

## **A Lateralized Arm Change Position is Correlated with Better Patient-Determined Outcomes after Reverse Total Shoulder Arthroplasty**

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**INTRODUCTION:** Reverse total shoulder arthroplasty (RTSA) can result in varying amounts of humeral medialization or lateralization. The amount of medial or lateral arm change position can be predicted preoperatively using 3D CT planning software. It is not clear if predicted arm change position (BACP) correlates with actual, radiographically-measured arm change position (RACP-LHO and RACP-GLH). In addition, it is not clear if predicted or actual arm change position correlates with patient-reported outcomes or complications.

### **METHODS:**

Patients undergoing RTSA underwent preoperative 3D CT planning to predict the postoperative medial to lateral arm change position (BACP). Preoperative and postoperative radiographs were used to calculate the actual medial-to-lateral arm change position using the measurement of the lateral edge of the greater tuberosity to the 1) lateral edge of the acromion (RACP-LHO) and 2) face of the glenoid (RACP-GLH). The Western Ontario Osteoarthritis Score (WOOS), American Shoulder and Elbow Surgeons score (ASES), Single Assessment Numeric Evaluation (SANE), Simple Shoulder Test (SST), and Shoulder Activity Level (SAL) were recorded at baseline, 1 year, and 2 years.  $P < 0.05$  was utilized to determine statistical significance.

### **RESULTS:**

There was a moderate direct relationship between RACP-LHO compared to RACP-GLH ( $R=0.57$ ;  $p < 0.0001$ ;  $n=248$ ). There was a weak direct relationship between planned BACP compared to RACP-LHO ( $R=0.36$ ;  $p < 0.0001$ ;  $n=230$ ) and a very weak relationship between planned ACP and ACP-GLH ( $R=0.15$ ;  $p=0.02$ ;  $n=229$ ).

A lateralized arm-change-position resulted in the same or better patient-determined outcome scores compared to a medialized or neutral arm-change position.

When examining planned BACP, there was a weak direct relationship between increased lateralization and higher WOOS scores ( $R=0.21$ ;  $P=0.04$ ;  $n=98$ ) and ASES scores ( $R=0.21$ ;  $P=0.04$ ;  $n=107$ ) at two years and improvement from baseline to 2 years in WOOS ( $R=0.22$ ;  $p=0.03$ ;  $n=98$ ). There was a very weak direct relationship between increased planned BACP lateralization and improvement compared to baseline in 1 year SANE ( $R=0.16$ ;  $p=0.04$ ;  $n=156$ ) and improvement compared to baseline in 2 year SANE ( $R=0.18$ ;  $p=0.049$ ;  $n=118$ ).

There was a statistically significant superior 2 year WOOS scores ( $85 \pm 15$  vs.  $78 \pm 15$ ;  $p=0.04$ ) in patients with a lateralized planned BACP (mean 6.4 mm;  $n=61$ ) compared to a medialized or neutral planned BACP (mean -3.2 mm;  $n=37$ ). There was a statistically significant superior 2 year ASES scores ( $82 \pm 14$  vs.  $73 \pm 1$ ;  $p=0.01$ ) in patients with a lateralized planned BACP (mean 6.2 mm;  $n=70$ ) compared to a medialized or neutral planned BACP (mean -3.2 mm;  $n=37$ ).

There were 1) significantly superior 2-year SANE scores ( $83 \pm 17$  vs.  $74 \pm 19$ ;  $p=0.01$ ) in patients with a lateralized planned BACP (mean 6.2 mm;  $n=77$ ) compared to a medialized or neutral planned BACP (mean -3.2 mm;  $n=42$ ) and 2) significantly superior improvements at 1-year SANE compared to baseline ( $44 \pm 28$  vs.  $54 \pm 24$ ;  $p=0.02$ ) in patients with a lateralized planned BACP (mean 5.9 mm;  $n=103$ ) compared to a medialized or neutral planned BACP (mean -2.9 mm;  $n=53$ ).

There was a weak direct relationship between lateralized RACP-LHO and 2 year postoperative SANE ( $R=0.2$ ;  $p=0.02$ ;  $n=130$ ) and a very weak direct relationship between lateralized RACP-GLH and 2 year postoperative SANE ( $R=0.18$ ;  $p=0.045$ ;  $n=129$ ).

