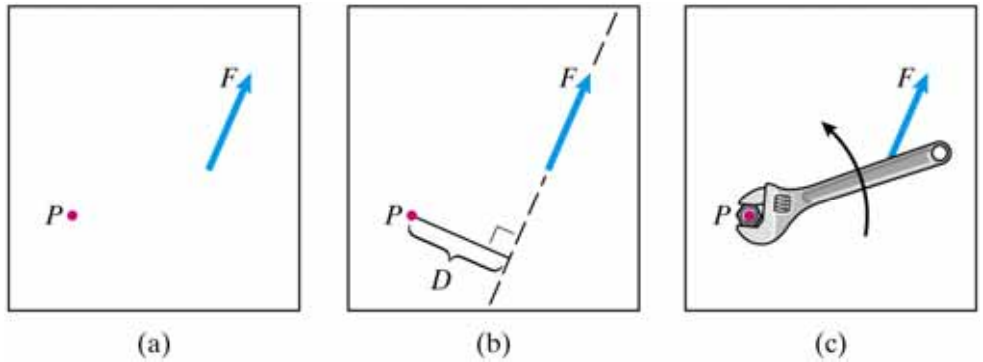
Section 10: Statics - Bioapplications

Moment (Torque) Concept

- A rotation-causing force
- Vector with direction perpendicular to plane (right-hand rule)



- $M_P = D * F$
- Units: N-m or lb-F

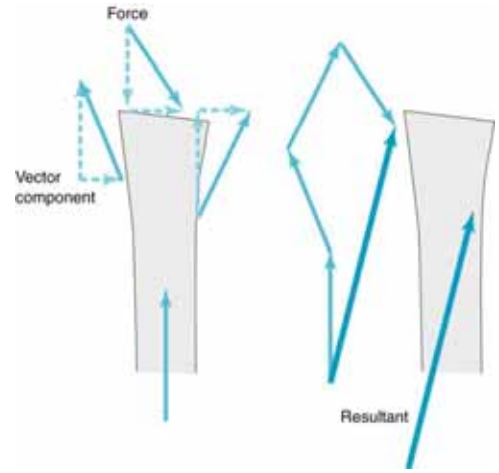
From: Gabauer

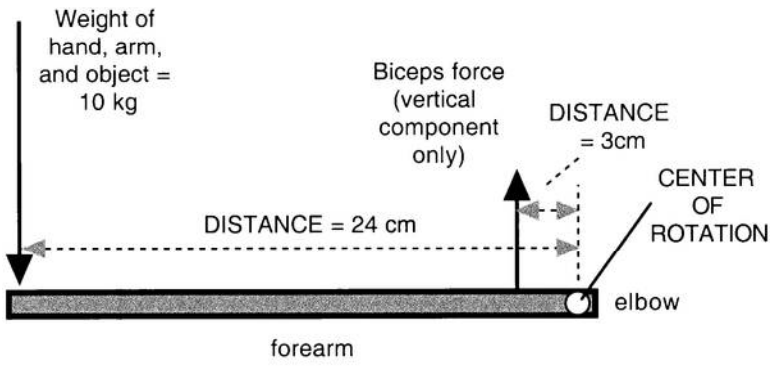
Mechanical Principle: Leverage

- Lever - mechanical device used to produce a turning motion around a fixed point called an *axis.*
- Lever components
  - Fulcrum - center or axis of rotation
  - Force arm - distance from the fulcrum to the point of application of the force
  - Resistance arm - distance from the fulcrum to the weight on which the force is acting

Forces Acting on Long Bones

- **Force** is a vector (magnitude with direction)
- **Moment**: Force acting on a bone causing rotation
- **Moment Arm**: lever that force acts on (some distance away from center of rotation)





Balance moments to hold arm steady:
24 cm x 10 N = 3 cm x Biceps force
Biceps force = 80 N

