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Patient-reported outcomes of reverse total shoulder arthroplasty: a comparative risk factor analysis of improved versus unimproved cases

Moby Parsons, MD [a,*], Howard D. Routman, DO [b], Christopher P. Roche, MS, MBA [c], Richard J. Friedman, MD [d]

[a] The Knee, Hip and Shoulder Center, Portsmouth, NH, USA
[b] Atlantis Orthopedics, Palm Beach, FL, USA
[c] Exactech, Gainesville, FL, USA
[d] Medical University of South Carolina, Charleston, SC, USA

Background: The purpose of this study was to compare characteristics of patients who reported to be subjectively unimproved vs. improved after reverse total shoulder arthroplasty.

Methods: Data were derived from a prospective registry of patients who underwent reverse total shoulder arthroplasty with a minimum 2-year follow-up. Patients were asked to rate their subjective satisfaction and then divided into those who were unchanged or worse (unimproved group [UG]) vs. better or much better (improved group [IG]). The groups were compared for differences in demographic characteristics, preoperative factors, functional outcomes, and complications.

Results: There were 1425 patients in the IG and 134 patients in the UG. Patients in the IG were more likely to have a diagnosis of osteoarthritis. Patients in the UG were more likely to have coronary artery disease and diabetes and to have undergone prior surgery. No differences in implant configuration were found between groups. Preoperative measures for patients in the UG were worse for pain and function but not for range of motion. The outcomes in patients in the UG were worse for all postoperative measures, as well as for preoperative-to-postoperative improvement. Of the patients in the UG, 48% continued to have moderate to severe pain postoperatively. The complication rate was significantly higher in the UG.

Discussion: Up to 8.5% of patients rate themselves as unimproved after surgery. These patients are more likely to have certain comorbidities and to have undergone prior surgery. Although outcomes were significantly worse for all measures in the UG, improvement occurred in all measures despite patients subjectively being worse or unchanged. Residual pain and difficulty sleeping play a substantial role in subjective assessment of overall outcome.

Reverse total shoulder arthroplasty (RTSA) has now surpassed anatomic total shoulder arthroplasty (ATSA) in terms of prevalence for patients with degenerative shoulder conditions and irreparable cuff pathology. Data from the Finnish Shoulder Registry have shown that between 2004 and 2015, the RTSA incidence increased 4500% compared with 500% for ATSA.[3] This is due in large part to expanding indications including the increasing use of RTSA for shoulder pathology other than cuff tear arthropathy. This includes primary shoulder osteoarthritis in cases in which there is concern for successful healing of the subscapularis, cases in which advanced glenoid wear may limit the ability to achieve adequate correction using standard glenoid implants, patients with massive cuff tears without arthritis, younger patients with rheumatoid arthritis, and chronic dislocation cases.[20] RTSA has also become increasingly popular for the treatment of proximal humeral fractures not amenable to fixation. According to national sales data from Exactech (Gainesville, FL, USA), RTSA now accounts for 70% of shoulder arthroplasty implant sales. Given the aging population and future demand projections for shoulder arthroplasty, understanding characteristics that may be associated with better vs. worse outcomes may assist surgeons in counseling patients about expectations following surgery. This is an important part of the shared decision-making process.

Recently, there has been interest in patient-reported outcome measures as a more accurate reflection of patient satisfaction

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compared with objective clinical data. Objective measures may fail to account for patient dissatisfaction because of unmet expectations regardless of postoperative function. Measures such as the Subjective Shoulder Value have proved valid and reliable compared with other objective outcome scores and are not as susceptible to measurement bias and error for parameters such as range of motion and strength.[2] For procedures such as RTSA with a wide variety of indications and a wide range of preoperative functional compromise, correlating demographic characteristics and clinical features with subjective satisfaction after surgery may provide insight into which patients are more likely to have a successful result.

The aim of this study was to compare demographic, diagnosis, comorbidity, implant, and outcome data between patients who graded their overall subjective outcome as much better, better, unchanged, or worse after primary RTSA.

