J Shoulder Elbow Surg (2022) 31, 294–301

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Predictors of poor and excellent outcomes after reverse total shoulder arthroplasty

Julianne M. Forlizzi, MD[a], Richard N. Puzzitiello, MD[a], Paul-Anthony Hart, BA[b], Ryan Churchill, MD[c], Andrew Jawa, MD[a,b], Jacob M. Kirsch, MD[a,b,*]

[a]*Department of Orthopaedic Surgery, New England Baptist Hospital, Boston, MA, USA*
[b]*Boston Sports and Shoulder Center, Waltham, MA, USA*
[c]*New England Orthopedic Specialists, Peabody, MA, USA*

Background: Favorable clinical and functional outcomes can be achieved with reverse total shoulder arthroplasty (RSA). Given the expanding utilization of RSA in the United States, understanding the factors that influence both excellent and poor outcomes is increasingly important.

Methods: A single-surgeon prospective registry was used to identify patients who underwent RSA from 2015 to 2018 with a minimum of 2 years' follow-up. An excellent postoperative clinical outcome was defined as a final American Shoulder and Elbow Surgeons (ASES) score in the top quartile of ASES scores. A poor outcome was defined as an ASES score in the bottom quartile. Logistic regression was used to determine preoperative characteristics associated with both excellent and poor outcomes.

Results: A total of 338 patients with a mean age of 71.5 years (standard deviation [SD], 6.4 years) met the inclusion and exclusion criteria. The average preoperative ASES score for the entire cohort was 35.3 (SD, 16.4), which improved to 82.4 (SD, 16.1) postoperatively ($P < .001$). Univariate analysis demonstrated that a diagnosis of primary osteoarthritis (OA), private insurance, and higher preoperative ASES scores were significantly associated with achieving excellent outcomes ($P < .01$ for all). Variables predictive of poor outcomes were workers' compensation status ($P = .03$), depression ($P = .02$), a preoperative diagnosis of rotator cuff tear arthropathy ($P < .01$), preoperative opioid use ($P < .01$), a higher number of allergies ($P < .01$), and prior ipsilateral shoulder surgery ($P < .01$). Multivariate regression analysis demonstrated that OA (odds ratio [OR], 5.6; 95% confidence interval [CI], 1.2-26.5; $P = .03$) and private insurance (OR, 2.7; 95% CI, 1.12-6.5; $P = .02$) correlated with excellent outcomes whereas a higher number of reported allergies (OR, 0.83; 95% CI, 0.71-0.97; $P = .02$), self-reported depression (OR, 0.39; 95% CI, 0.16-0.99; $P = .04$), a history of ipsilateral shoulder surgery (OR, 0.36; 95% CI, 0.15-0.87; $P = .02$), and preoperative opioid use (OR, 0.26; 95% CI, 0.09-0.76; $P = .01$) were predictive of poor outcomes.

Conclusions: A preoperative diagnosis of primary OA is the strongest predictor of excellent clinical outcomes following RSA. Patients with an increasing number of reported allergies, self-reported depression, a history of ipsilateral shoulder surgery, and preoperative opioid use are significantly more likely to achieve poor outcomes after RSA. Given the increasing utilization of RSA, this information is important to appropriately counsel patients regarding postoperative expectations.

Level of evidence: Level III; Retrospective Case-Control Design; Prognosis Study

Keywords: Patient-reported outcomes; ASES score; shoulder osteoarthritis; rotator cuff tear arthropathy; reverse shoulder arthroplasty; comorbid predictors

This study was approved by the Institutional Review Board of New England Baptist Hospital (project no. 165647-1).

*Reprint requests: Jacob M. Kirsch, MD, Boston Sports and Shoulder Center, 840 Winter St, Waltham, MA 02451, USA.
E-mail address: jmkirschmd@gmail.com (J.M. Kirsch).

1058-2746/$ - see front matter © 2021 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.
https://doi.org/10.1016/j.jse.2021.07.009

Reverse total shoulder arthroplasty (RSA) utilization is expanding in the United States.[7] Current indications include rotator cuff tear arthropathy (RCA), a massive rotator cuff tear with or without degenerative joint disease, inflammatory arthritis with or without a rotator cuff tear, proximal humeral fracture malunion or nonunion, and primary glenohumeral osteoarthritis (OA).[1,3,10,15] As both the indications for RSA and the overall volume of RSA procedures continue to expand, an understanding of the predictors of excellent and poor clinical outcomes is becoming increasingly important.

