RESEARCH ARTICLE

Factors Predicting Postoperative Range of Motion and Muscle Strength one Year after Shoulder Arthroplasty

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Abstract

Background: Shoulder arthroplasty improves shoulder range of motion (ROM), strength and function in patients with advanced shoulder disease. However, clinical outcomes vary and are not always predictable among patients. Pre-operative factors and patients' characteristics may influence improvement after surgery. This study examined the impact of the pre-operative objective measures range of motion (ROM) and strength, age, sex, and comorbidities on shoulder ROM, strength status and the amount of improvement one year following shoulder arthroplasty.

Methods: 140 patients were assessed pre-operatively and one year after shoulder arthroplasty in this prospective cohort study. Pearson's correlations and multiple regression analyses were performed to test the impact of potential predictors on abduction, flexion, internal rotation and external rotation ROM as well as on shoulder abductors, flexors, internal rotators and external rotators strength at one year.

Results: Pre-operative ROM significantly predicted 10% - 37% of the improvement in ROM after surgery. Less pre-operative ROM was associated with a greater improvement in ROM. Less pre-operative muscle strength was associated with a greater improvement in strength after surgery. Pre-operative shoulder muscles predicted 28% - 38% of the strength status at one year, and 24% - 43% of the improvement in strength postoperatively. Older age was associated with less improvement in ROM and strength at one year. With other predictors, age explained 37% of the change in ROM and 36% of the change in strength. Male sex was associated with greater improvement in muscle strength. Sex significantly predicted 24% - 36% of the change in strength.

Conclusion: Pre-operative ROM and strength, age, and sex are significant predictors of the improvement in the shoulder ROM and strength one year after shoulder arthroplasty. The improvement in these measures is expected to decline with age and men are expected to gain more strength than women following this surgical intervention.

Level of evidence: II

Keywords: Muscle strength, Range of motion, Shoulder arthroplasty

Introduction

Shoulder arthroplasty is a surgical procedure that involves replacing either part (partial) or all (total) of the articular surface. When considering all shoulder arthroplasty procedures currently recorded by the Australian Orthopedic Association registry (2018), total shoulder arthroplasty (TSA) was the most common procedure (75.5%), followed by hemiarthroplasty (HA) (14.5%) and revision procedures (10.0%) (1). Shoulder arthroplasty is more commonly undertaken in females (64%) with the majority between the ages of 65 and 84 years (1). The primary diagnosis for HA is fracture (45%) followed

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by osteoarthritis (40%) while the primary diagnosis for TSA is osteoarthritis (65%) followed by rotator cuff arthropathy (21%) (1).

The effect of shoulder arthroplasty on improving range of motion (ROM) is well documented (2). However, the degree of improvement in these objective measures varies among patients and is not always predictable. The factors contributing to this variability are not well investigated and little information is available regarding the pre-operative characteristics of the patients that may affect the quality of the outcomes (3).

Pre-operative ROM in all directions were shown to be predictive of postoperative forward flexion (FF), abduction, external rotation (ER) and internal rotation (IR) ROM one year following TSA (4). Further, pre- and intra-operative FF were found to be strong predictors of postoperative FF ROM one year after reverse shoulder arthroplasty (5). Furthermore, pre-operative ER ROM of less than 10 degrees was associated with less post-operative ER ROM in 118 patients four-years following HA but not TSA (6). However, pre-operative loss of FF did not predict postoperative FF following HA and TSA (6).

While age did not affect postoperative ROM, male sex was associated with increased postoperative ROM one year following reverse shoulder arthroplasty (4, 5). The presence of comorbidities, including diabetes and hypertension, did not predict postoperative ROM, except for IR ROM, which was decreased with diabetes (4). Lastly, humeral head subluxation was associated with lower active ER ROM following HA and TSA (6).

As shown above, few studies examined factors that influence postoperative ROM and muscle strength outcomes following shoulder arthroplasty. Further, there is a lack of reporting regression coefficients that illustrate the degree of change in outcomes after shoulder arthroplasty. This makes it difficult for surgeons and health care professionals to provide patients with realistic expectations of their postoperative outcomes and treatment plans. The purpose of this study was to analyze pre-operative factors that affect postoperative shoulder ROM and muscle strength.

Materials and Methods

Study design and patients

Institutional Review Board approval was obtained for this prospective study. All patients who underwent shoulder arthroplasty at our tertiary care hospital and followed up for a minimum of one year were included in this analysis. A consent form was obtained from all patients.