Methods

Data for this study were derived from a prospective, multicenter clinical outcomes registry that included 24 centers with fellowship-trained shoulder arthroplasty surgeons. This registry includes demographic information, diagnosis at the time of surgery, patient comorbidities, implant configuration, and preoperative and postoperative outcome information. The registry was queried for patients who underwent primary RTSA with a minimum 2-year follow-up and for whom all postoperative outcome data were available. Revision cases and cases performed for proximal humeral fractures were excluded from this analysis to focus on the use of RTSA for management of degenerative conditions and rotator cuff pathology.

The same implant system (Equinoxe; Exactech) was used in all cases. This system has a medialized center of rotation and an "onlay" humeral design. Glenospheres come in 38-, 42-, and 46-mm sizes. Constrained and non-constrained humeral liners are available (0 mm and +2.5 mm). Humeral trays include the following sizes: 0 mm, +5 mm, and +10 mm. This system also offers standard baseplates and 3 different augmented baseplates.

As part of the follow-up, patients were asked to grade their overall subjective outcome as much better, better, unchanged, or worse compared with their preoperative state. Patients were then divided into 2 groups. The improved group (IG) included patients who reported to be better or much better. The unimproved group (UG) included those who reported to be unchanged or worse. The groups were compared for the following categorical differences: demographic characteristics (age, sex, body mass index [BMI], and prior surgery); diagnosis (osteoarthritis, rotator cuff tear, cuff tear arthropathy, and rheumatoid arthritis); comorbidities (hypertension, coronary artery disease, diabetes, chronic renal insufficiency, and smoking history); implant and surgical factors (glenosphere diameter, liner thickness, tray thickness, use of a constrained liner, baseplate type, stem fixation, and subscapularis repair); and preoperative and postoperative outcome measures (active abduction; active forward elevation; active external rotation; and visual analog scale [VAS] pain, average daily function, Simple Shoulder Test [SST], University of California at Los Angeles [UCLA], Constant, American Shoulder and Elbow Surgeons [ASES], and Shoulder Pain and Disability Index [SPADI] scores). Finally, the mean differences in outcome improvement at latest follow-up were compared between the IG and UG cohorts with the minimal clinically important difference (MCID) and substantial clinical benefit (SCB) thresholds established by Simovitch et al[16,17] for RTSA, as an objective measure of outcome differences between cohorts.

To better understand the role of postoperative pain in subjective assessment of outcome, the average daily pain assessment (from 0 to 10) was categorically divided into none (0-1), mild (2-4),

moderate (5-7), and severe (8-10). The percentage of patients in each group was calculated along with the percentage of patients whose preoperative-to-postoperative change in pain was either worse or no better. We also compared the percentage of patients in each group who had preoperative and postoperative sleep difficulty. In addition, radiographic outcomes including humeral radiolucent lines, scapular notching, and grade of notching were compared, along with overall complication rates and revision rates.

A Student 2-tailed, unpaired t test was used to compare continuous variables between the IG and UG cohorts, and a χ^2 test was used to compare categorical variables between the IG and UG cohorts. $P < .05$ denoted a significant difference.

Results

A total of 1559 patients met the inclusion criteria for this study, including 1425 (91%) in the IG and 134 (9%) in the UG. Table I shows demographic, diagnosis, comorbidity, implant, and surgical data for each group. The average follow-up period was 43.7 ± 20.7 months in the IG and 51.3 ± 24.5 months in the UG ($P = .0001$). There were no differences in age, sex, or BMI between groups. Patients in the UG were significantly more likely to have undergone prior surgery (40% vs. 24%, $P = .0001$).

