Chapter 10
The Knee Joint

The Knee Joint

• Knee joint
  – largest joint in body
  – very complex
  – primarily a hinge joint

Bones

• Enlarged femoral condyles articulate on enlarged tibial condyles
• Medial & lateral tibial condyles (medial & lateral tibial plateaus) - receptacles for femoral condyles
• Tibia – medial
  – bears most of weight

Bones

• Fibula - lateral
  – serves as the attachment for knee joint structures
  – does not articulate with femur or patella
  – not part of knee joint


• Patella
  – sesamoid (floating) bone
  – imbedded in quadriceps & patellar tendon
  – serves similar to a pulley in improving angle of pull, resulting in greater mechanical advantage in knee extension

• Key bony landmarks
  – Superior & inferior patellar poles
  – Tibial tuberosity
  – Gerdy’s tubercle
  – Medial & lateral femoral condyles
  – Upper anterior medial tibial surface
  – Head of fibula

• Three vasti muscles of quadriceps originate on proximal femur & insert on patellar superior pole
  – insertion is ultimately on tibial tuberosity via patella tendon
• Iliotibial tract of tensor fasciae latae inserts on Gerdy’s tubercle
• Sartorius, gracilis, & semitendinosus insert just below the medial condyle on upper anteromedial tibial surface

• Semimembranosus inserts posteromedially on medial tibial condyle
• Biceps femoris inserts primarily on fibula head
• Popliteus originates on lateral aspect of lateral femoral condyle
• Tibial collateral ligament originates on medial aspect of upper medial femoral condyle & inserts on medial tibial surface
• Fibula collateral originates on lateral femoral condyle very close to popliteus origin & inserts on fibular head
Joints

• Knee joint proper (tibiofemoral joint)
  – classified as a ginglymus joint
    • Sometimes referred to as trochoginglymus joint
    • Joint internal & external rotation occur during flexion
    • Some argue for condyloid classification

• Patellofemoral joint
  – arthrodial classification
  – gliding nature of patella on femoral condyles

Joints

• Ligaments provide static stability
• Quadriceps & hamstrings contractions produce dynamic stability
• Articular cartilage surfaces on femur & tibia
• Menisci form cushions between bones
  – attached to tibia
  – deepen tibial fossa
  – enhance stability

Joints

• Medial meniscus forms receptacle for medial femoral condyle, Lateral meniscus receives lateral femoral condyle
  – Thicker on outside border & taper down very thin to inside border
  – Can slip about slightly, but held in place by various small ligaments
  – Medial meniscus - larger & more open C appearance
  – Lateral meniscus - closed C configuration

Joints

– Either or both menisci may be torn in several different areas from a variety of mechanisms, resulting in varying degrees of problems
  • Tears often occur due significant compression & shear forces during rotation while flexing or extending during quick directional changes in running
Joints

- Anterior & posterior cruciate ligaments
  - cross within knee between tibia & femur
  - vital in respectively maintaining anterior & posterior stability, as well as rotatory stability
- Anterior cruciate ligament (ACL) injuries
  - one of most common serious injuries to knee
  - mechanism often involves noncontact rotary forces associated with planting & cutting, hyperextension, or by violent quadriceps contraction which pulls tibia forward on femur

- Posterior cruciate ligament (PCL) injuries
  - not often injured
  - mechanism of direct contact with an opponent or playing surface
- Fibular (lateral) collateral ligament (LCL)
  - infrequently injured

Joints

- Tibial (medial) collateral ligament (MCL)
  - maintains medial stability by resisting valgus forces or preventing knee from being abducted
  - injuries occur commonly, particularly in contact or collision sports
  - mechanism of teammate or opponent may fall against lateral aspect of knee or leg causing medial opening of knee joint & stress to medial ligamentous structures

- Synovial cavity
  - supplies knee with synovial fluid
  - lies under patella and between surfaces of tibia & femur
  - “capsule of the knee”
- Infrapatellar fat pad
  - just posterior to patellar tendon
  - an insertion point for synovial folds of tissue known as “plica”
  - an anatomical variant that may be irritated or inflamed with injuries or overuse of the knee
Joints

- **Bursae**
  - more than 10 bursae in & around knee
  - some are connected to synovial cavity
  - they absorb shock or prevent friction

- **Extends to 180 degrees (0 degrees of flexion)**
  - Hyperextension of 10 degrees > not uncommon
  - Flexion occurs to about 140 degrees
  - With knee flexed 30 degrees or >
    - internal rotation 30 degrees occurs
    - external rotation 45 degrees occurs

- **Knee “screws home” to fully extend** due to the shape of medial femoral condyle
  - As knee approaches full extension tibia must externally rotate approximately 10 degrees to achieve proper alignment of tibial & femoral condyles
  - In full extension:
    - close congruency of articular surfaces
    - no appreciable rotation of knee
  - During initial flexion from full extension:
    - knee “unlocks” by tibia rotating internally, to a degree, from its externally rotated position to achieve flexion

- **Flexion**
  - bending or decreasing angle between femur & leg, characterized by heel moving toward buttocks

- **Extension**
  - straightening or increasing angle between femur & lower leg

Movements
Movements

- External rotation
  - rotary movement of leg laterally away from midline
- Internal rotation
  - rotary movement of lower leg medially toward midline
- Neither will occur unless flexed 20-30 degrees or >

Muscles

- Quadriceps muscle group
  - extends knee
  - located in anterior compartment of thigh
  - consists of 4 muscles
    - rectus femoris
    - vastus lateralis
    - vastus intermedius
    - vastus medialis

