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Predicting outstanding results after reverse shoulder arthroplasty using percentage of maximal outcome improvement

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Background: The purpose of this study was to determine whether thresholds regarding the percentage of maximal improvement in the Simple Shoulder Test (SST) score and American Shoulder and Elbow Surgeons (ASES) score exist that predict excellent patient satisfaction after reverse shoulder arthroplasty (RSA).

Methods: Patients undergoing RSA with a single implant system were evaluated preoperatively and at a minimum 2-year follow-up. Receiver operating characteristic curve analysis determined thresholds to predict excellent patient satisfaction by evaluating the percentage of maximal improvement for SST and ASES scores. Preoperative factors were analyzed as independent predictors for achieving SST and ASES score thresholds.

Results: There were 198 (SST score) and 196 (ASES score) patients who met inclusion criteria. For SST and ASES scores, receiver operating characteristic curve analysis identified 61.3% ($P < .001$) and 68.2% ($P < .001$) maximal improvement as the threshold for maximal predictability of excellent satisfaction, respectively. Significant positive correlation between the percentage of maximum score achieved and excellent patient satisfaction for both groups was found ($r = 0.440$ [$P < .001$] for SST score; $r = 0.417$ [$P < .001$] for ASES score). Surgery on the dominant hand, greater baseline visual analog scale pain score, and cuff arthropathy were independent predictors for achieving the SST and ASES score threshold.

Conclusion: Thresholds for the achievement of excellent satisfaction after RSA were 61.3% of maximal SST score improvement and 68.3% of maximal ASES score improvement. Independent predictors of achieving these thresholds were dominant-sided surgery and higher baseline visual analog scale pain scores for the SST score and rotator cuff arthropathy for the ASES score.

All work was performed at the Holy Cross Orthopedic Institute and Holy Cross Hospital, Fort Lauderdale, Florida, USA.
This study was granted an Institutional Review Board exemption determination (protocol No. 2017-016-EX) before initiation of this research.

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Level of evidence: Basic Science Study; Validation of Outcome Instrument

Keywords: Percentage of maximal improvement; predictors; American Shoulder and Elbow Surgeons score; Simple Shoulder Test; reverse shoulder arthroplasty; satisfaction

Reverse shoulder arthroplasty (RSA) has revolutionized the management of advanced arthritis in the rotator cuff–deficient shoulder[1,3,10,24,34] and has seen dramatic growth in utilization[13,15,18] with the expansion of indications.[4,9,12,16,20,23,27,33,40,44] With an optimistic goal of achieving excellent satisfaction with surgical outcomes, patient-reported outcome measures (PROMs) have gained recognition as an essential and convenient tracking tool to monitor subjective outcomes after RSA. Several PROMs have been validated for use in monitoring of patient outcomes, including the American Shoulder and Elbow Surgeons (ASES) score, Simple Shoulder Test (SST),[14,31] Constant-Murley score,[8] Single Assessment Numeric Evaluation,[43] and Western Ontario Osteoarthritis of the Shoulder index.[21] Using an anchor-based patient satisfaction value, several studies have extrapolated and quantified PROM scores to determine a minimal clinically important difference (MCID).[32,38,42] Yet, MCID remains limited by a potential ceiling effect, whereby patients may achieve high postoperative PROM scores but fail to reach the MCID threshold because of greater baseline scores.[14,32]

In 2012, Gilmer et al[14] analyzed improvements in SST scores and described a method to limit potential ceiling effects. This was accomplished by judging outcomes on the basis of the potential room for improvement using the SST score. A better outcome was defined as an improvement of >30% of the maximal possible improvement from baseline SST score.[14] This methodology was later used to perform a multivariate analysis that established a predictive model that used factors associated with better patient outcomes.[22] In a previous study focused on anatomic total shoulder arthroplasty (TSA), our institution applied this methodology to identify thresholds in percentage improvement of ASES and SST scores that predict achievement of an excellent result.[2] Achievement of 72.1% of maximal SST score and 75.6% of maximal ASES score improvement was predictive of excellent satisfaction. To date, no study has focused on determining thresholds for the achievement of excellent results after RSA.

The primary purpose of this study was to determine whether there are thresholds in the percentage of maximal SST score or ASES score improvement that are associated with a higher incidence of excellent patient satisfaction after RSA. A secondary purpose was to determine whether specific preoperative factors predict the achievement of these thresholds.