In terms of preoperative diagnosis, the groups did not significantly differ regarding diagnoses of rotator cuff tear, cuff tear arthropathy, or rheumatoid arthritis. Patients in the IG were significantly more likely to have osteoarthritis (54% vs. 40%, $P = .001$). In terms of comorbidities, patients in the UG had significantly higher rates of coronary artery disease and diabetes. Hypertension,

Table I
Demographic, diagnosis, comorbidity, implant, and surgery factors for each group

	IG	UG	P value
Demographic characteristic			
Follow-up, mo	43.7 ± 20.7	51.3 ± 24.5	<.0001*
n (%)	1425 (91.4)	134 (8.6)	
Age at time of surgery, yr	72.6 ± 7.5	71.4 ± 7.9	.0909
M/F sex, %	36.4/63.6	33.6/66.4	.5198
Height, cm	166 ± 10	166 ± 10	.7721
Weight, kg	79 ± 19	79 ± 19	.7923
BMI	28.6 ± 5.9	28.7 ± 5.9	.8420
Prior surgery, %	23.9	39.6	.0001*
Diagnosis, %			
Osteoarthritis	54.2	39.6	.0012*
Rotator cuff tear	41.0	41.8	.8608
Cuff tear arthropathy	41.0	41.1	.9940
Rheumatoid arthritis	3.8	6.0	.2175
Comorbidity, %			
None	38.9	30.3	.0628
Hypertension	49.5	55.7	.1856
Coronary artery disease	13.8	21.3	.0237*
Diabetes	11.7	18.9	.0217*
Chronic renal failure	1.9	0.8	.4063
Smoking	6.3	8.2	.4159
Implant or surgery factor			
38-/42-/46-mm glenosphere, %	61.1/35.4/3.5	60.3/36.7/3.1	
Humeral liner diameter, mm	39.7 ± 2.2	39.7 ± 2.2	.9150
Humeral tray + liner offset, mm	0.9 ± 1.9	0.8 ± 2.1	.4095
Constrained liner, %	6.3	3.8	.2533
Expanded glenosphere, %	4.3	5.2	.6575
Augmented baseplate, %	17.5	12.5	.1471
No. of baseplate screws	4.1 ± 0.6	4.1 ± 0.4	.6072
Humeral stem diameter, mm	11.3 ± 2.2	11.1 ± 2.0	.1734
Cemented humeral stem, %	13.5	9.7	.2167
Intraoperative complication, %	0.6	1.5	.2148
Subscapularis repair, %	46.4	44.6	.7045

IG, improved group; *UG*, unimproved group; *M*, male; *F*, female; *BMI*, body mass index.

* Statistically significant ($P < .05$).

Table II
Preoperative measures, postoperative measures, and preoperative-to-postoperative change in range of motion and outcome scores for each group

Outcome measure	IG	UG	P value
Preoperative			
Shoulder function score (0-10)	3.7 ± 2.0	3.2 ± 2.3	.0426*
VAS pain score (0-10)	6.1 ± 2.1	6.8 ± 2.2	.0021*
SST score	3.6 ± 2.7	2.6 ± 2.5	.0002*
UCLA score	13.2 ± 4.0	11.8 ± 4.1	.0004*
Constant score	35.6 ± 13.8	30.1 ± 12.3	.0002*
ASES score	35.9 ± 15.2	30.1 ± 14.9	.0002*
SPADI score	84.2 ± 22.4	92.3 ± 21.0	.0013*
Active abduction, °	71.3 ± 34.3	70.3 ± 35.2	.7442
Active forward elevation, °	85.6 ± 38.4	79.9 ± 39.4	.1110
Active external rotation, °	17.3 ± 21.6	14.4 ± 21.4	.1545
Internal rotation score (0-7)	3.2 ± 1.9	3.0 ± 2.0	.2041
Postoperative			
Shoulder function score (0-10)	8.3 ± 1.7	5.4 ± 2.6	<.0001*
VAS pain score (0-10)	0.9 ± 1.7	4.0 ± 3.0	<.0001*
SST score	10.1 ± 2.3	5.8 ± 3.4	<.0001*
UCLA score	31.1 ± 3.5	18.4 ± 6.4	<.0001*
Constant score	70.2 ± 12.2	48.4 ± 19.2	<.0001*
ASES score	84.6 ± 15.4	51.9 ± 24.6	<.0001*
SPADI score	20.4 ± 21.4	63.9 ± 35.6	<.0001*
Active abduction, °	118.8 ± 29.6	91.0 ± 35.3	<.0001*
Active forward elevation, °	140.7 ± 25.0	106.0 ± 39.7	<.0001*
Active external rotation, °	36.6 ± 17.9	25.6 ± 19.2	<.0001*
Internal rotation score (0-7)	4.5 ± 1.6	3.4 ± 1.9	<.0001*
Preoperative-to-postoperative change			
Shoulder function score (0-10)	4.6 ± 2.4	2.1 ± 3.3	<.0001*
VAS pain score (0-10)	5.2 ± 2.5	2.6 ± 3.1	<.0001*
SST score	6.7 ± 3.1	3.3 ± 3.9	<.0001*
UCLA score	17.8 ± 4.8	6.5 ± 6.8	<.0001*
Constant score	34.9 ± 15.2	19.0 ± 19.8	<.0001*
ASES score	49.0 ± 19.1	21.8 ± 23.7	<.0001*
SPADI score	64.5 ± 26.3	23.0 ± 30.1	<.0001*
Active abduction, °	47.4 ± 39.2	20.6 ± 43.1	<.0001*
Active forward elevation, °	55.5 ± 41.8	26.0 ± 47.8	<.0001*
Active external rotation, °	19.3 ± 23.5	10.8 ± 22.6	.0001*
Internal rotation score (0-7)	1.3 ± 2.1	0.4 ± 2.3	<.0001*