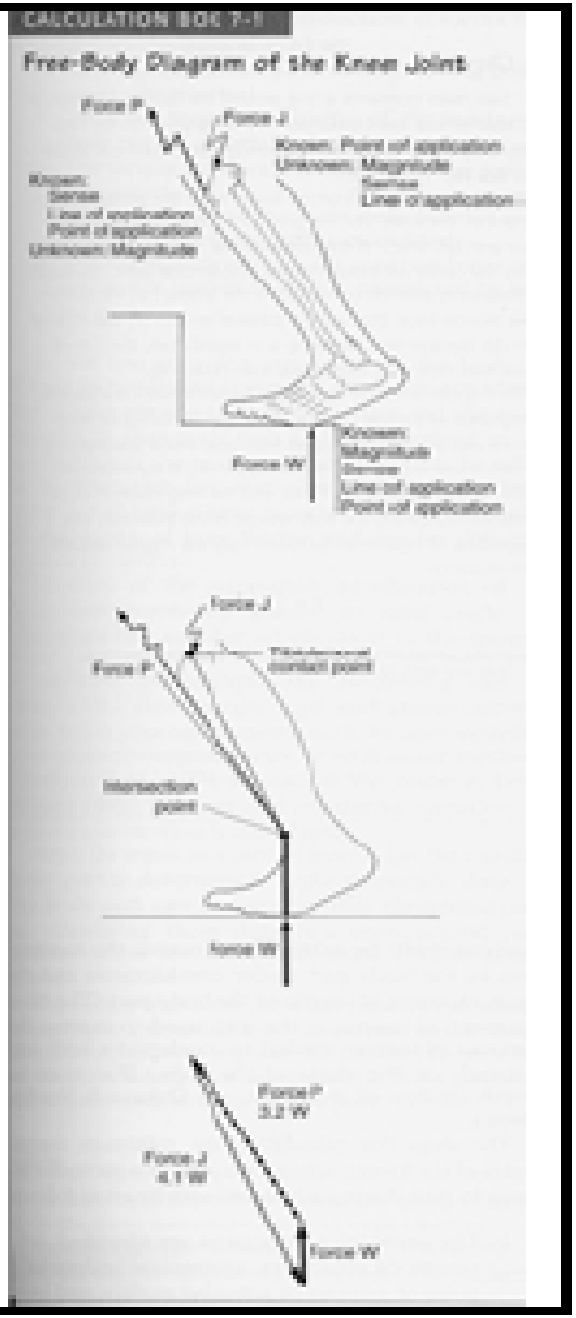
From: Justice

Statics of tibiofemoral joint

- Static analyses useful when
  - No motion takes place
  - At an instant of time during dynamic activity
- Complete static analysis
  - Highly complicated to analyze all forces and moments in 3-D
  - Simplified techniques often utilized
- Limit analysis to a single plane

