Knee Injuries in the Adolescent Population

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Knee Anatomy

- Anterior cruciate ligament
- Patellar (reflected)
- Patellofemoral groove
- Distal femoral condyle
- Lateral meniscus
- Tibial collateral ligament
- Medial meniscus
- Fibular collateral ligament
- Tibial plateau
- Tibia
- Fibula
A proper working knowledge of knee anatomy is essential to diagnose and treat adolescent knee complaints.

The knee has two distinct joints:

- **Tibiofemoral joint** (articulation of the femur and tibia)
  - Cruciate ligaments, collateral ligaments, menisci, articular cartilage
- **Patellofemoral joint**
  - Stability via medial retinaculum/MPFL and patella tendon
  - Most common source of Anterior Knee Pain
It’s not supposed to bend that way right?
Tibiofemoral Joint Ligaments

- **Cruciate Ligaments** – A(anterior)CL and P(posterior)CL
  - Intra-articular
  - **ACL**: limits anterior movement of the tibia on the femur and prevents rotational movements
    - Critical for pivoting and functions in landing from a jump, cutting, deceleration
  - **PCL**: restricts posterior movement of the tibia on the femur and stabilizes the body above the tibia
    - Essential for running downhill/descending stairs

- **Collateral Ligaments** – M(medial)CL and L(lateral)CL
  - Extra-articular; also referred to as tibial and fibular collateral ligaments
  - Provide medial and lateral stability to the joint respectively
  - Deep fibers of the MCL attach to the medial meniscus (intra-articular)
Medial and Lateral Menisci – intra-articular and attach to the knee capsule at the joint line

- C-shaped; concave (concavity increases knee stability at tibia)
- Decreases compressive joint force and protects the articular cartilage surfaces from damage (“shock absorbers”)

Articular Cartilage – also referred to as Hyaline cartilage

- Dense, smooth; functions to decrease friction between the weight bearing surfaces
- Protects the ends of the tibia and femur
Patellofemoral Joint
Patellofemoral Joint

- Formed from the articulation of the patella with the medial and lateral femoral condyles (trochlea)

- **Patella** – triangular shaped sesmoid bone within the quadriceps tendon
  - Protects the knee from direct trauma
  - Fulcrum for extension of the quadriceps
  - Motion constrained by the quadriceps (vastus medialis and lateralis), patellofemoral/ patellotibial ligaments, retinaculum
  - Suprapatellar fat pad limits extension

- Motion:
  - **20-30 degrees flexion** – patella engaged in trochlea
  - **90 degrees flexion** – contacts medial/ lateral femoral facets (in condylar fossa)
  - **130-135 degrees flexion** – medial facets of patella contact articulating surface of femoral condyles
Bony Anatomy/ Terminology

- **Diaphysis** – shaft of long bone
- **Epiphysis** – rounded end of long bone (between joints)
- **Metaphysis** – wide portion of long bone between diaphysis and epiphysis
  - *Epiphyseal plate* – hyaline cartilage plate within the metaphysis
- **Apophysis** – normal developmental outgrowth of bone from separate ossification center
  - later fuses with the bone
  - site of insertion of muscle tendon unit on bone
Unique Adolescent Anatomy

- The growing bone:
  - Thicker articular cartilage that can remodel (healing potential)
  - Risk of growth plate fractures
    - Junction between the epiphyseal plate and metaphysis is vulnerable to shearing forces
  - Cartilaginous tendon attachment sites (apophysis) predispose to avulsion injuries
  - Metaphysis of long bones are more resilient and elastic (withstand greater deflection without fracture)
    - Children tend to suffer incomplete (greenstick) fractures
  - During rapid growth the bone lengthens before muscles and tendons are able to provide corresponding strength and coordination (leads to acute injuries)

- Younger athlete more likely to injure cartilage and bone or completely avulse an apophysis then to have a significant ligament sprain
Um...my knee kind of hurts...