A computerized database was available for 477 patients. The inclusion criteria for this cohort were the presence of comorbidity data and prospectively collected measurements of shoulder ROM and muscle strength at baseline (pre-operative) and at one year follow-up visit.

This cohort included all patients treated with shoulder arthroplasty regardless of the type of surgery based on our previous study, which showed non-significant differences in ROM and muscle strength among patients who underwent TSA, reverse TSA, and HA (7). A total of 140 patients met these inclusion criteria. Patients whose shoulder ROM and muscle strength data were not available pre-operatively and at one-year follow-up visit were excluded from this study.

Instrumentation

Dependent variables included shoulder ROM and muscle strength. Shoulder ROM was assessed in flexion, abduction, and ER and IR using a standard goniometer. Shoulder ROM was measured using standardized procedures with known high reliability (Intraclass Correlation Coefficients (ICCs) > 0.97) placed along the joint axis by the therapist, was read by an independent assistant (8–10).

Isometric muscle strength was assessed for shoulder flexors, abductors, and lateral rotators (LR) and medial rotators (MR) using the JTech PowerTrack handheld dynamometer (JTech; JTech Medical, Salt Lake City, UT, USA). This device has known validity and reliability (ICCs 0.89-0.98) (11, 12).

Measurements of ROM and strength were recorded pre-operatively and at one year follow-up visit. These data were averaged and compared between patients based on their age, sex, and the presence of comorbidities [Table 1].

Independent variables

The predictive variables of interest included patients' demographics: age, sex, and comorbidities (diabetes, hypertension, depression), and the pre-operative ROM and muscle strength data. The prediction effect of these variables was assessed for the final ROM and strength measurements at one year and on the change of ROM and strength from pre-operative to one year postoperative visit, aiming to estimate the clinical benefits of shoulder arthroplasty.

Statistical analysis

Statistical analyses were performed using SPSS software, version 23 (SPSS Inc., Chicago, IL, USA). A *P value* of *<0.05* was considered statistically significant. An independent sample *t-test* was used to detect differences in the ROM and strength between patients based on age, sex and the presence of comorbidities (diabetes, hypertension, depression). All values are reported as mean and standard deviation (SD). Pearson's correlation coefficients (r) were calculated between the dependent and predictive variables and between the predictive variables. The effect size (ES) of Pearson's correlations were classified as follow: $0.1 \le r < 0.3$ = small effect, $0.3 \le r < 0.5$ = medium effect, $r \ge 0.5$ = large effect (13). A multivariable regression analysis was performed to examine the effect of the predictive variables on the improvement in ROM and strength one year after shoulder arthroplasty. To predict the clinical benefits of shoulder arthroplasty, we calculated the change in ROM and strength measurements by subtracting one year measures from pre-operative measures. Then, a second multivariable regression analysis was performed on the change values.

Table 1. Patient demographics and influence on shoulder ROM and muscle strength one year following shoulder arthroplasty

Patient characteristics	Shoulder ROM (degrees) (n= 140)						Muscle strength (kg) (n= 127)					
	Number of patients (%)	Age Mean (SD)	Flexion Mean (SD)	Abduction Mean (SD)	ER Mean (SD)	IR Mean (SD)	Number of patients (%)	Age Mean (SD)	Flexors Mean (SD)	Abductors Mean (SD)	LR Mean (SD)	MR Mean (SD)
Sex: Male	66 (47)*	69 (8)	136 (30)	124 (34)*	50 (22)	37 (18)	62 (49)	70 (8)	5 (3)*	6 (3)*	5 (3)*	6 (3)*
Female	74 (53)	73 (9)	128 (32)	113 (36)	44 (21)	39 (18)	65 (51)	72 (10)	4 (2)	4 (2)	3 (1)	5 (2)
Diabetes: Yes	27 (19)	73 (8)	132 (28)	115 (33)	48 (16)	37 (14)	23 (18)	74 (9)	4 (2)	4 (1)	4 (2)	4 (2)
No	113 (81)	71 (9)	131 (32)	119 (36)	47 (23)	38 (19)	104 (82)	70 (9)	5 (3)	5 (3)	4 (2)	6 (3)*
Hypertension: Yes	51 (36)	72 (8)	130 (30)	116 (36)	46 (19)	37 (18)	51 (40)	74 (7)*	4 (2)	4 (2)*	4 (1)*	5 (2)*
No	89 (64)	70 (9)	133 (32)	119 (35)	48 (23)	38 (17)	76 (60)	69 (10)	5 (3)	5 (3)	5 (3)	6 (3)
Depression: Yes	15 (11)	64 (7)*	138 (18)	125 (24)	53 (17)	35 (12)	14 (11)	62 (8)*	5 (1)	5 (1)	4 (2)	5 (2)
No	125 (89)	72 (8)	131 (32)	117 (36)	46 (22)	38 (18)	113 (89)	72 (8)	5 (3)	5 (3)	4 (2)	6 (3)

