

Reverse Total Shoulder Arthroplasty Inconsistently Improves Self-Reported Overhead Shoulder Strength

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Background: Composite patient-reported outcome measures (PROMs) following reverse total shoulder arthroplasty (rTSA) are widely used to assess postoperative outcomes, yet individual items targeting overhead strength recovery are rarely analyzed in isolation.

Hypothesis: We hypothesized that while composite American Shoulder and Elbow Surgeons (ASES) and Simple Shoulder Test (SST) scores would improve reliably following rTSA, patients would continue to report poor improvement in overhead strength-specific questionnaire items when treated for rotator cuff-deficient shoulder conditions.

Methods: This is a retrospective review of patients who underwent primary rTSA for either massive rotator cuff tear without arthritis or rotator cuff tear arthropathy between 2017-2023. ASES and SST patient reported outcome measures (PROMs) were collected preoperatively and at one-year postoperative follow-up. Patients answering "unable" or "very difficult" for ASES question 14 (ASES14) were deemed to have poor self-reported strength. Similarly, a negative answer for SST question 7 (SST7) was used as a proxy for poor self-reported strength. Univariate analysis was used to evaluate statistical significance comparing preoperative and postoperative PROMs. Multivariate logistic regression models were used to identify predictors of improvement in self-reported overhead strength for both ASES and SST PROMs.

Results: (ASES) Preoperatively, 96% (66/69) of patients self-reported poor strength by ASES14. Of those, only 52% (34/66) improved in self-reported ability to lift >10lbs overhead at one-year postoperative follow-up. (SST) Preoperatively, 96% (46/48) self-reported poor strength. Of those, only 35% (16/46) improved in self-reported ability to lift >8lbs to the level of the top of the head with the elbow straight at one-year postoperative follow-up. Multivariable logistic regression of age, sex and presence or absence of subscapularis repair demonstrated male sex as the only significant variable influencing self-reported strength improvement by ASES14.

Conclusion: This study demonstrates unreliable clinical improvement in patient-reported overhead strength at 1-year post-rTSA despite significant improvement in overall ASES ($p<0.0001$) and SST ($p<0.0001$) scores. Male sex was associated with self-report improvement in overhead strength as queried by ASES question 14, while age and subscapularis repair were not. Neither sex, age, nor subscapularis repair were associated with self-report strength improvement by SST question 7. These results can help guide specific aspects of preoperative counselling as patients consider rTSA for cuff deficient shoulder pathologies.

What this study adds to existing knowledge: This study quantifies a clinically recognized limitation of reverse total shoulder arthroplasty for rotator cuff-deficient conditions: improvement in composite PROM scores does not consistently translate into recovery of patient-reported overhead strength.

How this study might affect research, practice, or policy: This study can help guide patient preoperative counseling about the likelihood of strength improvement after reverse total shoulder arthroplasty for rotator cuff deficient indications.

Study Design: Retrospective Review

Level of Evidence: IV

Keywords: Reverse total shoulder arthroplasty (rTSA); Rotator cuff deficient shoulder; Overhead shoulder strength: Self-reported overhead strength; ASES and SST questionnaires

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Introduction

Reverse total shoulder arthroplasty (rTSA) reliably improves pain and function postoperatively, particularly in patients with degenerative shoulder pathologies [1][2][3][4][5][6][7][8]. Enhanced shoulder function is theorized to occur with rTSA via constraint and deltoid optimization; however, both subjective and objective postoperative strength outcomes are uncommonly reported as an outcome measure.

