Knee Pain: Differential for Adults and Pediatrics in Sports

02/19/15
OPSO - SUNRIVER, OR

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GSRMC – CORVALLIS, OR
Thought Process in the workup of Knee Pain
Referred Pain & atypical causes in Peds
Anatomy
History & Physical
Location of Pain and Differential
Imaging
Acute Knee Injuries (Adults vs Peds) - Sports
  - ACL
  - Meniscal Injuries
Knee Pain – Thought Process

- Was there a Definable Event: Trauma vs Insidious
  - Will help focus History & Physical
  - Define Trauma (Indirect vs Direct)
- Timing of Pain: Acute vs Chronic (Combo)
- Age: Adult vs Pediatric (Adolescent)
- Location of Pain: Discreet point vs Global or Deep
- Acute Swelling/Hematoma?

- **ALWAYS** watch out for Recurrent or Atypical causes of knee pain (ie. Osteochondral defect or Referred Pain)
- Referred pain is typically different in Adults and Peds
Hiltons Law – Describing Referred Pain

- Series of 3 lectures At the Royal College of Surgeons of England, 1860, 1861, and 1862.

- The same trunks of nerves whose branches supply the groups of muscles moving a joint *furnish also a distribution of nerves to the skin over the insertion of the same muscles* and the *interior of the joint* receives its nerves from the *same source*.

BY THE LATE
JOHN HILTON, F.R.S., F.R.C.S.,
Surgeon Extraordinary to Her Majesty the Queen, Consulting Surgeon to Guy's Hospital, Member of the College Council, President of the Royal College of Surgeons of England, Member of the Court of Examiners, and Professor of Anatomy and Surgery, Etc., Etc., Etc.

Referred Pain in Adults

- Hip Osteoarthritis
- Low Back pathology
- Femoral pathology
  - Oncology
  - Infection
  - Fracture/stress fx
  - Loose femoral implant – Total Hip Arthroplasty

Pain from sciatica radiates from the buttock down the leg and can travel as far as the feet and toes.
Referred Pain in Pediatrics

**Slipped Capital Femoral Epiphysis (SCFE)**
- Displacement across proximal femoral physis (growth plate)
- Obese or thyroid/renal disease
- 10-16 yo; Painful limp with hip and/or knee pain
- External Rotation; pain with ROM

**Legg-Calve-Perthes Disease**
- Idiopathic osteonecrosis of femoral head – blood supply?
- 4-8 yo; M>F; painful limp
- Decreased ROM of hip, especially Internal Rotation and Abduction
Slipped Capital Femoral Epiphysis (SCFE)
Slipped Capital Femoral Epiphysis (SCFE)
SCFE – Klein’s Line
SCFE Treatment – In Situ Screw (Bilateral?)
Referred Pain in Pediatrics

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Legg-Calve-Perthes Disease

Stage 1
Avascular necrosis

Stage 2
Fragmentation/Resorption

Stage 3
Re-ossification
Legg-Calve-Perthes Disease

- Better outcomes in younger patients (<6 y.o. onset)
- Treatment goals:
  - Symptomatic relief
  - Maintaining femoral head in the hip joint
  - Maintaining/Regaining ROM
- Nonoperative tx – offloading, bracing, traction
- Operative tx – Femoral osteotomy +/- acetabulum
Back to Knee Pain H&P
History – Be Specific

- Where is the Pain? – please point with one finger
- What were you doing... when the Injury occurred? Or when you first noticed the pain?
- Does your knee feel unstable?
- Do you have pain going up or down stairs?
- Did your knee swell up at all? If so, how quickly?
- Did you take anything for the pain?
- Any pertinent medical/surgical/family Hx?
- Any fracture Hx or overuse activities?
- Prior knee pain? How long before it resolved?
Physical Examination

- Inspection – Effusion, atrophy...
- Palpation – Start with the painless knee
- Range of Motion – active, passive...
- Motor/Strength – watch for guarding, contractures
- Stability
- Neurovascular
- Special Tests
Anatomy and Landmarks