Materials and methods

A retrospective query of our institution's Shoulder and Elbow Surgery Registry was conducted for the 362 patients undergoing primary RSA (*Current Procedural Terminology* code 23472) from 2007 to 2015 for nonacute fracture indications. Inclusion criteria were used to select all patients with complete preoperative and postoperative ASES and SST scores with a minimum of 2-year follow-up. Exclusion criteria were those undergoing arthroplasty for fracture, previous shoulder arthroplasty, incomplete ASES and SST records, and failure to meet the minimum 2-year follow-up. All procedures were performed by the senior author, using the same surgical technique through a deltopectoral approach and either DJO RSP (2007-2010) or DJO Monoblock RSP (2011-2015) RSA systems (DJO Surgical, Austin, TX, USA). This RSA implant system uses a more lateralized center of rotation glenosphere and a 135° neck-shaft angle. Soft tissue balancing was achieved through the use of polyethylene humeral shells of neutral, +4 mm, and +8 mm. All patients were treated by an identical postoperative rehabilitation protocol with a shoulder immobilizer for the first 6 weeks and patient-directed pendulum exercises, followed by 6 weeks of active stretching and delayed strengthening for 3 months. Per our registry protocol, ASES and SST scores are routinely collected for patients at preoperative and routine postoperative intervals. Patient satisfaction is reported postoperatively as excellent, good, satisfactory, or unsatisfactory.

With the same methodology used in analysis of TSA data,[2] the percentage of maximal improvement in SST score and ASES score was calculated by the following formula:

$$\frac{[(\text{Outcome score at most recent follow}-\text{up})-(\text{Preoperative outcome score})]\times 100\%}{(\text{Highest possible outcome score})-(\text{Preoperative outcome score})}$$

Correlation analysis was evaluated for the percentage of maximal improvement achieved and excellent patient satisfaction.

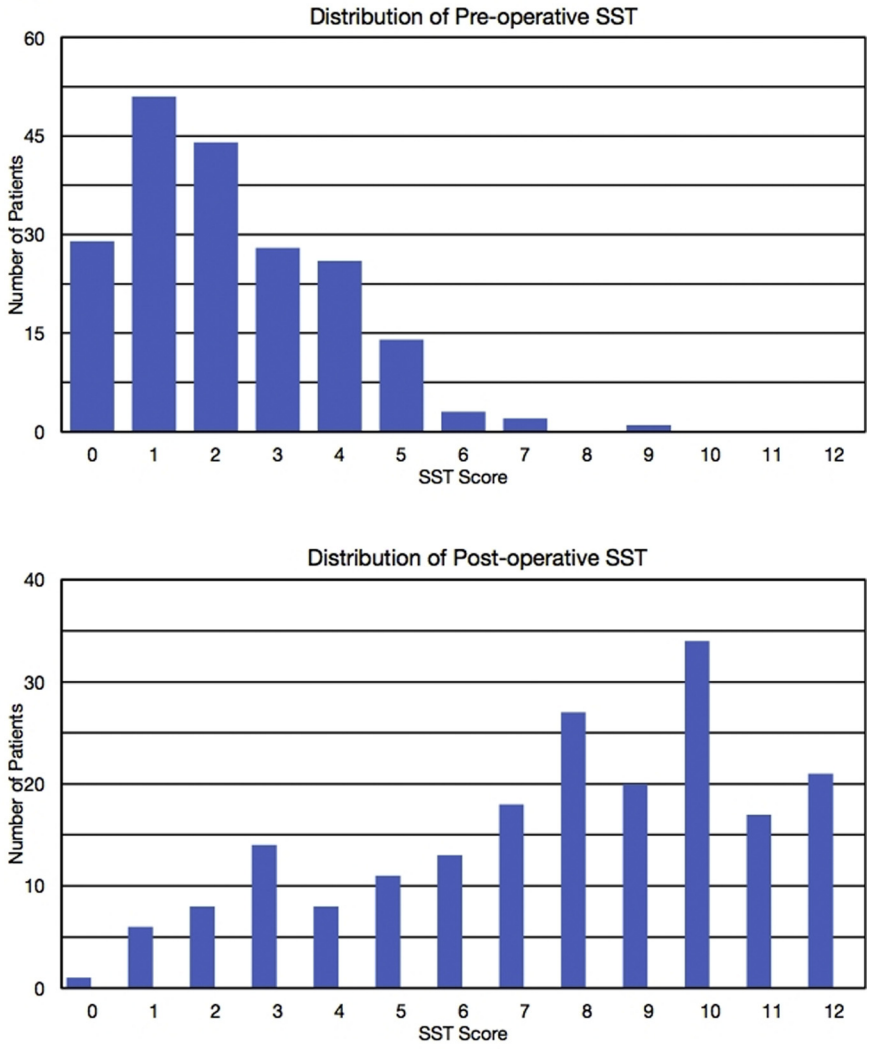

Figure 1 Number of patients achieving Simple Shoulder Test (*SST*) scores preoperatively and postoperatively.