Overhead shoulder strength, defined as the ability to elevate and sustain a load with the arm above shoulder height, is a fundamental yet underappreciated component of shoulder function that may be distinct from pain, motion, or composite outcome scores. In a systematic review of objective strength testing after shoulder arthroplasty, anatomic and reverse total shoulder arthroplasty were associated with only modest strength gains, with abduction improving by 0.4 to 4.9 kg and external rotation by 1.0 to 1.8 kg, and postoperative strength commonly remaining below normative values that may not be perceptible to patients [9]. Preoperative strength has similarly been associated with postoperative outcomes after rTSA, with weaker patients generally demonstrating greater improvement [2]. Isokinetic testing after reverse shoulder arthroplasty has shown persistent abduction, adduction, and rotational torque deficits that correlate with clinical outcome scores [10]. Despite this evidence that strength recovery after rTSA is variable and often limited, objective strength testing is not routinely incorporated into outcome reporting. The majority of the current rTSA literature reports composite PROMs scores, which may mask self-reported postoperative strength deficiencies. In a systematic review of PROMs after shoulder arthroplasty, over 25 different PROM tools were utilized, with the American Shoulder and Elbow Surgeons (ASES) score, Constant score, visual analog scale of pain, and SST being the most commonly reported [11]. Additionally, as each questionnaire is limited to a single self-reported overhead strength question, total SST and ASES scores can reach greater than 90% of normal, even if patients report the worst possible self-reported overhead shoulder strength [12][13].

The aim of this study was to analyze patient self-reported overhead strength after primary rTSA for cuff-deficient indications. We hypothesized that ASES and SST scores would improve reliably after rTSA but that patients would report poor improvement in the specific overhead strength questions from these outcome measures when treated for rotator cuff deficient shoulder conditions.

Materials and Methods

Study Design and Population

This study is a retrospective review of a single shoulder surgeon's patient reported outcomes measures (PROM) collected prospectively in an institutional registry database. The Institutional Review Board at our Institution deemed this study as exempt (2025-1091-EX-v2.7488). Inclusion criteria were primary rTSA for either massive rotator cuff tear without arthritis or rotator cuff tear arthropathy performed during registry data collection (May 2017 to May 2023). Exclusion criteria were rTSA for non-cuff deficient conditions (e.g. glenohumeral osteoarthritis, inflammatory arthritis, fracture), less than one year of follow-up, and those who did not complete both preoperative baseline and 1-year follow-up ASES and SST questionnaires.

ASES and SST questionnaires were collected prospectively at preoperative and one-year postoperative follow-up time points. Patients answering "unable" or "very difficult" for ASES question 14 (ASES14) "Is it difficult for you to lift 10lbs (4.5kg) above your shoulder?" were deemed to have poor self-reported overhead strength. Similarly, a negative answer for SST question 7 (SST7), "Can you lift 8 pounds (a full gallon container) to the level of your shoulder without bending your elbow?" was used as a proxy for poor self-reported overhead strength.

Surgical Technique

All rTSAs were performed by a single fellowship-trained shoulder surgeon through a standard deltopectoral approach with the patient in the beach chair position. A reverse shoulder prosthesis was implanted in all cases using a lateralized glenosphere medialized (inlay) humerus design philosophy. Subscapularis repair was performed when feasible and recorded as a surgical variable. All components were implanted using standard technique with attention to appropriate glenosphere positioning to minimize the risk of scapular notching and optimize postoperative function.

Rehabilitation Protocol

Postoperatively, all patients underwent a standardized postoperative physical therapy protocol. Patients were immobilized for four weeks with early gentle passive range of motion with forward flexion and external rotation. Home-based physical therapy with active range of motion exercises was initiated at four weeks postoperatively. Strengthening exercises were initiated at 12 weeks postoperatively for all patients.

Statistical Methodology

Standard univariate analysis was used to evaluate statistical significance comparing preoperative and postoperative PROMs (satisfaction, ASES and SST scores) and specific patient and surgical factors influencing postoperative

outcomes. Multivariate logistic regression models were used to identify predictors of improvement in self-reported overhead strength for both ASES and SST PROMs. The statistical models were adjusted for sex, age, and subscapularis repair. Statistical analysis was performed using JMPsoftware (Version 13.2; SAS Corp, Cary, NC). Statistical significance was considered when $P < 0.05$.

Results

One hundred and forty-one patients were identified for potential inclusion during the study period. Of one hundred and forty-one patients identified for potential inclusion, sixty-nine patients (48.9%) and forty-eight patients (34.0%) were ultimately included in the ASES and SST groups, respectively. Demographic and surgical data, as well as composite ASES and SST scores and improvements are seen in **Table 1**. No demographic differences between patients who completed ASES and SST questionnaires were found.

