Knee Injuries in the Young Athlete: from Injury to Recovery

LINDSEY DIETRICH, MD
SIDELINE ORTHO & SPORTS

WWW.DFWSPORTSDOC.COM
Outline

- Epidemiology of Youth Sports Injury
- Overview of Skeletal Immaturity
- Differential Dx of Knee Injuries in the Young Athlete
  - Diagnosis
  - Treatment
  - Prognosis
- Interesting Cases
Epidemiology

- **Sports Related Injury: kids and adolescents**
  - 4 million ER visits annually
    - 2 mil = “Serious”
  - Up to 68% of all youth injury related to sport/phys activity
  - From 90’s-2000 28% increase in sport injuries
  - More than half of injuries in 10-14 age group
  - M > F
    - 1.8 : 1

SSMR 2013; APAM 1995
Epidemiology

• Injury Types
  o Sprain/strain > Fx/dislocation
    □ ~60% soft tissue
    □ 53% chronic injury affect Physis or cartilage

• Risky Business
  o NCAA: FB > wrestling > Gymnastics > Soccer
  o Adolescents
    □ M = Football, F = Basketball vs Cheer
  o Time lost
    □ M 6.6days, F 7.7 days
    □ Cheer ~29 days
  o Surgical Rates 5%

JSMP 1998; NCAA IS; DMJ 1991; AJSM 1996
Epidemiology

- Sites of Injury
  - LE >> central & UE
    - Knee / Ankle
  - Obviously sport dependent
    - Each sport has a “fingerprint” injury profile
The Physis and Kid Bone

- **Increased Bone elasticity** (viscoelasticity)
  - Buckle and Greenstick type fractures

- **Physis = Growth plate**
  - Chondrocytes proliferate making a scaffold for longitudinal bone growth
  - Periphery of physis responsible for appositional growth (widening)
  - Weak link in MSK system
Skeletal Maturity

- Treatment strategies with the Physis in Mind
  - Male 16yo
  - Female 14yo
  - These are just averages!

- Patient based Factors to consider during treatment
  - Chronological age
  - Bone Age
    - Hand, pelvis, knee
  - Peak growth velocity
    - Menstrual cycle, Tanner staging
    - M 13.5yr, F 11.5yr
Skeletal Maturity

- **Patient Based Factors**
  - **Obesity**
    - Hormonal influence in ligaments
    - Mechanical overloading of joints
    - Malnourishment
    - Greater injury severity
  - **Racial/Geographic**
    - Vit D exposure
    - Puberty
Skeletal Maturity

- **Mechanical Considerations**
  - Subtle alignment changes
    - From valgus to more neutral
    - Increases on PF and medial compartment loads
  - Length discrepancies
    - Bone lengthening and muscle stretching
Muscle and Tendon

- **MT junction**
  - 10x increase in stiffness over the first 2 decades

- **Strength**
  - Plateaus in strength gains
    - M 18yo
    - F 14yo

- **Speed**
  - Peak gains
    - M 15yo
    - F 12yo
The Young Athlete’s Knee

- **History and PE**
  - Pivotal in diagnosis
  - Common pearls
    - Younger athletes frequently have more lax exam at baseline
      - Test both sides
    - Most 10-12 year olds don’t complain of pain
    - **Danger Signs and Considerations**
      - Intra articular swelling is NEVER normal in a kid
      - Refusal to weight bear
      - If they can’t walk, they can’t play
      - Most kids have a much HIGHER pain tolerance than adults
      - Limited extension
        - Posterior capsular tightness is the most common response
      - They are starfish! TIME SENSITIVE!!!
Young Athlete’s Knee: DDX

- Distal Femoral Physeal fracture*
- Tibial tubercle fx*
- Patellar Sleeve Avulsions*
- Tibial Eminence Avulsion*/ACL tears
- Meniscal Injury
- Osteochondritis Dessicans (OCD)
- Patellar Instability
SC Femur Fx

- Salter Harris Fx Grading System
- Commonly from varus/valgus blow
- High index of suspicion
  - Pain over physis w/ WB
- Can be difficult to see on XR
  - “Undulating Physis”
  - Advanced imaging
- Very High Complication Rate
  - LLD (9mm /yr)
  - Angular deformity
  - Pop AA injury
SC Femur Fx

- Growth Disturbance
  - 36% in SHI
  - 64% in SH4
SC Femur Fx

• **Treatment Principles**
  - Neurovascular Status
  - Reduction, Stabilization
    - Physis reduction
    - Articular reduction
    - Avoid repeated closed reductions
      - Periosteum interposed
  - Nonop only indicated for truly non-displaced SHI
    - LLC/bracing
    - Close F/u for displacement
SC Femur Fx

- **Surgery**
  - Smooth Pins only across
SC Femur Fx

- Post Op Course
  - Close f/u with serial radiographs
  - NWB, no ROM x 6 wk
    - Then try to regain motion over 3-4 wk
  - High tendency to re-displace
  - 2+ yr of f/u
    - Xr angular deformity
    - May need advanced imaging
      - for Physeal Bar
        - (much less pleasant than your local watering hole)
SC Femur Fx

• **Post-Op**
  - Typically HW Removal is planned
  - Eval for concomitant ligamentous injury
    - Advanced imaging
    - Stage any ligament procedure if possible

• **Managing family and patient expectation**
  - RTP 4-6 mos
  - Hold them out 6 wk after HWR
  - Risk of physis complication extends beyond healing time
Managing Expectations

- Compassion and Reality
  - Physeal injuries can be significantly and permanently life changing
  - Important to communicate kindly but be honest!
Tibial Tubercle Fx