To identify thresholds of percentage maximum improvement for both SST and ASES scores, receiver operating characteristic (ROC) curve analysis was used. Chen et al[6] defined thresholds as the point at which both specificity and sensitivity were maximized in predicting the highest level of excellent satisfaction. These thresholds were verified using χ^2 analyses.

In an effort to understand potential predictive factors that may have influenced the achievement of excellent results, available preoperative variables were examined through the repository query. For all patients included in the repository, preoperative demographics, comorbidities, and best effort preoperative active motion (elevation, external rotation, and internal rotation) as well as baseline PROMs are routinely recorded. Preoperative PROMs included were SST, ASES, Single Assessment Numeric Evaluation, visual analog scale (VAS) score for pain, VAS score for function, and physical component summary and mental component summary scores of the 12-Item Short-Form Health Survey (SF-12). Specific preoperative questions were directed to the patient about the presence of overall shoulder pain, nightly shoulder pain, instability of the shoulder, or mechanical symptoms (grinding, locking, catching of the shoulder joint). Over-the-counter and physician-prescribed medication use of narcotic and nonsteroidal anti-inflammatory drugs was assessed before surgery.

Univariate logistic regression analyses were used to determine whether any of these preoperative variables were predictors of achievement of the threshold in percentage of maximal improvement for both SST and ASES scores. Variables that showed statistical significance were incorporated into a multivariate model to determine independent predictors for achieving thresholds.

Statistically significant differences and correlations between continuous variables were evaluated with paired-sample *t*-tests and linear regression analysis. A dichotomous variable assessment was accomplished using χ^2 analysis. Statistical analyses were performed using SPSS version 23.0 (IBM, Armonk, NY, USA). Significance was set at $P < .05$.

Results

Thresholds for percentage maximal improvement in SST score

Of the 321 patients with preoperative data, 198 patients met inclusion criteria and had at least 2-year follow-up for SST data and patient satisfaction (mean follow-up, 45 months; range, 24-133 months); 77 patients (38.9%) were male and 120 (60.6%) were female (1 patient had no sex recorded). The mean age was 75.2 years (standard deviation [SD], 7.7 years; range, 46.2-90.2 years). The distributions of preoperative and most recent postoperative SST scores are shown in Figure 1. The mean preoperative SST score was 2.2 (SD, 1.7; range, 0-9). The average SST score at the most recent visit was 7.7 (SD, 3.1; range, 0-12), constituting a mean increase of 5.5 (3.2; range, −3 to 12; $P < .001$). There were 131 patients (66.2%) who rated their surgical outcomes excellent; 42 (21.2%), good; 16 (8.0%), satisfactory; and 8 (4.0%), unsatisfactory. One patient (0.5%) failed to rate the outcome.

There were 186 patients (93.9%) who had postoperative SST score improvements. With use of those data, ROC curve analysis determined 61.3% of maximal improvement in SST score as the threshold for maximal predictability of excellent satisfaction (area under the curve, 0.702; 95% confidence interval, 0.619-0.785; $P < .001$; Fig. 2). Patients achieving the threshold of >61.3% of maximal SST score improvement had significantly higher rates of excellent satisfaction compared with those below this threshold (79.6% vs. 47.6%; $P < .001$). For the 186 patients with SST score improvement (93.9%), there was a significant positive correlation between the percentage of maximum SST score achieved and excellent satisfaction ($r = 0.440$; $P < .001$).

A univariate analysis determined surgery on the dominant hand (odds ratio [OR], 0.408; $P = .005$), greater height (OR, 1.038; $P = .010$), sex (OR, 2.341; $P = .005$), and greater baseline VAS score for pain (OR, 1.115; $P = .046$) to be predictors of achieving the threshold in percentage of maximal SST score improvement (Table I). However, multivariate analysis determined surgery on the dominant hand (OR, 0.347; $P = .002$) and baseline VAS score for pain (OR, 1.151; $P = .021$) to be the only independent predictors (Table II).