Table 1. Demographic characteristics, surgical variables, and outcome measures of patients treated with reverse total shoulder arthroplasty for rotator cuff-deficient conditions.

	ASES	SST	p
N	69	48	
Demographic Characteristics			
Age at treatment, mean (range)	71 (46–94)	70 (52–87)	0.756
Sex			0.726
Female	31 (44.9%)	20 (41.7%)	
Male	38 (55.1%)	28 (58.3%)	
Race			0.89
White	60 (87.0%)	42 (87.5%)	
Black or African American	2 (2.9%)	2 (4.2%)	
American Indian or Alaskan	0 (0.0%)	0 (0.0%)	
Other Race	7 (10.1%)	4 (8.3%)	
Surgical Variables			
Subscapular Take Down			
N	54	37	
Subscapularis Peel	32 (59.3%)	18 (48.6%)	
Subscapularis Tenotomy	22 (40.7%)	19 (51.4%)	
Subscapular Management			
N	53	36	
Repaired	22 (41.5%)	13 (36.1%)	
Not Repaired	31 (58.5%)	23 (63.9%)	
Outcome Measures			
Overall Composite Score			
Preop	38% (n=69)	27% (n=48)	
1-Year Postop	74% (n=67)	66% (n=47)	
Delta (between pre-postop)	35% (n=67)	38% (n=47)	

*denotes statistically significant p-value < 0.05 . ASES = American Shoulder and Elbow Surgeons; SST = Simple Shoulder Test. n = number of patients.

ASES14

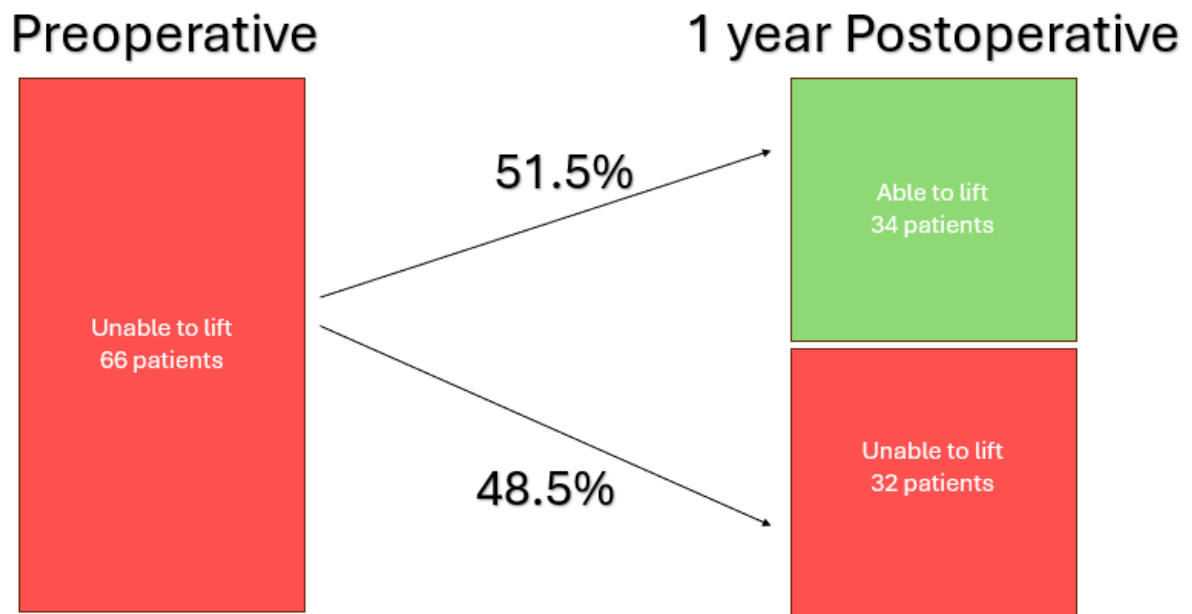


Figure 1. Results of American Shoulder and Elbow Surgeon question 14 (ASES14) regarding self-reported overhead strength preoperatively and one year postoperatively after reverse total shoulder arthroplasty.

