Mechanics of Human Movement
Material and Mechanics in Medicine HS 2019

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Joints Tradeoff

- Glenohumeral joint (shoulder)
- Hip joint
- Elbow joint
- Intervertebral joints
- Suture

Mobility

Most mobile

Immobile

Stability

Very unstable

Most stable
Anatomy

Knee

- Fibula is not part of the joint
- Tibiofemoral joint: Condyloid hinge joint
- Patellafemoral joint: Saddle joint

Elbow

- Radius is part of the joint
- Ulnohumeral joint: Typical hinge joint
- Radiohumeral joint: limited ball-and-socket joint
- Radioulnar joint: pivot joint
Anatomy

Knee
- Extension dominant
- Lever arm achieved with patella

Elbow
- Flexion dominant
- Lever arm with biceps-radius attachment

Interosseous Membrane:
- Stability
- Transmits forces

- 100% transmitted tibia $\rightarrow$ femur
- 57% radius vs 43% humerus
- Separates tissues during twisting
Cartilage and Meniscus

- Osteoarthritis
  - Women are more susceptible
  - Risk factors:
    - Overuse
    - Skeletal deformations
    - Joint laxity

**Meniscus**
- 60-70%
- Type I 75% dw
- 1.5% dw
- ‘Fibrochondrocytes’

**Composition**
- Water
- Collagen
- Proteoglycans
- Cells

**Cartilage**
- 65-85%
- Type II 60% dw
- 12.5% dw
- Chondrocytes

- Stability due to wedge effect
- Optimized load distribution (shock absorption)
Ligaments and Tendons

Knee

- LCL: restrain to varus stress
- MCL: restrain to valgus stress
- ACL:
  - anterior displacement of tibia
  - Internal knee rotation
  - Hyperextension
- PCL:
  - Posterior displacement of tibia
  - External knee rotation

Elbow

- LCL: restrain to varus stress
- MCL: restrain to valgus stress
- Quadrature ligament: prevents hyper-supination
**Kinematics**

**Knee**
- **Rotation**
  - Condyloid hinge joint: 2 axes
  - Frontal plane rotation blocked by MCL and LCL
- **Flexion:**
  - Tissue contact
- **Extension:**
  - ACL
- **Centre of rotation not fixed**

**Elbow**
- **Rotation**
  - Hinge joint: 1 axis,
  - Pivot/Hinge joint: 2 axes
  - others axes blocked by joint shape and collateral ligaments
- **Flexion:**
  - Tissue Contact
- **Extension:**
  - Olecranon
- **Fix centre of rotation**
Kinetics

**Patella**
- **Patellar force:**
  - Low in extension
  - Very high in flexion
- **Force reducing mechanisms**
  - Meniscus and femur slide posterior
  - Patella sinks into patella groove (provides also joint stability)

**Meniscus**
- **Shock-absorption**
- **Increase congruency & area of contact**
- **Deepens articulation**
- **Wedge shape:**
  - Increased area of contact
  - Less contact between opposing cartilages in flexion
- **Load transmission:**
  - 50% in extension
  - 85% in flexion
Thank you!