Limited data exist on the predictors of poor clinical outcomes following RSA in the subset of patients who are free of perioperative complications. These patients may lack motion and have more pain than their counterparts. Furthermore, the existing body of literature is conflicting regarding demographic characteristics such as age, sex, and body mass index and their effects on RSA outcomes.[9,14,20,24,28] Prior ipsilateral shoulder surgery has been found to be a poor prognostic indicator after RSA,[5,11] although some studies have demonstrated no significant difference in RSA outcomes despite prior surgery.[19] Treatment of the dominant arm has also been suggested to yield better functional outcomes after RSA, although clinical outcome scores were not affected by arm dominance.[6]

Understanding the preoperative factors that can predict excellent or poor outcomes after RSA is essential for patient education and expectations, which is even more imperative given the expanding indications and utilization of RSA. The purpose of this study was to evaluate preoperative prognosticators of both excellent and poor postoperative outcomes in patients undergoing RSA. Our hypothesis was that excellent outcomes would be associated with a diagnosis of OA whereas poor outcomes would be associated with a history of shoulder surgery, a higher preoperative American Shoulder and Elbow Surgeons (ASES) score, and preoperative opioid use.

Methods

Study population

An institutional database was used to perform a retrospective cohort review of prospectively collected data identifying all consecutive patients who underwent primary RSA between 2015 and 2018. All procedures were performed by a single fellowship-trained shoulder and elbow surgeon (A.J.) at a large private institution that performs a high volume of shoulder arthroplasty procedures. Patients were included if they underwent primary RSA, had a minimum of 2 years' clinical follow-up, and had complete preoperative and postoperative functional outcome scores. Patients were excluded if they had incomplete outcome scores; underwent RSA for fracture, chronic dislocation, or avascular necrosis; or underwent revision arthroplasty. Of the patients, 336 (99.4%) received DJO Surgical AltiVate Reverse arthroplasties (Lewisville, TX, USA); the remaining 2 patients (0.6%) received Wright Medical Aequalis Reversed Shoulder System prostheses (Memphis, TN, USA).

Patient demographic characteristics including age, sex, body mass index, American Society of Anesthesiologists score, prior ipsilateral shoulder surgery, preoperative diagnosis, history of diabetes, hypertension, thyroid disease, dyslipidemia, depression, daily opiate use, and inflammatory arthritis were extracted from the electronic medical record. Patient-reported outcome measures including the visual analog scale (VAS) score for pain, Single Assessment Numerical Evaluation (SANE) score for the shoulder, and ASES score were recorded prospectively and analyzed with proprietary software (OBERD, Columbia, MO, USA). Active range of motion including forward elevation, internal rotation, and external rotation was measured by the senior author (A.J.) using the surgeon's visual estimation at the preoperative visit, as well as at the last documented postoperative visit. Internal rotation was measured on a 10-point scale as described by Levy et al[13] and was defined as the most proximal segment reached: buttock or greater trochanter, 2 points; sacrum to L4, 4 points; L3 to L1, 6 points; T12 to T8, 8 points; and T7 to T1, 10 points. Postoperative complications including infection, instability, acromial stress fracture, scapular notching, and continued pain, as well as revision surgery, were prospectively recorded.

Postoperative rehabilitation was physician directed without formalized physical therapy. Active and active-assisted forward elevation was initiated after 2 weeks, whereas internal rotation and external rotation were allowed after 6 weeks. Strengthening exercises and subsequent return to activity were allowed at 3 months.

Statistical analysis

The primary clinical outcome was the postoperative ASES score at a minimum of 2 years' follow-up. Patients with excellent clinical outcomes were defined as those with ASES scores within the top 25th percentile of postoperative ASES scores, whereas patients with poor outcomes were defined as those with ASES scores within the lowest 25th percentile. Bivariate analysis was used to compare preoperative patient characteristics between the excellent- and poor-outcome groups. Preoperative variables found to have $P \leq .2$ on univariate analysis were further analyzed with multivariate logistic regression to identify those factors that had statistically significant values, which were reported as odds ratios (ORs) with 95% confidence intervals (CIs). The only exception regarding the multivariate analysis was workers' compensation, which was excluded because of the low number of workers' compensation cases (n = 8). For continuous variables, the independent *t* test was used. For categorical variables, the Fisher exact test or Pearson χ^2 test was used when indicated. The α value was set to .05 for all tests to estimate statistical significance. All statistical analysis was performed using SPSS statistical software (version 25; IBM, Armonk, NY, USA).

