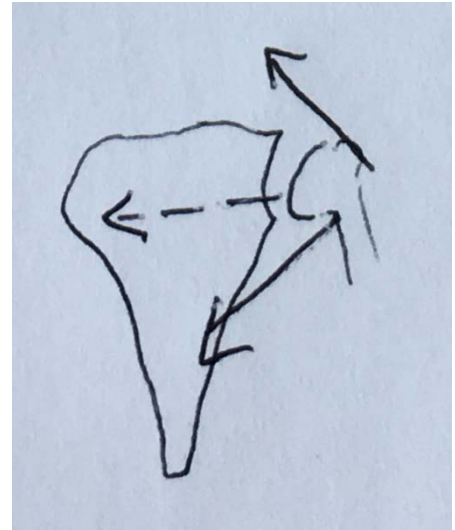


1A) Muscle 1: A shoulder abductor (elevator) and prime mover  
Muscle 2: A shoulder adductor (depressor)

1B) Muscle 1: Middle deltoid (the anterior deltoid arises from the clavicle, the posterior deltoid is a depressor/weak abductor)

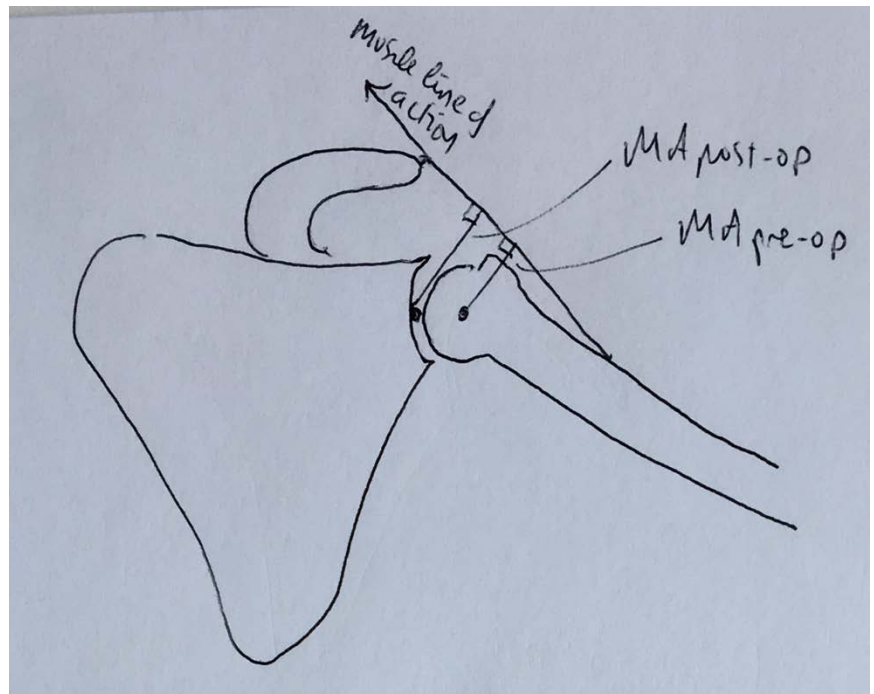
1C) A shoulder agonist and antagonist, if simultaneously activated, may form a "force couple" to generate a resultant compressive force at the glenohumeral joint; for example, with activity of an abductor and an adductor, or opposing muscle lines of action.



2A) Assume: muscle line of action directed toward acromion (superiorly), and attachment on humerus (e.g. middle deltoid)

2B) Assumptions:

- max change in muscle 1 moment arm is 25mm increase
- length of arm,  $l$ , is 78 cm (50<sup>th</sup> percentile male)
- weight of arm,  $M_a$ , is 4% body weight or  $0.04 \times 750\text{N}$  (50<sup>th</sup> percentile male)  $\rightarrow M_a = 30\text{N}$
- arm is of uniform density and cross-sectional area



$$MA_{pre} \cdot F_{max} = \frac{\ell}{2} \cdot M_a$$

$$0.0151 \cdot F_{max} = (0.78/2)(30)$$

$$F_{max} = 774.8 \text{ N}$$

$$MA_{post} \cdot F_{max} = \frac{\ell}{2} M_a + \ell \cdot M_w$$

$$(0.0401)(774.8) = (0.78/2)(30) + (0.78)M_w$$

$$M = 24.9 \text{ N}$$

where  $M_w$  is the external weight of the mass grasped at the hand, and  $F_{max}$  is the maximum force provided by Muscle 1.

$$MA_{pre} = \text{pre-op moment arm at } 45^\circ = 15.1 \text{ mm}$$

$$MA_{post} = \text{post-op moment arm at } 45^\circ = 15.1 + 25 = 40.1 \text{ mm}$$