Muscles

- Q angle
  - Central line of pull for entire quadriceps runs from ASIS to the center of patella
  - Line of pull of patella tendon runs from center of patella to center of tibial tuberosity
  - Angle formed by the intersection of these two lines at the patella is the Q angle
  - Normally, angle will be 15 degrees or less for males & 20 degrees or less in females
  - Generally, females have higher angles due to a wider pelvis

Muscles

- Q angle
  - Higher Q angles generally predispose people in varying degrees to a variety of potential knee problems including lateral patellar subluxation or dislocation, patellar compression syndrome, chondromalacia, and ligamentous injuries
  - For people with above normal Q angles, it is particularly important to maintain high levels of strength & endurance in vastus medialis so as to counteract lateral pull of vastus lateralis
Muscles

• Hamstring muscle group
  – responsible for knee flexion
  – located in posterior compartment of thigh
  – consists of 3 muscles
    • semitendinosus - medial, internal rotator
    • semimembranosus - medial, internal rotator
    • biceps femoris - lateral, external rotator
  • Popliteus assist medial hamstrings in knee internal rotation

• Two-joint muscles
  – most effective when either origin or insertion is stabilized to prevent movement in direction of the contacting muscle
  – To a degree, muscles are able to exert greater force when lengthened than when shortened
  – Hamstring muscles & rectus femoris are biarticular (two-joint) muscles

Muscles

• Ex. sartorius muscle
  – increases its total length & becomes a better flexor at knee when pelvis is rotated posteriorly & stabilized by abdominal muscles
    • exemplified by trying to flex knee & cross the legs in the sitting position
    • one usually leans backward to flex legs at knees
  – Football kicker invariably leans well backward to raise & fix the rectus femoris origin to make it more effective as a knee extensor

• Gracilis, sartorius, & semitendinosus join together distally to form pes anserinus
  – attaches to anteromedial aspect of proximal tibia below the level of tibial tuberosity
  – Their attachment & posteromedially line of pull enable them to assist with knee flexion particularly once the knee is flexed & hip is externally rotated
  – Medial & lateral gastrocnemius heads attach posteriorly on medial & lateral femoral condyles
  – assist with knee flexion
Muscles

Knee joint muscles location

- **Anterior** - primarily knee extension
  - Rectus femoris
  - Vastus medialis
  - Vastus intermedius
  - Vastus lateralis

- **Posterior** - primarily knee flexion
  - Biceps femoris
  - Semimembranosus
  - Semitendinosus
    - Sartorius
    - Gracilis
    - Popliteus
    - Gastrocnemius

Nerves

- **Femoral nerves**
  - innervates the knee extensors (quadriceps)
    - rectus femoris
    - vastus medialis
    - vastus intermedius
    - vastus lateralis

- **Sciatic nerve**
  - tibial division
    - semitendinosus, semimembranosus, biceps femoris (long head)
  - common peroneal (fibular) division
    - biceps femoris (short head)
Quadriceps Muscles

- Quadriceps muscles - vital in jumping
  - functions as a decelerator
    - when decreasing speed to change direction
    - when coming down from a jump
  - eccentric contraction during decelerating actions
  - controls slowing of movements initiated in previous phases of the sports skill

Quadriceps Muscles

- Rectus femoris (two-joint), vastus medialis, vastus intermedius, vastus lateralis (largest)
  - All attach to patella then to tibial tuberosity via patellar tendon
  - All superficial & palpable except vastus intermedius (under rectus femoris)
  - Strength or power may be indicated by vertical jump test
  - Generally desired to be 25% to 33% stronger than hamstring group

Quadriceps Muscles

- Strength & endurance is essential for maintenance of patellofemoral stability
  - often a problem
  - quads are particularly prone to atrophy when injuries occur
  - may be developed by resisted knee extension activities from a seated position
  - functional weight bearing activities such as step-ups or squats are particularly useful for strengthening & endurance

Rectus Femoris Muscle

- Flexion of hip
- Extension of knee
- Anterior pelvic rotation
Vastus Lateralis Muscle

Extension of knee

Vastus Intermedius Muscle

Extension of knee

Vastus Medialis Muscle

Extension of knee

Hamstring Muscles

- Hamstring muscle group
  - Semitendinosus
  - Biceps femoris
  - Semimembranosus
Hamstring Muscles

- Hamstring muscle strains very common
- “Running muscles” function in acceleration
- Antagonists to quadriceps muscles at knee
- Named for cordlike attachments at knee
- All originate on ischial tuberosity of pelvis
- Semitendinosus inserts on anteromedial tibia
- Semimembranosus inserts on posteromedial tibia
- Biceps femoris inserts on lateral tibial condyle & head of fibula

Semitendinosus Muscle

- Flexion of knee
- Extension of hip
- Internal rotation of hip
- Internal rotation of flexed knee
- Posterior pelvic rotation

Semimembranosus Muscle

- Flexion of knee
- Extension of hip
- Internal rotation of hip
- Internal rotation of flexed knee
- Posterior pelvic rotation

Biceps Femoris Muscle

- Flexion of knee
- Extension of hip
- External rotation of hip
- External rotation of flexed knee
- Posterior pelvic rotation
Popliteus Muscle
- Flexion of knee
- Internal rotation of flexed knee

Knee Extension
- Agonists
  - Rectus Femoris
  - Vastus Lateralis
  - Vastus Intermedius
  - Vastus Medialis

Knee Flexion
- Agonists
  - Biceps Femoris (Long & Short Head)
  - Semitendinosus
  - Semimembranosus

Knee Internal Rotation
- Agonists
  - Semitendinosus
  - Semimembranosus
  - Popliteus
Knee External Rotation

- **Agonists**
  - Biceps Femoris