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

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Article info

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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.

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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. 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. 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 implants, understanding the aging population and future demand projections for shoulder arthroplasty implants, 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 more accurate reflection of patient satisfaction

No institutional review board approval was required for this retrospective study.

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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.3 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 were 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 χ² 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 1 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 1 | Demographic, diagnosis, comorbidity, implant, and surgery factors for each group |
|-----------------|-----------------|-----------------|-----------------|
| Demographic characteristic | IG | UG | P value |
| Follow-up, mo | 43.7 ± 20.7 | 51.3 ± 24.5 | <.0001* |
| 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, % | 61.3/35.4/3.3 | 60.3/36.7/3.1 | .8692 |
| 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).
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 Glenal boneplate (standard vs. augmented), use of a constrained liner, use of an expanded glenosphere, or stem fixation (press fit vs. cemented).

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| .052    |
| VAS pain score (0-10)          | 6.1 ± 2.1| 6.8 ± 2.2| .002    |
| SST score                      | 3.6 ± 2.7| 2.6 ± 2.5| .0001   |
| UCLA score                     | 13.2 ± 4.0| 11.8 ± 4.1| .0004    |
| Constant score                 | 35.6 ± 13.8| 30.1 ± 12.3| .002   |
| ASES score                     | 35.9 ± 15.2| 30.1 ± 14.9| .0002   |
| SPADI score                    | 84.2 ± 22.4| 92.3 ± 21.0| .0013   |
| Active abduction, <sup>1</sup> | 71.3 ± 34.3| 70.3 ± 35.2| .7442  |
| Active forward elevation, <sup>2</sup> | 85.6 ± 38.4| 79.9 ± 39.4| .1110 |
| Active external rotation, <sup>3</sup> | 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                     | 31.3 ± 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, <sup>1</sup> | 118.8 ± 29.6| 91.0 ± 35.3| <.0001 |
| Active forward elevation, <sup>2</sup> | 140.7 ± 25.0| 106.0 ± 39.7| <.0001 |
| Active external rotation, <sup>3</sup> | 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 ± 23.3| 23.0 ± 30.1| <.0001 |
| Active abduction, <sup>1</sup> | 47.4 ± 39.2| 20.6 ± 43.1| <.0001 |
| Active forward elevation, <sup>2</sup> | 55.5 ± 41.8| 26.0 ± 47.8| <.0001 |
| Active external rotation, <sup>3</sup> | 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.

<sup>1</sup> Statistically significant (P < .05).

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 IG 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 IG 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 IG 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 IG compared with 6% in the IG, whereas no difference or worsening pain after surgery was reported by 26% of patients in the IG 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 IG were significantly more likely to report sleep difficulty, with 68% in the IG 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 IG. The overall complication rate was 19% in the IG and 3% in the IG, whereas the revision rate was 11% in the IG 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...
that diabetes was an independent risk factor for failing to achieve surgery as a risk factor for worse outcomes after RTSA. Matsen et al7 reported that RTSA for glenohumeral osteoarthritis has similar outcomes to other researchers have reported prior fracture treatment. Other researchers have reported prior rotator cuff repair experience less improvement in 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 al7 found that lower preoperative SST scores correlated with improved outcomes. Moreover, Werner et al22 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.

Regarding the effect of implant configuration on the results of RTSA, prior studies have not achieved a consensus on this matter. Sabesan et al13 found that glenosphere size did not affect postoperative range of motion or patient satisfaction. Mollon et al14 reported that patients treated with a larger glenosphere had better postoperative forward elevation and external rotation range of motion. Valenti et al15 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 al7 found that lower preoperative SST scores correlated with improved outcomes. Moreover, Werner et al22 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 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 al7 demonstrated that patients with no history of surgery had better outcomes. Shields et al26 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.

To avoid missed 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 al27 showed that RTSA for glenohumeral osteoarthritis has similar outcomes to ATSA in a matched-cohort analysis. Postacchini et al28 found that patients with rheumatoid arthritis can achieve similar results to those with cuff tear arthropathy after RTSA. Ekelund and Nyberg1 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.

Our results agree with those of previous studies that have confirmed obesity is not associated with worse results after RTSA.21,31,14,15 Other studies have shown that the complication rate is higher in obese patients.22,23 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 morbidity between groups also agree with those of other studies. Mahure et al24 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 al25 found that diabetes was an independent risk factor for failing to achieve improvement after shoulder arthroplasty. Werner et al22 reported that the total number of comorbidities correlated with poor postoperative improvement after RTSA.

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Table IV
Comparison of postoperative pain score distribution between patient cohorts

| Postoperative pain scale | IG, % | UG, % | P value |
|--------------------------|-------|-------|---------|
| 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).

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

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