Thresholds for percentage maximal improvement in ASES score

Of the 316 patients with preoperative data, 196 patients met inclusion criteria and had a minimum of 2-year follow-up data for ASES (mean follow-up, 45 months; range, 24-133 months). The average age was 75.2 years (SD, 7.7 years; range, 46.1-88.1 years). The distribution of preoperative and most recent postoperative ASES scores is shown in

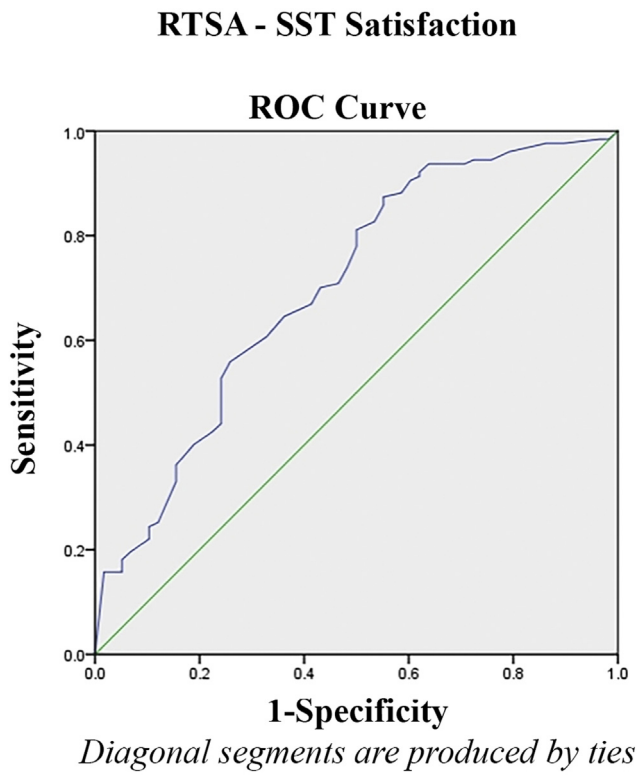

Figure 2 Receiver operating characteristic (*ROC*) curve for Simple Shoulder Test (*SST*) score as a predictor of excellent satisfaction. Area under the curve (*AUC*), 0.702; 95% confidence interval (*CI*), 0.619-0.785; $P < .001$. *RTSA*, reverse total shoulder arthroplasty.

Figure 3. Mean ASES score increased from 32.3 (SD, 19.1; range, 0-100) preoperatively to 75.8 (SD, 21.3; range, 0-100) postoperatively, representing an average increase of 43.5 (SD, 28.1; range, −32.1 to 100; $P < .0001$). There were 140 (71.4%) patients who rated their surgical outcomes excellent; 34 (17.3%), good; 16 (8.16%), satisfactory; and 4 (2.04%), unsatisfactory. Two patients (1.02%) failed to rate the outcome.

ROC curve analysis determined that a threshold of 68.2% of maximal improvement in ASES score had maximal predictability for determining the presence of excellent satisfaction (area under the curve, 0.758; 95% confidence interval, 0.685-0.831; $P < .001$; Fig. 4). Patients achieving this threshold had significantly higher rates of excellent satisfaction compared with those who did not (82.3% vs. 45.1%; $P < .0001$). For all patients with postoperative ASES score improvement (180 patients [91.4%]), there was a significant positive correlation between the percentage of maximum ASES achieved and excellent satisfaction ($r = 0.417$; $P < .001$).

A univariate analysis determined that greater baseline VAS score for pain (OR, 1.265; $P < .001$), greater baseline ASES total score (OR, 0.967; $P < .001$), and presence of rotator cuff arthropathy (OR, 2.08; $P = .019$) were predictors of achieving the threshold in percentage of maximal

Table I SST – Univariate logistic regression of preoperative variables for patients with and without outstanding results undergoing reverse shoulder arthroscopy

