
    - PLC injury
    - meniscal injuries
    - osteochondral fractures

Tibial Spine Avulsion – Treatment

**Type I fractures**
- Non-surgical
- Immobilization
- Position of comfort – 20 degrees vs. extension
- Conventional knee immobilizers vs. cylindrical cast
- Serial (weekly) radiographs – beware of late displacement

**Type II fractures**
- Often aspiration of hemarthrosis needed
- Closed reduction
- Immobilization in extension / position of comfort
- Need to achieve anatomic reduction

**Type III – IV**
- Arthroscopic assisted versus open reduction and fragment fixation
- Surgeon’s comfort level and expertise
- Suture versus screw fixation…no good comparative studies

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Tibial Spine Avulsion – Treatment

- **Type III – IV**
  - Suture fixation
    - Various techniques
    - Good results seen with both ligament and bone purchase
    - Type IV or smaller bony fragments
    - Bone tunnels / bridge
    - Little risk of physeal disturbance
    - No need for hardware removal

- **Type IV or smaller bony fragments**
  - Bone tunnels / bridge
  - Little risk of physeal disturbance
  - No need for hardware removal

- **Screw fixation**
  - Well documented results
  - Anterograde or retrograde
  - Less technically difficult
  - Canulated (accurate starting point, screw trajectory) versus non-cannulated
  - Retained or proud hardware can be problematic
  - Possible growth disturbance in crossing open physis...recurvatum, distal femoral valgus deformity, and limb-length discrepancy
  - Data suggests earlier mobilization and range of motion

Regardless of operative technique, often residual laxity
- Likely due to attenuation at injury
- Laxity is detectable using objective outcome measures.
- Reported in 10% of knees managed surgically / 22% managed non-surgically
- *It rarely causes clinically significant instability or adverse functional outcomes.
  - Few patients require conventional ACL reconstruction

Tibial Spine Avulsion – Rehabilitation

- **Variable - quality of fixation, compliance, nature of the fracture**
- **Type I-2**
  - Immobilized 2-6 weeks; serial radiographs
  - Longer for preadolescent, noncompliant
  - Radiographic union 6-12 weeks
  - Followed by progressive protected WB / ROM
  - Isometric quad exercises to minimize atrophy
- **Post surgical**
  - Early ROM recommended - higher risk of stiffness
  - Tailored to pr
  - Generally, longer periods of immobilization and protected WB for suture fixation...scant literature

Adolescent knee injury
- Treat like acute ACL
- On field exam may be helpful...Lachman
- Restrict WB, crutch assisted, KI
- Reduce risk of displacement
Adolescent Knee Injuries – Outline

TOPICS
- Tibial Spine Avulsion
- Growth Plate Fractures
- Discoid Meniscus

Basic Anatomy
History / Physical Exam
Findings / XR - MRI
Treatment (Non-op and Operative) / Outcomes
Post operative PT / Rehabilitation

Growth Plate Fractures - Knee

Adolescence – between childhood and adulthood
- Girls: 8-13; skeletal maturity appr. 14
- Boys: 10-16; skeletal maturity appr. 16

Bone
- less mineralized
- more vascular, porous, and elastic
- absorb more energy before they fracture, heal more quickly, greater callus
- Physis are weakest link in the bone

Growth Plate Fractures

KNEE – Distal Femur / Proximal Tibia
- High energy trauma
- Sports-related
- May have acute, limb threatening injuries
- Chronically – growth disturbances

Careful neurological and vascular exam!
- Frequent serial exams
- CT angiography as indicated
- Assess for potential compartment syndrome
- Pain out of proportion
- Pain with passive stretch
- Pallor, paresthesia, paralysis, pulses...too late

Growth Plate Fractures - Imaging

General Principles:
- Orthogonal views
- Joint above and below
- Comparative or contra lateral views
- CT – Intraarticular fractures / Better detail
- MRI – associated intraarticular injuries / “health” of the physis

Growth Plate Fractures - Classification

Salter Harris Classification of Physeal fractures
Growth Plate Fractures – Distal Femur

- Metaphyseal or diaphyseal
- Reduce into anatomic alignment
- Maintenance of reduction

Growth Plate Fractures – Distal Femur / Principles of Treatment

1. Reduce displaced physis fractures - traction and very gentle manipulation.
2. Avoid multiple attempts – OR is better!
3. Do not attempt to reduce a physis fracture later than seven to ten days after injury, unless there is an intra-articular step-off of >2 mm.
4. Pins or screws used for internal fixation should be parallel to the physis. Use smooth pins if they must cross the physis. Pins crossing the physis are removed as soon as early signs of fracture-healing appear.
5. Arthroscopic examination during internal fixation of intra-articular fractures can improve the accuracy of a reduction.
6. Most physis fractures heal in three weeks.
7. Monitor the patient for growth disturbances for at least six months or until skeletal maturity.