There was a statistically significant superior 2 year WOOS scores ( $86 \pm 13$  vs.  $79 \pm 18$ ;  $p=0.03$ ) in patients with a lateralized RACP-LHO (mean 6.6 mm;  $n=45$ ) compared to a medialized or neutral RACP-LHO (mean -6.1 mm;  $n=61$ ) and a statistically superior improvement in improvement in WOOS from baseline to 2 year follow up ( $50 \pm 21$  vs.  $40 \pm 22$ ;  $p=0.04$ ) with a lateralized RACP-LHO (mean 6.5 mm;  $n=45$ ) compared to a medialized or neutral RACP-LHO (mean -6.0 mm;  $n=58$ ).

There was a statistically superior improvement in WOOS from baseline to 2 year follow up ( $52 \pm 19$  vs.  $39 \pm 26$ ;  $p=0.008$ ) with a lateralized RACP-GLH (mean 4.8 mm;  $n=34$ ) compared to a medialized or neutral RACP-GLH (mean -5.9 mm;  $n=71$ ).

There was a statistically superior 2 year postoperative SANE ( $83 \pm 16$  vs.  $75 \pm 22$ ;  $p=0.04$ ) with a lateralized RACP-GLH (mean 4.9 mm;  $n=51$ ) compared to a medialized or neutral RACP-GLH (mean -6.1 mm;  $n=78$ ).

There was no statistically significant difference in mean planned BACP, RACP-LHO or RACP GLH between patients with and without any complication ( $n=32$ ), scapular notching ( $n=11$ ), or acromial stress fractures ( $n=8$ ). Patients that had a postoperative dislocation had less planned lateralized BACP compared to those without a dislocation (-1.4 mm vs. 2.9 mm lateralized BACP;  $p=0.03$ ) but similar RACP-LHO (-1.8 mm vs. 0.41 mm;  $p=0.41$ ) and RACP-GLH (-2.7 mm vs. -0.8 mm;  $p=0.44$ ).

**DISCUSSION AND CONCLUSION:** Predicted BACP correlated with actual RACP-LHO and RACP-GLH. Patient-determined outcomes were the same or better in patients with a lateralized arm change position compared to those that were medialized or remained neutral. A lateralized arm-change-position did not result in increased complications.

Table I. Correlation between lateralized arm change position and patient-determined outcomes

	BACP		RACP-LHO		RACP-GLH	
	R	p-value	R	p-value	R	p-value
WOOS						
1 year	-0.07	0.43	-0.03	0.77	-0.02	0.83
Change from baseline to 1 year	0.1	0.30	0.07	0.43	0.11	0.26
2 years	0.21	0.04*	0.18	0.06	0.17	0.09
Change from baseline to 2 years	0.22	0.03*	0.19	0.05	0.18	0.06
ASES						
1 year	-0.09	0.27	0.11	0.16	0.10	0.22
Change from baseline to 1 year	-0.001	0.99	-0.03	0.87	0.05	0.54
2 years	0.21	0.04*	0.16	0.07	0.15	0.08
Change from baseline to 2 years	0.13	0.16	0.06	0.52	0.10	0.29
SANE						
1 year	0.06	0.42	0.06	0.42	0.10	0.21
Change from baseline to 1 year	0.16	0.04*	0.03	0.68	0.03	0.71
2 years	0.21	0.01*	0.20	0.02*	0.18	0.045*
Change from baseline to 2 years	0.18	0.049*	0.14	0.12	0.004	0.97
SST						
1 year	-0.15	0.13	-0.13	0.17	-0.15	0.12
Change from baseline to 1 year	-0.005	0.96	-0.04	0.7	-0.11	0.29
2 years	0.03	0.75	0.04	0.7	-0.0005	0.99
Change from baseline to 2 years	0.12	0.23	0.07	0.49	-0.02	0.81
SAL						
1 year	-0.07	0.4	-0.09	0.22	-0.08	0.32
Change from baseline to 1 year	0.02	0.75	-0.07	0.37	-0.03	0.74
2 years	-0.08	0.4	-0.12	0.17	-0.1	0.26
Change from baseline to 2 years	0.07	0.44	-0.07	0.42	-0.1	0.25

BACP = predicted arm change position from preoperative 3D CT planning software

RACP-LHO = actual arm change position determined from preoperative and postoperative radiographs by comparing the distance from the lateral most aspect of the greater tuberosity compared to the lateral most aspect of the acromion.

