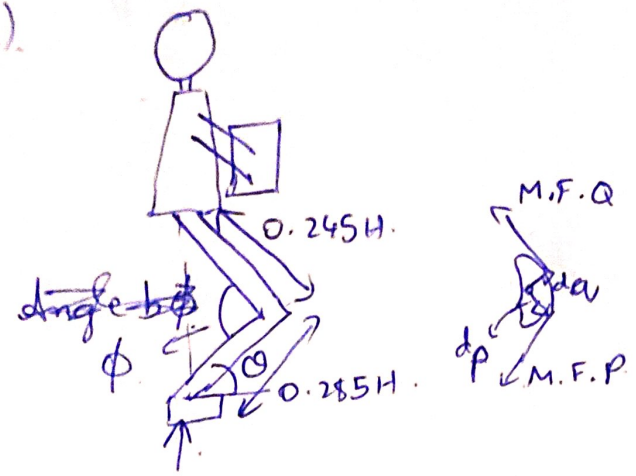
Using anthropometric data from the slide.

(4).



The ratios of moment arms of the quadriceps and ~~patellofemoral~~ patellar tendon are taken from an online source.

Balancing moment about patellofemoral joint

$$M.F.Q\ (\text{quadriceps muscle force}) \times d_q = M.F.P \times d_p\ (\text{patellar tendon force})$$

$$\Rightarrow \frac{M.F.Q}{M.F.P} = \frac{d_p}{d_q} = \frac{18.4}{17.1} = 1.076$$

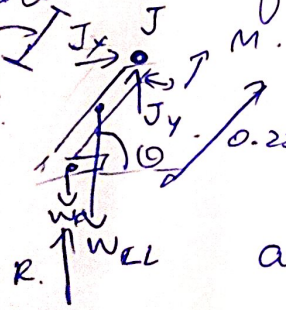
Assuming the leg origination point to be directly above the feet

$$\Rightarrow 0.285H \times \cos\theta = 0.245 \cos(\phi - \theta)$$

$$\Rightarrow \frac{0.285}{0.245} = \frac{\cos\phi\cos\theta + \sin\phi\sin\theta}{\cos\theta} = \cos\phi + \sin\phi\tan\theta$$

$$\Rightarrow \theta = \tan^{-1}\left[\left(\frac{0.285}{0.245} - \cos\phi\right) \times \frac{1}{\sin\phi}\right]$$

Separating the portion below the knee about the tibiofemoral joint (SHANK)



The value of patellofemoral moment arm of patellar tendon about tibiofemoral joint from o

$$\Sigma M_J = 0$$

$$R \times 0.285H = W_F \times 0.285H\cos\theta + d_p \times MFP + W_{LL} \times a\cos\theta$$

$$a = \frac{43.95}{100} \times 0.285H = 0.125H.$$

$$W_{LL} = \frac{4.33}{100} \times W = 0.0433W.$$

$$W_F = 0.0137W.$$

d_p = Value of patellar tendon force moment arm about tibiofemoral joint taken from online source = 49 mm.

Knowns: W, H, Shank Length, Thigh Length, Shank to Thigh Angle (phi), Moment Arm Ratios, Patellar Tendon Force Moment Arm, External Load
Unknowns: Patellar Tendon Force, Patellofemoral Joint Reaction, Tibiofemoral Joint Reaction, Quadriceps Force, Theta.

cos(theta)
x

$$\Rightarrow \frac{\left[(W+10)\times 0.285H - (0.0137W)\times 0.285H\cos\theta - (0.0433W)\times 0.125H\cos\theta\right]}{0.049} = M.F.P.$$

$\Sigma F_x = 0 \Rightarrow J_x = -M.F.P\cos\theta$

$\Sigma F_y = 0 \Rightarrow J_y = W_F + W_{LL} - R = (0.0433 + 0.0137)W - (W+10)$

-MFP x sin(theta)

-MFP x sin(theta)

J_x and J_y are the two perpendicular components of the tibiofemoral joint force.

M.F.P → patellar tendon force.

Let $Q_x\hat{i} + Q_y\hat{j}$ be the patellofemoral joint force. Then,

$$Q_x = M.F.P\cos\theta + M.F.Q\cos(\phi - \theta)$$

$$Q_y = M.F.P\sin\theta - M.F.Q\sin(\phi - \theta)$$