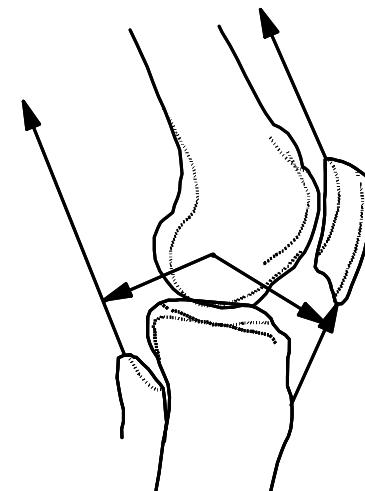


Introduction to Knee & Ankle Biomechanics

February 7, 2018

Presented by: Anthony Gatti



Adapted from Monica Maly, Michael Pierrynowski, & Nicholas Brisson

Knee Joint Complex

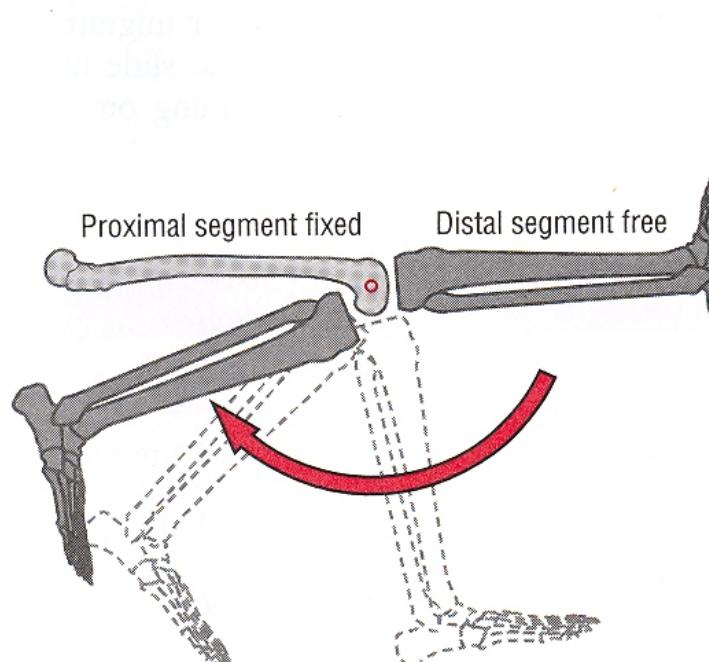
- Tibiofemoral Joint (TF)
 - Osteokinematics
 - Arthrokinematics
 - Role of Muscles
 - Role of Menisci
- Patellofemoral Joint
 - Joint Congruency
 - Arthrokinematics
 - Role of Muscles
 - Role of Alignment



Tibiofemoral Joint Osteokinematics

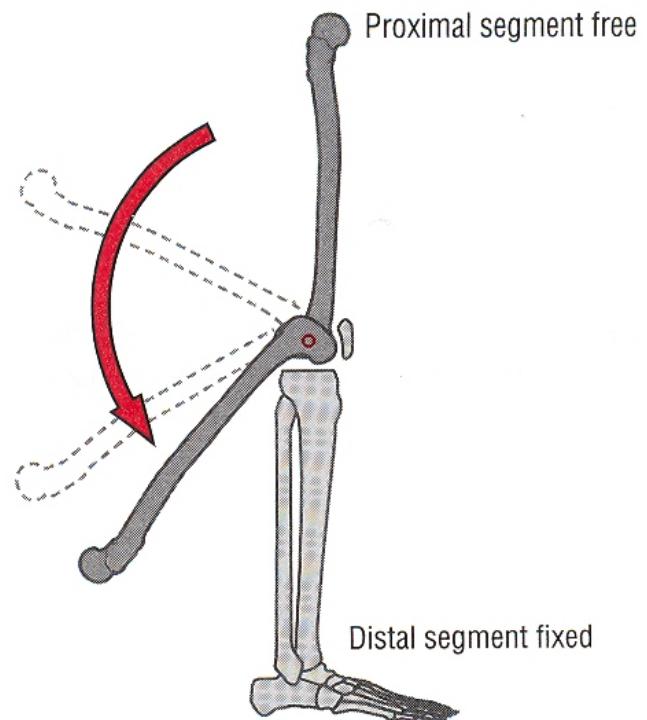
Large femoral condyles and small tibial plateau.

Two perspectives:



A Tibial-on-femoral perspective

Knee flexion



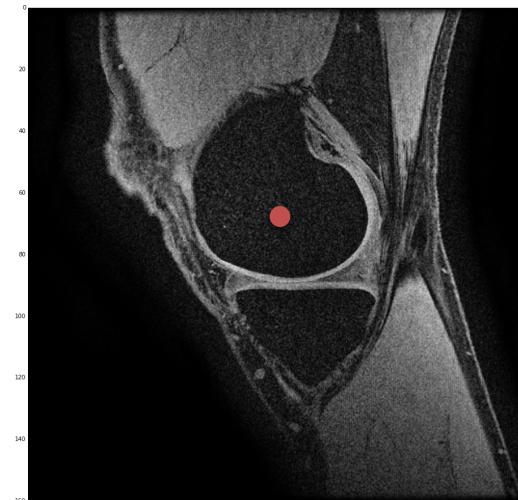
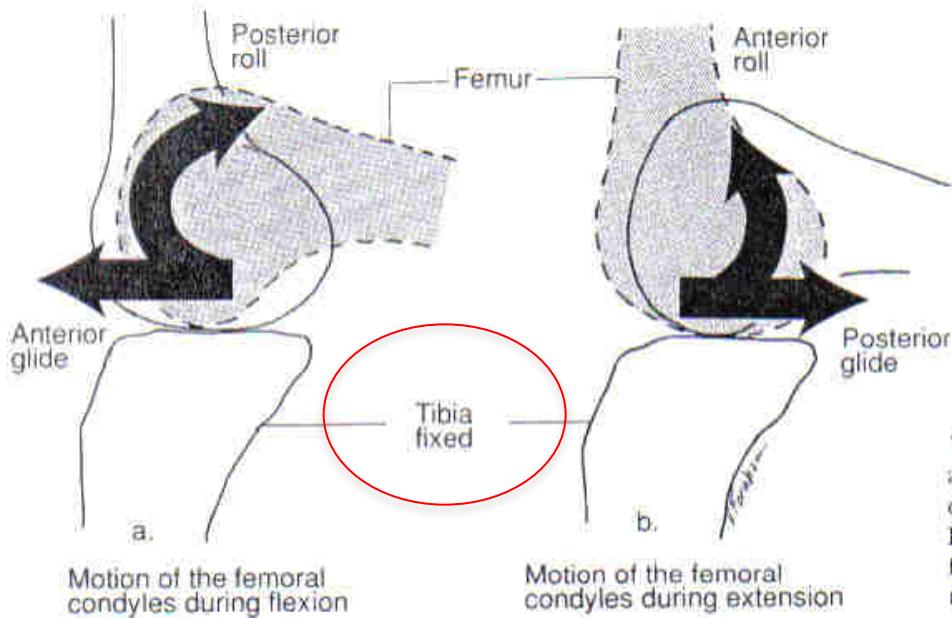
B Femoral-on-tibial perspective