- Vastus intermedius muscle
- Articularis genus muscle
- Vastus lateralis muscle
- Femur
- Vastus medialis muscle
- Iliotibial tract
- Lateral patellar retinaculum
- Lateral condyle of femur
- Fibular collateral ligament and bursa
- Biceps femoris tendon and bursa
- Broken line indicates bursa under iliotibial tract
- Common peroneal nerve
- Head of fibula
- Insertion of iliotibial tract to Gerdy's tubercle and oblique line
- Peroneus longus muscle
- Extensor digitorum longus muscle
- Tibialis anterior muscle
- Right Knee
- Medial patellar retinaculum
- Semitendinosus tendon (part of pes anserinus)
- Gracilis tendon (part of pes anserinus)
- Sartorius tendon (part of pes anserinus)
- Anserine bursa
- Medial condyle of tibia
- Patellar ligament
- Gastrocnemius muscle
- Tuberosity of tibia
Anatomy and Ligaments
Anatomy and Ligaments
Anatomy

Superior view

- Posterior meniscofemoral ligament
- Arcuate popliteal ligament
- Fibular collateral ligament
- Bursa
- Popliteus tendon
- Subpopliteal recess
- Lateral meniscus
- Superior articular surface of tibia (lateral facet)
- Iliotibial tract blended into capsule
- Infrapatellar fat pad
- Joint capsule
- Anterior cruciate ligament
- Patellar ligament
- Semimembranosus tendon
- Oblique popliteal ligament
- Posterior cruciate ligament
- Tibial collateral ligament (deep part bound to medial meniscus)
- Medial meniscus
- Synovial membrane
- Superior articular surface of tibia (medial facet)
<table>
<thead>
<tr>
<th>Location of Pain</th>
<th>DIFFERENTIAL</th>
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<tbody>
<tr>
<td><strong>Adult</strong></td>
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<tr>
<td><strong>Anterior</strong></td>
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<tr>
<td>- Meniscus</td>
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<td>- Plica syndrome</td>
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<tr>
<td>- Patello-femoral syndrome</td>
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<tr>
<td>- Patellar tendonitis (-opathy)</td>
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<td>- Pes Anserinus Bursitis (tendinopathy)</td>
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<tr>
<td>- <strong>Trauma:</strong> Quad rupture, Patellar fracture, Tibia fx</td>
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<tr>
<td><strong>Posterior</strong></td>
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<tr>
<td>- Popliteal cyst = Meniscal pathology</td>
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<tr>
<td>- Hamstring tendonopathy</td>
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<tr>
<td><strong>Medial/Lateral</strong></td>
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<tr>
<td>- Ligament strain/sprain</td>
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<td>- IT band syndrome</td>
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<td><strong>Pediatric</strong></td>
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<td><strong>Anterior</strong></td>
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<td>- Meniscus</td>
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<td>- Plica syndrome</td>
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<tr>
<td>- Patellar dislocation vs PFS</td>
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<td>- Osgood-Schlatter</td>
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<td>- Sinding-Larsen-Johansson</td>
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<tr>
<td>- <strong>Trauma:</strong> ACL vs tibial tubercle Avulsion</td>
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<td>- Miserable Malallignment</td>
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<tr>
<td><strong>Posterior</strong></td>
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<tr>
<td>- Discoid Meniscus</td>
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Imaging

- **XR**
  - Fractures/Dislocation
  - Secondary signs of ligament injuries

- **MRI**
  - Define soft tissue injuries (i.e., Meniscus, ACL, PCL, other ligaments...)
  - Chondral and subchondral bone damage vs Osteoarthritis
  - Infection/Tumor – better defined with contrast

- **US**
  - Soft tissue/cysts – User dependent
  - Injections/Drainage of cysts
Applicable to Children >5
Meta-analysis in 2009 with 99% sens and 46% spec
Reduction in radiography 30-40%

XR – 2 vs 3 views

- 3 Views – AP, lateral and Sunrise/Merchant (Notch?)
- **Weight Bearing** when possible
Sports Injury #1 – Instability after Indirect Injury

- Athlete (of any age) admits to knee pain, usually deep after a non-contact injury during a change-of-direction maneuver
- Pt may feel knee hyperextension during an awkward landing/fall (may be difficult to describe)
- A “pop” may or may not be heard/felt
- **Acute Swelling/Hemarthrosis**
- Instability if the pt is able bear weight or attempts to return to sport
- Possible meniscal symptoms (catching, locking...)
Acute Knee Injury vs Chronic Pain

- **Acute**
  - Specific Injury +/- Knee Effusion
  - Intra-articular vs Extra-articular

- **Chronic**
  - Age specific
  - Degenerative vs Microtrauma (Overuse)
Thought Process

- Acute Knee Injury
  - + Effusion & Significant Trauma
  - NO effusion & Minimal Trauma
    - Knee Immobilizer & Follow-up in 2 weeks
    - Further Diagnostic Workup
Acute Knee Injury, NO Effusion