Results

Demographic characteristics

Full preoperative and postoperative outcome measures were available for a total of 358 of 438 consecutive patients

Table I Patient demographic and clinical data

Parameter	Data (N = 338)
Age, mean (SD), yr	71.5 (6.4)
Sex, n (%)	
Female	206 (60.9)
Male	132 (39.1)
Dominant arm, n (%)	191 (56.5)
Insurance type, n (%)	
Medicare or Medicaid	232 (68.6)
Private	91 (26.9)
Workers' compensation	13 (3.8)
Follow-up period, mean (SD), mo	28.3 (8.1)
Indication, n (%)	
OA	202 (59.8)
RCA	116 (34.3)
Other	19 (4.1)
BMI, mean (SD)	30.7 (6.1)
ASA class, n (%)	
1	4 (1.1)
2	243 (72.8)
3	86 (25.7)
4	1 (0.3)
No. of reported allergies, mean (SD)	2.2 (3.2)
Comorbid conditions, n (%)	
Anxiety	53 (16.1)
Depression	76 (23.0)
Diabetes	52 (15.5)
Obesity	74 (21.9)
Smoker	18 (5.3)
HTN	210 (62.1)
HLD	132 (39.1)
Thyroid disease	72 (21.6)
Rheumatoid arthritis	11 (3.3)
Previous ipsilateral shoulder surgery, n (%)	105 (31.1)
Preoperative opioid use, n (%)	53 (15.8)
Marital status (married), n (%)	235 (69.9)
Inpatient opioid consumption, mean (SD), morphine equivalents	100.5 (81.8)
Peak postoperative pain score, mean (SD)	6.9 (2.2)
Length of stay, mean (SD), d	2.1 (0.87)
VAS pain score, mean (SD)	
Preoperative	6.0 (2.4)
Postoperative	0.86 (1.6)
Δ	−5.1 (2.7)
ASES score	
Preoperative, mean (SD)	35.2 (16.4)
Postoperative, mean (SD)	83.4 (16.1)
Δ, mean (SD)	48.1 (21.1)
MCID reached, n (%)	322 (95.3)
SCB reached, n (%)	264 (78.1)
SANE score, mean (SD)	
Preoperative	31.2 (20.0)
Postoperative	85.9 (18.0)
Δ	54.6 (26.3)
Forward flexion, mean (SD), °	
Preoperative	87.6 (28.1)
Postoperative	133.8 (20.8)
Δ	46.5 (29.8)
External rotation, mean (SD), °	
Preoperative	27.1 (13.9)
Postoperative	50.4 (19.1)
Δ	23.7 (20.7)
Internal rotation,* mean (SD)	
Preoperative	2.9 (1.3)
Postoperative	4.6 (1.5)
Δ	1.7 (1.9)
Postoperative acromial stress fracture, n (%)	11 (3.5)

SD, standard deviation; *OA*, osteoarthritis; *RCA*, rotator cuff arthropathy; *BMI*, body mass index; *ASA*, American Society of Anesthesiologists; *HTN*, hypertension; *HLD*, hyperlipidemia; *VAS*, visual analog scale; *ASES*, American Shoulder and Elbow Surgeons; *MCID*, minimal clinically important difference; *SCB*, substantial clinical benefit; *SANE*, Single Assessment Numerical Evaluation.

* Level of internal rotation converted to numerical scale as previously described[13]: buttock or greater trochanter, 2 points; sacrum to L4, 4 points; L3 to L1, 6 points; T12 to T8, 8 points; and T7 to T1, 10 points.

(81.7%). The remaining patients (18.3%) included 5 patients (1.1%) who were known to be deceased for reasons unrelated to their arthroplasty, 1 (0.2%) who moved out of state, and 18 (4.1%) who had scheduled follow-up visits since the close of the study. This cohort was not thought to differ significantly from the study group. After application of the exclusion criteria, 338 patients were ultimately included in this study. The average age of the cohort was 71.5 years (standard deviation [SD], 6.4 years), with a mean follow-up period of 28.3 months (SD, 8.1 months). The most common medical comorbidity was hypertension (n = 207, 61.6%), followed by hypercholesterolemia (n = 131, 38.9%). Complete patient demographic characteristics, including comorbid conditions, are listed in Table I.

Prior surgical procedures on the ipsilateral shoulder had been performed in 105 patients (31%), the most common of which was rotator cuff repair (n = 73, 69.5%). The most common preoperative diagnosis was OA (202 shoulders, 59.7%), followed by RCA (116 shoulders, 34%).