Tibiofemoral Joint Arthrokinematics

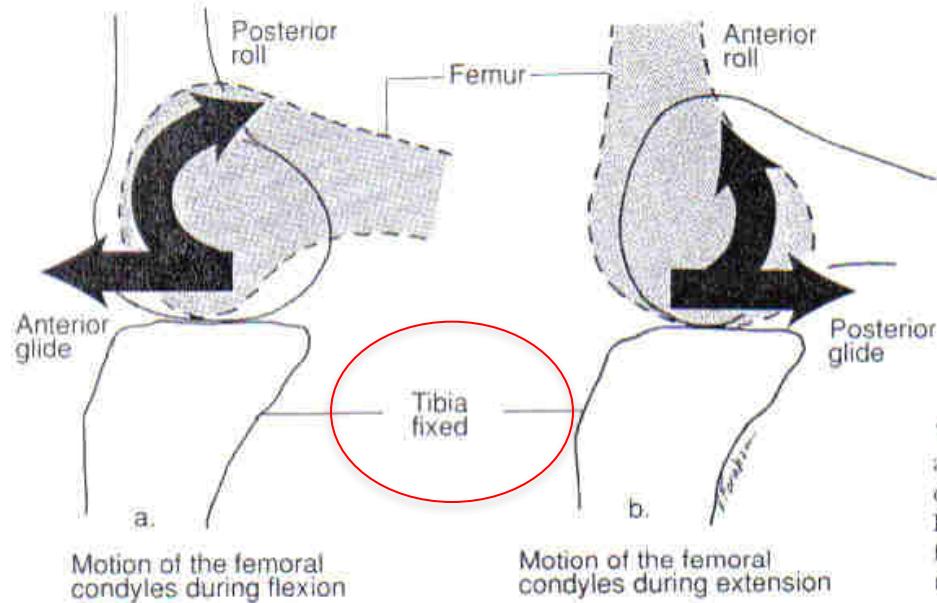
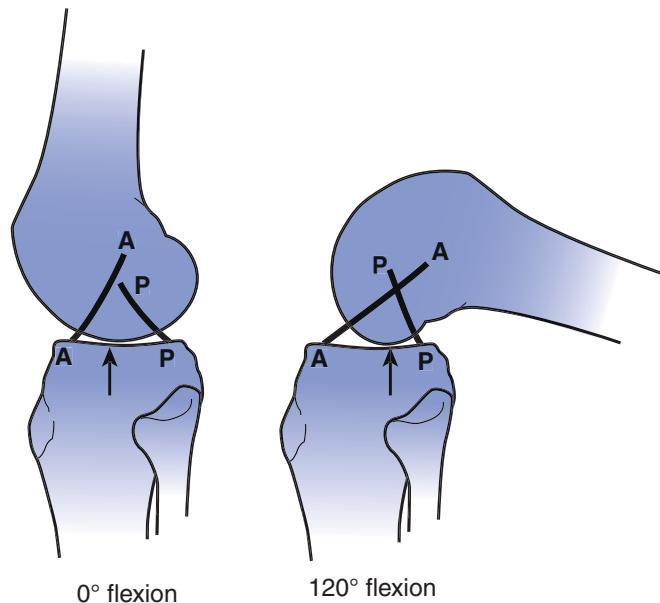


Tibiofemoral Joint Arthrokinematics

Femur on tibia (closed chain)	Tibia on femur (open chain)
Flexion: femur rolls posteriorly & glides anteriorly	Flexion: tibia rolls & glides posteriorly
Extension: femur rolls anteriorly & glides posteriorly	Extension: tibia rolls & glides anteriorly



Tibiofemoral Joint Arthrokinematics



Tibiofemoral Joint

Range of Motion

Tibiofemoral Flexion-Extension Range of Motion

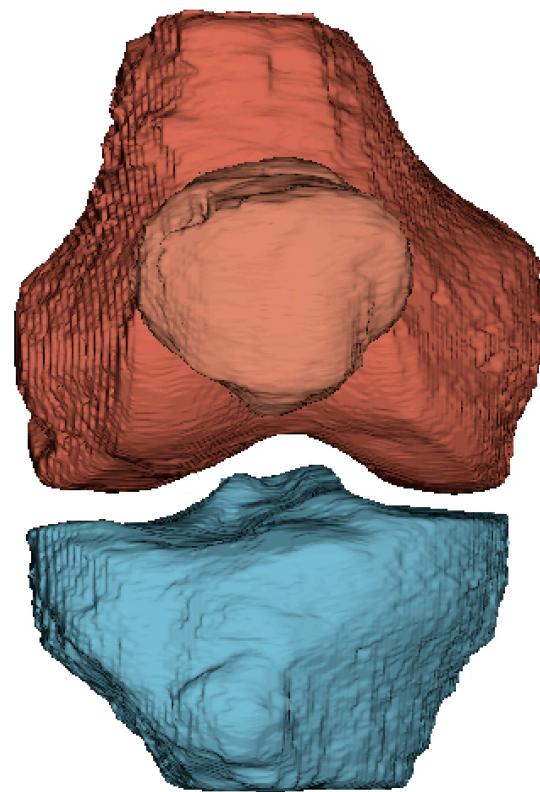
- Flexion
 - Passive = 130-140°
 - Normal gait = 60-70°
 - Stair climbing = 80°
 - Sitting & Standing = 90° (or more)
 - Squatting = 160°
- Extension
 - Up to 5° is considered normal

Tibiofemoral Joint

Arthrokinematics

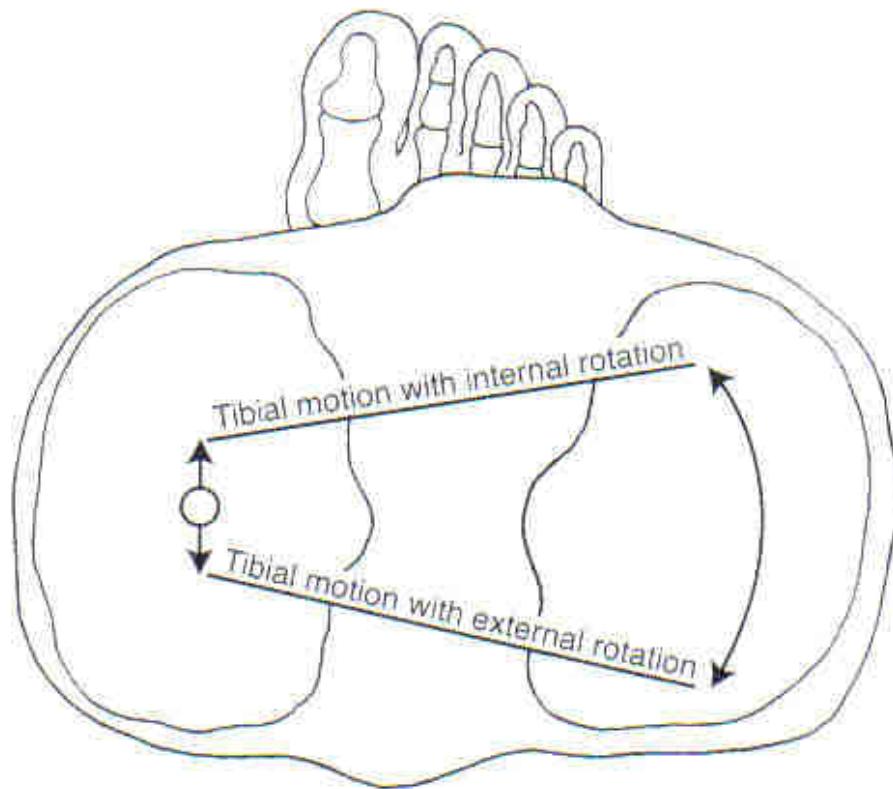
- Internal and External Rotation
 1. Is int/ext ROM the same through knee flexion?
 2. Where is the axis of rotation?