Example: static force analysis

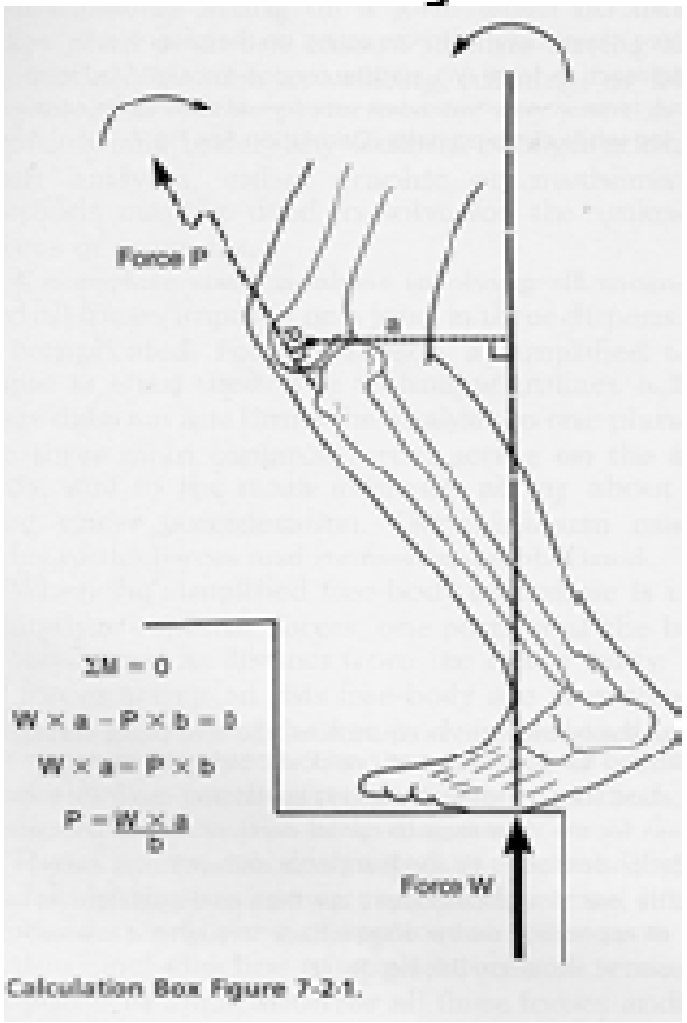
- 3 main coplanar forces on the knee joint
  - Ground reaction force (W)
  - Patellar tendon force (P)
  - Joint reaction force (J)
- Main muscle force has a much larger impact than ground reaction force
- Only minimum magnitude of joint reaction force was calculated
  - Inclusion of other muscles forces (e.g., hamstrings) increases joint reaction force



From: Iatridis

Example – static moment analysis

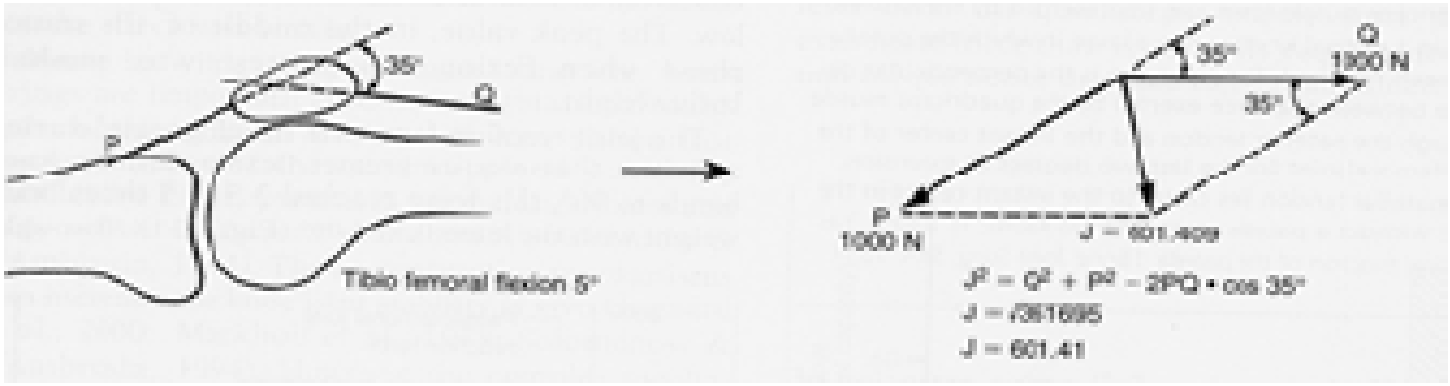
- Calculate minimum magnitude of moment produced through patellar tendon which counterbalances the moment on the lower leg



Calculation Box Figure 7-2-1.

Statics of PFJ: influence of flexion angle

- Knee in **5** deg of flexion
  - P=patellar tendon
  - Q=quadriceps tendon
  - J=joint force obtained from trigonometry
  - P and Q assumed 1000N
  - Angles obtained from x-ray
  - Joint force estimated to be 601N



From: Iatridis