TITLE:

The Impact of Humeral Component Version on Outcomes Following Reverse Total Shoulder Arthroplasty: A Prospective, Randomized Trial

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Study Protocol and Statistical Analysis Plan

The Impact of Humeral Component Version on Outcomes Following Reverse Total Shoulder Arthroplasty: A Prospective, Randomized Trial

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BACKGROUND AND SIGNIFICANCE

Reverse total shoulder arthroplasty (RTSA) relieves pain and improves function in patients with rotator cuff-deficient arthropathy.[2, 5] RTSA has consistently been reported to improve forward elevation and pain, however, its effect on internal and external rotation has been less predictable.[6] Some studies indicate that humeral component version plays a role in improvement of humeral rotation following RTSA, however, the published data is contradictory and inconclusive. Several biomechanical studies have suggested that increasing humeral component retroversion may improve external rotation, while subsequently decreasing internal rotation. [1,2,4] Conversely, Henninger *et al.* reported on a cadaveric study that showed no differences in rotation over a range of different humeral component versions.[3] A retrospective study by Rhee *et al.* also suggests that increasing humeral component retroversion does not affect measured internal or external rotation. However, they found that patients with neutral version may experience better function with daily activities requiring internal rotation compared to those with 20 degrees of retroversion.[5] Prospective data on clinical outcomes comparing different humeral component versions in RTSA is currently lacking.

The proposed study is a prospective, double-blinded, randomized trial to investigate the impact of humeral component version on shoulder range-of-motion and patient-reported functional outcomes following reverse total shoulder arthroplasty.

OBJECTIVE

- The primary objective of this study is to determine whether external rotation and internal rotation two years postoperatively is impacted by humeral component version in reverse shoulder arthroplasty
- The secondary objective is to determine whether functional outcomes two years postoperatively are impacted by humeral component version in reverse shoulder arthroplasty

HYPOTHESIS

- Patients that receive RTSA with the humeral component positioned in 30 degrees of retroversion will have greater external rotation and worse internal rotation postoperatively than those that have 0 degrees of version.
- Patients that receive RTSA with the humeral component positioned in 0 degrees of version will have higher functional outcomes scores, due to improved internal rotation, than those that have 30 degrees of retroversion.

RESEARCH DESIGN AND METHODOLOGY

We will perform a prospective, randomized trial with a total of 85 patients. Patients undergoing primary RTSA by Dr. J. Michael Wiater at Beaumont Hospital Royal Oak will be screened for eligibility. After the patient has been consented they will be randomized to one of the following two groups:

1. RTSA with humeral component positioned in 0 degrees of version
2. RTSA with humeral component position in 30 degrees of retroversion

The patient will be blinded to the study group.

INCLUSION CRITERIA

- Patients undergoing primary reverse total shoulder arthroplasty (with Biomet component, glenosphere size 36)
- Diagnosis of cuff tear arthropathy, massive cuff tear, or primary osteoarthritis with cuff tear
- negative external rotation lag sign, ability to externally rotate beyond neutral
- Age 18 years or older

EXCLUSION CRITERIA

- Revision arthroplasty
- Prior open shoulder surgery
- Concomitant latissimus dorsi transfer
- Diagnosis of rheumatoid arthritis, infection, acute trauma or instability
- Patients not undergoing a standard-of-care physical therapy protocol
- Pregnant, patient-reported
- Minors (under 18 years of age)
- Cognitively impaired

ENROLLMENT AND CONSENT

Patients scheduled to undergo reverse total shoulder arthroplasty with Dr. Wiater will be screened preoperatively for eligibility. Patients will be identified in the clinic and by operative schedules. Patients that meet all criteria will be contacted by personnel on the delegation of authority as a consent provider before their procedure. If the patient is interested, the research coordinator will offer to email or mail a copy of the consent for the patient to review beforehand. During the time of consent, the patient will confirm they have read and understand the consent. Patients can discuss any questions they may have with the consent provider at this time. Patients will be allowed to drop out of the study at any time before or after their procedure.

RANDOMIZATION

The 85 patients enrolled in the study will be randomized in a 1:1 ratio to have their procedure performed either with a humeral component positioned in 0 degrees of version or 30

degrees of retroversion. Randomization assignments will be contained in sequentially numbered, opaque, sealed envelopes, which will be prepared by a statistician in the research institute. After the patient is consented, they will be assigned to a group following the treatment listed in the envelope. Key personnel not collecting data will perform randomization and inform the surgeon of the group in order to keep data collection blinded. The patient will also remain blinded to their assignment. Logs will be maintained by the randomizing personnel.