RACP-GLH = actual arm change position determined from preoperative and postoperative radiographs by comparing the distance from the lateral most aspect of the greater tuberosity compared to the lateral most aspect of the face of the glenoid.

R = correlation coefficient

\*reaches the level of statistical significance (p<0.05)

Table II. Differences in patient-determined outcomes between a lateralized arm change position compared to a medialized or neutral arm change position

	BACP		P value	RACP-LHO		P value	RACP-GLH	
	Lateralized	Medialized or Neutral		Lateralized	Medialized or Neutral		Lateralized	Medialized or Neutral
	Mean ± standard deviation							
WOOS								
1 year	81±17	83±14	0.56	80±17	83±15	0.40	81±17	82±15
Change from baseline to 1 year	47±20	46±16	0.72	47±19	45±17	0.71	50±18	43±18
2 years	85±15	78±15	0.04*	86±13	79±18	0.03*	86±14	80±17
Change from baseline to 2 years	48±25	40±24	0.15	50±21	40±22	0.04*	52±19	39±26
ASES								
1 year	79±15	79±17	0.87	80±17	78±16	0.46	80±17	79±16
Change from baseline to 1 year	42±21	41±22	0.71	41±21	41±21	0.95	40±20	41±22
2 years	82±14	73±10	0.01*	80±14	77±18	0.30	80±14	77±17
Change from baseline to 2 years	46±23	39±19	0.27	43±22	38±23	0.27	41±23	38±22
SANE								
1 year	81±19	77±23	0.20	81±19	76±24	0.19	81±20	77±24
Change from baseline to 1 year	54±24	44±28	0.02*	53±23	48±27	0.22	53±24	48±26
2 years	83±17	74±19	0.01*	83±15	74±23	0.02*	83±16	75±22
Change from baseline to 2 years	54±29	45±26	0.13	55±24	45±31	0.06	52±27	48±29
SST								
1 year	7.8±3.0	8.1±2.1	0.62	8.0±2.7	8.1±2.7	0.61	7.6±2.8	8.0±2.7
Change from baseline to 1 year	5.1±3.6	4.8±2.3	0.66	5.0±3.2	4.8±3.4	0.77	4.8±3.2	4.9±3.4
2 years	7.9±2.4	7.5±2.4	0.41	7.9±2.4	7.5±2.5	0.49	7.9±2.5	7.5±2.5
Change from baseline to 2 years	4.7±3.0	4.3±3.2	0.51	5.0±2.7	4.2±3.3	0.18	4.7±2.7	4.4±3.3
SAL								
1 year	8.0±4.7	8.2±4.5	0.76	7.9±4.4	8.5±4.9	0.42	7.8±3.9	8.1±5.2
Change from baseline to 1 year	1.8±4.0	2.1±6.2	0.67	1.6±4.5	2.4±5.2	0.30	1.9±4.6	1.9±5.1
2 years	7.6±4.1	7.1±4.2	0.56	7.0±4.7	8.1±4.2	0.17	6.8±4.1	8.1±4.7
Change from baseline to 2 years	1.2±4.7	-0.1±5.7	0.21	0.9±4.7	1.4±5.2	0.23	0.9±5.1	1.1±4.9

BACP = predicted arm change position from preoperative 3D CT planning software

RACP-LHO = actual arm change position determined from preoperative and postoperative radiographs by comparing the distance from the lateral most aspect of the greater tuberosity compared to the lateral most aspect of the acromion.

RACP-GLH = actual arm change position determined from preoperative and postoperative radiographs by comparing the distance from the lateral most aspect of the greater tuberosity compared to the lateral most aspect of the face of the glenoid.

\*reaches the level of statistical significance (p<0.05)