Clinical outcomes

The average ASES score for the entire cohort significantly improved from 35.2 (SD, 16.4) to 83.6 (SD, 16.1) at most recent follow-up (>2 years) ($P < .001$). Over 95% of patients surpassed the minimal clinically important difference for the change in ASES score at final follow-up. Similarly, there were significant improvements in the mean VAS score (from 6.0 [SD, 2.4] to 0.86 [SD, 1.6]; $P < .001$) and Single Assessment Numerical Evaluation score (from 31.2

Table II Univariate comparison between patients with poor outcomes and those with excellent outcomes

Parameter	Top quartile (n = 82)	Bottom quartile (n = 80)	*P* value
Preoperative factors			
Age, mean (SD), yr	70.6 (4.9)	71.6 (7.5)	.35
Male sex, n (%)	28 (34.6)	36 (43.9)	.22
Dominant arm, n (%)	55 (67.1)	43 (52.4)	.06
Insurance type, n (%)			
Medicare or Medicaid	47 (57.3)	56 (68.3)	.15
Private	34 (41.5)	17 (20.7)	.004
Workers' compensation	1 (1.2)	7 (8.5)	.03*
Indication, n (%)			
OA	61 (74.4)	29 (35.4)	<.001*
RCA	18 (22)	45 (56.3)	.008*
Other	3 (3.7)	6 (7.4)	>.999
BMI, mean (SD)	30.6 (6.4)	31.4 (6.2)	.41
ASA class > 2, n (%)	28 (32.9)	18 (22)	.11
No. of reported allergies, mean (SD)	1.4 (1.9)	3.4 (4.9)	.001*
Comorbid conditions, n (%)			
Anxiety	13 (16.3)	18 (22.8)	.3
Depression	13 (16.3)	25 (31.6)	.02*
Diabetes	9 (11.3)	10 (12.3)	.83
Obesity	20 (24.4)	20 (24.4)	>.999
Smoker	5 (6.1)	10 (11.8)	.2
HTN	51 (62.2)	56 (68.3)	.41
HLD	33 (40.2)	38 (46.3)	.43
Thyroid disease	21 (25.6)	14 (17.1)	.18
Rheumatoid arthritis	1 (1.2)	4 (4.9)	.37
Previous ipsilateral shoulder surgery, n (%)	16 (19.5)	35 (42.7)	.001*
Preoperative opioid use, n (%)	8 (9.8)	27 (33.8)	<.001*
Marital status (married), n (%)	48 (60)	60 (73.2)	.08
Preoperative ASES score, mean (SD)	39.0 (17.5)	31.5 (17.5)	.006*
Perioperative factors			
Inpatient opioid consumption, mean (SD), morphine equivalents	81.2 (64.9)	124.7 (102.3)	<.001*
Peak postoperative VAS pain score, mean (SD)	6.2 (2.2)	7.7 (2.3)	<.001*
Length of stay, mean (SD), d	1.7 (0.63)	2.4 (1.0)	<.001*
Postoperative factors			
Postoperative VAS pain score, mean (SD)	0	2.8 (2.2)	<.001*
Postoperative forward flexion, mean (SD), °	143 (16)	116 (26)	<.001*
Postoperative external rotation, mean (SD), °	57 (18.0)	41 (20)	<.001*
Postoperative acromial stress fracture, n (%)	2 (3.2)	6 (7.1)	.27

SD, standard deviation; *OA*, osteoarthritis; *RCA*, rotator cuff arthropathy; *BMI*, body mass index; *ASA*, American Society of Anesthesiologists; *HTN*, hypertension; *HLD*, hyperlipidemia; *ASES*, American Shoulder and Elbow Surgeons; *VAS*, visual analog scale.
Quartiles were determined by absolute postoperative ASES scores.
* Statistically significant.

[SD, 20.0] to 85.9 [SD, 18.0]; $P < .001$). These data are summarized in Table I.

Univariate analysis

Patients were divided into quartiles based on absolute postoperative ASES score, with the top quartile defined as "excellent" and the bottom quartile defined as "poor." The patient-specific variables were subdivided into preoperative, perioperative, and postoperative factors as shown in Table II. The following variables were associated with excellent outcomes: diagnosis of primary OA ($P < .001$), private insurance ($P = .004$), and higher mean preoperative ASES score ($P = .006$). The following variables were predictive of poor results: workers' compensation ($P = .03$), depression ($P = .02$), preoperative diagnosis of RCA ($P = .008$), preoperative opioid use ($P < .001$), and prior ipsilateral shoulder surgery ($P = .001$). Other variables associated with poor outcomes included a higher number of allergies ($P = .001$), higher inpatient opioid consumption ($P < .001$), peak postoperative inpatient pain score ($P < .001$), longer duration of hospital stay ($P < .001$), higher VAS pain score