Tibiofemoral Joint Arthrokinematics



Tibiofemoral Joint

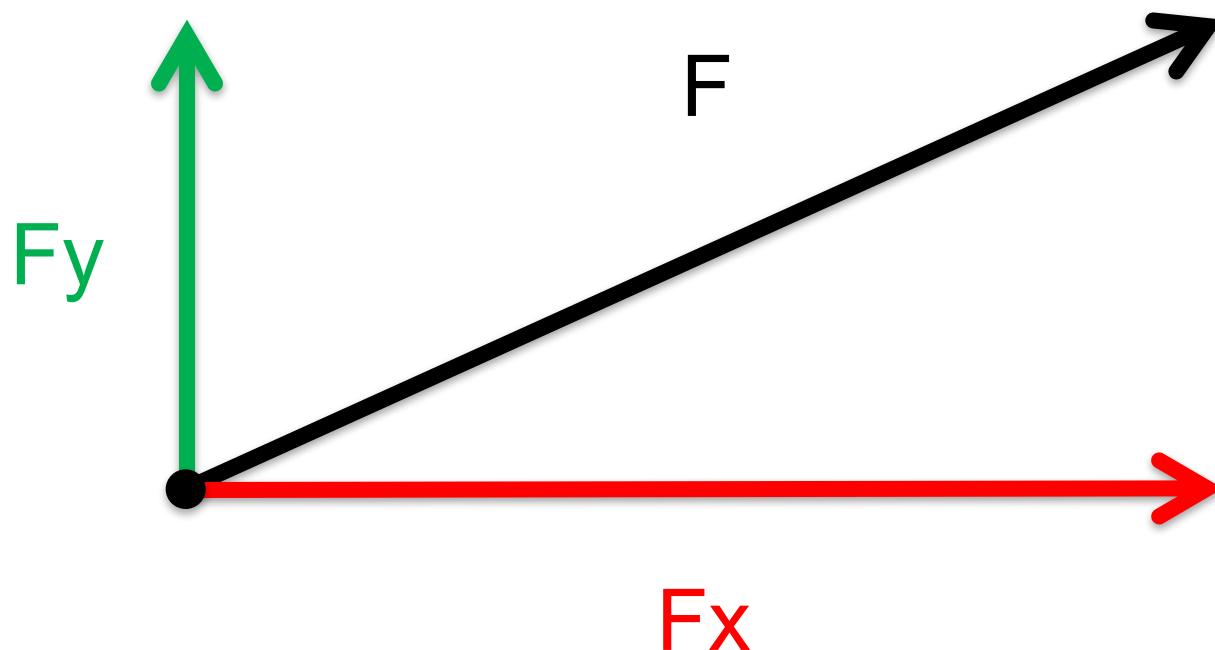
- Internal and External Rotation
 - Axis of rotation through the medial intercondylar tubercle



