Does Deltoid Muscle Volume Correlate with Patient Outcome After Reverse Shoulder Arthroplasty?

Size Does Matter

Liz Knazek, MD; Jason Holcomb, MD, Stephen Lemos MD, PhD., Alexandria Dupuie, MPH.

July 28, 2016

DMC Sports Medicine

HJ2

Disclosures

- The ultrasound machine used in this study was provided by Sonosite.
- No other disclosures.

DMC Sports Medicine

HJ1

Background

- Management of Rotator Cuff Arthropathy has long been challenging with the evolution of the reverse total shoulder prosthesis in the 1970's.
- Reverse Total Shoulder Arthroplasty is a procedure initially designed for the rotator cuff deficient arthritic shoulder and now becoming more commonly utilized for proximal humerus fractures.
- Reversal of the ball and socket configuration stabilizes the glenohumeral center of rotation.



DMC Sports Medicine

Slide 2

HJ2 I just changed the wording of your statement.
Holcomb, Jason, 7/24/2016

Slide 3

HJ1 Medialization and distalization are not necessary to restore function. RSA restores function by providing a stable center of rotation.
Holcomb, Jason, 7/24/2016

Background

- Traditionally a higher complication rate than a standard total shoulder arthroplasty (four times) but still a consideration for patients with cuff tear arthropathy and proximal humerus fractures.
- More reliable for pain relief than restoration of function and range of motion, and as multiple generations have subsequently been developed has lead to an improvement in postoperative range of motion.
- Therefore patient selection and optimizing deltoid function continue to be important factors, and this study aims to determine if there is a correlation between deltoid volume and patient function and satisfaction in postoperative reverse total shoulder arthroplasty patients.

DMC Sports Medicine

Background

- A prior study by Audenaert validated the use of ultrasound to estimate deltoid volume.
- Our hypothesis was that patients with greater deltoid volumes would show greater satisfaction, function, and constant scores.
- Utilizing that objective data and its correlation to patient satisfaction, outcome scores, range of motion, and strength may:
  - Predict Patient Outcomes
  - Guide whether a patient is a good candidate for RTSA
  - Help guide postoperative rehabilitation protocols.
  - Have an impact on future implant design.

DMC Sports Medicine

Methods

- Reverse total shoulder patients of a single surgeon with the same prosthesis type with their operation performed between 2009-2015 were used for this study.
- We excluded anyone with significant postoperative complications including infections or revision surgeries.
- 28 patients (33 shoulders) enrolled.
- Patients were called in for a one time visit which included patient surveys (Simple Shoulder Test, American Shoulder and Elbow Society, Visual Analog Pain and Function Scale), range of motion and strength assessment, and calculation of their deltoid volume with use of ultrasound measurements.
- Range of motion and strength measurements were also used to calculate a Constant Murley Score.

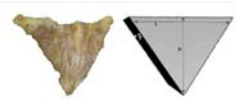
DMC Sports Medicine

Methods

DMC Sports Medicine

Methods

- Deltoid Height and Length measured after insertion sites located with ultrasound.
- Muscle length was defined as the distance from its origin at the spina scapulae, over the acromion, to the clavicle.
- The height of the deltoid muscle was defined as the distance between the insertion on the humerus and the middle of its origin.
- Localized these points with ultrasound and then measured both the non-operative and operative sides.



DMC Sports Medicine

Methods

- Seven Ultrasound Points to calculate mean thickness (T):
  - Point 1 5 cm off acromion angle anterior
  - Point 2 10 cm off acromion angle
  - Point 3 15 cm off acromion angle
  - Point 4 Bicipital Groove
  - Point 5 5 cm anterior to bicipital groove
  - Point 6 5 cm posterior to bicipital groove
  - Point 7 10 cm posterior to bicipital groove

Volume = [(Length x Height) / 2] x T

DMC Sports Medicine

Methods

- Range of Motion assessed for the Constant Score: Forward flexion, Lateral elevation, External and Internal rotation.
- Photos taken and evaluated by three different blinded individuals who recorded their measurements for three separate randomized attempts with goniometers.