Table III Multivariate logistic regression of preoperative factors associated with excellent outcomes after reverse total shoulder arthroplasty

Predictor	OR*	95% CI	*P* value
OA	5.6	1.2-25.6	.03†
RCA	1.4	0.30-6.3	.69
Private insurance	2.70	1.12-6.5	.03†
No. of reported allergies	0.83	0.71-0.97	.02†
Depression	0.39	0.16-0.99	.046†
Previous surgery	0.36	0.15-0.87	.02†
Preoperative ASES score	1.00	0.99-1.04	.27
Preoperative opioid use	0.26	0.09-0.76	.01†

OR, odds ratio; *CI*, confidence interval; *OA*, osteoarthritis; *RCA*, rotator cuff arthropathy; *ASES*, American Shoulder and Elbow Surgeons.
* Significant ORs > 1 are interpreted as being associated with the top quartile of absolute postoperative ASES scores.
† Statistically significant ($P < .05$).

postoperatively ($P < .001$), decreased postoperative forward flexion ($P < .001$), and decreased postoperative external rotation ($P < .001$).

Multivariate analysis

After multivariate adjustment with logistic regression, a preoperative diagnosis of primary OA (OR, 5.6; 95% CI, 1.2-26.5; $P = .03$) and private insurance (OR, 2.7; 95% CI, 1.12-6.5; $P = .03$) were the only 2 preoperative factors significantly associated with an ASES outcome score in the top quartile (Table III). Patients with an increasing number of reported allergies (OR, 0.83; 95% CI, 0.71-0.97; $P = .02$), self-reported depression (OR, 0.39; 95% CI, 0.16-0.99; $P = .03$), a history of ipsilateral shoulder surgery (OR, 0.36; 95% CI, 0.15-0.87; $P = .02$), and preoperative opioid use (OR, 0.25; 95% CI, 0.09-0.76; $P = .01$) had significantly increased odds of having postoperative ASES scores in the bottom quartile. Preoperative ASES scores were not associated with high postoperative ASES scores (OR, 1.0; 95% CI, 0.99-1.04; $P = .27$).

Discussion

The findings of this study indicate that primary OA was the strongest preoperative predictor for achieving excellent outcomes following primary RSA. Private insurance status was also identified as a strong predictor of excellent outcomes on multivariate analysis. Preoperative factors that were associated with poor outcomes included prior ipsilateral shoulder surgery, an increased number of reported allergies, self-reported depression, and preoperative opioid use. As the indications for RSA and overall volume of RSA procedures being performed continue to expand, identification of preoperative factors associated with clinical outcomes becomes increasingly important.

A diagnosis of primary OA had the highest correlation with achieving excellent results following RSA. It should be noted that in 60% of the study cohort, RSA was performed for primary glenohumeral OA. The more routine use of RSA in the setting of primary OA was the result of evolving indications of the senior surgeon as opposed to patient-specific pathology. Recent evidence has suggested similar clinical outcomes[17,21,30] with lower rates of revision surgery at 10-year follow-up[4] when RSA is performed in the setting of OA compared with total shoulder arthroplasty (TSA). Given the similar clinical outcomes and lower risk of revision coupled with the increased rate of secondary rotator cuff failure and glenoid component loosening that can be seen with TSA,[4,8,31] more patients in the senior surgeon's practice are offered RSA for primary OA irrespective of glenoid morphology. Additional literature has demonstrated favorable outcomes and an expanding role for RSA in the setting of primary OA. A recent matched-cohort study in patients aged > 70 years with primary OA and an intact rotator cuff demonstrated similar clinical outcomes between those treated with anatomic TSA and those treated with RSA.[30] Similarly, a recent level III study compared outcomes after RSA in matched cuff tear arthropathy and OA cohorts and found similar improvements for both groups.[26] Furthermore, Polisetty et al[17] recently performed a value analysis comparing RSA and TSA in the setting of OA with an intact rotator cuff. They determined that RSA and TSA resulted in similar clinical outcomes and value in the setting of primary OA. As the indications for RSA continue to expand, our study builds on the increasing evidence supporting the role of RSA in the setting of primary OA in appropriately selected patients.