IG, improved group; *UG*, unimproved group; *VAS*, visual analog scale; *SST*, Simple Shoulder Test; *UCLA*, University of California at Los Angeles; *ASES*, American Shoulder and Elbow Surgeons; *SPADI*, Shoulder Pain and Disability Index.
P values reflect differences between groups for all measures including preoperative-to-postoperative change.
* Statistically significant (P < .05).

renal insufficiency, and smoking did not significantly differ between groups.

No significant differences in implant configuration were found between groups, including glenosphere diameter, humeral liner thickness, humeral tray thickness, type of glenoid baseplate (standard vs. augmented), use of a constrained liner, use of an expanded glenosphere, or stem fixation (press fit vs. cemented).

No difference in the rate of subscapularis repair at the time of RTSA was noted between groups.

Table II shows differences in preoperative and postoperative outcomes, as well as preoperative-to-postoperative change. Patients in the UG had significantly worse preoperative VAS pain and shoulder function scores and worse preoperative functional outcome scores (SST, UCLA, Constant, ASES, and SPADI), although range-of-motion measures did not significantly differ between groups. Postoperatively, patients in the IG showed significantly better findings for all measures. Preoperative-to-postoperative improvement was also significantly better for the IG for all measures.

Table III shows group comparisons for the MCID and SCB for shoulder function, VAS pain scores, and the previously listed outcome scores. There were significant differences between groups in the percentage of patients who achieved threshold values for each score. When we compared values for preoperative-to-postoperative improvement from Table II with the SCB threshold values, on average, patients in the UG did not achieve the SCB threshold of improvement for the subjective shoulder function, UCLA, ASES, and SPADI scores but did exceed the SCB threshold for the SST and Constant scores.

Table IV demonstrates categorical postoperative subjective pain ratings. Patients in the UG had significantly greater postoperative pain for all categories (none, mild, moderate, and severe) than patients in the IG. Continued moderate to severe pain was reported by 48% of patients in the UG compared with 6% in the IG, whereas no difference or worsening pain after surgery was reported by 26% of patients in the UG compared with 4% in the IG.

Table V compares preoperative-to-postoperative sleep comfort between groups. Preoperatively, IG and UG patients differed significantly only for slight sleep difficulty, whereas postoperatively, patients in the UG were significantly more likely to report sleep difficulty, with 68% in the UG reporting continued slight to considerable difficulty sleeping compared with 22% in the IG. The postoperative VAS pain score was highly correlated with sleep comfort (Pearson correlation coefficient = 0.6).

Table VI compares postoperative radiographic and complication rates between groups. Humeral radiolucent lines and scapular notching were both significantly more common and grade of notching was significantly higher in the UG. The overall complication rate was 19% in the UG and 3% in the IG, whereas the revision rate was 11% in the UG and 2% in the IG. Both differences were significant.