Independent sample *t-test* was used to detect differences between groups (mean (SD)). *Significant difference between groups, $p < 0.05$. ROM: range of motion; ER: external rotation; IR: internal rotation; LR: lateral rotators; MR: medial rotators.

Results

Descriptive statistics

Within this cohort, measures of ROM were available for 140 patients and measures of muscle strength were available for 127 patients. The average age of patients was 71 years (range, 47-89 years). The influence of age, sex, and comorbidities on ROM and strength measures one year after shoulder arthroplasty are presented in Table 1. Patients with depression were younger (64±7 years) than patients without depression (72±8 years), men were stronger (5±3, 6±3, 5±3, & 6±3 kg for flexors, abductors, LR & MR, respectively) and had greater abduction ROM (124 degrees ±34) than women (4±2, 4±2, 3±1, 5±2 kg, & 113 ± 36 degrees, for flexors, abductors, LR, MR muscle strength, & abduction ROM, respectively). Diabetic patients had weaker MR (5±2 kg) than non-diabetes patients (6±3 kg), and hypertensive patients were older (74±7 years) and had weaker muscle strength (4±2, 4±1, & 5±2 kg for abductors, LR and MR, respectively) than non-hypertensive patients (5±3, 5±3, & 6±3 kg, for abductors, LR and MR, respectively) [Table 1].

Pearson's correlations

Pearson's correlation between pre-operative ROM and ROM at one year was significant (*P<0.05*) with small ES (0.2) for flexion and IR ROM. Greater pre-operative flexion and IR ROM were associated with greater ROM at one year. The correlation between pre-operative ROM and the change in ROM after surgery was significant (*P<0.001*) with medium to large ES (-0.3 to -0.6) for flexion, abduction, ER and IR ROM. Worse pre-operative ROM was associated with greater change after surgery. This give opportunity for more profound postoperative gains.

Pearson's correlation between pre-operative strength and strength at one year was significant (*P <0.001*) with medium to large ES (0.4 to 0.6) for flexor, abductor, LR, and MR muscle strength. The greater pre-operative strength was associated with greater strength at one year. However, the lesser pre-operative strength was associated with greater change in strength after surgery with significant (*P <0.001*) medium to large ES (-0.3 to -0.64) for flexors, abductors, LR and MR strength.

Pearson's correlations between ROM and strength and predictors (age, sex, and comorbidities) are summarized in Table 2. The coefficients (ES) ranged from -0.4 to 0.01. There were significant correlations (*P <0.05*) with medium to small ES among shoulder ROM and age (-0.3 to -0.2), and muscle strength and age (-0.3 to - 0.2); indicating that these measures decrease with age. Male patients had significant greater abduction ROM (small ES: -0.2) and stronger shoulder muscles (medium ES: -0.3 - -0.4) when compared to female patients. Diabetic patients had weaker flexors, abductors, and MR muscle strength (small ES: -0.2) when compared to non-diabetic patients. Lastly, hypertensive patients had weaker abductors, LR, and MR muscle strength (small ES: -0.2) when compared to non-hypertensive patients [Table 2].