Growth Plate Fractures – Proximal Tibia

- Proximal tibial epiphysis
- Tibial tubercle
- Tibial spine avulsion

Growth Plate Fractures – Complications

- About 50% of all distal femoral physeal fractures lead to a growth disturbance
- Salter-Harris Type-II injury have the greatest risk
- Nonunion - bone graft and rigid fixation
- Arthrofibrosis - knee manipulation and aggressive physical therapy after the fracture heals

Growth Plate Fractures – Principles of Treatment

- Operative options (displaced)
  - CR / Pinning / Cast
  - Crossed, transphyseal, smooth pins
  - Removed at 4 weeks
  - Screw Fixation (transphyseal or transmetaphyseal)
  - Ex fix (open fractures)
  - Sub muscular plating (older than 10)

NWB until fracture heals
Growth Plate Fractures – Proximal Tibia

- Proximal tibia epiphysis
  - Valgus / hyperextension force
  - Rare, 3% of LE epiphyseal fractures
  - Salter classification
  - Ligaments bypass proximal tibial epiphysis and instead insert more distally
  - Similar treatment approach as distal femoral fractures
  - NV injury, compartment syndrome, growth disturbances not uncommon

Growth Plate Fractures – Tibial Tubercle

- Teenage males
- Repetitive jumping activities
- Anterior knee pain, swelling, inability to extend knee
- Differentiate from Osgood Schlatter (anterior surface vs. true traumatic avulsion)

Growth Plate Fractures – Tibial Tubercle

- Developmental anatomy:
  1. cartilaginous stage
  2. apophyseal stage
    - secondary ossification center
    - in gals (8–12 years of age)
    - boys (9–14 years of age)
  3. epiphyseal stage:
    - secondary ossification centers of the proximal tibia and the tubercle merge

Growth Plate Fractures – Tibial Tubercle

- Watson-Jones, modified by Ogden
  - I – Nondisplaced
  - II – Displaced tubercle
  - III – Thru epiphysis
  - IV – Involves proximal tibial epiphysis
  - V – Periosteal sleeve

Growth Plate Fractures – Tibial Tubercle

- Treatment
  - Nondisplaced (Type I) – cylinder cast, 4-6 weeks
  - All displaced fractures require operative treatment (Types II – IV)
    - ORIF with 4.5 or 6-mm screws
  - Type III – arthroscopic evaluation
  - Type V fractures – periosteal sleeve should be reattached with use of sutures or suture anchors
  - Some advocate prophylactic anterior compartment fasciotomy should be performed
Growth Plate Fractures – Tibial Tubercle

- Postoperatively
  - Knee should be immobilized until the bone heals.
  - Potential complications include
    - prominent implants requiring removal
    - compartment syndrome
    - genu recurvatum due to premature closure of the tibial apophysis.

Adolescent Knee Injuries – Outline

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- Tibial Spine Avulsion
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- Discoid Meniscus

Discoid Meniscus

Medial Meniscus
- Crescent shaped
- 50% articular contact
- 2 to 5 mm excursion
- Attached to MCL with meniscocapsular ligaments

Lateral Meniscus
- C-shaped
- 70% articular contact
- 9 to 11 mm excursion

Discoid Meniscus

- Watanabe classification (discoid lateral meniscus)
  - A – Type I, Block-shaped stable, complete meniscus
  - B – Type II, Block-shaped stable, partial meniscus
  - C - Type III, Unstable meniscus, with stability arising only from the ligament of Wrisberg
Discoid Meniscus

- Young children with snapping knee
- More symptomatic in older children
- Exam findings:
  - Lateral bulge or fullness at joint line
  - Positive McMurray’s exam with clunk / apprehension
  - snaps usually occur as the knee moves from flexion to extension -> pain and apprehension

Radiographic findings:
- Often normal plain films
- Condylar squaring, cupping of plateau
- Widening of lateral joint line
- Hypoplasia of lateral tibial spine

MRI criteria for discoid:
- Transverse meniscal diameter >15 mm
- 20% of the coronal tibial width
- Continuity between the anterior and posterior horns of the meniscus (i.e., bow tie sign) noted on at least three consecutive 5-mm thick sagittal

Incomplete (type II) and Wrisberg variant (type III) often appear normal
- Wrisberg variant MRI may reveal
  - Subtle anterior subluxation of the posterior horn
  - Signal interposed between meniscus and capsule

Treatment

Nonoperative
- Asymptomatic
- Prognosis generally good
- Popping or snapping without pain or swelling should be observed
- Leave alone if incidentally noted on arthroscopy for alternate pathology
- Keep in mind – discoid lateral meniscus are more prone to tear – prophylactic saucerization

Operative
- If symptomatic
- Pain, swelling, history of trauma
- Meniscal preservation with arthroscopic saucerization
  - Create stable, functional remnant
  - Limit resection – leave 6-8 mm rim if possible
Discoid Meniscus - Treatment

- **Operative**
  - Peripheral stabilization added for unstable variants
  - Meniscal repair to capsule
  - All inside repairs vs. inside-out repairs (younger patients with smaller knees)
  - Total meniscectomy avoided unless deemed unsalvageable
  - 45% to 50% decrease in total contact area and a 235% to 335% increase in peak local contact pressure (nondiscoid)
  - Candidates for meniscal allograft transplantation

- **Saucerization**
  - Immediate weight bearing
  - PT / gradual return to sports 6-8 weeks
  - Analogous to partial meniscectomy in adult

- **With Meniscal repair**
  - Limited versus partial weight bearing
  - Hinged knee brace; progressive ROM (0-90 degrees by week 6)
  - RTP 3-4 months postoperatively

Discoid Meniscus - Results

- Recent studies have shown encouraging results after arthroscopic saucerization of a discoid lateral meniscus
- Long-term studies are needed to determine whether saucerization will prevent future onset of clinical and radiographic lateral compartment OA.

Discoid Meniscus - Rehab

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  - PT / gradual return to sports 6-8 weeks
  - Analogous to partial meniscectomy in adult

- **With Meniscal repair**
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Discoid Meniscus - IN THE TRAINING ROOM

- Exam is superior diagnostically versus MRI!
  - MRI has a low sensitivity compared with physical examination (38.9% versus 88.9%, respectively)
  - Preoperative diagnosis by the surgeon better than formal interpretation of MRI scans by a radiologist

- May traumatic or atraumatic

- Remember exam findings

References

- www.wheelessonline.com
- www.aaos.org

THANKS