“Let’s not call it a ‘career-ending’ injury. Let’s call it a ‘character-building’ injury.”
School Evaluation

- **Effusion** = fluid within the knee (intra-articular); Swelling = soft tissue injury outside of the knee joint (extra-articular)

- The most important thing to determine on initial evaluation is if an *effusion* (fluid inside of the knee joint) is present

- Four primary acute injuries that elicit an *effusion* within a knee:
  - Bony injury (fracture, bone contusion)
  - Ligament injury (primarily the ACL)
  - Cartilage injury (meniscus/ articular cartilage injury)
  - Patella dislocation

- Each of the aforementioned injuries requires immediate further evaluation and intervention
School Evaluation

- **Degree of functional limitations** (i.e. walking normal, limping, inability to bear weight, etc.)

- **Timing of injury (gradual vs. acute)**
  - If acute: establish a clear mechanism of injury

- **Presence of an effusion?**

- **Location, severity, context of pain**
  - Localized vs. diffuse
  - Anterior vs. medial/ lateral
  - Does pain inhibit function?
  - Pain after activity, during sports participation, or at rest?

- **Clinical description of symptoms**
  - “Heard a pop” – think ligament
  - “locking, catching” – think cartilage
  - “knee buckles” – if associated with acute injury then it’s an ACL unless proven otherwise
  - “grinds” – think patellofemoral pain
  - “knee feels stiff/ full; won’t bend all the way” – intra-articular abnormality (refers to effusion)
Knee Examination

- **Inspection** (initially with ambulation and at rest)
  - Does the knee appear swollen (is an *effusion* present)? Is there bruising?
  - Examine both sitting and supine

- **Palpation** (localize point of maximal tenderness)
  - Think anatomically and reference pertinent structures around the area of pain (anterior vs. medial/ lateral)
  - Identify an *effusion* (always necessitates additional imaging)

- Passive and active **range of motion** with flexion/ extension
  - A knee *effusion* often presents with decreased ROM
  - Identify muscle strains by tenderness/ pain with resisted motion of muscle

- **Compare** to the opposite (unaffected) side

- **Functional activities** (squatting, jumping, running, etc.)
This is more like it…
Anterior Knee Pain

- Most common presenting symptom with knee pain in adolescents; usually non-traumatic
  - Patellofemoral Pain/ Patellar tendinopathy
  - Patellofemoral Instability
  - Pre-patellar/ Infrapatellar bursitis
  - Osgood-Schlatter disease/ Sinding-Larsen-Johansson
  - Patella Stress Fractures
  - Osteochondritis Dissecans
  - Referred pain from the hip (SCFE/ Perthes’ disease)

- Don’t forget common sources of pain around knee from injury (muscle strains, contusions, etc.)

- Important to localize the pain: around the knee cap, beside the knee cap, underneath the knee cap, etc.

- Identify bilateral vs. unilateral symptoms; if an effusion present then think intra-articular

- Physician referral to address underlying causes (i.e. just don’t treat the symptoms!)
**Patellofemoral Pain Syndrome**

- **Presentation:** Insidious onset with diffuse ache exacerbated by loaded activities (running, stairs, etc.)
  - Can be aggravated with prolonged sitting (theatre sign)
  - Pain usually with running that gradually worsens with activity
  - Knee effusion usually suggests a different etiology of pain (intra-articular)
- **Examination:** vague, non-specific pain (may localize medial/ lateral, above/ below the patella)
  - Tenderness with palpation around the knee cap
  - “Feels like my knee gives out” – often due to pain inhibiting the quadriceps (differentiate from acute ligament injury)
  - Pain with functional exam (squatting)
Patellofemoral Pain Syndrome

- **Mechanism:** numerous contributing extrinsic and intrinsic factors (at hip, knee, ankle, and foot)
  - Anatomic, biomechanical, neuromuscular abnormalities

- **Treatment:** allow continued activities in short term, but needs proper evaluation to address underlying causes
  - Compression/ icing/ anti-inflammatories for symptoms
  - Rehabilitative exercises for hip/ quadriceps/ core musculature weakness
  - Bracing for patella malalignment/ maltracking

- **Failure to address underlying mechanical problems can lead to more serious structural injuries (i.e. ligament/ menisci)**
Patella Tendonitis/ Tendinopathy

- **“Jumper’s Knee”** – inflammation of patella tendon primarily at inferior patella pole