Table 2. A multivariate logistic regression of patient and surgical factors predicting self-reported overhead strength at one year postoperatively, based on response to ASES question 14.

Patient Factors ASES	Odds Ratio	Confidence Interval	p Value
Age (65-74: <65)	0.36	0.07-1.85	0.220
Age (75≥: <65)	0.33	0.06-1.75	0.190
Sex (M:F)	3.48	1.03-11.68	0.044*
Subscapularis repair (Y:N)	1.58	0.46-5.40	0.462

*denotes statistically significant p-value <0.05. ASES=American Shoulder and Elbow Surgeon; F=female; M=male; Y=yes; N=no.

American Shoulder and Elbow Surgeon (ASES) Score

Preoperatively, 96% (66/69) of patients self-reported poor strength by ASES14. Of those self-reporting poor preoperative strength, only 51.5% (34/66) self-reported the ability to lift greater than 10lbs above the shoulder at 1-year postoperative follow-up (95% CI, 36.8-60.3) (**Figure 1**).

A multivariable logistic regression including age, sex, and presence or absence of subscapularis repair demonstrated that male sex was the only statistically significant variable influencing self-reported strength at one-year postoperative follow-up, with males being 3.48 times more likely to report improved overhead strength than females as denoted by a positive response to ASES14 (OR 3.48, 95% CI 1.03–11.68,

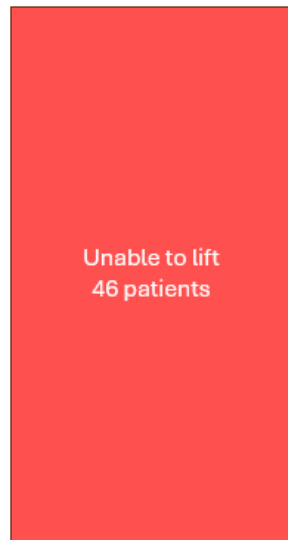
p=0.044) (Table 2). This finding likely reflects greater deltoid muscle mass and residual rotator cuff muscle volume in males, which may contribute to improved self-reported overhead strength following rTSA for cuff-deficient indications [1].

Simple Shoulder Test (SST) Score

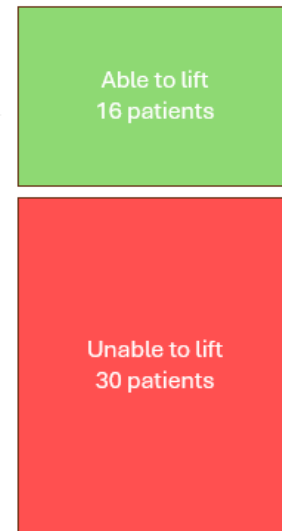
Preoperatively, 96% (46/48) of patients self-reported poor strength by SST7. Of those with self-reporting inability to lift more than 8lbs with the elbow straight to the level of the shoulder preoperatively, 34.8% (16/46) self-reported the ability to do so at 1-year postoperative follow-up (95% CI, 22.7-49.3) (**Figure 2**).

SST7

Preoperative



1 year Postoperative



34.9%

65.2%

Figure 2: Results of Simple Shoulder Test question 7 (SST7) regarding self-reported overhead strength preoperatively and one year postoperatively after reverse total shoulder arthroplasty.

Table 3. A multivariate logistic regression of patient and surgical factors predicting self-reported overhead strength at one year postoperatively, based on response to SST question 7.

Patient FactorsSST Factors	Odds Ratio	Confidence Interval	p Value
Age (60-74: <60)	0.81	0.12-5.56	0.827
Age (75≥: <60)	1.40	0.17-11.26	0.752
Sex (M:F)	5.08	0.97-26.89	0.055
Subscapularis repair (Y:N)	0.70	0.14-3.46	0.665

*denotes statistically significant p-value <0.05. SST=Simple Shoulder Test; F=female; M=male; Y=yes; N=no.