Multivariable regression analysis

Regression models of ROM

We controlled for the pre-operative flexion, abduction, ER, and IR ROM by adding these measures to the regression models as shown in Table 3. In predicting flexion, age was the only significant predictor of flexion ROM at one year; indicating that with each one year increase in age, flexion decreases by one degree. Together, all predictors (age, sex, diabetes, hypertension, depression, and pre-

Table 2. Pearson's correlations between predictors and dependent factors one year following shoulder arthroplasty

Dependent variables	Predictors				
	Age	Sex	Diabetes	Hypertension	Depression
Shoulder ROM:					
Flexion	-0.3*	-0.1	0.01	-0.04	0.1
Abduction	-0.2*	-0.2*	-0.04	-0.05	0.1
External rotation	-0.2*	-0.1	0.02	-0.05	0.1
Internal rotation	0.02	0.1	-0.03	-0.04	-0.1
Muscle strength:					
Flexors	-0.2*	-0.3*	-0.2*	-0.1	0.1
Abductors	-0.3*	-0.3*	-0.2*	-0.2*	0.04
Lateral rotators	-0.3*	-0.4*	-0.1	-0.2*	0.02
Medial rotators	-0.2*	-0.4*	-0.2*	-0.2*	-0.1

* Significant at $P < 0.05$. ROM: range of motion.

operative flexion ROM) explained 10% of the variability of flexion at one year. In predicting the change in flexion, both age and pre-operative flexion were significant predictors. Lower pre-operative flexion was associated with greater improvement in flexion at one year. All predictors explained 37% of the improvement in flexion ROM [Table 3].

Age was the only significant predictor for abduction ROM indicating that with each one year increase in age, abduction ROM decreases by 0.9 degree. All predictors explained 8% of the variability in abduction ROM at one year. In predicting the change in abduction, both age and pre-operative abduction were significant predictors of the improvement in the abduction ROM at one year. Less pre-operative abduction ROM was associated with a greater improvement in abduction. All predictors explained 30% of the improvement in abduction ROM [Table 3].

For ER and IR ROM, pre-operative IR ROM was a significant predictor of IR ROM. With each one degree increase in pre-operative IR, there was a 0.5 degree increases in IR at one year. All predictors explained 5% of the variability in ER and IR ROM. In predicting the change in ER and IR ROM, pre-operative ER and IR ROM were significant predictors of the improvement in ER and IR ROM at one year, respectively. Less pre-operative rotational ROM was associated with greater improvement in ER and IR ROM. Together, all predictors explained 20% and 10% of the improvements in ER and IR ROM, respectively [Table 3].

Regression models of muscle strength

We controlled for the pre-operative flexor, abductor, LR, and MR muscle strength by adding these measures to the regression models as shown in Table 4. In predicting flexor strength at one year and the change in flexor strength, pre-operative flexor strength was the

Table 3. Regression model summary for shoulder ROM one year following shoulder arthroplasty

Dependent variables Shoulder ROM	R	R^2	Adj. R^2	SE	F	Sig
Flexion	0.31[a]	**0.10**	0.06	31	2.4	0.03
Change in flexion	0.61[a]	**0.37**	0.34	31	13	<0.001
Abduction	0.28[b]	0.08	0.04	35	2.0	NS
Change in abduction	0.55[b]	**0.30**	0.27	34	9	<0.001
External rotation	0.22[c]	0.05	0.005	22	1.1	NS
Change in external rotation	0.45[c]	**0.20**	0.17	22	5.7	<0.001
Internal rotation	0.22[d]	0.05	0.004	18	1.1	NS
Change in internal rotation	0.31[d]	**0.10**	0.06	18	2.4	0.03

Dependent variables: one-year status and change in ROM from pre-operative to one-year following shoulder arthroplasty
a Predictors: (constant), age, sex, hypertension, diabetes, depression, pre-operative flexion ROM
b Predictors: (constant), age, sex, hypertension, diabetes, depression, pre-operative abduction ROM
c Predictors: (constant), age, sex, hypertension, diabetes, depression, pre-operative external rotation ROM
d Predictors: (constant), age, sex, hypertension, diabetes, depression, pre-operative internal rotation ROM
ROM: range of motion

Table 4. Regression model summary for shoulder muscle strength one year following shoulder arthroplasty

Dependent variables Shoulder muscle strength	R	R^2	Adj. R^2	SE	F	Sig
Flexors	0.62[a]	0.38	0.35	2	12	< 0.001
Change in flexors	0.65[a]	0.43	0.40	2	15	< 0.001
Abductors	0.55[b]	0.31	0.27	2	9	< 0.001
Change in abductors	0.60[b]	0.36	0.33	2	11	< 0.001
Lateral rotators	0.54[c]	0.29	0.25	2	8	< 0.001
Change in lateral rotators	0.49[c]	0.24	0.20	2	6	< 0.001
Medial rotators	0.53[d]	0.28	0.24	2	8	< 0.001
Change in medial rotators	0.61[d]	0.38	0.35	2	12	< 0.001