DATA COLLECTION

Baseline data will be collected before the patient's procedure, after consent has been signed. Patients will be followed at standard-of-care follow-up appointments in the clinic at 3 months, 6 months, one year, and two years postoperatively. To help prevent dropouts, follow-up requirements will be discussed with the patient before consent and all patients will be called as each time point approaches to schedule follow-up appointments. At each appointment the patient will complete patient-reported outcomes questionnaires and will undergo a physical exam with a clinical research coordinator blinded to the patient's study group. Standard-of-care x-ray images will also be assessed.

Demographics and Operative

- Name
- Age
- Gender
- BMI
- Comorbidities, as recorded by anesthesiology
- Date of surgery
- Laterality
- Dominant hand

Patient Reported Outcomes

- American Shoulder and Elbow Surgeons' Score (ASES)
- Western Ontario Osteoarthritis of the Shoulder Score (WOOS)
- Patient-Reported Outcomes Measurement Information System Global 10 (PROMIS-10)
- Visual analog scale (VAS) pain

Physical Evaluation

- Range-of-motion, measured with a goniometer (forward elevation, abduction, external rotation, internal rotation) (See Appendix A)
- Strength, measured with a dynamometer (in forward elevation, abduction, external rotation, internal rotation) (See Appendix A)
- External rotation lag sign test
- Drop arm test
- Lift off test
- Belly press test

SCHEDULE OF EVENTS

Study Procedure	**Preoperative**	**Surgery**	**3 months**	**6 months**	**1 year**	**2 years**
Visit Window	8 wks to surgery	N/A	± 4 weeks	± 6 weeks	± 2 months	± 4 months
Review inclusion and exclusion criteria	X					
Informed consent review and signature	X					
Study group determination (randomization)	X*					
Intervention		X				
Patient-reported outcomes questionnaires (ASES, WOOS, PROMIS, VAS)	X*		X	X	X	X
Physical exam (range-of-motion and strength)	X*		X	X	X	X
Standard-of-care x-rays	X*		X	X	X	X

Assess for adverse events	X*	X	X	X	X	X

*Consent will happen before any study procedures or assessment are done and randomization will occur at that time

STATISTICAL ANALYSES

SAMPLE SIZE

We performed a sample size analysis to determine how many patients are needed to be able to detect the minimal clinically important difference in shoulder external/internal rotation, which is between 14° and 22°.[7] We used 80% power and a significance level of 0.05, and based on a review of the literature, we expect a standard deviation between 8° and 18°.[5] Table I illustrates for each effect size, the minimum detectable difference with a standard deviation of 8° and of 18°. Using a sample size of 35 per group (effect size = 0.68), we would be able to detect between 5.4° and 12.2° difference, which will be sufficient to detect a clinically important difference.

Table I. Varying effect size and sample size for 80% power and α=0.05, and the minimum detectable differences with a standard deviation of both 8 and 18.

Effect Size	Total N	n Per Group	Standard Deviation	Minimum Detectable Difference	Standard Deviation	Minimum Detectable Difference
0.55	106	53	18	9.9	8	4.4
0.60	89	45	18	10.8	8	4.8
0.64	80	40	18	11.52	8	5.12
0.65	76	38	18	11.7	8	5.2
0.68	70	35	18	12.2	8	5.4
0.7	66	33	18	12.6	8	5.6
0.75	58	29	18	13.5	8	6
0.8	51	26	18	14.4	8	6.4

DATA ANALYSIS

The range-of-motion, strength measures, patient-reported outcomes scores, and patient demographic factors will be compared between the two treatment groups. A table of descriptive summaries by treatment group will be prepared (means and standard deviations if normally distributed, median and range if not normally distributed, counts and percentages for categorical variables). Confidence intervals for the means/medians for each of the two groups will also be computed. The change from baseline as well as the absolute postoperative outcomes measurements will be used for comparison. Before comparing continuous variables, data sets will be assessed for normality using a Shapiro-Wilk Test. For normal data, an independent student's t-test will be used to compare means. A Mann-Whitney Rank Sum Test will be used for data that is ordinal or not normally distributed. The two treatment groups will be compared on categorical variables using the Fisher's Exact test.

Missing data will not be imputed, but the number of data points available at each time point postoperatively will be clearly reported in publications. For all tests, a p-value < 0.05 will be considered statistically significant. A Bonferroni correction will be used to account for repeated measures and control for a Type I error. Graduate-trained engineers will analyze data with SPSS statistical software (SPSS Version 22.0, IBM, Inc).

RISKS AND BENEFITS

POTENTIAL BENEFITS TO SUBJECTS

Patients enrolled in the study may have better range-of-motion or function if one technique proves superior. However, there may be no direct benefit from inclusion in this study. It is hoped that the results of this study will help doctors learn which treatment is most effective for maximizing outcomes after reverse total shoulder arthroplasty.

