Chapter 10
The Knee Joint

Manual of Structural Kinesiology
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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

• 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

Bones

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

The Knee Joint

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

- 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

Bones

- Semimembranosus inserts posteromedially on medial tibial condyle
- Biceps femoris inserts primarily on fibula head
- Popliteus originates on lateral aspect of lateral femoral condyle
- Tibialis 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 internal & external rotation occur during flexion
  - Some argue for condyloid classification
- Patellofemoral joint
  - articular 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

- 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

- 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
Joints

- 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

Movements

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

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

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

Muscles

• 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

Muscles

• Gracilis, sartorius, & semitendinosus join 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

Muscles

Knee joint muscles location

• 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

- 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

- 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

Semitendinosus Muscle
Flexion of knee
Extension of hip
Internal rotation of hip
Internal rotation of flexed knee
Posterior pelvic rotation

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
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

Web Sites

**Radiologic Anatomy Browser**
http://radlinux1.usuf1.usuhs.mil/rad/iong
  - This site has numerous radiological views of the musculoskeletal system.

**University of Arkansas Medical School Gross Anatomy for Medical Students**
http://anatomy.uams.edu/anatomyhtml/gross.html
  - Dissections, anatomy tables, atlas images, links, etc.

**Loyola University Medical Center: Structure of the Human Body**
www.med.luc.edu/lumen/meded/grossanatomy/index.htm
  - An excellent site with many slides, dissections, tutorials, etc. for the study of human anatomy

**Wheeless’ Textbook of Orthopaedics**
www.wheelessonline.com/
  - This site has an extensive index of links to the fractures, joints, muscles, nerves, trauma, medications, medical topics, lab tests, and links to orthopedic journals and other orthopedic and medical news.

Web Sites

**Premiere Medical Search Engine**
www.medsite.com
  - This site allows the reader to enter any medical condition and it will search the net to find relevant articles.

**Arthroscopy.com**
www.arthroscopy.com/sports.htm
  - Patient information on various musculoskeletal problems of the lower extremity

**Virtual Hospital**
www.vh.org
  - Numerous slides, patient information, etc.

**Human Anatomy Online**
www.innerbody.com/image/musc08.html
  - Interactive musculoskeletal anatomy

**The Hip and Knee Institute**
www.hipsandknees.com/knee/index.html
  - Arthritis of the Knee Joint

Web Sites

**Adam Healthcare Center**
http://adam.about.com/surgery/100088.htm#
  - Knee joint replacement

**American Academy of Orthopaedic Surgeons**
http://orthoinfo.aaos.org/category.cfm?TopCategory=Knee
  - Patient education library on the knee

**Edheads Activities**
www.edheads.org/activities/knee/
  - Allows you to perform virtual knee surgery

**Gross Anatomy: The Functional Anatomy of the Knee Joint**
www.upstate.edu/cdb/grossanat/limbs8.shtml
  - Functional Anatomy of the Knee

**Knee Ligament Anatomy and Injury**
www.orthoassociates.com/knee/lig.htm
  - Anatomy and injuries of the Knee and its ligaments

Web Sites

**The Physician and Sportsmedicine**
www.physportsmed.com/issues/1997/05may/bach.htm
  - Acute Knee Injuries: When to Refer

**The Physician and Sportsmedicine**
www.physportsmed.com/issues/1999/10_01_99/laprade.htm
  - Acute Knee Injuries: On-the-Field and Sideline Evaluation