Private insurance also correlated with excellent results following RSA. This factor may be a surrogate marker for age, as the Medicare population is typically older. Another possibility is the socioeconomic status of the population of patients who comprise the private insurance group. If these patients have access to more resources postoperatively, including visiting nurse assistance, they may have a tendency to fare better. However, this may not accurately explain the association, as the senior author's patients do not undergo formal postoperative physical therapy. In these cases, the private insurance group would not be entitled to more therapy visits compared with patients with other types of insurance given the lack of therapy in the first place.

Prior reports have demonstrated that the Medicaid population has inferior ASES scores at all time points following shoulder arthroplasty, but the degree of improvement compared with patients with other insurance types was similar.[12] Examination of a cohort of 84 patients showed that, after controlling for baseline ASES score, patients with private insurance had significantly better postoperative scores than both Medicaid and workers'

compensation patients.[22] The authors concluded that the reason for the observed differences was multifactorial but the information could be used to counsel patients in the office when discussing elective arthroplasty. Workers' compensation insurance was present in only 8 patients in our cohort; therefore, this group is too small to draw significant conclusions.

Prior ipsilateral shoulder surgery has often been shown to be a poor prognostic indicator after shoulder arthroplasty.[5,11,25] Our study found that prior shoulder surgery was significantly associated with worse outcome scores. The most common type of prior surgery was rotator cuff repair. This result should not be surprising given correlations with previous studies. Additionally, we found that an increasing number of allergies correlated with worse outcomes. This finding has been reported in the lower-extremity arthroplasty literature as a poor prognosticator. Regarding shoulder arthroplasty, a report on a single-surgeon cohort of 98 patients did not find multiple allergies to have an effect on outcome.[18] The study had a short follow-up time (180 days), and only 26 patients had multiple allergies. The larger number of patients in our cohort combined with the longer follow-up time may explain the difference in outcomes in patients with multiple allergies. Furthermore, the patients with ASES scores in the top quartile reported an average of 1.4 allergies (SD, 1.9 allergies), whereas those with ASES scores in the bottom quartile reported, on average, 3.4 medication allergies (SD, 4.9 allergies), indicating that >2 allergies may be a better threshold for prognostic measurements.

Depression and preoperative opioid use are both complex preoperative characteristics, and they may have multifactorial underlying socioeconomic reasons for being associated with poor postoperative outcomes. Werner et al[27] reported that patients with depression experienced a significant improvement in ASES scores following shoulder arthroplasty but they demonstrated less improvement than patients without depression. Another study, evaluating 150 patients, found that male sex, an intact rotator cuff, and depression were associated with poor outcomes following RSA.[28] Morris et al[16] concluded that patients with preoperative opioid supplementation can improve following surgery. However, their level of improvement was not as substantial as those without opioid supplementation preoperatively. In addition, preoperative opioid use has been associated with prolonged postoperative opioid use following shoulder arthroplasty, and it has been shown that patients using opioids at 1 year postoperatively are likely to continue indefinitely.[2] In our cohort, patients who took opioids preoperatively had significantly greater odds of being in the poor-outcome group. This could be because of the need to continue to use opioid pain medication postoperatively or because, compared with patients who did not take opioids, these patients' peak improvement was lower. In our cohort, both depression and preoperative opioid use were associated with poor ASES scores. These correlations may be related to the complex interplay of patient expectations and pain levels both preoperatively and postoperatively.

Different studies have identified the ability of preoperative ASES scores to predict postoperative outcomes.[23,29] We found postoperative scores to be significantly increased compared with preoperative scores; however, on multivariate regression analysis, we found that preoperative scores were not correlated with higher postoperative scores (OR, 1.0). This finding may be a result of a ceiling effect, where a patient with a high preoperative score does not have as much room for improvement as a patient with a lower preoperative score does.

This study had numerous strengths. We included a large number of patients from a consecutive series with a high rate of follow-up, which minimizes selection bias. All clinical outcomes were prospectively collected and maintained in an institutional database, therefore minimizing recall bias. Furthermore, using a single-surgeon database ensures internal reproducibility with both the surgical technique and rehabilitation performed. We performed both univariate and multivariate analyses to account for confounding.

This study also has its limitations. We limited the indications for RSA by excluding inflammatory arthropathy, fracture, and avascular necrosis. These criteria may limit applicability to the RSA population at large; however, OA and RCA are the most commonly encountered reasons for performing RSA and were included. The retrospective nature of the analysis may introduce certain biases; however, this is limited by including a consecutive series and performing prospective data collection. In addition, these data reflect a single surgeon's experience and therefore may not be generalizable to other surgeons in other geographic locations.