Tibiofemoral Joint

Role of Muscles

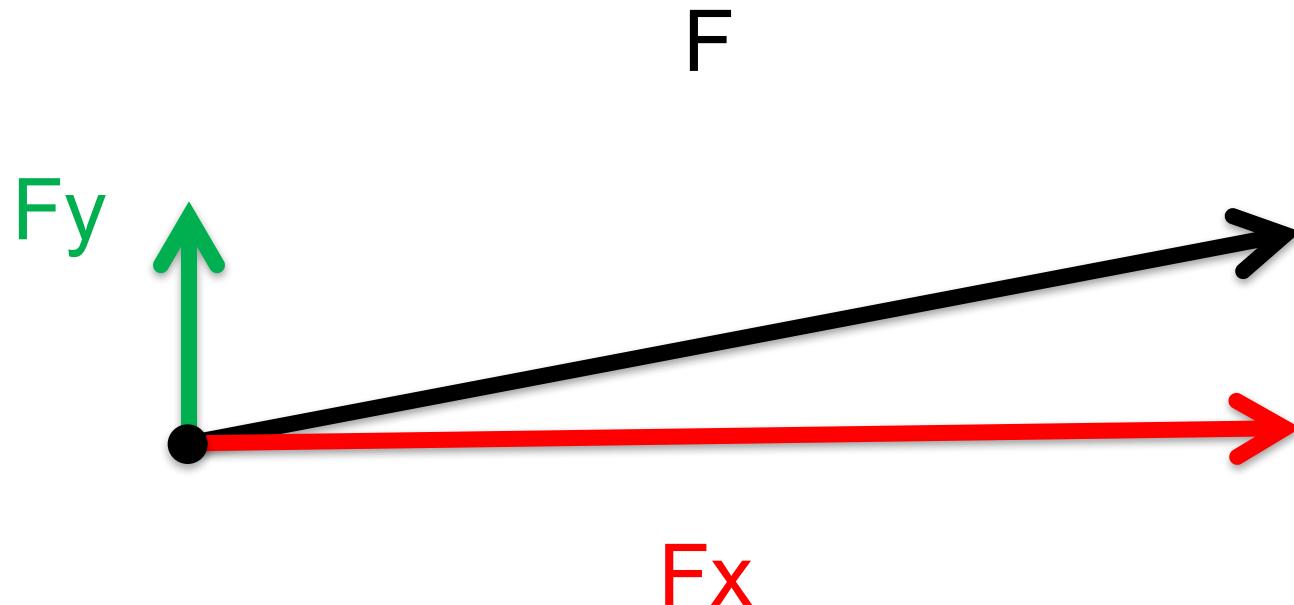
Forces



Tibiofemoral Joint

Role of Muscles

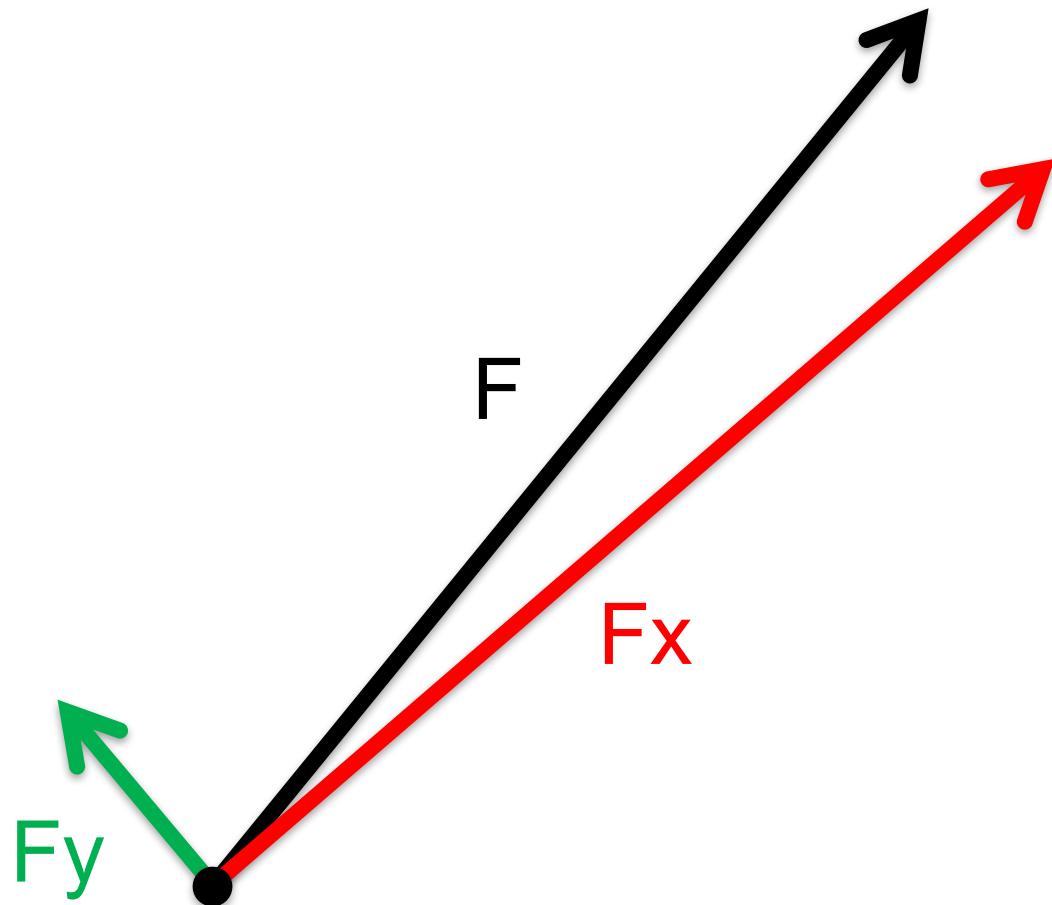
Forces



Tibiofemoral Joint

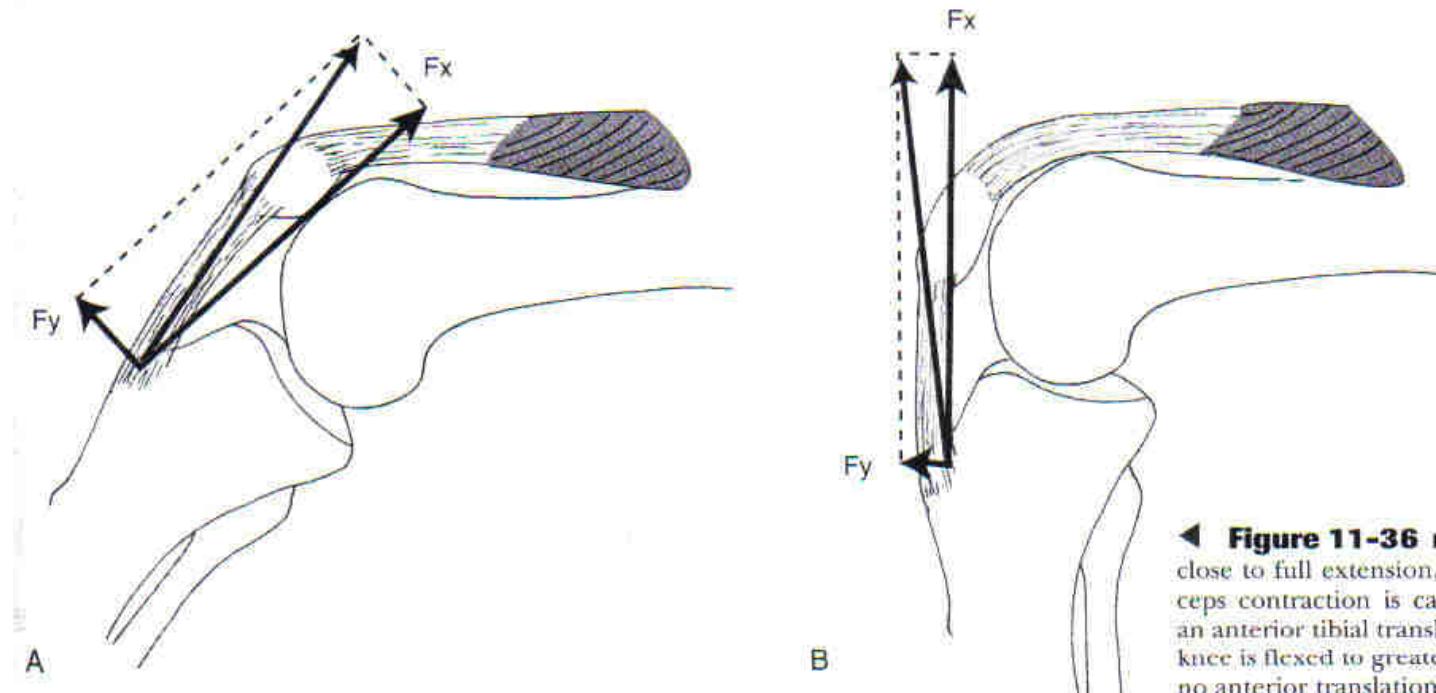
Role of Muscles

Forces



Tibiofemoral Joint Role of Muscles

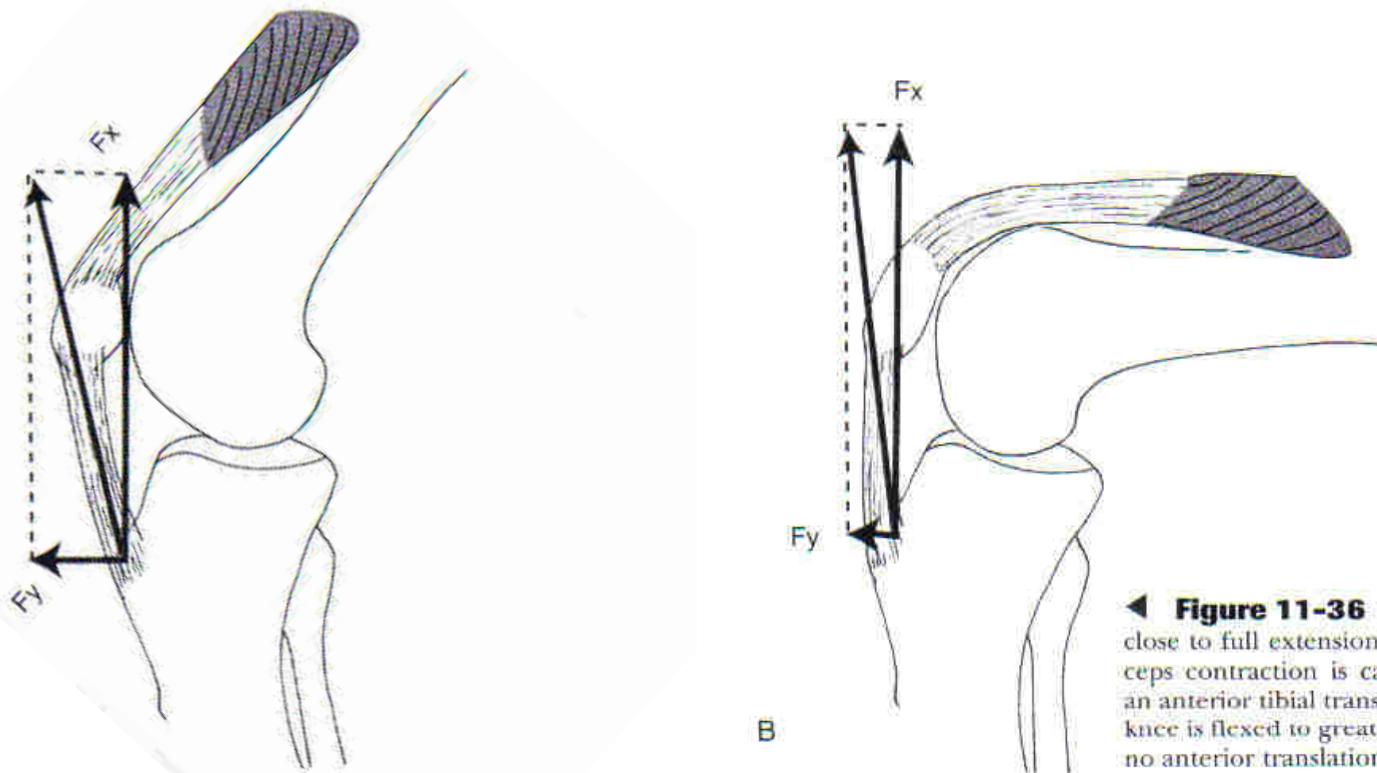
Anterior translation vs. rotation



◀ **Figure 11-36** ■ A. With the knee close to full extension, a forceful quadriceps contraction is capable of inducing an anterior tibial translation. B. Once the knee is flexed to greater than 60°, little to no anterior translation occurs.

Tibiofemoral Joint Role of Muscles

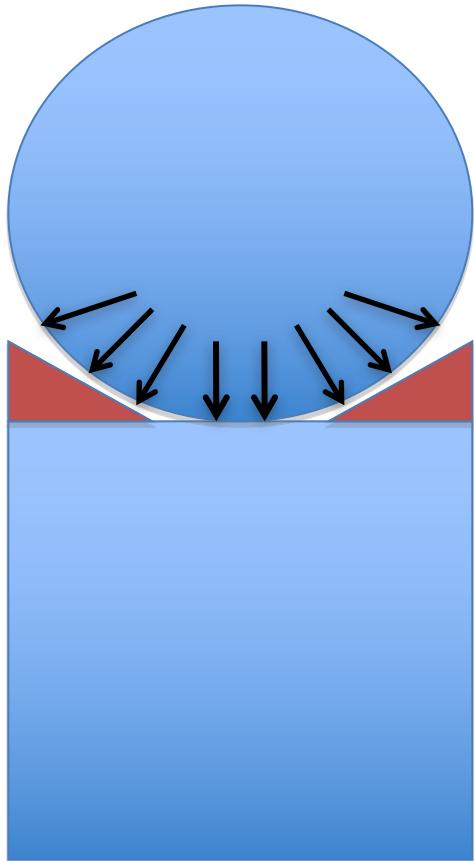
Anterior translation vs. rotation



B

◀ **Figure 11-36** ■ A. With the knee close to full extension, a forceful quadriceps contraction is capable of inducing an anterior tibial translation. B. Once the knee is flexed to greater than 60°, little to no anterior translation occurs.