A multivariable logistic regression including age, sex and presence or absence of subscapularis repair demonstrated no statistically significant variable influencing self-reported strength at one-year postoperative follow-up (**Table 3**).

Discussion

Composite ASES and SST scores improved significantly at one-year following rTSA for rotator cuff-deficient indications; however, self-reported overhead strength improvement was inconsistent, confirming our hypothesis. Male sex was the only independent predictor of improved overhead strength, which may reflect sex-based differences in deltoid muscle mass and residual rotator cuff volume. These findings suggest that composite PROMs scores alone may mask clinically meaningful deficiencies in overhead strength

recovery following rTSA, underscoring the importance of evaluating individual PROM items rather than composite scores alone when counseling patients on expected functional outcomes.

A biomechanical rationale may explain this inconsistency. A musculoskeletal modeling study has shown that although rTSA increases the middle deltoid moment arm in early and mid-abduction, the deltoid contributes only 9% to 38% of elevation torque in terminal abduction, where the infraspinatus and subscapularis generate up to 80% [14]. Loaded overhead function after rTSA thus remains dependent on residual rotator cuff function, muscles that are compromised in our cuff-deficient cohort, which may explain why composite scores improved without reliable recovery of overhead strength.

This dissociation is supported by the objective strength literature. A systematic review found that although strength improves after rTSA, gains are modest and often imperceptible, with abduction strength increasing only 0.4 to 4.9 kg and each study falling below the published MCID [9]. Because our analysis relied on self-reported strength, this concordance suggests the limited overhead recovery reflects a true, subthreshold functional gain rather than a questionnaire artifact.

The composite SST and ASES scores can substantially mask strength limitations. Even with the worst possible self-reported overhead strength (ASES14 and SST7), composite ASES and SST scores can still exceed 90%, well above the minimal clinically important difference (MCID) for shoulder arthroplasty [15],[MD9.1]. In the present study, the composite ASES and SST scores improved to 74% (from 34% preoperatively, $p<0.0001$) and 65% (from 23% preoperatively, $p<0.0001$), respectively. Using an anchor-based method, a prior study determined that a 21-point and 2.4-point improvement in ASES and SST scores, respectively, were required to achieve MCID after shoulder arthroplasty[15] [MD10.1].

Interpretation of these thresholds is itself uncertain, as a systematic review reported wide variability in MCID, substantial clinical benefit, patient acceptable symptom state, and maximal outcome improvement values across the rTSA literature (ASES MCID 6.2–21; SST 1.4–3.58) [16]. These instruments are further limited by ceiling effects, with ceiling scores reported in 34.1% of rTSA patients for the SST and 13.3% for the ASES [12], and comparable effects after cuff repair that raise the risk of type II error [13]. Composite scores may therefore overestimate recovery in specific domains such as overhead lifting, for which no dedicated PROM exists.

While ASES14 and SST7 are similar questions, they have nuanced differences. SST7 specifically asks about raising the arm with the elbow straight, a more mechanically demanding task than that queried by ASES14; additionally, SST7 is binary (yes or no), whereas ASES14 is answered along a spectrum of difficulty (0–3 Likert scale). Even with a relatively small sample, perceived strength appeared to be influenced by question phrasing, as 53.6% (37/69) of patients reported good strength at one year by ASES14 (no elbow-position requirement) compared with 37.5% (18/48) by SST7 (requiring the elbow to remain straight). This aligns with biomechanical evidence that muscle contributions to elevation vary markedly across the arc of abduction [14], so small differences in weight, elbow position, and elevation angle may alter perceived strength. Item-level analysis also has precedent, as prior work has separately modeled individual ASES and SST overhead questions [17].

The association between male sex and overhead strength improvement aligns with prior evidence that sex influences rTSA recovery. In a large multicenter cohort, men had better postoperative SST, UCLA, Constant, ASES, and SPADI scores and greater motion than women [18] and higher ceiling-score rates have been reported in men [12]. Sex-related differences in deltoid mass, residual cuff quality, and functional reserve may thus influence both global and task-specific recovery. Subscapularis repair, by contrast, was not associated with improved overhead strength; this does not diminish its importance, as biomechanical work has identified it as a key compensator in terminal abduction [14], but rather indicates that a binary repair variable cannot capture tendon healing, muscle quality, or neuromuscular function.