DMC Sports Medicine

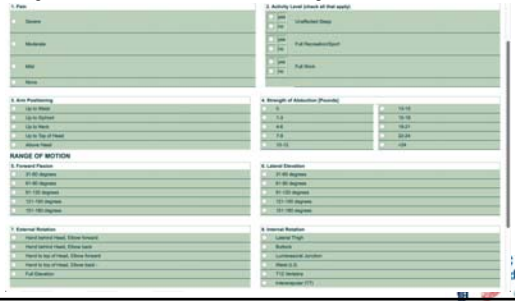
Methods

- Strength evaluated with use of a dynamometer and single examiner with calculation of both average and maximum strengths obtained with Tracker 5 software.
- Performed abduction strength for bilateral shoulders.

DMC Sports Medicine

Methods

- ROM and strength measurements used to calculate a constant score. Calculated three separate times due to three different sets of range of motion measurements and averaged these.



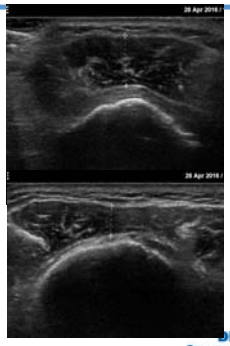
Statistical Analysis

- A Spearman's correlation test was performed to determine if association/relationship exists between deltoid size of the surgical side and the following variables:
  - Function
  - Pain
  - ASES
  - Constant Murley score
  - Abduction Strength
- A t-test was performed to determine if there was a significant difference between the deltoid size of the surgical side and the non-surgical side.
- Also evaluated if any correlation between length of time since surgery or age with deltoid size.

DMC Sports Medicine

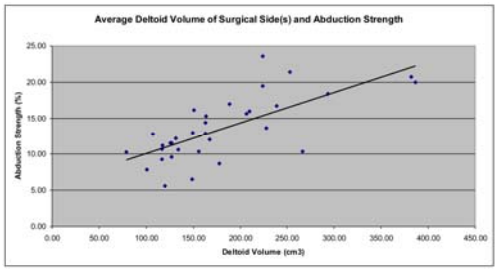
Results

- No statistically significant correlation between function and deltoid size (p=0.468).
- No statistically significant correlation between the VAS and deltoid size (p=0.649).
- No statistically significant correlation between ASES and deltoid size (p=0.277).
- Strong positive correlation with deltoid size and abduction strength (r_s=0.712, p<0.001).



DMC Sports Medicine

Results

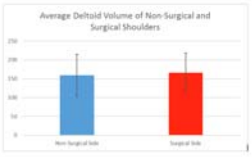


DMC Sports Medicine

HJ3

Results

- There was a moderate positive correlation between deltoid size and the Constant Murley score (r_s=0.450, p=0.036).
- No statistically significant difference between the deltoid size of the surgical and non-surgical deltoid size (p=0.482). Average nonsurgical deltoid volume was 159.02 cm^3. Average operative deltoid volume was 180.16 cm^3.



DMC Sports Medicine

HJ4

Results

Averages on Surgical Side(s)

	Average	Standard Deviation
CM Strength of Abduction with Max Strength	13.50	4.42
ASES	77.17	15.11
Constant Murley with Max Strength	71.69	13.83
Deltoid Size	180.16	73.94

Simple Shoulder Survey

Question	Percentage who Answered "Yes")
1	93.94%
2	81.82%
3	65.63%
4	90.91%
5	90.63%
6	93.94%
7	45.16%
8	67.86%
9	60.71%
10	37.93%
11	54.55%
12	46.67%

DMC Sports Medicine

Results

Paired Samples Test

		Paired Differences 95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Pair 1	Ultrasound Ht_Surgical - Ultrasound Ht_NonSurgical	1.3115	3.069	22	.006
Pair 2	Ultrasound length_Surgical - Ultrasound length_Non Surgical	.9686	.454	22	.654
Pair 3	Thickness avg_Surgical - Thickness avg_Non Surgical	.106569	.326	22	.747

- There was a significant difference in height of the operative and non-operative shoulders.