Conclusion

This study found that a preoperative diagnosis of OA was the strongest preoperative predictor associated with achieving excellent outcomes following RSA. Additionally, patients with private insurance were more likely to achieve excellent outcomes. Patients with an increasing number of reported allergies, self-reported depression, a history of ipsilateral shoulder surgery, and preoperative opioid use had a greater chance of having a poor postoperative outcome. Given the expanding role of RSA, this information is critical when counseling patients regarding postoperative expectations.

Disclaimer

Ryan Churchill is a paid consultant for DePuy Synthes.

Andrew Jawa is a paid speaker and consultant for DJO Global, is a paid consultant for Ignite Orthopedics, receives royalties from DePuy Synthes, and has equity in Boston Outpatient Surgical Suites.

The other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Atoun E, Van Tongel A, Hous N, Narvani A, Relwani J, Abraham R, et al. Reverse shoulder arthroplasty with a short metaphyseal humeral stem. Int Orthop 2014;38:1213-8. https://doi.org/10.1007/s00264-014-2328-8
2. Berglund DD, Rosas S, Kurowicki J, Horn B, Mijic D, Levy JC. Preoperative opioid use among patients undergoing shoulder arthroplasty predicts prolonged postoperative opioid use. J Am Acad Orthop Surg 2018;27:e691-5. https://doi.org/10.5435/JAAOS-D-18-00008
3. Boileau P, Gonzalez JF, Chuinard C, Bicknell R, Walch G. Reverse total shoulder arthroplasty after failed rotator cuff surgery. J Shoulder Elbow Surg 2009;18:600-6. https://doi.org/10.1016/j.jse.2009.03.011
4. Brown JS, Gordon RJ, Peng Y, Hatton A, Page RS, Macgroarty KA. Lower operating volume in shoulder arthroplasty is associated with increased revision rates in the early postoperative period: long-term analysis from the Australian Orthopaedic Association National Joint Replacement Registry. J Shoulder Elbow Surg 2020;29:1104-14. https://doi.org/10.1016/j.jse.2019.10.026
5. Carducci MP, Zimmer ZR, Jawa A. Predictors of unsatisfactory patient outcomes in primary reverse total shoulder arthroplasty. J Shoulder Elbow Surg 2019;28:2113-20. https://doi.org/10.1016/j.jse.2019.04.009
6. Cvetanovich GL, Chalmers PN, Streit JJ, Romeo AA, Nicholson GP. Patients undergoing total shoulder arthroplasty on the dominant extremity attain greater postoperative ROM. Clin Orthop Relat Res 2015;473:3221-5. https://doi.org/10.1007/s11999-015-4400-0
7. Day JS, Lau E, Ong KL, Williams GR, Ramsey ML, Kurtz SM. Prevalence and projections of total shoulder and elbow arthroplasty in the United States to 2015. J Shoulder Elbow Surg 2010;19:1115-20. https://doi.org/10.1016/j.jse.2010.02.009
8. Evans JP, Batten T, Bird J, Thomas WJ, Kitson JB, Smith CD. Survival of the Aequalis total shoulder replacement at a minimum 20-year follow-up: a clinical and radiographic study [Epub ahead of print]. J Shoulder Elbow Surg 2021. https://doi.org/10.1016/j.jse.2021.01.038
9. Friedman RJ, Cheung EV, Flurin PH, Wright T, Simovitch RW, Bolch C, et al. Are age and patient gender associated with different rates and magnitudes of clinical improvement after reverse shoulder arthroplasty? Clin Orthop Relat Res 2018;476:1264-73. https://doi.org/10.1007/s11999.0000000000000270
10. Haritinian EG, Belgaid V, Lino T, Nove-Josserand L. Reverse versus anatomical shoulder arthroplasty in patients with intact rotator cuff. Int Orthop 2020;44:2395-405. https://doi.org/10.1007/s00264-020-04754-z
11. Kelly JD II, Zhao JX, Hobgood ER, Norris TR. Clinical results of revision shoulder arthroplasty using the reverse prosthesis. J Shoulder Elbow Surg 2012;21:1516-25. https://doi.org/10.1016/j.jse.2011.11.021
12. Lansdown DA, Ma GC, Aung MS, Gomez A, Zhang AL, Feeley BT, et al. Do patient outcomes and follow-up completion rates after shoulder arthroplasty differ based on insurance payor? J Shoulder Elbow Surg 2021;30:65-71. https://doi.org/10.1016/j.jse.2020.04.028