Discussion

This article demonstrates that as many as 9% of patients who undergo primary RTSA subjectively report to be unchanged or

Table III
Percentages of patients in each group who achieved or exceeded MCID and SCB for each outcome metric score

	Shoulder function	VAS pain score	SST score	UCLA score	Constant score	ASES score	SPADI score
MCID							
Threshold	1.0	1.4	1.4	7.0	−0.3	10.3	20.0
IG, %	94.9	92.4	93.8	97.8	98.9	97.2	94.7
UG, %	70.5	59.7	60.8	50.0	87.3	64.2	54.4
P value	<.0001*	<.0001*	<.0001*	<.0001*	<.0001*	<.0001*	<.0001*
SCB							
Threshold	2.4	2.6	3.2	10.4	13.6	25.9	42.7
IG, %	82.7	85.7	84.2	93.7	90.9	88.1	78.9
UG, %	46.4	52.6	43.9	26.4	64.4	37.6	26.6
P value	<.0001*	<.0001*	<.0001*	<.0001*	<.0001*	<.0001*	<.0001*

MCID, minimal clinically important difference; *SCB*, substantial clinical benefit; *VAS*, visual analog scale; *SST*, Simple Shoulder Test; *UCLA*, University of California at Los Angeles; *ASES*, American Shoulder and Elbow Surgeons; *SPADI*, Shoulder Pain and Disability Index; *IG*, improved group; *UG*, unimproved group.
* Statistically significant (P < .05).

Table IV
Comparison of postoperative pain score distribution between patient cohorts

	IG, %	UG, %	P value
Postoperative pain scale			
None (0-1)	78.0	27.6	<.0001[*]
Mild (2-4)	15.9	24.6	.0091[*]
Moderate (5-7)	5.4	29.9	<.0001[*]
Severe (8-10)	0.8	17.9	<.0001[*]
Moderate to severe	6.2	47.8	<.0001[*]
Change in pain worse or no better	3.8	26.3	<.0001[*]

IG, improved group; *UG*, unimproved group.
[*] Statistically significant ($P < .05$).

worse after surgery and these patients are more likely to have complications and require revision surgery. Analysis of factors associated with lack of improvement indicates that certain medical comorbidities and a history of shoulder surgery are associated with worse subjective outcomes. Age, sex, BMI, and smoking history did not differ between patients were improved after RTSA and those were not.

Our results agree with those of previous studies that have confirmed obesity is not associated with worse results after RTSA.[9,11,14,18] Other studies have shown that the complication rate is higher in obese patients.[2,4] Our study did not quantify complications as a function of BMI but does indicate that BMI does not appear to factor into subjective improvement after surgery.

Our results comparing rates of medical comorbidity between groups also agree with those of other studies. Mahure et al[6] studied the risk of perioperative complications after elective shoulder arthroplasty associated with diabetes. They found that patients with diabetes had a higher comorbidity burden and were more likely to have worse outcomes after surgery. Mahony et al[5] found that diabetes was an independent risk factor for failing to achieve improvement after shoulder arthroplasty. Werner et al[22] reported that the total number of comorbidities correlated with poor postoperative improvement after RTSA.

The literature on prior surgery and RTSA has focused on revision of failed anatomic shoulder arthroplasty. Our study excluded revision arthroplasty as a reason for RTSA but included patients who had undergone prior non-arthroplasty shoulder surgery including rotator cuff repair, instability surgery, and non-arthroplasty operative fracture treatment. Other researchers have reported prior surgery as a risk factor for worse outcomes after RTSA. Matsen et al[7] demonstrated that patients with no history of surgery had better outcomes. Shields et al[15] found that patients who have undergone a prior rotator cuff repair experience less improvement in ASES and pain scores after RTSA. Our results agree with these findings, showing a significantly higher rate of prior surgery in the UG.

