Increased breast implant size leads to reduced markers of shoulder function in breast cancer patients: A modeling analysis

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Introduction

- Long-term shoulder dysfunction is common among breast cancer survivors who have reconstructive surgery[1]
- Previous work has been done to develop implant models[2]
- It is unknown how changing implant volume impacts pectoralis major muscle moment arm and muscle stiffness

Objective: Modify computational models of sub-pectoral implants to account for differences in implant volume size and position and determine effect on pectoralis major muscle moment arm and passive fiber force

Methods

Implant Volume

- MoBL-ARMS upper limb model[3] scaled to 50th percentile female anthropometry[4] and muscle forces scaled to middle aged adult female[5] in OpenSim (v 4.1)[6]
- Pectoralis major muscle paths modified to accommodate implant wrapping surface

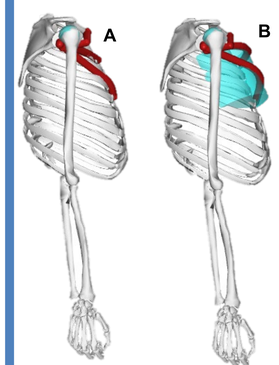

Figure 1. Implant wrapping surface placed under the pectoralis major muscle path. Differences shown between [A] 0cc model and [B] 405cc model

- Implant wrapping surface radius and position modified to match projections in manufacturer specifications[7]
- Pectoralis major moment arm and passive fiber force compared across implant size

Table 1. Implant wrapping surface projection from ribs based on manufacturer specifications

Implant Volume	Model Projection
0cc	0 cm
195cc	3.4 cm
405cc	4.4 cm
600cc	4.9 cm

Implant Location

- For each model, implant wrapping surface translated in four directions as indicated by Figure 2 below
- All translations by 1.0 cm with exception of medial translation for 405cc and 600cc model
- Average muscle moment arm and passive fiber force calculated for each translation

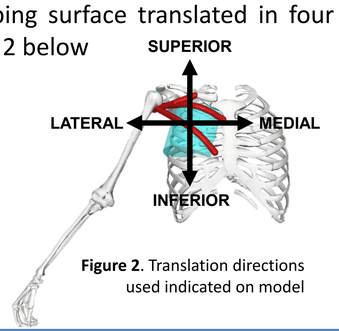

Figure 2. Translation directions used indicated on model

Methods

Model Posture

- Model positioned in scapular plane (elevation angle of 30 degrees)
- Moment arm and passive fiber force measured at varying shoulder elevation angles

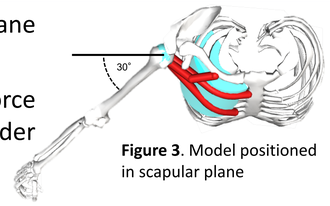

Figure 3. Model positioned in scapular plane

Results

Implant Volume

- Increased implant volume associated with decreased moment arm and increased passive fiber force

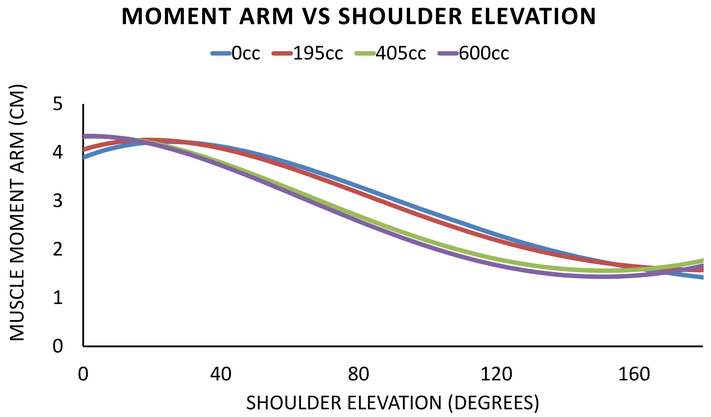

Figure 4. Pectoralis major muscle moment arm for each implant model as shoulder elevation increased from 0 to 180 degrees in the scapular plane