Tibiofemoral Joint Role of Menisci



<https://www.youtube.com/watch?v=1FtLUdozmfA>

Patellofemoral Joint

- Sesamoid bone
 - Anatomic pulley for the quadriceps
 - Dependent on dynamic structures for stability
- Maybe most incongruent joint
 - Greater risk for instability in full extension
 - Contact between patella and femoral sulcus/groove changes throughout TF ROM

Patellofemoral Joint Contact Points

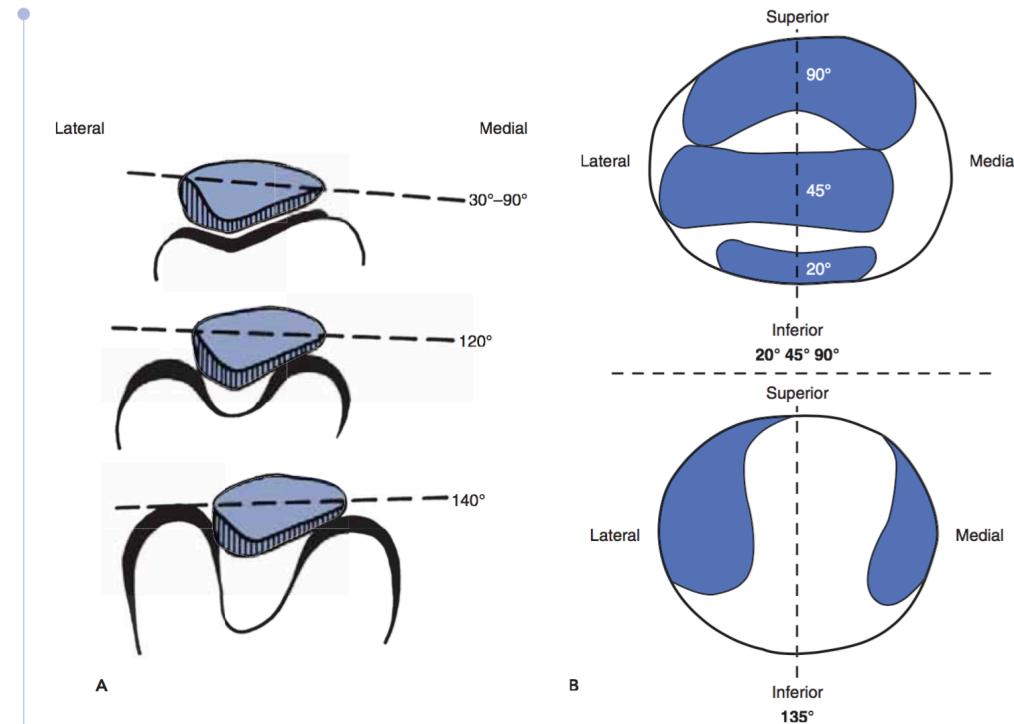
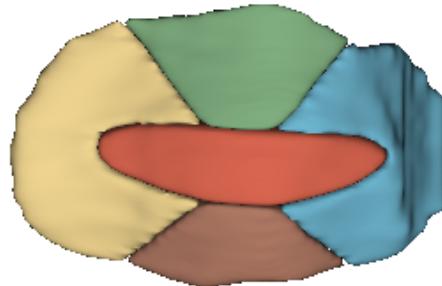


FIG. 7-12

A. The position of the patella at different ranges of knee flexion. Until 90° flexion, contact is on the lateral and medial sides of the femoral trochlea. In high flexion the contact splits into two distinct areas. Adapted from Goodfellow, J., Hungerford, D.S., Zindel, M. (1976). Patellofemoral joint mechanics and pathology. 1. Functional anatomy of the patellofemoral joint. *J Bone Joint Surg*, 58B, 287; and Hehne, H.J. (1990). Biomechanics of the patellofemoral joint and its clinical relevance. *Clin Orthop*, 258, 73-85.

Surg, 58B, 287; and Hehne, H.J. (1990). Biomechanics of the patellofemoral joint and its clinical relevance. *Clin Orthop*, 258, 73-85. B. The contact areas at different flexion angles. Note the gradual superior shift of the contacts with the flexion angle. The split contact in high flexion is evident.