Good to excellent results have been reported for RTSA for a variety of diagnoses. In recent years, RTSA has been increasingly used in patients with primary osteoarthritis. Steen et al[19] showed that RTSA for glenohumeral osteoarthritis has similar outcomes to

ATSA in a matched-cohort analysis. Postacchini et al[12] found that patients with rheumatoid arthritis can achieve similar results to those with cuff tear arthropathy after RTSA. Ekelund and Nyberg[1] reported improved shoulder function with a low incidence of complications in patients with rheumatoid arthritis. Although we did not perform a comparative analysis of outcomes by diagnosis, our data do suggest that patients with osteoarthritis are more likely to be improved after surgery, whereas the rates of irreparable cuff tear, cuff tear arthropathy, and rheumatoid arthritis did not differ between groups.

Regarding the effect of implant configuration on the results of RTSA, prior studies have not achieved a consensus on this matter. Sabesan et al[13] found that glenosphere size did not affect postoperative range of motion or patient satisfaction. Mollon et al[8] reported that patients treated with a larger glenosphere had better postoperative forward elevation and external rotation range of motion. Valenti et al[21] found that less medialization improves rotational range of motion. Our study did not support a relationship between implant configuration and subjective improvement after RTSA. This finding suggests that multiple factors can influence outcomes, of which implant configuration may play some part, but this is, as yet, not fully defined. A comprehensive analysis of the effect of implant configuration on improvement in pain and function after RTSA is beyond the scope of this study but merits further investigation, recognizing that the findings may be implant specific.

In terms of preoperative function, patients in the UG graded worse for subjective function and pain scores, as well as SST, UCLA, Constant, ASES, and SPADI scores, but not for range of motion. Although this finding might suggest that patients who are worse prior to surgery are less likely to improve after RTSA, other studies have shown just the opposite. Matsen et al[7] found that lower preoperative SST scores correlated with improved outcomes. Moreover, Werner et al[22] showed that higher baseline ASES scores correlated with poor postoperative improvement after RTSA. Collectively, these results demonstrate that some patients with poor preoperative function, who have a higher margin for improvement, achieve excellent results after RTSA whereas others with poor preoperative function do not achieve satisfactory results.

The difference may lie in the degree of residual pain that patients experience after surgery and how this shapes perception of outcome. Our study showed that 48% of patients who were unimproved had residual moderate to severe pain and 26% of all patients reported the same or worse pain after surgery. Roughly 6% of patients who graded themselves as improved reported residual moderate to severe or worse pain after surgery. Furthermore, 68% of unimproved patients reported continued sleep difficulty after RTSA. Few studies have specifically analyzed the impact of preoperative pain on RTSA outcomes, although Morris et al[10] have shown that patients receiving preoperative opioid therapy have less improvement in outcomes. Assessing as well as understanding pain is a complex matter that remains difficult to quantify and qualify in a manner that can help surgeons predict who is likely to benefit from surgery. This is evidenced by the fact that some patients who

Table V
Comparison of preoperative and postoperative sleep comfort between patient cohorts

Sleep comfort	Preoperative/postoperative		
	IG, %	UG, %	P value
Normal	7.0/77.8	6.2/30.6	.7566/<.0001[*]
Slightly difficult	41.8/18.2	31.0/36.6	.0251[*]/<.0001[*]
Very difficult	45.7/3.4	54.0/31.3	.0908/<.0001[*]
Unable	5.5/0.6	8.9/1.5	.1517/.1970

IG, improved group; *UG*, unimproved group.
[*] Statistically significant ($P < .05$).

Table VI
Comparison of radiographic data and complication rates between cohorts

	IG	UG	P value
Humeral radiolucent line rate, %	7.5	13.4	.0194[*]
Scapular notching rate, %	9.2	15.2	.0294[*]
Scapular notching grade	0.13 ± 0.47	0.27 ± 0.73	.0030[*]
Complication rate, %	3.2	19.4	<.0001[*]
Revision rate, %	1.6	11.2	<.0001[*]

IG, improved group; *UG*, unimproved group.
[*] Statistically significant ($P < .05$).

grade themselves as much better after surgery continue to have moderate to severe pain and grade their pain as worse than before surgery.