Our results, limited self-reported overhead strength after rTSA, are consistent with published literature. Several studies have highlighted the lack of correlation between patient satisfaction and objective strength outcomes after rTSA15–18. One study evaluating patient-reported outcomes (PROMs) for primary rTSA across multiple etiologies found that patient satisfaction did not correlate with self-reported or clinical objective outcomes, such as global clinical outcomes, Simple Shoulder Test (SST), Constant-Murley score, or range of motion (ROM) [19]. Despite 93% of patients being “substantially satisfied,” many patients had significant ROM and strength deficits [19]. Similarly, another study found no association between PROMs and objective upper limb movement data collected through accelerometers at 12 months postoperatively after rTSA, suggesting that perceived strength improvement may be more reflective of patient experience than of objective functional change [3]. A separate study following 78 patients post-rTSA, the majority of whom were treated for rotator cuff pathology, found that patients were overall able to maintain a relatively high level of physical activity except for activities that involved overhead actions such as golf, swimming, and heavy lifting, again highlighting the caveats and shortcomings after rTSA [20].

Similar improvement in ASES and SST composite scores for rotator cuff-deficient conditions has been reported at 2-years post-rTSA, with an average increase to 75% (from 34% preoperatively) in the ASES score and an increase to 62% (from 23% preoperatively) in the SST score [21]. The ASES and SST are validated PROMs with one question each regarding self-reported overhead strength [22][23][24][25]. Improvement in the composite scores highlights the maintained satisfaction postoperatively despite limited improvement in self-reported overhead strength and emphasizes how the composite score can mask the limited improvement in postoperative strength. However, it is important to note that the ASES and SST PROMs are only validated as composite scores and drawing conclusions regarding shoulder outcomes from a single question should

be limited [22][23][24][25]. While these are subjective and self-reported PROMs, which come with its own inherent biases and limitations, continuing to utilize and explore these widely adopted PROMs present a clinical tool that can be further explored in terms of patient-reported overhead strength and associated satisfaction [26][27][28].

Limitations

There are several limitations within this study. This is a retrospective review of prospectively collected data. The results of this study are limited by a small sample size, with a significant number of patients excluded due to lack of 1-year follow-up PROMs. Additionally, while ASES and SST PROMs are well adopted and validated in outcome studies of shoulder pathology, there are inherent limitations and biases based on the self-reporting nature of the questionnaires, and the absence of objective clinical examination and in-person strength testing limits the validity of strength-related conclusions. Objective strength gains after rTSA are themselves modest [9], supporting the plausibility of these self-reported findings. One-year follow-up was selected as the assessment time point; although most recovery after rTSA occurs by 6 to 12 months [18], overhead function may decline slowly thereafter [17], and this short duration may not capture the long-term trajectory of strength recovery. Future studies should correlate ASES14 and SST7 responses with objective strength testing at longer follow-up. Furthermore, this study was limited to rotator cuff-deficient indications, which precludes meaningful comparison with patients undergoing rTSA for glenohumeral osteoarthritis; future studies comparing self-reported overhead strength outcomes across rTSA indications would provide valuable comparative data.

Conclusion

This study demonstrates unreliable clinical improvement in patient-reported overhead strength at one-year post-rTSA. Despite significant improvement in overall composite ASES ($p < 0.0001$) and SST ($p < 0.0001$) scores, only one-third to one-half of patients reported self-reported overhead strength improvement at one year, depending on how the question is phrased. Male sex was associated with self-reported improvement in overhead strength as queried by ASES question 14, while age and subscapularis repair were not. Neither sex, age, nor subscapularis repair were associated with self-reported strength improvement by SST question 7. These results can help guide specific aspects of preoperative counseling as patients consider rTSA for cuff-deficient shoulder pathologies.

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Conflict of Interest Statement

Briana Pompa-Hogan, Mikalyn T. DeFoor, Reyhan Meetheen, and James K. Aden: These authors, their immediate family, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

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