Dependent variables: one-year status and change in muscle strength from pre-operative to one-year following shoulder arthroplasty
a Predictors: (constant), age, sex, hypertension, diabetes, depression, pre-operative flexors strength
b Predictors: (constant), age, sex, hypertension, diabetes, depression, pre-operative abductors strength
c Predictors: (constant), age, sex, hypertension, diabetes, depression, pre-operative Lateral rotators strength
d Predictors: (constant), age, sex, hypertension, diabetes, depression, pre-operative Medial rotators strength

only significant predictor of these dependent variables; indicating that patients with stronger pre-operative flexors had less improvement in flexor strength at one year postoperatively. All predictors explained 43% of the improvement of flexor strength one year postoperatively [Table 4].

In predicting abduction strength at one year and the change in abductors strength, age, sex, and pre-operative abductor strength were the only significant predictors. With each one year increase in age, abductor strength decreases by 0.06 kg; men had stronger abductors (0.9 kg) than women; and patients with stronger pre-operative abductors had less improvement in abductor strength at one year. All predictors explained 36% of the improvement in abductors strength one year postoperatively [Table 4].

Age, sex, and pre-operative LR strength were significant predictors of LR strength at one year and the change in LR strength. Each one year increase in age was associated with a 0.05 kg decrease in LR strength, men had stronger LR (one kg) than women, and patients with stronger pre-operative LR had less improvement in LR strength. All predictors explained 24% of the variability in LR muscle strength one year after surgery [Table 4].

Lastly, sex and pre-operative MR strength were significant predictors of MR strength at one year and the change in MR strength. Men were stronger (1.4 kg) than women, and stronger pre-operative MR was associated with less improvement in MR strength. Together, all predictors explained 38% of the improvement in MR muscle strength at one year postoperatively [Table 4].

Discussion

This study found that pre-operative ROM and muscle strength measures are important factors (ES=0.3 for ROM & 0.64 for muscle strength) in determining the overall improvement in shoulder ROM and muscle strength one year following shoulder arthroplasty. Greater pre-operative ROM and muscle strength are associated with greater ROM and strength one year after shoulder arthroplasty. Further, less pre-operative ROM and strength are associated with greater postoperative change and improvement in ROM and muscle strength. This indicates that patients with worse pre-operative ROM and strength have more room to improve; however, those patients are not expected to achieve the same results as patients who have better ROM and muscle strength pre-operatively.

In this study, younger age is associated with greater flexion and abduction ROM and stronger abductors and LR muscles as well as greater change or improvement in these measures one year postoperatively. Further, males are expected to get stronger abductors, LR, and MR muscle strength and greater change in strength from preoperative to one year after shoulder arthroplasty.

Indeed, although pre-operative flexion, abduction, and ER are not significant factors in predicting shoulder ROM status at one year, these measures predicted the change in shoulder ROM following shoulder arthroplasty; suggesting that patients with lesser pre-operative flexion, abduction, and ER ROM are expected to gain greater improvements in shoulder ROM postoperatively. However, pre-operative IR ROM is significantly associated with greater IR at one year status but with less change in IR ROM after surgery.

These findings are consistent with the study of Iannotti & Norris (n=118) who found that pre-operative flexion ROM did not predict postoperative flexion four years after shoulder arthroplasty (6). Further, Levy et al. (n=230) reported that pre-operative IR ROM significantly predicted postoperative IR ROM one year following TSA (4). On the contrary, previous research found that pre-operative flexion, abduction and ER ROM were significantly associated with greater postoperative ROM (4, 5). These contradictions might be related to the differences in the inclusion criteria and the various sample size.

Although Iannotti & Norris found that pre-operative ER ROM is a significant predictor of the change in ER ROM after surgery, which concurs with our study, the authors reported that pre-operative ER ROM of less than 10 degrees was associated with less improvement in postoperative ER ROM (6). Our results show the opposite; less pre-operative ER ROM is associated with greater improvement in ER ROM one year after shoulder arthroplasty. In our previous paper, which summarized the improvements in ROM following shoulder arthroplasty, the average of pre-operative ER ROM was (22 ±12 degrees), indicating that the majority of our patients had an ER ROM greater than 10 degrees (7). This might explain the conflicting findings.