Variable	OR (95% CI)	*P* value
Demographic variables		
Surgery on dominant hand	0.408 (0.220-0.757)	.005
Age	1.007 (0.972-1.044)	.692
Height (cm)	1.038 (1.009-1.069)	.010
BMI	1.031 (0.984-1.081)	.197
Sex	2.341 (1.297-4.226)	.005
Preoperative PROMs		
SST	1.03 (0.873-1.216)	.726
PCS	1.033 (0.988-1.082)	.155
MCS	1.014 (0.985-1.043)	.357
VAS instability	0.977 (0.880-1.085)	.668
SANE	1.002 (0.989-1.015)	.789
VAS function	1.110 (0.976-1.263)	.111
VAS pain	1.115 (1.002-1.24)	.046
ASES total	0.998 (0.983-1.013)	.793
Preoperative motion		
External rotation	1.001 (0.981-1.021)	.949
Active elevation	1.011 (0.991-1.032)	.266
Abduction	1.015 (0.987-1.045)	.298
Internal rotation	1.030 (0.853-1.244)	.757
Preoperative questionnaire		
Shoulder pain	0.538 (0.189-1.531)	.245
Nightly shoulder pain	0.911 (0.390-2.126)	.829
Narcotic use	0.701 (0.370-1.328)	.276
NSAID use	0.615 (0.295-1.283)	.195
Instability	0.946 (0.502-1.782)	.863
Mechanical symptoms	0.613 (0.320-1.175)	.140
Comorbidities		
Osteoarthritis	0.751 (0.277-2.040)	.575
Osteoporosis	1.298 (0.582-2.893)	.523
Thyroid disease	1.110 (0.568-2.169)	.761
Smoker	1.089 (0.305-3.886)	.896
Hypercholesterolemia	0.769 (0.405-1.461)	.422
Diabetes	0.970 (0.478-1.970)	.933
Inflammatory arthritis	1.656 (0.673-4.073)	.272

OR, odds ratio; *CI*, confidence interval; *BMI*, body mass index; *PROMs*, patient-reported outcome measures; *SST*, Simple Shoulder Test; *PCS*, physical component summary; *MCS*, mental component summary; *VAS*, visual analog scale; *SANE*, Single Assessment Numeric Evaluation; *ASES*, American Shoulder and Elbow Surgeons; *NSAID*, nonsteroidal anti-inflammatory drug.
An outstanding result is based on achievement of 61.3% of maximal improvement in SST score.

Table II SST – Multivariate logistic regression for predictors of outstanding results for patients undergoing reverse shoulder arthroscopy (based on significant results from univariate regression)

Variable	OR (95% CI)	*P* value
Surgery on dominant hand	0.347 (0.177-0.678)	.002
Height (cm)	1.019 (0.975-1.065)	.409
Sex	2.399 (0.945-6.094)	.066
Preoperative VAS pain	1.151 (1.021-1.297)	.021

OR, odds ratio; *CI*, confidence interval; *VAS*, visual analog scale.
An outstanding result is based on achievement of 61.3% of maximal improvement in SST score.

ASES score improvement (Table III). However, multivariate analysis determined the presence of rotator cuff arthropathy (OR, 2.018; $P = .032$) to be the only independent predictor (Table IV).

Discussion

The results of our study demonstrate thresholds in percentage improvement of ASES and SST scores that predict achievement of excellent patient satisfaction after RSA. Furthermore, a positive correlation exists between the percentage of maximal improvement achieved in both ASES and SST scores and attaining excellent postoperative satisfaction. Achievement of 61.3% of maximal improvement in SST score or 68.2% of maximal improvement in ASES score represents the threshold for defining excellent satisfaction after RSA. Surgery on the dominant hand and greater baseline pain scores (VAS score for pain) were the only significant independent predictors of achieving excellent satisfaction for SST score improvement. Comparatively, the single independent predictor of achieving excellent satisfaction for ASES score improvement was a surgical indication of rotator cuff arthropathy.

An MCID has been used to determine a meaningful change in functional scores postoperatively. MCIDs in RSA have been reported recently by several authors. In 2017, Tashjian et al[38] noted that an increase in SST score of 2.4 points and in ASES score of 21 points is required to achieve MCID. Simovitch et al[35] found that an increase of 10.4 points in ASES score and 1.4 points in SST score was needed to achieve MCID in the RSA group. However, Werner et al[42] found that a 23-point increase in ASES score was required for significant clinical improvement, although the MCID was reported as 13.5. Wong et al[45] reported that the MCID for shoulder arthroplasty patients (RSA and TSA) was 6.5 for ASES function, 8.0 for ASES pain, 5.4 for SF-12 physical component summary, and 5.7 for SF-12 mental component summary.

