BONES OF THE KNEE JOINT

Shaft and Distal Femur

- Linea aspera gives rise to quadriceps.
- Flatten into supracondylar ridges
- End in condyles, joined anteriorly and separate posteriorly
- Condyles differ from one another

MEDIAL CONDYLE

- Extends farther distally, contributing to oblique alignment of shaft
- Articular surface differs from lateral and influences tibiofemoral motion.
- Radius of curvature is greatest distally, smaller posteriorly.

LATERAL CONDYLE

- Lies closer to sagittal plane
- Flattest distally
- Radius of curvature for tibiofemoral articular surfaces similar in medial and lateral condyles

Proximal Tibia

- Large proximally, with two separate articular surfaces
- Tibial plateaus slope posteriorly
- Palpable landmarks

ARTICULAR SURFACES OF THE PROXIMAL TIBIA

- Smaller than femoral surfaces
- Articular surface of medial plateau larger than lateral, decreasing stress
- Medial plateau is biconcave and relatively flat.
- Lateral plateau convex anterior to posterior

Effects of the Shapes of the Articular Surfaces on Tibiofemoral Joint Motion

- Differences in articular surface size between tibia and fibula
- Differences between medial and lateral femoral condyles
- Variation in curvatures of all surfaces

DISPARITY BETWEEN THE TIBIAL AND FEMORAL SURFACES

- Moving limb must undergo more complex motion than just rolling.

DISPARITY BETWEEN THE SIZE OF THE MEDIAL AND LATERAL FEMORAL CONDYLES

- Increases frontal and transverse plane motions
VARIABILITY OF CURVATURE IN ALL OF THE ARTICULAR SURFACES OF THE TIBIOFEMORAL JOINT

- Tibiofemoral joint motion varies with knee joint position.

Tibiofemoral Motion

- Knee exhibits three-dimensional motion.
- Medial rotation of femur accompanies knee extension or lateral rotation with flexion.
- Contact migrates posteriorly with flexion and anteriorly with extension.
- Small anterior-posterior and medial-lateral translations occur in flexion and extension.
- Medial femoral condyle translates less than lateral condyle
- Motion not consistent with concave-convex rule
- Femoral rotation occurs throughout most of flexion-extension ROM.
- Rate of femoral rotation greatest near full extension ROM, consistent with “screw-home” mechanism
- Relative motion of tibia and femur are the same in open- and closed-chain movements.
- Knee has six degrees of freedom (DOFs).

Patella

- Largest sesamoid bone
- Three facets on articular surface
- Protects quadriceps from excessive friction
- Increases angle of application of quadriceps

Proximal Fibula

- Provides muscle and ligamentous attachments for knee

Palpable Landmarks of the Knee

- Several important palpable landmarks

ARTICULAR STRUCTURES OF THE KNEE

- Tibiofemoral joint is synovial, modified hinge.
- Patellofemoral joint is synovial, gliding

Organization of the Trabecular Bone and Articular Cartilage Found in the Knee

- Trabecular bone is organized according to applied loads.
- Thickest articular cartilage of the body, which helps improve congruity of articular surfaces, decreasing stress

Menisci

STRUCTURE

- Fibrocartilaginous discs, covering more than 50% of tibial articular surface
- More coverage by lateral meniscus
Firmly attached to tibia, medial more so than lateral
Medial meniscus attached to capsule and medial collateral ligament

FUNCTION OF THE MENISCI

- Protect joint health
- Joint lubrication, shock absorption, stabilization, stress reduction, guide and control tibiofemoral joint motion
- Approximately doubles contact area

Motion of the Menisci on the Tibia

- Move with rolling femoral condyles, posteriorly in flexion, anteriorly in extension
- Menisci deform during flexion and extension.

MENISCAL LESIONS

- Susceptible to injury because of position between two longest bones, attached to tibia, distortion during knee motion

Noncontractile Supporting Structures

- Capsule and ligaments work together to support the knee.

ARTICULARCAPSULE OF THE KNEE JOINT

- Largest joint capsule
- Reinforced anteriorly by patellar retinaculi
- Synovial and fibrous layers separate posteriorly
- No anterior femoral attachment of fibrous capsule.
- Medial and lateral attachments to patellar are reinforced by patellofemoral and patellotibial ligaments and my the medial and lateral patellar retinaculi.
- Anterior expansion of synovial layer is suprapatellar pouch
- Folds in synovial layer are plicae

COLLATERAL LIGAMENTS

- Medial is larger and stronger than lateral, with deep and superficial layers.
- Medial withstands valgus stresses, lateral, varus stresses.
- Both also contribute to rotational stability.
- Knee position alters stretch of collateral ligaments.
- Collateral ligaments provide the primary medio-lateral support with the knee flexed to about 20°.

