Functional Anatomy

• **Anatomy as it relates to**
  – Function and DYSFUNCTION
  – History and Physical Exam

• **Think about static and dynamic anatomy.**
  – At rest
  – Moving: walking, stairs, jogging, running, swimming, sport specific movement
KNEE CONDITIONS
“My Knee Hurts”

• Mechanical sx: locking, catching
  – Meniscus
  – Loose body
  – Large chondral defect

• Giving Way
  – ACL tear
  – Extensor mechanism: quad weakness, effusion

• Grinding, popping: OA

• Swelling: all of the above
Important Histories

- Noncontact injury, pop, could not complete game/activity
- Giving way with cutting, pivoting
- Uncertain injury, locking or catching
- Remote injury, obesity
- Stair/ladder climbing
HISTORY

- **ACL**
  - Contact vs. Non-contact
  - Immediate effusion
  - Twisting / Valgus Injury
  - Instability or “Giving Way“

- **PCL**
  - Contact
    - Dashboard / Anterior Blow to Flexed Knee
    - Hyperextension Injury
  - Posterior Instability
Mechanism of Injury

Baghdad Bowl, 2/3/07; CPL Yde USMC
KNEE EXAMINATION
KNEE EXAM

• **Inspection**
  – Atrophy, asymmetry
  – ROM: active and passive
  – Leg length inequality
  – Alignment: neutral, varus, valgus

• **Palpation:** tenderness, crepitus

• **Auscultation:** listen for crepitus

• **Ballotment** instead of percussion

• **Special tests**
Inspection

- Skin - Acute
  - Abrasions
  - Lacerations
  - Contusions
  - Infection

- Limb Alignment
  - Genu varus, genu valgus, neutral
  - Genu recurvatum

- Muscle Atrophy
Palpation

• Discrete structures
  – Many anatomic structures are palpable.

• Where the patient says: “It hurts right here.”
BALLOTMENT

• To determine effusion

SPECIAL TESTS

• Structure based
• Static tests
• Dynamic (Provocative Tests)
Lower Limb: Medial View
Flexion/Extension: Knee
Fig. 63-8. Muscular anatomy of the anterior aspect of the knee.
Knee model: Anterior View
EFFUSION

• Ballotment
  – Proximal hand Milks mid
    - thigh down to superior
    patella
  – Distal hand
    – Palpates for fluid wave in
      peripatellar region
EFFUSION

- Effusion size
  - 3+ = “severe”
    - Tense effusion
  - 2+ = “moderate”
    - Large effusion, supple skin
  - 1+ = “mild”
    - Small, palpable effusion
PATELLOFEMORAL SYNDROME
EARLY OA

PHYSICAL EXAMINATION

– normal or nearly normal
– effusion
– tenderness
– pain with patellofemoral compression
– abnormal alignment of patella in some
Patellofemoral Joint Static Tests

- Palpation 0 & 90 (bone)
  - Osteophytes
    - Medial, lateral facets
    - MFC, LFC
  - Prominences
    - tibial tubercle
    - patella

- Palpation 0 & 90
  - Quad
  - Patellar tendon
  - Medial retinaculum / medial PFL / fat pad
    - Plica
  - Lateral retinaculum / ITB / fat pad
Patellofemoral Joint Dynamic Tests

- Apprehension test (instability)
- Subluxation
- “J” sign

- ROM
  - Ext / Flex
  - Crepitance, flexion angle
  - Plica
  - Patellar tilt,

- Retinaculum tightness (malalignment)
  - Medial (25% sublux lateral)
  - Lateral (8-10 mm sublux medial)

- Patellar tilt test (malalignment)
Internal/External Rotation: Knee

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FUNCTIONAL KNEE ANATOMY

- Medial capsular lig., anterior third
- Lateral capsular lig., anterior third
- Medial capsular lig., middle third
- Transverse (intermeniscal) ligament
- Patellar ligament
- Iliotibial tract
- Lateral meniscus
- Lateral capsular ligament, middle third
- Fibular collateral lig.
- Ligament of Wrisberg
- Ligament of Humphry
- Tibial plateau
- Tibial collateral ligament
- Medial meniscus
- Popliteal tendon
Left Knee Joint, Ligaments, from above
Knee joint and menisci, from above
Tibial plateau and menisci, from above
Meniscus

• **Static Tests**
  - Swelling over the meniscus
  - Pain with palpation of the joint line

• **Dynamic tests**
  - McMurray’s
  - Apley’s
  - Flick
  - Axial Compression / Rotation
  - Duck walk, squat
Joint line palpation with knee flexed should produce pain if meniscus is torn

Externally rotate tibia for medial meniscus tears, Internally rotate for lateral meniscus tears
SELECTING AN ACL PREVENTION PROGRAM:
Concepts & Review of Programs
Observation: ML Ireland
Screw home mechanism (Smillie) tibial externally rotates in terminal knee extension
LIGAMENT TESTS

• Collaterals and Posterolateral Corner
  – Static exam: Palpation
• Cruciates, Collaterals, PL Corner
  – Cannot palpate
  – Dynamic tests
    • Normal result = intact ligament
    • Abnormal result → INFER THAT THE LIGAMENT IS TORN
      – Amount of severity = Amount of damage
      – Binary finding
ACL

• **Lachman Examination at 30 deg**
  – Binary: increased anterior translation (yes/no)
  – Grade: amount of anterior translation in mm
    • I 1 - 5 mm
    • II 6 - 10 mm
    • III 11 - 15 mm
    • IV > 15 mm
  – *End - point (solid or soft)*
  – ALWAYS Compare to other side
ACL