However, a significant limitation of MCID is the ceiling effect as achievement of MCID may not be possible with high preoperative scores, even if the patient has an excellent result. Patients typically have low preoperative PROM scores before shoulder arthroplasty. However, when high baseline scores are reported, the ceiling effect prevents achievement of an MCID. Gilmer et al[14] were the first to report an alternative method of evaluating significant clinical improvement using the percentage of maximal improvement in SST scores. This methodology limits the ceiling effect in trying to obtain an MCID with high baseline scores and has since been

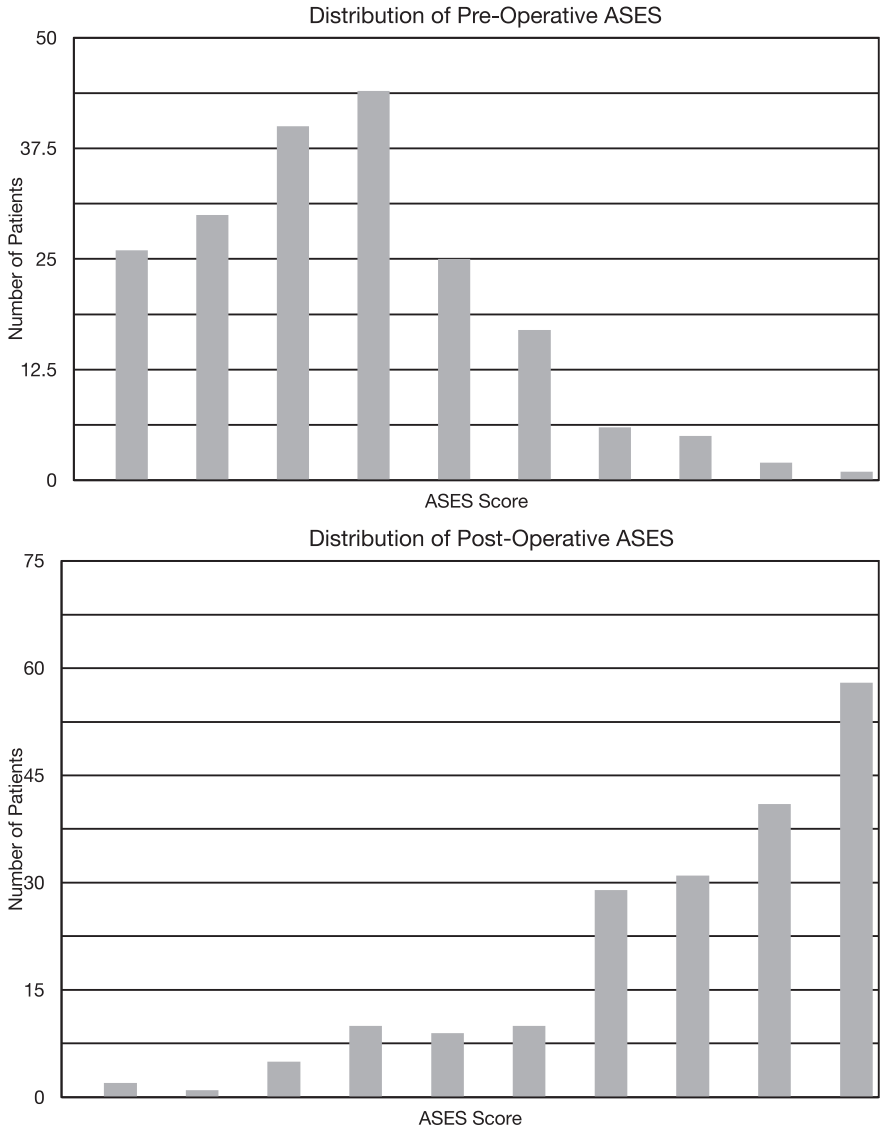

Figure 3 Number of patients achieving American Shoulder and Elbow Surgeons (*ASES*) scores preoperatively and postoperatively.

extrapolated to the ASES score to help identify thresholds in percentage of maximal improvement that can predict excellent satisfaction after anatomic TSA.[2]

Several studies have demonstrated increased patient satisfaction after shoulder arthroplasty,[19,28,29,30,39] but few have then proceeded to emphasize which factors may predict an excellent result. In an analysis of TSA patients, Berglund et al[2] found that achievement of 72.1% of maximal SST score improvement and 75.6% of maximal ASES score improvement represented thresholds for the achievement of excellent satisfaction. On evaluation of various predictors of achievement of these thresholds, younger age was identified as the only independent predictor of maximal improvement in SST score. No independent predictors for achievement in ASES score were found.