If NO Effusion

→ Brief Immobilization
→ Re-examine in 2 weeks
→ Diagnostic Workup if indicated

Differential:

Bruise
Bone/Muscle Contusion
Mild Sprain
Acute Knee Effusion


131 pts w/acute knee effusion
10-18 y.o. (over a two yr period)

#1: ACL Tear
#2: Patellar Dislocation
#3: Meniscal Tear
#4: Chondral Injury

“Adolescents presenting with a traumatic knee effusion should undergo MRI because of the high rate of positive findings missed by physical examination and plain radiographs that may warrant surgical repair or reconstruction.”
113 athletes with “significant acute trauma” with early onset hemarthrosis

No demonstrable clinical laxity

All had arthroscopy w/in 3 weeks of injury (most <10 days)

102 pts (90%) had surgically significant issue

ACL tears in 81 pts (72%)

Meniscal lesions in 2/3 of ACL tears + 17 pts (15%) with isolated cases

Osteochondral fractures in 7 pts (6%)

PCL tears in 3 pts (3%)
Non-Contact Injury
Non-Contact Injury
ACL Injuries

- **Non-Contact**
  - Landing awkwardly
  - Cutting
  - Pivoting

- **Contact**
  - Direct trauma - Football, Lacrosse, Rugby, Soccer...
Anatomy

Intercondylar region
Anterior cruciate ligament
Posterior cruciate ligament
Medial meniscus
Lateral meniscus

PCL
AM
PL
ACL

● ACL Anatomy
  ○ 33mm x 11mm in size
  ○ from Lateral Femoral Condyle to anterior tibia two bundles
    ▪ anteromedial bundle
      ○ more isometric
      ○ tight in flexion
    ▪ posterolateral bundle
      ○ tightest in extension (where it likely contributes greatest to rotational stability)

● ACL Blood supply
  ○ middle geniculate artery

● ACL Innervation
  ○ posterior articular nerve (branch of tibial nerve)
ACL Function

- Primary restraint to **anterior displacement** of the tibia on the femur
- Secondary stabilizer to **tibial rotation**

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- ACL-deficient knee can lead to meniscal injury, functional instability, and early-onset osteoarthritis.
ACL - Gender

- ACL injury is more common in females due to...
  - **Landing** biomechanics and Neuromuscular control differences
    - conditioning and strength play the biggest role
    - females land with their knees in **more extension and valgus** due to hip internal rotation
  - **Smaller Tibial notch**
  - **Smaller ACL size**
  - **Cyclic hormonal levels**
    - ACL at greater risk for injury during the first half phase) of the menstrual cycle
  - **Leg alignment (Q angle)**
  - **Possible Genetic predisposition**
    - underrepresentation of **CC genotype of a COL5A1 gene** sequence in females with ACL ruptures
Pediatric patients treated >150 days after injury for ACL tears have a higher rate of MMT than those treated ≤150 days.

Increased age and weight are independently associated with a higher rate of MMT.

Patients with ACL tears and an MMT or LMT are more likely to have a chondral injury in that particular compartment than those without meniscal tears.
Meniscal and Chondral Injuries Associated With Pediatric Anterior Cruciate Ligament Tears

### Relationship of Treatment Time and Patient-Specific Factors

Guillaume D. Dumont, MD, Grant D. Hogue, MD, Jeffrey R. Padalecki, MD, Ngozi Okoro, MPH, DrPH(c), and Philip L. Wilson, MD

*Investigation performed at the Children’s Medical Center, Dallas, Texas*

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>&lt;150 Days</th>
<th>&gt;150 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial Meniscal Tear</td>
<td>91/241 (38%)</td>
<td>69/129 (54%)</td>
</tr>
<tr>
<td>Lateral Meniscal Tear</td>
<td>135/241 (56%)</td>
<td>82/170 (48%)</td>
</tr>
<tr>
<td>Cartilage Injury</td>
<td>No difference</td>
<td></td>
</tr>
</tbody>
</table>

*More likely to have Chondral injury if you have a meniscus injury
*Retropective chart review*

*The American journal of sports medicine. 2012;40(9):2128-33*
Associated Injuries in Pediatric and Adolescent Anterior Cruciate Ligament Tears: Does a Delay in Treatment Increase the Risk of Meniscal Tear?

Peter J. Millett, M.D., M.Sc., Andrew A. Willis, M.D., and Russell F. Warren, M.D.