• Anterior Drawer
  – Secondary test
  – 90 degrees of flexion
  – Stabilize foot in neutral
  – Apply anterior force to proximal tibia
    • Amount of translation
    • End – point

  – More sensitive in chronic tears.
ACL

• **Pivot Shift**
  - Complete vs. partial ACL tear
  - Ext → Flex / Valgus / IR vs. ER
  - ROM 0-90
  - Extending Knee (0 degrees)
    • Subluxes anterior
  - Flexing Knee (20 -30 degrees)
    • Reduces posterior
    • Clunk with Reduction

  - Position of IR ablates the finding
ACL

• **Pivot Shift**
  
  – Grade I = slide or glide
  – Grade II = jump” or jerk
  – Grade III = momentary locking
  – Grade IV = “prolonged locking”
ACL

• Flexion Rotation Drawer
  Modified pivot shift, Noyes 1978
  – ROM 0 - 90 degrees
  – Neutral rotation
  – Ankle between examiner’s trunk and arm
  – Hands around proximal tibia / joint line
Knee model: Medial View
Medial Knee - MCL

• MCL Stress Testing
  – Apply Valgus load at 0 & 30 degrees
  – Compare

• Can test the posteromedial capsule
Knee model: Lateral View

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Posteromedial corner

- Medial collateral ligament
  - Superficial and deep layers
  - Meniscotibial and meniscofemoral ligaments
- Posterior Oblique ligament
  - Runs posterior to superficial MCL
  - Multiple bands attaching to posteromedial capsule, semimembranosus, and proximal tibia

Kaar, OKU 10, P 455
Posterolateral Corner: Static stabilizers

- Fibular collateral ligament
- Popliteofibular ligament
- Posterolateral capsule
- Popliteus serves as dynamic and static stabilizer
- Popliteus femoral attachment in anterior popliteal sulcus, 2cm. anterior and distal to FCL attachment
  - Upside down muscle: origin distal, insertion proximal

*Kaar, OKU 10 p 455*
Posterolateral Complex

• Varus Stress Test
  – Perform at 0 & 30 degrees
  – Apply varus load
  – $30^\circ > 0^\circ$

• Dial test
  – ER Testing at 30 & 90 degrees
  – 30 degrees (PLC)
  – 90 degrees (PLC + PCL)

• Gait Observation
  – Limb alignment
  – Varus thrust
Knee model: Posterior View
PCL

- **Observation**
  - Anterior Medial Tibial Step
    - Off
      - Knee at 90 deg of flexion
  - Posterior “Sag” Sign
    - Hip at 90 degrees
    - Knee at 90 degrees
    - Gravity and / or posterior force
    - Amount of posterior translation or “sag”

- **Posterior Drawer**
  - Primary Test
  - 90 deg of flexion
  - Stabilize foot
  - Apply posterior force to proximal tibia
    - translation
    - End - point
  - degrees, Stabilize foot
  - Averages 10 mm
    - Compare
PCL

• Reverse Pivot Shift Sign
  – ROM 0- 90
  – Slight valgus, ER / IR (controversial)
  – Extending Knee (20 degrees)
    • Reduces anterior
  – Flexing Knee (80-90 degrees)
    • Subluxes posterior
Knee Instabilities

Bird's-Eye view of Tibia

- Medial Meniscus
- Anterior cruciate ligament (ACL)
- Lateral Meniscus
- Lateral Collateral Ligament (LCL)
- Popliteus
- PosteroLateral Complex (PLC)
- Superficial Medial Collateral Ligament (SMCL)
- Posterior cruciate ligament (PCL)
- Ligament of Humphrey
- Ligament of Wrisberg
- Posteromedial Complex (PMC)
Ligament Testing

• Defined clinical maneuver to determine pathologic laxity (TEAR).

• Position of knee is where the ligament exhibits its greatest effect on restraint.
  – ACL Lachman: 25-30 deg
  – PCL Posterior Drawer: 90 deg

• Abnormal result = ligament tear
  – Compare to contralateral knee
EXAMINATION OF THE LEG
The history is key.

- Use PQRST
- Observe
- Palpate the site of maximal tenderness
  - Determine origin of pain
  - Bone, soft tissue, both
- Perform a neurovascular exam
EXERCISE INDUCED LEG PAIN

• ANATOMIC APPROACH
  – Bone and Periosteum
  – Soft Tissue
    • Muscle and Fascia
    • Vessels
    • Nerves
Anatomic Sources of Leg Pain: Bone and Periosteum

• Bone
  bone strain $\rightarrow$ stress $\rightarrow$ stress reaction $\rightarrow$ fracture

• Periosteum
  – Inflammation at muscle insertions
    • tibialis posterior
    • soleus

• Both: Shin splints
  – Medial tibial stress reaction

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Anatomic Sources of Leg Pain: Soft Tissue

• **Muscles**
  - 4 fascial compartments
  - Chronic strains and tendinopathy
    • Achilles

• **Nerves**
  - CRPS
  - Radiculopathy
  - Peripheral nerve entrapment

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80% of CECS involve the anterior or lateral compartments
(Cross-section just above middle of leg)

SUMMARY

• Know your anatomy
• Listen to the history
  – Get a working diagnosis
  – Focus the exam to prove or disprove your dx
• Systematic Approach & Anatomy Based Exam
  – Develop your own routine
  – Cover all anatomic structures
  – **Do it the same every time**
  – Compare to contralateral knee