

HW #1

DATE: Monday, January 12, 2009

ASSIGNMENT DUE: Wednesday, January 21, 2009 by 5PM in Rebecca's TA mailbox (Hudson Annex, 2nd floor)

RECOMMENDED READING:

1. **CLASS PROBLEM CONTINUATION:** Find the force generated by the muscles, F_m , the joint reaction force, F_j , and the angle at which it acts, α , as a function of flexion angle Φ for the standing knee problem begun in class. Use the free body diagram developed in class and show all work necessary. Plot F_j , F_m , and α on the same graph as a function of Φ with forces normalized to W .

Let h be the person's height and W be the person's weight.

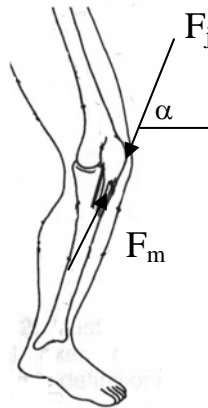
Angle of muscle insertion, $\theta = 15^\circ$

Force due to gravity on the leg, $F_G = 0.06W$

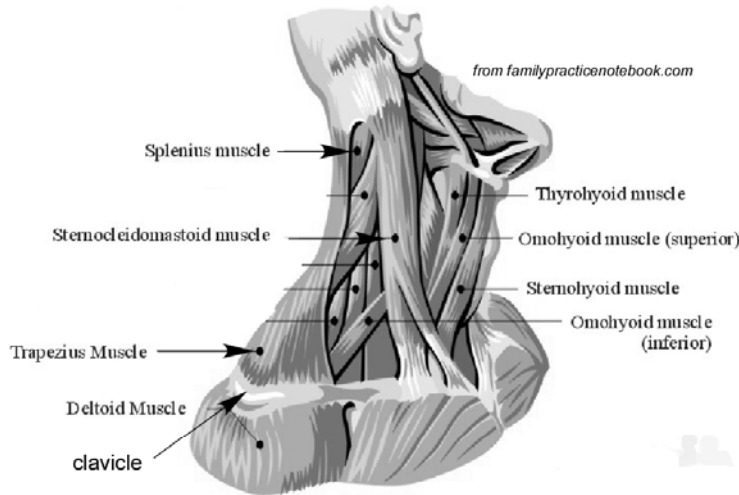
Distance from top of the lower leg to muscle origin point, $a = 0.06h$

Distance from top of the lower leg to its center of gravity, $b = 0.14h$

Length of lower leg, $c = 0.28h$

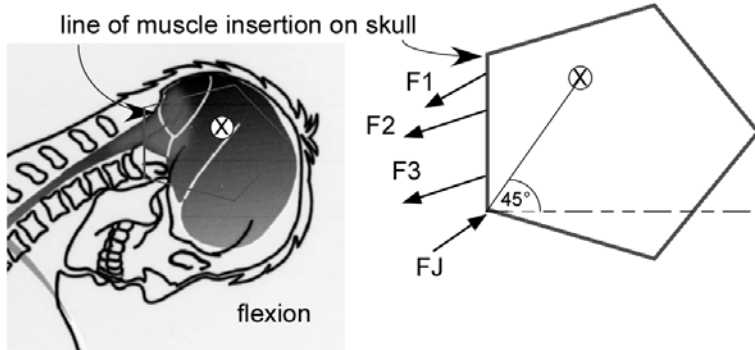


2. A subset of muscles of the neck is shown below along with the bony anatomy of the cervical spine. We are asked to determine the forces transmitted to the joint at the top of the spinal column (called the atlas) during flexion of the head, under the weight of the skull.



During flexion, there are at least three extensors that remain in tension. They are:

- (1) splenius muscle (F_3): connects skull to C7 of cervical vertebrae;
- (2) sternocleidomastoid muscle (F_2): connects skull to clavicle and sternum;
- (3) trapezius muscle (F_1): connects skull to clavicle.



In flexion, the insertions of these muscles occur along a vertical line that extends from the atlas, termed “line of muscle insertion” in the Figure at left. These insertions and skull weight can be (loosely) represented by a pentagon in the lateral view shown at left. Note that the atlas-skull joint is denoted at the point of F_J .

(a) Draw your own free-body diagram and label all forces, distances from insertions to atlas (at F_J), angles of muscle insertion, and weight of the head (center of mass denoted by the hatched circle).

muscle	PCSA (cm ²)	angle (degrees)	distance (cm)
trapezius	1.96	30	7.1
sternocleidomastoid	3.72	37	6.5
splenius	4.26	20	3.2
head ($W=50N$)	flexion angle from resting position of 45°		19.6 (length from atlas to CM as drawn)

- (b) Determine the forces generated in each muscle for this movement, with use of the reduction method.
- (c) Determine the joint reaction force acting at the atlas under the weight of the head.