Patellofemoral Joint
Incongruent



Anterior View



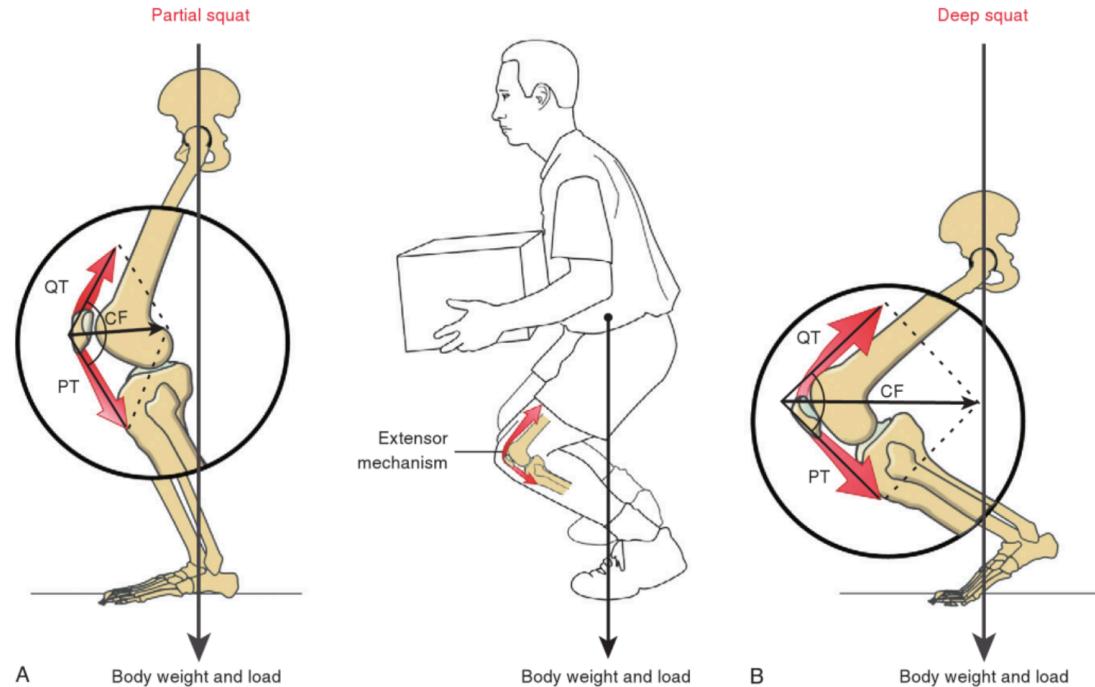
Superior View



Lateral View

Patellofemoral Joint Role of Muscles

Patellofemoral joint compression forces change with knee angle



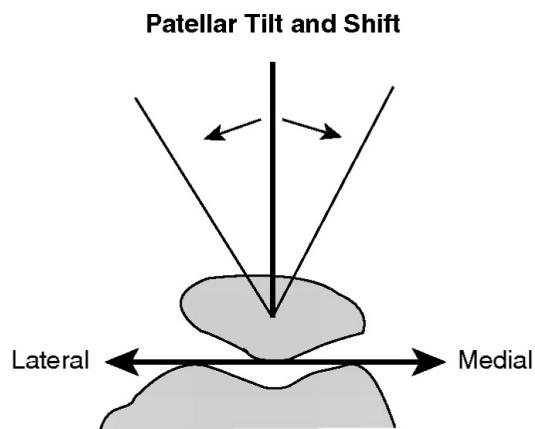
Patellofemoral Joint Role of Muscles

Bicycle setup – Sagittal plane

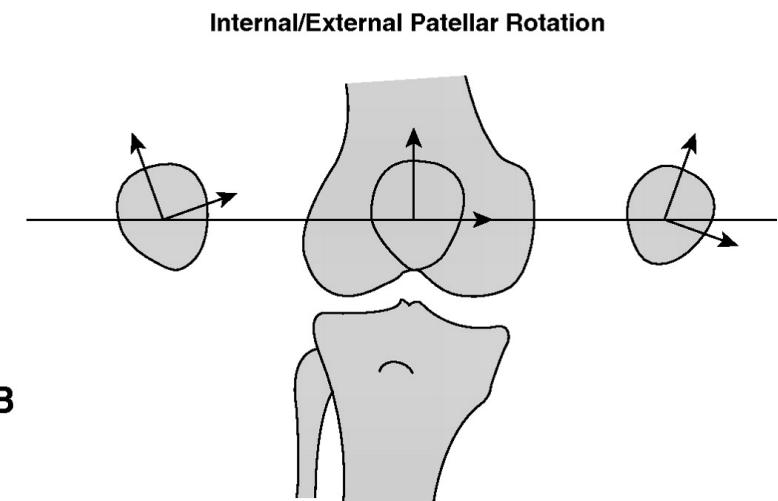


Patellofemoral Joint Arthrokinematics

Tilt

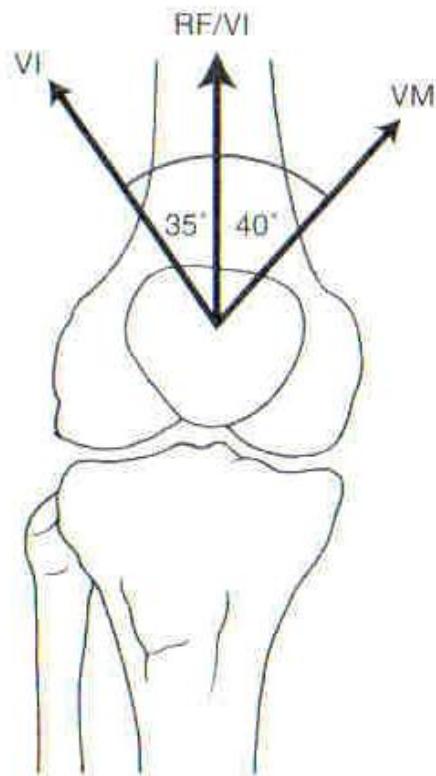


Rotation

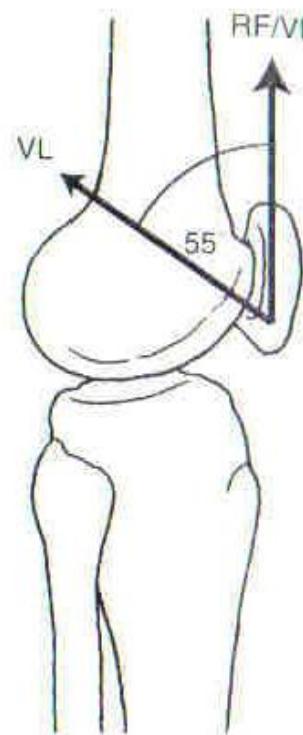


Patellofemoral Joint Role of Muscles

Joint Compression

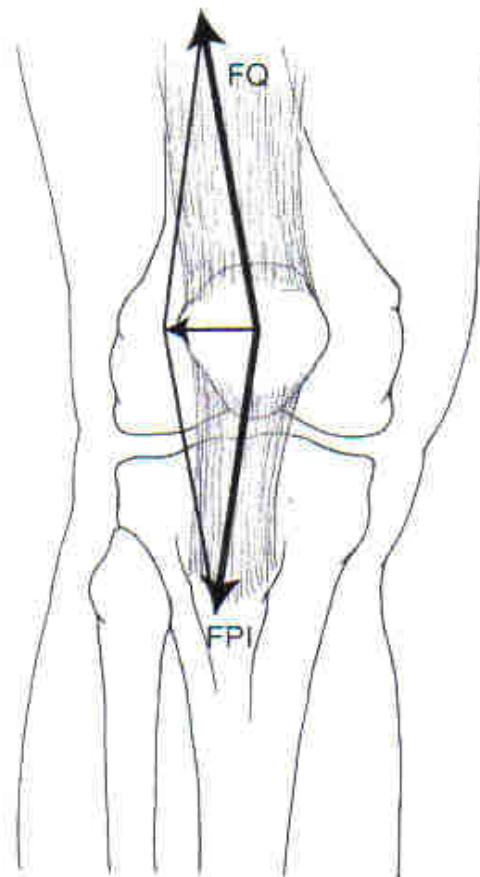


A Frontal view



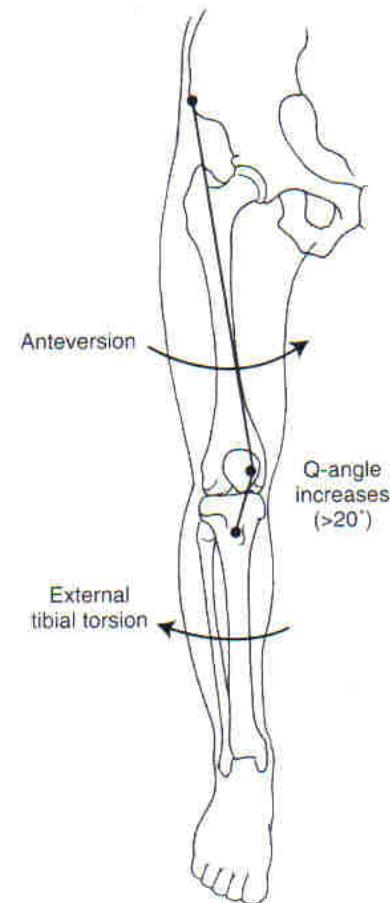
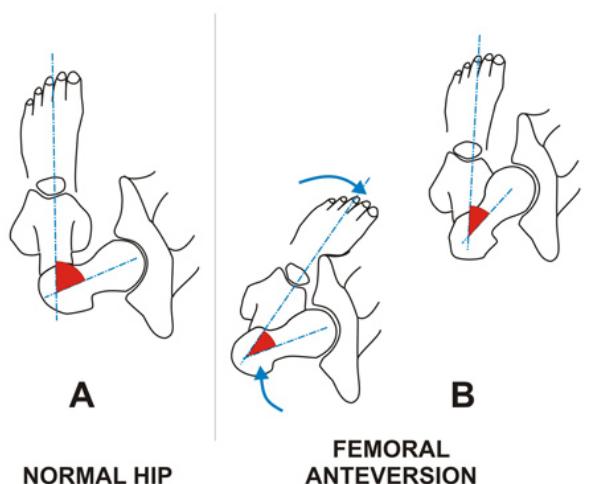
B Lateral view

Lateral > Medial?

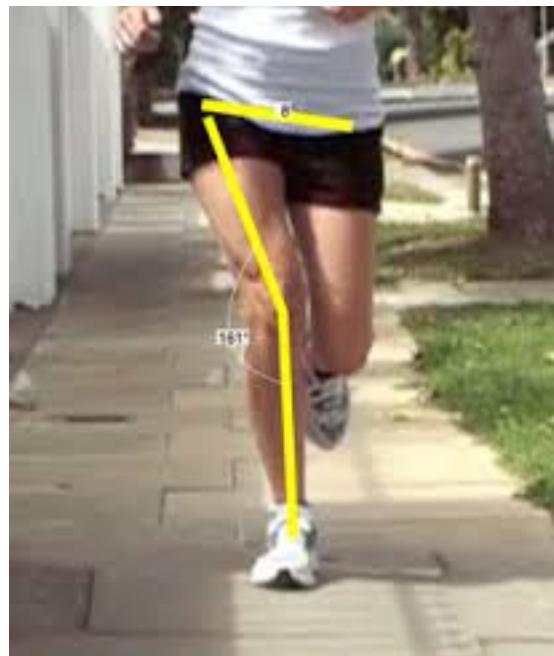


Patellofemoral Joint Role of Alignment

- Frontal plane stability challenged by:
 - Femoral anteversion
 - Tibial torsion