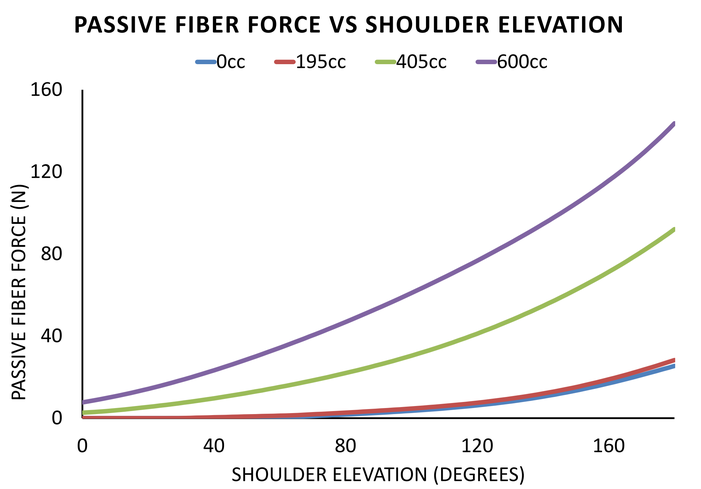

Figure 5. Pectoralis major muscle passive fiber force for each implant model as shoulder elevation increased from 0 to 180 degrees in the scapular plane

Results

Implant Location

- Lateral and superior translations decrease moment arm and increase passive fiber force for all implant models

Table 2. Average pectoralis major muscle moment arm and percent change for each implant translation

	Average Moment Arm (cm)								
Implant Volume	No Translation	Medial Translation	% Change	Lateral Translation	% Change	Superior Translation	% Change	Inferior Translation	% Change
195cc	**3.66**	3.68	0.56%	-0.73%	-0.63%	3.63	-0.93%	3.69	0.78%
405cc	**3.37**	3.42	1.42%	-2.22%	-0.83%	3.31	-1.93%	3.43	1.79%
600cc	**3.31**	N/A	N/A	-2.19%	-0.48%	3.24	-1.99%	3.37	1.89%

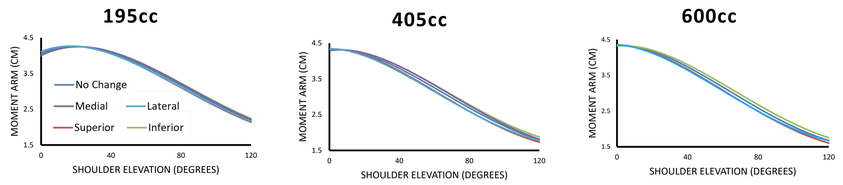

Figure 6. Pectoralis major muscle moment arm for each implant translation in each implant size model. Shoulder elevation increased from 0 to 120 degrees in the scapular plane

Table 3. Average pectoralis major muscle passive fiber force and percent change for each implant translation

	Average Passive Fiber Force (N)								
Implant Volume	No Translation	Medial Translation	% Change	Lateral Translation	% Change	Superior Translation	% Change	Inferior Translation	% Change
195cc	**1.50**	1.34	-11.00%	1.72	14.22%	2.05	36.41%	1.15	-23.22%
405cc	**14.62**	14.47	-1.04%	16.50	12.89%	22.68	55.17%	9.46	-35.26%
600cc	**32.19**	N/A	N/A	32.68	1.51%	48.68	51.20%	20.74	-35.58%

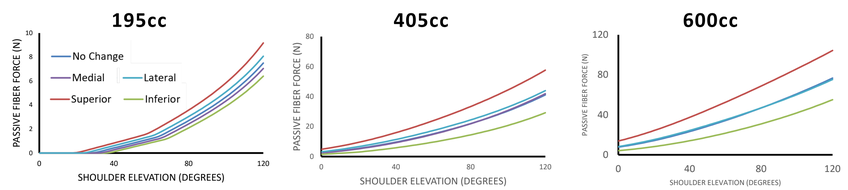

Figure 7. Pectoralis major muscle passive fiber force for each implant translation in each implant size model. Shoulder elevation increased from 0 to 120 degrees in the scapular plane

Discussion

- Increase in implant size is associated with a decrease in pectoralis major muscle moment arm and an increase in passive fiber force
- Superior and medial translations had a positive effect in parameters for shoulder function while inferior and lateral translations had negative effect
- Models suggest that breast implants may increase stiffness in the pectoralis major muscle and decrease the muscle's ability to produce a torque about the shoulder joint, larger volumes increase this effect

References

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