Understanding the contribution of functional improvement to patient satisfaction is also difficult. In our study, more than half of patients in the UG achieved or exceeded the MCID for functional outcome measures. In the UG, 53% of patients also achieved or exceeded the SCB threshold for the VAS pain score whereas 38% achieved or exceeded the SCB for the ASES score. These results indicate a complex interaction between assessment of overall outcome and actual improvement in function. Persistence of postoperative pain likely plays a substantial role, and these findings likely indicate that the degree of improvement relative to patient expectations may be a critical factor in satisfaction after surgery. Unfortunately, expectation management was not specifically measured as part of this data set, although future studies should consider this as it likely has a strong influence on patient-reported outcomes.

We did not report on general health measures such as the Short Form 12 or Short Form 36 or comorbidity indices, which may have proved useful in determining whether such measures can help predict poor subjective improvement. We also did not independently analyze the degree of postoperative pain and how it affects function because the focus of this study was on subjective improvement. Future studies should attempt to better quantify the role of pain in perception of outcome.

Conclusion

Nearly 9% of patients who undergo RTSA report subjective outcomes that are unchanged or worse after surgery. Patients who are unimproved are far more likely to have residual moderate to severe pain than those who are improved and more likely to have undergone prior surgery. Patients with a diagnosis of osteoarthritis are more likely to be improved, whereas those with diabetes and heart disease are more likely to be unimproved. Implant configuration does not have an impact on subjective satisfaction after RTSA.

Disclaimer

Moby Parsons is a paid consultant for Exactech.

Howard D. Routman receives intellectual property royalties and research support and is a paid consultant for Exactech.