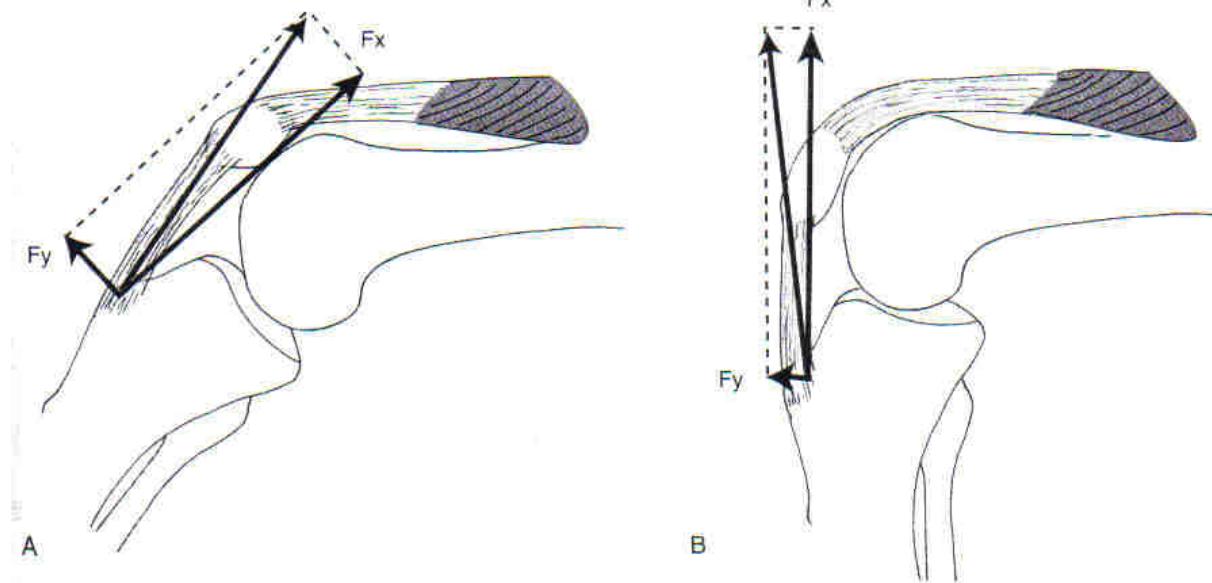


Patellofemoral Joint Running/Biking Coronal Plane



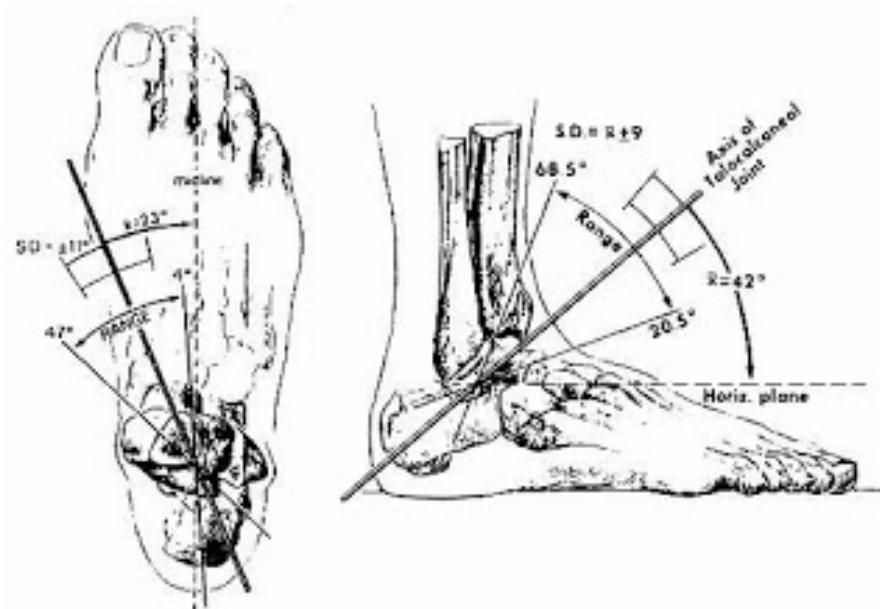
Patellofemoral Joint Role of Muscles

Force applied to femur by Quadriceps via patella changes with knee angle



Ankle/Foot Biomechanics

- Talocrural Joint
- Subtalar Joint
- Transverse Tarsal Joint
 - Osteokinematics
 - Arthrokinematics
 - Joint coupling



Ankle/Foot Complex

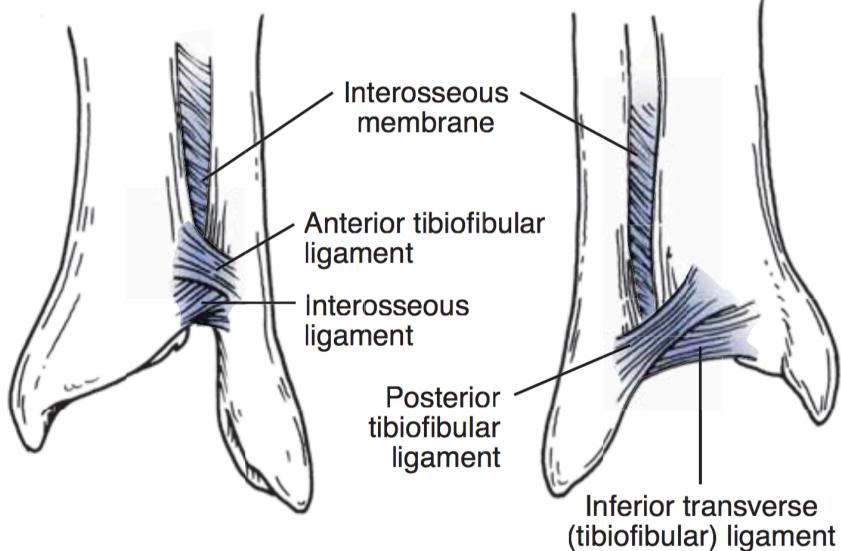
Osteokinematics

- Cardinal Axes (Anatomical)
 - Dorsiflexion/plantarflexion (mediolateral axis, sagittal plane)
 - Inversion/eversion (anteroposterior axis, frontal plane)
 - Abduction/adduction (superoinferior axis, transverse plane)
- Composite Motions
 - Pronation (dorsiflexion, eversion, abduction)
 - Supination (plantarflexion, inversion, adduction)