13. Levy JC, Everding NG, Gil CC Jr, Stephens S, Giveans MR. Speed of recovery after shoulder arthroplasty: a comparison of reverse and anatomic total shoulder arthroplasty. J Shoulder Elbow Surg 2014;23:1872-81. https://doi.org/10.1016/j.jse.2014.01.051
14. 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
15. Mizuno N, Denard PJ, Raiss P, Walch G. Reverse total shoulder arthroplasty for primary glenohumeral osteoarthritis in patients with a biconcave glenoid. J Bone Joint Surg Am 2013;95:1297-304. https://doi.org/10.2106/JBJS.L.00820
16. Morris BJ, Laughlin MS, Elkousy HA, Gartsman GM, Edwards TB. Preoperative opioid use and outcomes after reverse shoulder arthroplasty. J Shoulder Elbow Surg 2015;24:11-6. https://doi.org/10.1016/j.jse.2014.05.002
17. Polisetty TS, Colley R, Levy JC. Value analysis of anatomic and reverse shoulder arthroplasty for glenohumeral osteoarthritis with an intact rotator cuff. J Bone Joint Surg Am 2021;103:913-20. https://doi.org/10.2106/JBJS.19.01398
18. Rosenthal BD, Knesek MJ, Kahlenberg CA, Mai H, Saltzman MD. Shoulder arthroplasty outcomes in patients with multiple reported drug allergies: does number of drug allergies have an effect on outcome? Orthop J Sports Med 2016;4:2325967116671501. https://doi.org/10.1177/2325967116671501
19. Sadoghi P, Vavken P, Leithner A, Hochreiter J, Weber G, Pietschmann MF, et al. Impact of previous rotator cuff repair on the outcome of reverse shoulder arthroplasty. J Shoulder Elbow Surg 2011;20:1138-46. https://doi.org/10.1016/j.jse.2011.01.013
20. 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
21. 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
22. Strotman P, Perry M, LeDuc R, Joyce C, Garbis N. Effect of insurance status on clinical outcomes after shoulder arthroplasty. Orthopedics 2020;43:e523-8. https://doi.org/10.3928/01477447-20200827-02
23. Tashjian RZ, Hung M, Keener JD, Bowen RC, McAllister J, Chen W, et al. Determining the minimal clinically important difference for the American Shoulder and Elbow Surgeons score, Simple Shoulder Test, and visual analog scale (VAS) measuring pain after shoulder arthroplasty. J Shoulder Elbow Surg 2017;26:144-8. https://doi.org/10.1016/j.jse.2016.06.007
24. Wagner ER, Houdek MT, Schleck C, Harmsen WS, Sanchez-Sotelo J, Cofield R, et al. Increasing body mass index is associated with worse outcomes after shoulder arthroplasty. J Bone Joint Surg Am 2017;99:929-37. https://doi.org/10.2106/JBJS.15.00255
25. Wall B, Nove-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;89:1476-85. https://doi.org/10.2106/JBJS.F.00666
26. Waterman BR, Dean RS, Naylor AJ, Otte RS, Sumner-Parilla SA, Romeo AA, et al. Comparative clinical outcomes of reverse total shoulder arthroplasty for primary cuff tear arthropathy versus severe glenohumeral osteoarthritis with intact rotator cuff: a matched-cohort analysis. J Am Acad Orthop Surg 2020;28:e1042-8. https://doi.org/10.5435/JAAOS-D-19-00493
27. Werner BC, Wong AC, Chang B, Craig EV, Dines DM, Warren RF, et al. Depression and patient-reported outcomes following total shoulder arthroplasty. J Bone Joint Surg Am 2017;99:688-95. https://doi.org/10.2106/JBJS.16.00541

28. 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
29. Wong SE, Zhang AL, Berliner JL, Ma CB, Feeley BT. Preoperative patient-reported scores can predict postoperative outcomes after shoulder arthroplasty. J Shoulder Elbow Surg 2016;25:913-9. https://doi.org/10.1016/j.jse.2016.01.029
30. Wright MA, Keener JD, Chamberlain AM. Comparison of clinical outcomes after anatomic total shoulder arthroplasty and reverse shoulder arthroplasty in patients 70 years and older with glenohumeral osteoarthritis and an intact rotator cuff. J Am Acad Orthop Surg 2020;28:e222-9. https://doi.org/10.5435/JAAOS-D-19-00166
31. Young AA, Walch G, Pape G, Gohlke F, Favard L. Secondary rotator cuff dysfunction following total shoulder arthroplasty for primary glenohumeral osteoarthritis: results of a multicenter study with more than five years of follow-up. J Bone Joint Surg Am 2012;94:685-93. https://doi.org/10.2106/JBJS.J.00727