DMC Sports Medicine

Slide 16

HJ3 why do we have to say "moderate". if p > 0.05 then we can say statistically significant correlation. This is an important finding.
Holcomb, Jason, 7/24/2016

Slide 17

HJ4 It the ASES average correct? I would expect this number to be above 70
Holcomb, Jason, 7/24/2016

Discussion

- Small study numbers may affect the lack of significant differences observed, however power analysis initially reported need for 37 shoulders, and will collect data on several more shoulders (n=33 presently).
- There is a positive correlation with constant score and deltoid volume and abduction strength and volume.
- As expected, there is a decrease in size as patients age (p=0.016) and (r=-0.436).
- No trend with regards to length of time since surgery (p=0.397) and (r= -0.155).

DMC Sports Medicine

Discussion

- Limitations:
  - Many of the patients had similar complaints of pain/dysfunction on the non-operative side.
  - Many reported conflicting pain/satisfaction when asked for the Constant Score and what they reported on their written surveys.
  - Single examiner did the ultrasound and also the same separate examiner for strength testing, but might be some variability in measurements.
  - Retrospective study.

DMC Sports Medicine

Discussion

- Future directions:
  - Could include prospective study with ultrasound measurements preoperatively and postoperatively, and assessment of pre-operative function.
  - Evaluate further for any changes over different time points postoperatively.
  - Comparison with another surgeon's patient population or different prosthesis, especially a direct comparison to a prosthesis that doesn't lateralize.

DMC Sports Medicine

Conclusions

- No difference in deltoid size and patient reported function, VAS, and ASES score.
- No difference in overall size between the surgical and non-surgical sides, but there was a difference in deltoid height.
- No apparent correlation between deltoid size and length of time since surgery, although size did decrease with age.
- However, there was a strong positive correlation with deltoid size and abduction strength.
- Moderate positive correlation between deltoid size and constant score, so size does matter!

DMC Sports Medicine

References

- Audenaert EA, De Roo PJ, Mahieu P, Cools A, Baelde N, D'Herde K, Verdonk R. Deltoid muscle volume estimated from ultrasonography: in vitro validation and correlation with isokinetic abduction strength of the shoulder. Med Biol Eng Comput (2009) 47:557–563.
- Flatow, Evan and Alicia K. Harrison, MD. A History of Reverse Total Shoulder Arthroplasty. Clin Orthop Relat Res. 2011 Sep; 469(9): 2432–2439.
- Miyatani M, Kanehisa H, Fukunaga T. Validity of bioelectrical impedance and ultrasonographic methods for estimating the muscle volume of the upper arm. Eur J Appl Physiol (2000) 82: 391-396.
- Miyatani M, Kanehisa H, Ito M, Kawakami Y, Fukunaga T. The accuracy of volume estimates using ultrasound muscle thickness measurements in different muscle groups. Eur J Appl Physiol (2004) 91: 264–272.
- D. Nam, C.K. Kepler, A.S. Neviaser, K.J. Jones, T.M. Wright, E.V. Craig and R.F. Warren. Reverse Total Shoulder Arthroplasty: Current Concepts, Results, and Component Wear Analysis. *J Bone Joint Surg Am.* 2010;92:23-35.
- Wiater BP, Koueiter DM, Maerz T, Moravek JE, Yonan S, Marcantonio DR, Wiater JM. Preoperative Deltoid Size and Fatty Infiltration of the Deltoid and Rotator Cuff Correlate to Outcomes After Reverse Total Shoulder Arthroplasty. Clin Orthop Relat Res (2015) 473:663–673.

DMC Sports Medicine