In this study, we found that an increase in SST score of 61.3% and increase in ASES score of 68.3% will result in 90% of patients achieving excellent satisfaction after RSA. Univariate analysis identified several predictors for the achievement of thresholds for excellent outcome, including surgery on the dominant hand, greater height, sex, greater baseline VAS pain scores, and greater baseline ASES scores. However, multivariate analysis showed that the only factors to independently predict achievement of the thresholds were dominant-sided surgery and higher baseline VAS pain scores (for SST score) and the surgical indication of rotator cuff arthropathy (for ASES score). RSA is generally the surgical treatment of choice for rotator cuff arthropathy, with the most optimal results observed in this population of patients.[17,24,41] It is thus not surprising to anticipate that this surgical indication would be a predictor

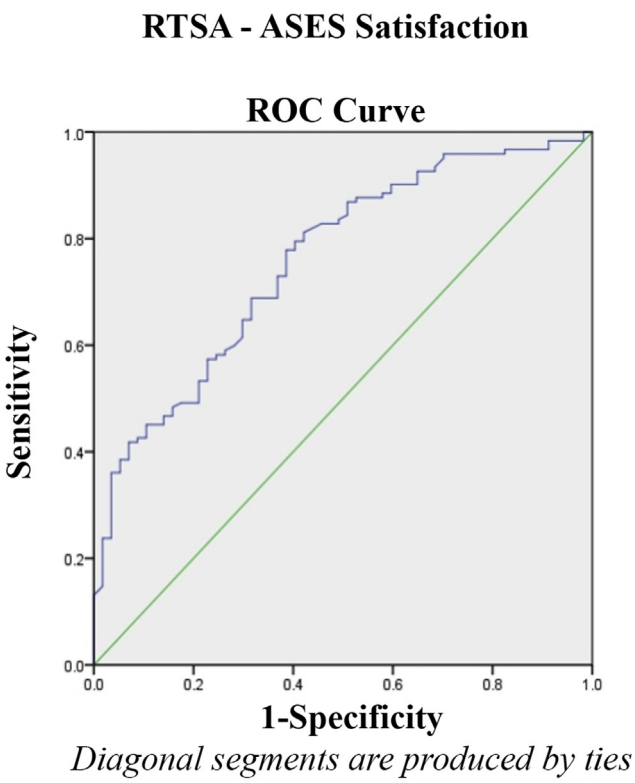

Figure 4 Receiver operating characteristic (*ROC*) curve for American Shoulder and Elbow Surgeons (*ASES*) score as a predictor of excellent satisfaction. Area under the curve (*AUC*), 0.758; 95% confidence interval (*CI*), 0.685-0.831; $P < .001$. *RTSA*, reverse total shoulder arthroplasty.

Table III ASES – Univariate logistic regression of preoperative variables for patients with and without outstanding results undergoing reverse shoulder arthroplasty

Variable	OR (95% CI)	*P* value
Demographic variables		
Surgery on dominant hand	0.582 (0.306-1.107)	.099
Age	1.004 (0.967-1.043)	.824
Height (cm)	1.024 (0.994-1.055)	.121
BMI	1.009 (0.961-1.059)	.723
Sex	1.373 (0.742-2.540)	.313
Preoperative PROMs		
SST	0.947 (0.793-1.131)	.546
PCS	0.990 (0.945-1.038)	.685
MCS	1.021 (0.991-1.051)	.181
VAS instability	0.972 (0.869-1.088)	.626
SANE	1.002 (0.989-1.016)	.728
VAS function	1.010 (0.882-1.157)	.882
VAS pain	1.265 (1.113-1.438)	<.001
ASES total	0.967 (0.950-0.986)	<.001
Preoperative motion		
External rotation	0.997 (0.985-1.010)	.677
Active elevation	1.006 (0.996-1.017)	.227
Abduction	1.015 (0.998-1.032)	.081
Internal rotation	0.920 (0.825-1.027)	.137
Preoperative questionnaire		
Shoulder pain	0.552 (0.167-1.823)	.329
Nightly shoulder pain	0.957 (0.387-2.368)	.924
Narcotic use	0.531 (0.265-1.062)	.074
NSAID use	0.898 (0.414-1.948)	.785
Instability	1.087 (0.556-2.126)	.807
Mechanical symptoms	1.410 (0.699-2.845)	.338
Comorbidities		
Osteoarthritis	0.682 (0.372-1.249)	.215
Osteoporosis	1.500 (0.643-3.499)	.348
Thyroid disease	1.047 (0.525-2.087)	.897
Smoker	1.678 (0.435-6.468)	.452
Hypercholesterolemia	1.135 (0.579-2.226)	.713
Diabetes	1.046 (0.488-2.245)	.907
Inflammatory arthritis	1.520 (0.586-3.942)	.390
Cuff tear arthropathy	2.080 (1.130-3.829)	.019