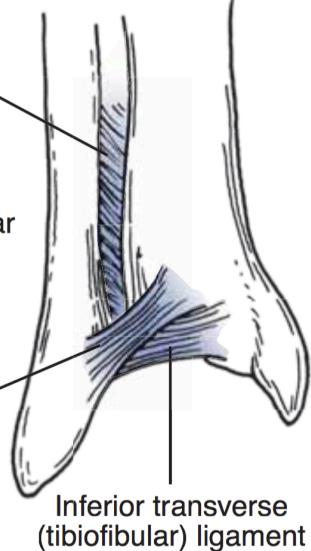
Talocrural Joint

- Mortise

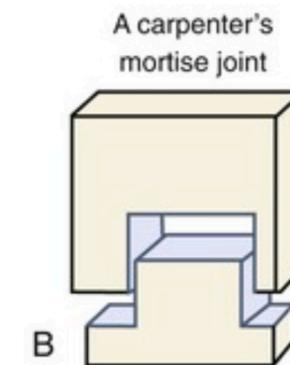
Anterior View



Posterior View

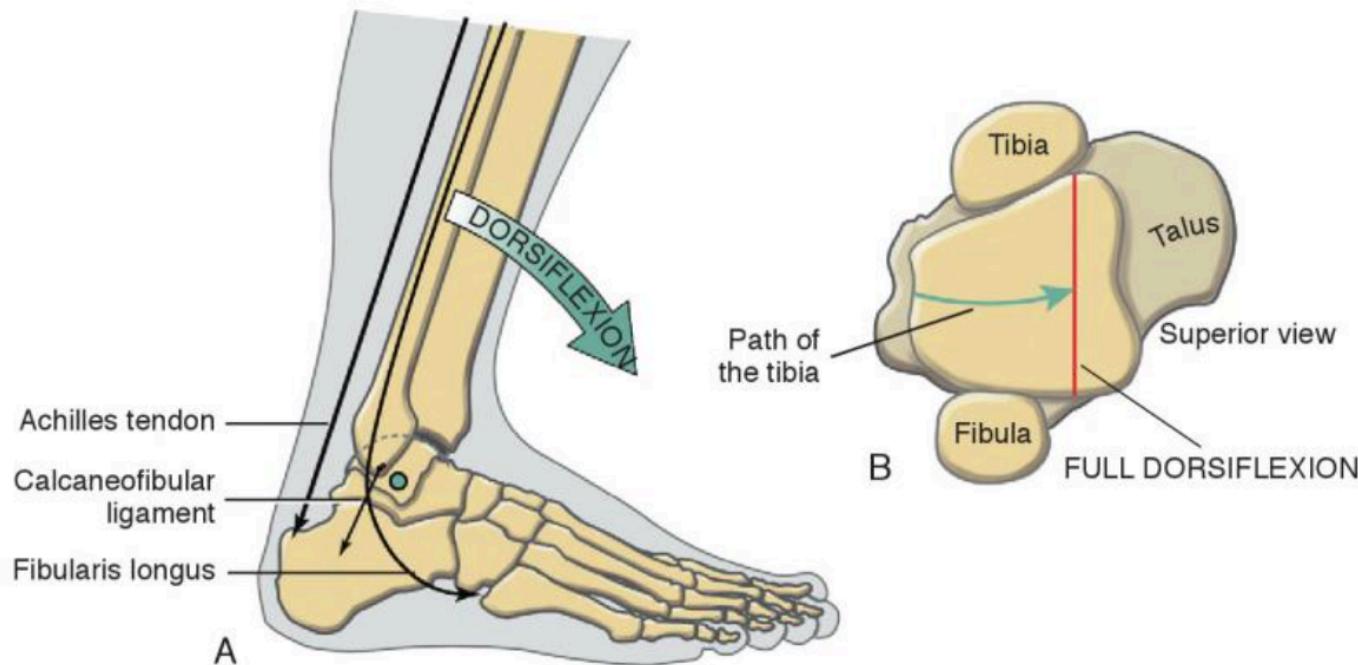


The shape of the talocrural joint

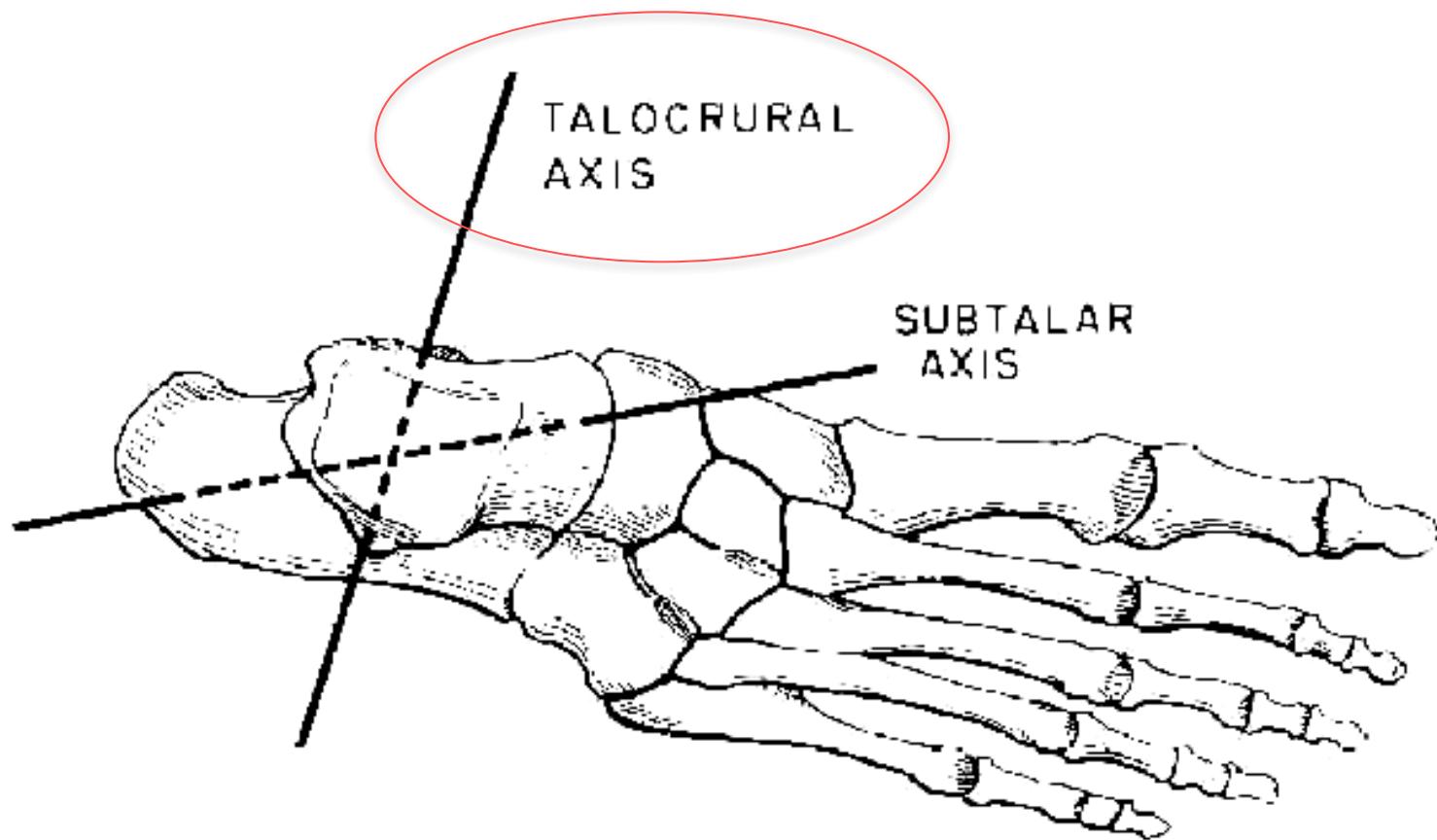


Talocrural Joint

- Talus
 - Wider anteriorly than posteriorly
- Stability
 - Relies on ligaments – Ant/Post



Talocrural Joint

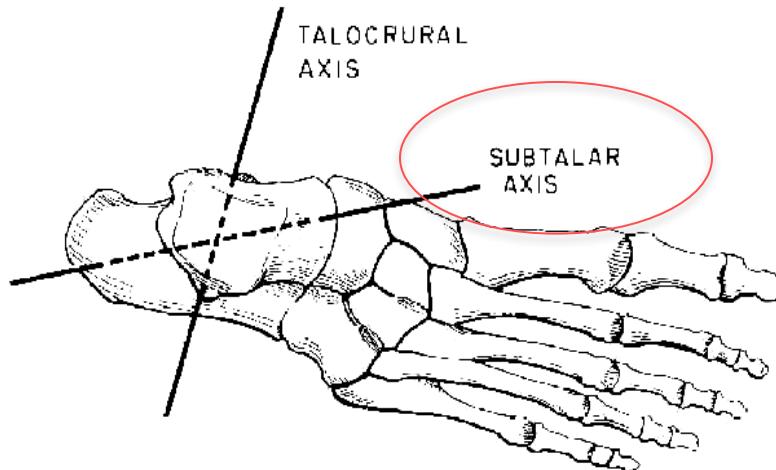


Subtalar (Talocalcaneal) Joint

- Weight-bearing joint motion
 - Calcaneus fixed
 - Talus completes motion
- Non-weight-bearing joint motion
 - Calcaneus on stationary talus

Subtalar (Talocalcaneal) Joint

- Weight-bearing joint motion affects leg
 - Pronation forces medial rotation of leg
 - Supination forces lateral rotation of leg



Transverse Tarsal Joint

- Talonavicular + calcaneocuboid
- Navicular and cuboid immobile in weight-bearing
- Transitional link between the hindfoot and forefoot
 - Add supination/pronation ROM to subtalar joint
 - Compensate the forefoot to hindfoot position