- **Mechanism** – excessive jumping running or other high patellofemoral stress activities (basketball, soccer, volleyball etc.)
  - Initially occurs at the start of or after an activity, but may progress to persistent pain during the sport or at rest

- **Examination** – inferior patella pole pain with knee extension/ functional flexion (single, double leg squat)

- **Treatment** – rehabilitative exercise program; modification of activity
  - Hamstring, heel cord, quadriceps flexibility
  - Eccentric strengthening of the quadriceps and heel cord
  - Icing/ anti-inflammatories for symptom relief
  - Infrapatella strap brace

- Chronic tendon changes referred to as tendinopathy (thickening, hypervascularity, partial intra-substance tears, etc.)
Osgood-Schlatter Disease

- **Presentation:** painful enlargement of tibial tuberosity at patella insertion
  - Due to mechanical stress and excessive tension on the growing tibial tuberosity apophysis
  - Preadolescence and adolescence (girls 10-12/ boys 13-15; rapid growth period)
  - Worsens with activity

- **Mechanism:** overuse in normal childhood activities (sports with excessive running/jumping)
  - Predisposed by anterior muscle weakness/tightness and posterior hamstring/achilles tendon tightness

- **Examination:** tender tibial tuberosity with occasional focal swelling; painful extension/active flexion

- **Treatment:** activity modification based on symptoms; icing; local padding
  - Self-limiting and resolves with bony fusion of the tibial tubercle (apophyseal closing)
  - Therapy for anterior quadriceps strengthening/stretching and posterior (hamstring/achilles) stretching
  - **Limping = NOT playing**

- **Sinding-Larson-Johansson Disease** = equivalent to OS but at the inferior pole of the patella
Iliotibial Band Friction Syndrome

- **Mechanism:** Chronic inflammatory syndrome involving soft tissues adjacent to the lateral femoral epicondyle
  - Friction of Iliotibial Band rubbing over bony lateral prominence
  - Overuse injury (i.e. running)

- **Presentation:** lateral knee pain with occasional popping

- **Examination:** tenderness over the lateral femoral condyle with tight IT band and absence of intra-articular findings (no effusion)

- **Treatment:** IT band stretching, quadriceps strengthening, anti-inflammatory, corticosteroid injections
**Bursitis**

- **Presentation:** Inflammation of any of various bursae around knee presenting with swelling (extra-articular) and/or pain
  - Prepatella/ pes anserine/ deep infrapatella bursa, etc.

- **Mechanism:** Principally from overuse injury or (traumatic bursitis) can occur from a direct blow to the knee (pre-patella)

- **Examination:** localize tenderness to palpation and focal swelling and determine if intra- or extra-articular
  - Consider mechanism of injury when forming differential diagnosis
  - *Refer to differentiate between effusion and soft tissue swelling (it’s difficult!)*

- **Treatment:** localize the underlying problem and fix mechanical deficits
  - Ice, compression, anti-inflammatories, padding
  - Rehabilitative exercises and possible steroid injection
Referred Pain from the Hip

- Conditions affecting the hip commonly present as knee pain
  - Slipped Capital Femoral Epiphysis (SCFE)
    - Shortened, externally rotated leg
  - Perthes’ disease
    - Limp or low-grade ache in the thigh, groin or knee

- Examination of the hip joint is mandatory in the assessment of any young athlete presenting with knee pain
  - Assess range of motion passively
  - Poorly localized pain with passive/active movement
  - Gait abnormalities

- Require immediate referral and evaluation (compromised blood supply to the femoral head may lead to avascular necrosis)
Acute Knee Injuries
Is this picture more bearable?
Ligament Injuries

- ACL injuries usually present with an acute history of a “pop” in the knee with an inability to return to activity
  - Can occur with or without contact

- **Mechanism:** hyperextension; extremes of varus/valgus and internal/external rotation of the leg
  - Functional instability of the knee with pivoting (knee buckles)

- **Presentation:** loud pop with immediate *effusion* within 1-2 hours (severe hemarthrosis)
  - Knee instability on examination (Lachman’s, Anterior drawer)
  - Treatment requires surgery (ACL reconstruction) and in adolescent population, special physeal sparing procedure required
Ligament Injuries