- Males aged 12-15
- Eccentric contraction
  - On flexed knee
    - Landing or initiating jump
    - Basketball, T&F
- 2 ossification centers
  - Posterior Fuses first
Tibial Tubercle Fx

- Modified Ogden classification
- Exam
  - Tenderness and deformity
  - Extensor lag or loss
  - Immediate anterior compartment swelling
  - Can be open injury
  - Can be periosteal sleeve injury
- HIGH risk Compartment syndrome
  - Recurrent Anterior Tibial AA
Tibial Tubercle Fx

- Periosteal Sleeve Avulsion
  - Tibial
  - Patellar
Tibial Tubercle Fx

- **Treatment**
  - Closed reduction and long leg cast, nwb
    - If not involving joint
    - If easily reducible and less than 2mm displacement
    - Sometimes up to 10 weeks
  - Can cause meniscus entrapment
  - Periosteum can block reduction
  - More commonly ORIF and anterior fasciotomy
  - Patella need drill hole or suture anchor repair
Tibial Tubercle Fx

- **ORIF**
  - Can need longer cast
    - Extensor torque
  - Less issue with growth arrest
- **Most will open ant. comp.**
- **Check joint for meniscus**
- **Hardware always painful**
  - HWR
- **RTP 5-6 mos**
Patellar Sleeve Avulsion

- Most require ORIF
  - Get MRI to eval cartilage component
  - Prefer suture / drill hole repair
  - Tension band wire repair
    - More HW irritation

- Complication
  - Extensor lag or weakness
  - Post traumatic OA
  - Large arthroscopy
    - Stiffness
    - Quad atrophy
Tibial Tubercle Fx

- Long leg casts are fun ... for no one
Tibial Tubercle Fx

- Except I guess this person on a nature hike, in heels
  - ????
  - Not recommended for young athletes recovering
Tibial Eminence Fx

- Tibial eminence
  - Non articular area of tibial ACL footprint

- Mechanism same as ACL
  - Ages 8-14
  - Hyperext, abrupt deceleration, pivot injury

- Exam
  - Laxity with ACL testing
  - Immediate tense hemarthrosis
  - May be more painful than ACL
Tibial Eminence Fx

- **Meyers and McKeever Classification**
  - 1 = non displaced
  - 2 = hinged posteriorly
  - 3 = detached

- **Advanced Imaging**
  - CT: defines bony fragment
  - MRI
    - Addl ligament/meniscus injury
Tibial Eminence Fx

- **Treatment**
  - Nonoperative
    - Truly nondisplaced fracture
      - Immobilize in slight flexion
Tibial Tubercle Fx

- Surgical treatment
  - ORIF
  - Arthroscopic or open ORIF
    - Easier technically
    - Possibly stronger fixation
    - Screw can impinge/cause irritation
    - Can injure physis
  - Arthroscopic Suture fixation
    - More technically difficult
    - Incomplete reduction
    - Avoid physis
Tibial Eminence Fx

- Arthroscopic Suture fixation
  - Many technical variations
Tibial Eminence Fx

- **Complications Common**
  - Arthrofibrosis
    - Hold early ROM bc of propensity for fragment displacement
  - Block to full extension
    - Cyclops or bony cyclops
  - Growth arrest of tibial physis
  - Residual ACL incompetence/laxity
    - 20% (probably more)
Managing Expectations

- Patient and family, as well as ATCs/coaches/PTs
  - Will perform early much worse than ACL
  - All get profoundly stiff
    - Some will require reoperation / LOA
  - Around 3-4 mos begin to improve
  - Expect 6-9 mos RTP if uncomplicated
Case 1: Pediatric ACL

- Case CC
  - Hx: 11yo M with L knee injury getting cut in FB game and felt a pop now with mild swelling and significant lax Lachman exam
    - Wide open Physes
    - Small stature, no pubertal signs
    - Not a good candidate for transphyseal ACL
Pediatric ACL

- Why skeletal maturity matters
  - Physeal considerations change surgical options in young athletes
  - Multiple techniques
    - All epiphyseal
    - Transtibial soft tissue graft
      - Getting close to maturity
    - IT Band Reconstruction
      - “physeal sparing”
Pediatric ACL

- ITB Reconstruction
Pediatric ACL

- **ITB reconstruction**
  - ITB left attached to gerdy’s tubercle and sutured to posterior capsule
  - Pass under IML
  - Suture to tibia periosteum
    - Low horizontal graft
    - Sits in tibial trough
Pediatric ACL

- Postop
  - Bracing
  - NWB 6 wk
  - ROM 0-30 x 2 week
    - 0-90 until 6 wk then FROM
  - No running x 3 mo
  - Similar RTP 9-12 mo
    - Higher risk of re-tear in younger athletes
    - Protect them long enough to get close to maturity
Case 2

- 14yo Obese freshman lineman, presents 3 days s/p lateral blow to R knee
  - Skeletally immature, on crutches
  - Large effusion
  - ROM 10-40deg
  - Valgus stress laxity
  - UTO Lachman/PD
Case 2

- 14yo R knee injury
  - SH 3 distal femur fx
  - ACL tear
Case 2: SH3 Distal Femur Fx/ACL

- **Stabilization of Bony injury**
  - ORIF of femur
  - Cast was not possible
  - 6 wk NWB, then aggressive ROM
    - Strength rehab

- **Staged ACL Recon w HWR**
  - Medial structures damaged
  - 3 mos once full ROM
Case 2

- 14yo R knee injury
  - SH 3 distal femur fx - ORIF
  - ACL tear- Staged ACLR with HWR
Thank You!

- LindseyDietrich@TexasHealth.org

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