CRUCIATE LIGAMENTS

- Intracapsular and extrasynovial
- Each consists of multiple segments, or bundles.
- Anterior cruciate ligament (ACL) limits anterior glide of tibia on femur.
- ACL also limits rotation and resists valgus loads.
- Non-contact injuries of ACL often involve lateral rotation and abduction of tibia with respect to femur.
- Knee flexion affects tension in ACL.
- ACL limits extension and with menisci is primary limiter of extension ROM.
- Results of ACL clinical assessments depend on knee position during test, portion of ligament torn, force of test, and integrity of other tissues.
- No single test to assess specific bundles of ACL
- Posterior cruciate ligament (PCL) also has a complex stabilizing role.
- PCL limits posterior glide of tibia, maximum knee flexion, varus, valgus, and lateral rotation.
ACCESSORY LIGAMENTS OF THE KNEE

- Found posteriorly and laterally
- Secondary supporting function, reinforcing cruciate ligaments
- Injuries to PCL and accessory ligaments produce significant instability

CONCLUSIONS REGARDING THE CONNECTIVE TISSUE SUPPORT OF THE KNEE

- Collaterals are primary medial–lateral supports, but cruciates add support.
- Cruciates are primary anterior-posterior support, but collaterals and accessory ligaments aid in support.
- Rotary stability is added by all four ligaments.
- Menisci and articular surfaces also stabilize the knee.

NORMAL ALIGNMENT OF THE KNEE JOINT

- Affected by foot, ankle, and hip alignment
- Affects joint stresses

Frontal Plane Alignment

- Using anatomical axis, normal adult knees exhibit small valgus angles. Using mechanical axis, normal adult alignment is very slight varus.
- Newborn exhibits varus that changes during development.

Sagittal Plane Alignment

- Normal alignment of 180°

Transverse Plane Alignment

- Normal version is 0°

ALIGNMENT OF THE PATELLOFEMORAL JOINT

- Described by linear and angular positions

Medial–Lateral Alignment

- Slight lateral deviation is normal.
- Abnormal alignment described by medial or lateral tracking

Proximal–Distal Alignment

- Ratio of distance between tibia and patella and length of patella

Angular Positioning of the Patella

PATELLAR TILT

- Transverse plane angle between plane of femoral condyles and width of patella

SUCULUS ANGLE
Instructor’s Manual

Chapter 41

- Angle between lines from floor of sulcus to highest point on each condyle
- Varies with location on femur

**CONGRUENCE ANGLE**

- Measures how well patella fits in sulcus
- Angle between line bisecting sulcus and a line from sulcus to apex of patellar ridge
- Malalignments associated with knee joint disorders

**MOTION OF THE KNEE**

- Complex three-dimensional motion

**Normal Range of Motion of the Knee in the Sagittal Plane**

- Hyperextension ROM is uncommon.
- ROM changes with age.
- Functional requirements vary with tasks.

**Transverse and Frontal Plane Rotations of the Knee**

- Not well studied
- Small and variable
- Small excursions in both planes are seen in locomotion.

**Patellofemoral Motion**

- Depends on knee position
- In extension, patella is movable.
- Total medial-lateral excursion up to half of width of patella appears normal with knee extended, lateral excursion slightly greater than lateral.
- In knee flexion, patella lies in trochlear notch and is less mobile.

**TRANSLATION OF THE PATELLA DURING KNEE FLEXION**

- 5–7 cm of distal glide with knee flexion
- Allowed by unfolding of suprapatellar pouch
- Translates medially in initial flexion then begins lateral translation after 20° - 30° of flexion, continuing until at least 90°

**ROTATION OF THE PATELLA DURING KNEE FLEXION**

- Flexes as knee flexes
- Tilts laterally as knee flexes until at least 90° of knee flexion
- Rotation about anterior posterior axis is negligible.
- Contact on patella moves proximally and increases in area as the knee flexes from the extended position to at least 60° of knee flexion. Patellar contact in maximum knee flexion occurs in an arch on the lateral and odd facets of the patella and on the proximal articular surface of the patella.

**SUMMARY**