- **Medial Collateral Ligament** – excessive valgus force applied with external tibial rotation (non-contact twist or lateral side blow)
  - Medial joint line pain, positive valgus stress test (30 degrees flexion; if with extension then consider ACL injury as well); **effusion** can be present
  - Grade I/II sprains – RICE, crutches, rehabilitation
  - Grade III sprain – consider surgery with other associated injuries; if no surgery, immobilize for short period of time and begin rehab ASAP

- **Lateral Collateral Ligament** – varus or twisting injury either contact (blow to anteriomedial tibia) or non-contact
  - Lateral ligament complex pain and occasional instability with twisting, cutting, pivoting (with posterolateral corner injuries hyperextension with standing, walking, or running backward); positive varus stress test
  - Grade I/II sprains – RICE, crutches, rehabilitation
  - Grade III sprain (complete tear) – mild instability with RICE and functional rehabilitation and other associated posterolateral corner injuries require surgery
A bone contusion (microfracture of the bone) of the femur or tibia can produce significant pain and an effusion

Fractures of the growth plate are of particular concern because of the dangers of interrupting the growth process via injury to the cells in the zone of hypertrophy

Severe pain and large effusion

Classified by Salter and Harris classification (I-IV)
- I and II can be managed conservatively
- III and IV involve the joint surface as well as the growth plate and require anatomic reduction (high complication rate)

If not recognized properly these injuries can result in permanent injury to the growth plate (growth disturbances)

Even with anatomical reduction the initial insult may result in permanent growth arrest

Any history of severe rotational or shear force with localized effusion, bony tenderness, and loss of function should be regarded as a growth plate fracture
Cartilage Injuries

- **Meniscus injuries** – due to twisting or squatting injuries (load to the meniscus with rotation)
  - Presents with joint line pain and *effusion*
  - Congenital discoid meniscus (lateral) may predispose to injury

- **Osteochondritis dissecans (OCD)** – intermittent pain and *effusion* with gradual onset (can present acutely with a locked knee)
  - Compromised blood flow to the articular cartilage (more common on lateral aspect of medial femoral condyle); loose body formation
  - Often requires fixation or removal of the loosened fragment
Patella Dislocation/Subluxation

- **Presentation:** a dislocation presents with lateral displacement of the patella from the femoral trochlea
  - Persists until reduction (extension with lateral force)
  - Large *effusion* within first 1-2 hours (hemarthrosis) and patella hypermobility

- **Mechanism:** valgus force with twisting injury (can be due to a contact or non-contact injury)

- **Treatment:** patella stabilization, early range of motion, extensive rehabilitation and symptom management

- **Subluxation:** transient partial displacement of patella from femoral trochlea (presence of *effusion* often denotes injury)
  - Treatment similar as for dislocation
Summary of last 5 slides:

What you likely would have heard at this point:
Blah, blah…ligament…blah, blah…cartilage…blah, blah…patella…blah, blah…bone…

The message I want to convey:
“A knee effusion needs further evaluation and treatment soon”
Inflammatory Knee Conditions

- Juvenile Rheumatoid Arthritis
  - Persistent intermittent effusion with increased temperature and restricted range of motion
  - Family history often present
  - Requires serological evaluation/ joint aspiration

- Reiter’s Syndrome

- Pediatric knee effusions can also occur from infectious (tuberculosis, lyme disease, gonorrhea, etc.) and from benign/ malignant bone tumors

- Bottom line: effusion = immediate referral for evaluation
Take Home Points

- Knowing the *knee anatomy* is essential for an initial evaluation of knee pain and treatment.
- Obtain a good working *history* of the injury prior to the examination to help narrow your focus.
- *Anterior knee pain* is the most common presenting complaint among adolescent boys/girls.
- LIMPING = restriction of activity until further evaluation.
- *Don’t just treat the symptoms* (rest, ice, anti-inflammatory, bracing) but refer to a physician to find the underlying cause of knee pain.
- An *effusion* requires a quick referral and evaluation and suggests an intra-articular structural/inflammatory abnormality.
- Don’t be afraid to ask for help!
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