OR, odds ratio; *CI*, confidence interval; *BMI*, body mass index; *PROMs*, patient-reported outcome measures; *SST*, Simple Shoulder Test; *PCS*, physical component summary; *MCS*, mental component summary; *VAS*, visual analog scale; *SANE*, Single Assessment Numeric Evaluation; *ASES*, American Shoulder and Elbow Surgeons; *NSAID*, nonsteroidal anti-inflammatory drug.
An outstanding result is based on achievement of 68.2% of maximal improvement in ASES score. The odds ratio predicts the probability of achieving an outstanding result given a specific predictor variable.

of excellent satisfaction. Cabarcas et al[5] showed that patients with cuff tear arthropathy who were treated with RSA achieved maximal medical improvement in all PROMs within 1 year of surgery and demonstrated rapid improvement in the VAS score and other preoperative PROMs within the first 3 months after surgery. Our study shows that surgery on the dominant side may be a factor in meeting the thresholds required in ASES score to obtain an excellent result. Whereas Cvetanovich et al[11] showed an increased postoperative range of motion with dominant-sided surgery, most of the evidence is mixed, with several studies demonstrating no changes in clinical outcomes with dominant-sided surgery in the setting of shoulder arthroplasty.[7,25,26,36,37] It is reasonable to assume that if the dominant side of a patient was affected, significant limitations in function resulted in lower baseline ASES and SST scores. Restoration of function after RSA would facilitate a return to many of the functional tasks questioned in the ASES and SST surveys, which even in a functional shoulder are not possible with a nondominant arm. Finally, severe levels of pain can limit functional activities in dramatic fashion. Improvement in pain after RSA can thus translate into major improvements in functional ability. This helps explain how higher baseline VAS pain scores were predictive of achieving excellent satisfaction using a functional score such as the SST score.

One of the strengths of this study is that all RSA procedures were performed by the same surgeon with the same surgical technique, standardizing preoperative, intraoperative, and postoperative protocols. In addition, by using multivariate analysis, we controlled for confounding

Table IV ASES – Multivariate logistic regression for predictors of outstanding results for patients undergoing reverse shoulder arthroscopy (based on significant results from univariate regression)

Variable	OR (95% CI)	*P* value
Preoperative VAS pain	1.189 (0.970-1.457)	.096
Preoperative ASES total	0.988 (0.959-1.018)	.440
Cuff tear arthropathy	2.018 (1.062-3.834)	.032

OR, odds ratio; *CI*, confidence interval; *VAS*, visual analog scale; *ASES*, American Shoulder and Elbow Surgeons.
An outstanding result is based on achievement of 68.2% of maximal improvement in ASES score.

variables that may have affected the significance of the univariate analysis. The study focused on patients with a minimum of 2-year follow-up and a large sample size with just below 200 patients in each cohort (SST and ASES), thus improving the fragility index of our findings. Finally, by using percentage of maximal improvement, we avoided the ceiling effect seen with previous studies using MCID, in which high preoperative scores may not meet the minimum criteria.

This study also has several limitations. Our data ultimately come from patients completing a series of surveys. Survey fatigue may have contributed to inaccurate and rushed responses as well as poor reproducibility between answers. In addition, all shoulder arthroplasties were performed by the same surgeon at one institution. Thus, the application of these results to different populations of patients may not be universal. Last, there is subjectivity in what defines an excellent result for each patient; thus, using only the SST and ASES scores may not be clinically representative of what matters to a patient. However, the correlation of improvement in both SST and ASES scores and patient satisfaction was observed, suggesting that this methodology can be used to predict excellent satisfaction.

Conclusion

Patients achieving 61.3% of maximal SST score improvement or 68.3% of maximal ASES score improvement can be expected to reach excellent satisfaction about 80% of the time, whereas patients who do not reach these thresholds have excellent satisfaction only about 45% of the time. Future investigations can use these thresholds to analyze clinical outcomes after RSA. There was a significant positive correlation between the percentage maximal improvement in ASES and SST scores and achieving excellent satisfaction. Surgery on the dominant shoulder, higher baseline VAS pain scores, and diagnosis of rotator cuff arthropathy were independent predictors of reaching these thresholds of maximal improvement to obtain an excellent result.

Disclaimer

Jonathan C. Levy is a paid consultant for DJO Orthopaedics and Globus Medical and receives royalties from DJO Orthopaedics and Innomed. All 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.

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