<table>
<thead>
<tr>
<th></th>
<th>&lt; 6 weeks</th>
<th>&gt; 6 weeks</th>
</tr>
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<tbody>
<tr>
<td>Medial Meniscal Tear</td>
<td>2/17 (11%)</td>
<td>8/22 (36%)</td>
</tr>
<tr>
<td>Lateral Meniscal Tear</td>
<td>8/17 (47%)</td>
<td>8/22 (36%)</td>
</tr>
</tbody>
</table>

More **Non Repairable** Medial Meniscal Tears in the Chronic Group

Imaging

- XR - to rule out significant fracture and identify secondary signs of ACL tear

- MRI - identify ligamentous, meniscal or possible chondral pathologies
  - Classic bone contusions
Lateral Capsular avulsion of proximal tibia
Tibial Spine Avulsion
Bone Bruising

- Posterolateral Tibia and Lateral Femoral Condyle

Anterior Translation of Tibia
Lachman test

- Knee flexed ~30 deg with anterior translation of tibia
- Assessing excursion and endpoint
- Compare to contralateral knee – Most Sensitive test

**Grading**
- 1: 0-5mm
- 2: 5-10mm
- 3: >10mm

**Endpoint**
- A: Good
- B: Absent
Anterior Drawer

- Knee flexed 90 deg with anterior translation of tibia
- Laxity/Anterior excursion
- Compare to contralateral knee ——— Posterior drawer test
ACL Non-Operative Management

**Adults**
- Low Demand
- In-Line activity w/ or w/out Brace use
- Early physical therapy
- Risk of Osteoarthritis, but OA more directly correlates to meniscal injury or meniscectomy  (Neuman P, et al AJSM 2008)

**Pediatrics**
- Low Demand, Highly Compliant patient
- Avoidance of Sports and Brace use
- Early physical therapy
Several studies show increased meniscal tears in delayed surgery...
And meniscal tears correlate to chondral damage

OK to delay surgery with Open Physes (Woods et al. AJSM 2004)
- No difference in articular injury or meniscal tears

Systematic literature review in Arthroscopy, May 2011, recommended for surgical stabilization

ACL reconstruction techniques: must consider physis in Pediatric patients – (growth arrest, angular deformity)
ACL Surgical Reconstruction
Graft w/ button and interference screw fixation
Prevention in Pediatrics

- Bracing NOT demonstrated to prevent
- Appropriate footwear
- Neuromuscular Training - Jump & Land Correctly
- Hip Abductor strengthening

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- **Sportmetrics** - [www.sportsmetrics.org](http://www.sportsmetrics.org)
  - Cincinnati Sportsmedicine Research and Education Foundation
- **Sportmetrics** - **preseason training sessions/courses**

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- **PEP** (Prevent injury Enhance Performance)
  - Santa Monica Orthopedic and Sports Medicine Research Foundation
- **PEP** can be implemented as a pre-practice warm-up 3 d/wk
Landing & Non-impact injuries

- 52% reduction in female
- 85% reduction in male
Sports Injury #2 – Joint Line tenderness

• Pt with acute knee pain following twisting, planting or change of direction injury
• Effusion? (may resolve prior to office visit)
• Specific symptoms: clicking, popping, catching/locking...

Physical Exam:
• Pinpoint tenderness over joint line (but not always)
• McMurray (55% sens; 77% spec)
• Apley’s (22% sens; 88% spec)
Meniscal Tears

- **Medial meniscus tears 3 times more often** than lateral meniscus tear
- **Degenerative tears more common in adults**
  - Insidious onset +/- specific injury
- **Traumatic meniscal tears more common in peds**
  - Look out for other injuries (ie. ACL, medial/lateral collaterals..)
- Treatment guided by age and symptoms
- Imaging: XR (rule out fx) and MRI (timing)
Meniscal Tears

Adults:
- Degenerative vs Acute
- More likely to debride

Pediatrics:
- Acute
- Associated injuries (ACL, PCL...)
Meniscal Tear - Workup

- Good H&P – rule out fx with XR (may show other signs of ligament injuries)
- MRI...
Bucket Handle Tear

- Risk of Flipping into notch
- Locking symptoms and/or damaging Cartilage
Meniscus Anatomy