POTENTIAL RISKS TO SUBJECTS

The risks of participating in this study include the same risks normally associated with reverse total shoulder arthroplasty surgery whether the patient is in the study or not. Both techniques (30 degrees of humeral component retroversion versus 0 degrees of version) are standard-of-care, based on surgeon preference. There is a chance that patients enrolled in the study may have worse range-of-motion or function if one technique proves inferior. However, this has yet to be proven.

With any procedure, unusual, unexpected or previously unreported side effects may occur. Risks will be assessed throughout the course of the study.

There is also the rare risk of breach of confidentiality. Every effort will be made to maintain patient privacy, however this cannot be guaranteed.

ADVERSE EVENTS

The participants will be monitored for risks and AEs related to surgery or the device throughout the course of the study. The PI will be responsible for tracking the occurrence of AEs while the patient is enrolled in the study. The PI will determine the relationship between the study-based surgical technique (i.e. humeral version) and the occurrence of an AE/SAE.

REFERENCES

1. Berhouet J, Garaud P, Favard L. Influence of glenoid component design and humeral component retroversion on internal and external rotation in reverse shoulder arthroplasty: A cadaver study. Orthop. Traumatol. Surg. Res. 2013;99(8):887–894. doi:10.1016/j.otsr.2013.08.008
2. Gulotta L V, Choi D, Marinello P, Knutson Z, Lipman J, Wright T, et al. Humeral component retroversion in reverse total shoulder arthroplasty: a biomechanical study. J. Shoulder Elbow Surg. 2012;21(9):1121–7. doi:10.1016/j.jse.2011.07.027
3. Henninger HB, Barg A, Anderson AE, Bachus KN, Tashjian RZ, Burks RT, et al. Effect of deltoid tension and humeral version in reverse total shoulder arthroplasty: a biomechanical study. J. Shoulder Elbow Surg. 2012;21(4):483–90. doi:10.1016/j.jse.2011.01.040
4. Jeon B-K, Panchal KA, Ji J-H, Xin Y-Z, Park S-R, Kim J-H, et al. Combined effect of change in humeral neck-shaft angle and retroversion on shoulder range of motion in reverse total shoulder arthroplasty - A simulation study. Clin. Biomech. (Bristol, Avon). 2016;31:12–9. doi:10.1016/j.clinbiomech.2015.06.022
5. Rhee YG, Cho NS, Moon SC, Boileau P, Walch G, Boileau P, et al. Effects of humeral component retroversion on functional outcomes in reverse total shoulder arthroplasty for cuff tear arthropathy. J. Shoulder Elb. Surg. 2015;24(10):1574–1581. doi:10.1016/j.jse.2015.03.026

6. Wall B, Nové-Josserand L, O'Connor DP, Edwards TB, Walch G. Reverse total shoulder arthroplasty: a review of results according to etiology. J. Bone Joint Surg. Am. 2007;89(7):1476–85. doi:10.2106/JBJS.F.00666
7. Muir SW, Corea CL, Beaupre L. Evaluating change in clinical status: reliability and measures of agreement for the assessment of glenohumeral range of motion. North American Journal of Sports Physical Therapy. 2010; 5(3) 98-110.

APPENDIX A

Research Assessment Form

MOTION	Left Shoulder	Right Shoulder
Abduction:	_____ degrees	_____ degrees
Forward Flexion:	_____ degrees	_____ degrees
External Rotation:	_____ degrees	_____ degrees
	☐ Hand Behind Head, Elbow Forward	☐ Hand Behind Head, Elbow Forward
	☐ Hand Behind Head, Elbow Back	☐ Hand Behind Head, Elbow Back
	☐ Hand to top of Head, Elbow Forward	☐ Hand to top of Head, Elbow Forward
	☐ Hand to top of Head, Elbow Back	☐ Hand to top of Head, Elbow Back
	☐ Full Elevation	☐ Full Elevation
Internal Rotation:	_____ degrees	_____ degrees
	☐ Lateral Thigh	☐ Lateral Thigh
	☐ Buttock	☐ Buttock
	☐ Lumbosacral Junction	☐ Lumbosacral Junction
	☐ Waist (L3)	☐ Waist (L3)
	☐ T12 Vertebra	☐ T12 Vertebra
	☐ Interscapular (T7)	☐ Interscapular (T7)
STRENGTH (N or lbs)		
Abduction	_____ _____ _____	_____ _____ _____
Forward Flexion	_____ _____ _____	_____ _____ _____
Internal Rotation	_____ _____ _____	_____ _____ _____
External Rotation	_____ _____ _____	_____ _____ _____
Drop Arm?	Positive Negative	Positive Negative
Belly Press?	Positive Negative	Positive Negative
Lift-Off?	Positive Negative	Positive Negative
External Rotation Lag?	Positive Negative	Positive Negative
Is testing affected by pain?	Yes No	Yes No
Neural Deficits?	Motor Sensory None	Motor Sensory None