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References

1. Ekelund A, Nyberg R. Can reverse shoulder arthroplasty be used with few complications in rheumatoid arthritis. Clin Orthop Relat Res 2011;469:2483—8. https://doi.org/10.1007/s11999-010-1654-4.
2. Gilbart MK, Gerber C. Comparison of the subjective shoulder value and the Constant score. J Shoulder Elbow Surg 2007;16:717—21. https://doi.org/10.1016/j.jse.2007.02.123.
3. Harjula JNE, Paloneva J, Haapakoski J, Kukkonen J, Äärimaa V, Finnish Shoulder Arthroplasty Registry Group. Increasing incidence of primary shoulder arthroplasty in Finland—a nationwide registry study. BMC Musculoskelet Disord 2018;19:245. https://doi.org/10.1186/s12891-018-2150-3.
4. Izquierdo-Fernández A, Minarro JC, Carpintero-Lluch R, Estévez-Torres EM, Carpintero-Benítez P. Reverse shoulder arthroplasty in obese patients: analysis of functionality in the medium-term. Arch Orthop Trauma Surg 2018;138:1—5. https://doi.org/10.1007/s00402-017-2816-6.
5. Mahony GT, Werner BC, Chang B, Grawe BM, Taylor SA, Craig EV, et al. Risk factors for failing to achieve improvement after anatomic total shoulder arthroplasty for glenohumeral osteoarthritis. J Shoulder Elbow Surg 2018;27:968—75. https://doi.org/10.1016/j.jse.2017.12.018.
6. Mahure S, Mollon B, Quien M, Karia R, Zuckerman J, Kwon Y. Impact of diabetes on perioperative complications in patients undergoing elective total shoulder arthroplasty. Bull Hosp Jt Dis (2013) 2017;75:173—9.
7. Matsen FA III , Russ SM, Vu PT, Hsu JE, Lucas RM, Comstock BA. What factors are predictive of patient-reported outcomes? A prospective study of 337 shoulder arthroplasties. Clin Orthop Relat Res 2016;474:2496—510. https://doi.org/10.1007/s11999-016-4990-1.
8. Mollon B, Mahure SA, Roche CP, Zuckerman JD. Impact of glenosphere size on clinical outcomes after reverse total shoulder arthroplasty: an analysis of 297 shoulders. J Shoulder Elbow Surg 2016;25:763—71. https://doi.org/10.1016/j.jse.2015.10.027.
9. Morris BJ, Haigler RE, Cochran JM, Laughlin MS, Elkousy HA, Gartsman GM, et al. Obesity has minimal impact on short-term functional scores after reverse shoulder arthroplasty for rotator cuff tear arthropathy. Am J Orthop (Belle Mead NJ) 2016;45:E180—6.
10. Morris BJ, Sciascia AD, Jacobs CA, Edwards TB. Preoperative opioid use associated with worse outcomes after anatomic shoulder arthroplasty. J Shoulder Elbow Surg 2016;25:619—23. https://doi.org/10.1016/j.jse.2015.09.017.
11. Pappou I, Virani NA, Clark R, Cottrell BJ, Frankle MA. Outcomes and costs of reverse shoulder arthroplasty in the morbidly obese: a case control study. J Bone Joint Surg Am 2014;96:1169—76. https://doi.org/10.2106/JBJS.M.00735.
12. Postacchini R, Carbone S, Canero G, Ripani M, Postacchini F. Reverse shoulder prosthesis in patients with rheumatoid arthritis: a systematic review. Int Orthop 2016;40:965—73. https://doi.org/10.1007/s00264-015-2916-2.
13. Sabesan VJ, Lombardo DJ, Shahriar R, Petersen-Fitts GR, Wiater JM. The effect of glenosphere size on functional outcome for reverse shoulder arthroplasty. Musculoskelet Surg 2016;100:115—20. https://doi.org/10.1007/s12306-015-0396-6.
14. Savin DD, Frank RM, Sumner S, Richardson C, Nicholson GP, Romeo AA. Good functional outcomes expected after shoulder arthroplasty irrespective of body mass index. J Shoulder Elbow Surg 2018;27:S43—9. https://doi.org/10.1016/j.jse.2018.03.022.
15. Shields EJW, Koueiter DM, Maerz T, Schwark A, Wiater JM. Previous rotator cuff repair is associated with inferior clinical outcomes after reverse total shoulder arthroplasty. Orthop J Sports Med 2017;5:2325967117730311. https://doi.org/10.1177/2325967117730311.
16. Simovitch R, Flurin PH, Wright T, Zuckerman JD, Roche CP. Quantifying success after total shoulder arthroplasty: the minimal clinically important difference. J Shoulder Elbow Surg 2018;27:298—305. https://doi.org/10.1016/j.jse.2017.09.013.
17. Simovitch R, Flurin PH, Wright T, Zuckerman JD, Roche CP. Quantifying success after total shoulder arthroplasty: the substantial clinical benefit. J Shoulder Elbow Surg 2018;27:903—11. https://doi.org/10.1016/j.jse.2017.12.014.
18. Statz JM, Wagner ER, Houdek MT, Cofield RH, Sanchez-Sotelo J, Elhassan BT, et al. Outcomes of primary reverse shoulder arthroplasty in patients with morbid obesity. J Shoulder Elbow Surg 2016;25:e191—8. https://doi.org/10.1016/j.jse.2015.12.008.
19. Steen BM, Cabezas AF, Santoni BG, Hussey MM, Cusick MC, Kumar AG, et al. Outcome and value of reverse shoulder arthroplasty for treatment of glenohumeral osteoarthritis: a matched cohort. J Shoulder Elbow Surg 2015;24:1433—41. https://doi.org/10.1016/j.jse.2015.01.005.
20. Urch E, Dines JS, Dines DM. Emerging indications for reverse shoulder arthroplasty. Instr Course Lect 2016;65:157—69.
21. Valenti P, Sauzières P, Katz D, Kalouche I, Kilinc AS. Do less medialized reverse shoulder prostheses increase motion and reduce notching. Clin Orthop Relat Res 2011;469:2550—7. https://doi.org/10.1007/s11999-011-1844-8.
22. Werner BC, Wong AC, Mahony GT, Craig EV, Dines DM, Warren RF, et al. Causes of poor postoperative improvement after reverse total shoulder arthroplasty. J Shoulder Elbow Surg 2016;25:e217—22. https://doi.org/10.1016/j.jse.2016.01.002.