- Crescent-shaped Fibrocartilaginous structure
- Type 1 collagen
- Blood supply to lateral 10-30% from medial and lateral genicular arteries
- Enhances tibial articular surface and provides joint stability and help with joint lubrication/nutrition
Meniscus Blood Supply - Peripheral
Meniscal Repair
Arthroscopic Repair of Meniscal Tears Extending into the Avascular Zone in Patients Younger Than Twenty Years of Age*

Frank R. Noyes,† MD, and Sue D. Barber-Westin

- Patients <19 years
- Repaired tears extending into avascular zone
- 75% asymptomatic
- 87% of ACL recon group (good/normal)
Outcome of repaired unstable meniscal tears in children and adolescents

25/29 Meniscal repairs healed
4 failures were “new injuries”
Meniscal Repair
Meniscal Repair
Positive Factors for Repair Success

- Acute (<6 weeks)
- Red-Red zone
- Vertical tear
- 1-4 cm in length
- Pt less than 40 y.o.
- Repair other ligaments (ACL, etc.)
- No mal-alignment or minimal to no osteoarthritis
Post Op protocol for Debridement

- WBAT immediately (with crutches for balance)
- ELEVATE, ELEVATE, ELEVATE...
- ICE...
- Goal to decrease swelling in order to regain or improve ROM
- Decreased time to full ROM and painless ambulation will shorten Rehab time 2/2 atrophy
Post Op protocol for Repair

- Variable...
- Postoperative care is determined by the size or extent of the tear, stability, and whether the repair is combined with a ligament reconstruction.
- Small and stable tear - the knee is placed in a hinged brace and immediate range of motion from 0 to 90 degrees is permitted.
- Touch-down weight bearing is permitted immediately, and full weight bearing is permitted at 6 weeks when the brace and crutches are discarded. No sports are allowed for 3 months.
Post Op protocol

- If the tear is sufficiently large to allow displacement into the joint, the **hinged brace that is locked in full extension for 3 to 4 weeks.**
- Only touch-down weight bearing with crutches is permitted.
- At 4 weeks, the hinge mechanism of the brace is adjusted and motion from 0 to 90 degrees is begun. The brace is worn for 6 weeks and then removed.
- Weight bearing to 50% is reached at this point. Crutches can be discontinued at 8 weeks.
- **No sports are allowed for 6 months**, depending on the success of rehabilitation.
- If the meniscal repair is combined with a reconstructive procedure, such as reconstruction of the anterior cruciate ligament, motion, brace wear, and weight bearing are determined by the postoperative care required for the reconstructive procedure.
Pediatric Anterior Knee Pain - Overuse

Sinding-Larsen-Johansson

Patellar Tendonitis (-opathy)

Osgood-Schlatter
Osgood-Schlatter Disease

- Most common overuse injury in Peds (~10%)
- Traction induced apophysitis/inflammation at **patellar tendon insertion** (tibial tubercle)

♂ > ♀

**History:**
- Anterior knee pain with activity
- but persists...
- Generally localized to tibial tubercle

**Exam:**
- Tender over tubercle +/- Swelling
- Pain with **resisted knee extension**
- Check quad and hamstring flexibility

Patella (kneecap)

Area of pain

Tibial tuberosity (bump is enlarged)

Tibia (shinbone)

Normal insertion of patellar ligament of ossifying tibial tuberosity

In Osgood-Schlatter disease, superficial portion of tuberosity pulled away, forming separate bone fragments

Bone fragment Separation filled with fibrous tissue and fibrocartilage

Growth plate (hyaline cartilage)

Metaphysis of tibia
Usually Self Limiting

Non-Operative 90% successful
- 237/261 patients at 12 – 24 months follow up
- “24 patients who did not improve with conservative measures underwent surgical excision of ossicles, and all returned to normal activities (mean time, 4.5 weeks)”

Activity as tolerated vs. activity restriction

Operative Tx only in severe refractory cases

NSAIDS and RICE and strengthening/stretching (quads)

Sinding-Larsen-Johansson Syndrome

- Traction tendonitis at inferior pole of patella.

- **History:** Pain with stairs, jumping and running, and generally younger than Osgood-Schlatter Dz

- **Exam:** Tender at inferior pole of patella

- **Imaging:** Fragmentation or calcification at inferior pole of patella

- **Treatment:** RICE, NSAID’s, Physical Therapy
Thank you!!!!
References

- Thank you to Shriners Hospital staff and my fellow residents
- Miller’s Review of Orthopaedics, 5th edition
- www.orthobullets.com
- Netter’s Concise Orthopaedic Anatomy, 2nd ed.
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- www.wheelessonline.com
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