In our previous research, we reported a significant improvement in shoulder strength one year following shoulder arthroplasty (7). In this paper, we showed that pre-operative muscle strength is a significant predictor of postoperative strength, and stronger pre-operative muscles are associated with less improvement. We could not find previous research examining the prediction effect of pre-operative muscle strength on the postoperative strength; therefore, no comparisons are made.

Previous research has demonstrated a loss of shoulder ROM and muscle strength with age (14, 15). Age-related sarcopenia or loss in muscle mass can be compounded by disuse atrophy due to arthritis or an incomplete resolution of symptoms following surgery. In the present study, older age is associated with less shoulder flexion and abduction ROM as well as a lower strength in the abductors and LR strength status at one year. Besides, older age is associated with smaller improvements in flexion and abduction ROM as well as with less improvement in strength following shoulder arthroplasty. The association of age with strength, motion and the amount of improvement at one year suggests that both direct and indirect age-related mechanisms are involved. Not all studies concur with ours, as Schwartz et al. study found no significant relationship between age and ROM one year follow-up in 540 patients undergoing reverse shoulder arthroplasty (5). Variations in ROM measuring techniques, the use of a digital goniometer and asking patients not to go beyond the point of pain may have contributed to this variation (5).

In our study, statistically significant greater shoulder strength and greater improvements in strength are associated with male sex, suggesting that men gain more shoulder strength one year after shoulder arthroplasty. Since men have substantially more upper body strength than women this may explain these findings as a sex-based difference. However, gender differences in activities that men and women engage in may also affect recovery patterns. However, sex was not a significant predictor of postoperative ROM, contradicting the findings of Schwartz et al. which reported significantly greater shoulder ROM in their male patients one year following reverse shoulder arthroplasty (5).

Comorbidities of diabetes, hypertension, and depression are not significant factors in predicting shoulder ROM and strength at one year and are not associated with the changes in these measures. This is consistent with our previous research, in which these comorbidities were not significant factors in predicting shoulder pain and function as well as physical health status (16). Our findings are inconsistent with the Levy et al. study who reported that diabetes was a significant factor in predicting shoulder IR ROM (4). However, we found a significant correlation between diabetes and flexors, abductors and MR strength as well as between hypertension and abductors, LR, and MR strength, suggesting that diabetic and hypertensive patients may suffer from weaker muscles following shoulder arthroplasty. Previous research had reported a higher prevalence of chronic diseases among older people (17). Hence, weaker muscles after shoulder arthroplasty could be related to ageing rather than to the actual presence of comorbidities.

Possible implications of these associations include investigating the benefits of pre-rehab approaches that attempt to improve strength and motion pre-operatively. Alternatively, older adults with arthritic symptoms that limit the effectiveness of pre-rehab may require longer or appropriately targeted rehabilitation. The clinical implications of these findings are speculative since only clinical trials comparing different solutions can identify if predictors are modifiable. Otherwise, the predictors can only be confidently used to help patients understand the probability they will achieve a specific outcome.

Strengths and limitations

Our study provided new insights about the effect of pre-operative ROM, pre-operative strength, age, sex, and comorbidities on one year postoperative shoulder ROM and strength status and clinical benefits after shoulder arthroplasty. This study was a large prospective cohort of patients who underwent shoulder arthroplasty. Shoulder ROM and strength were objectively measured using validated and reliable instruments. Further, in some of our models, the explained improvements in shoulder ROM and strength were large, which makes them useful for clinical prognostication. However, our study has some limitations. The data was collected in a single-specialty upper extremity program and may not be generalized to other practices. In addition, we did not control for other factors such as the quality and types of implant, postoperative complications, and neck ROM that might affect the improvement in shoulder ROM and muscle strength after shoulder arthroplasty. Lastly, controlling for age and body weight may provide a better estimate of the differences in muscle strength between men and women. In our study, we measured and reported absolute but not relative muscle strength (dividing muscle strength by body weight).

This study found that less pre-operative ROM and weak shoulder muscles are significantly associated with greater improvement and surgical benefits one year after shoulder arthroplasty. Further, young age and male sex are associated with greater surgical benefits. Furthermore, the presence of comorbidities does not impact the final ROM and strength status at one year postoperative and the amount of improvement gained with surgery. Detecting factors that affect clinical outcomes can assist clinicians in providing realistic expectations about the expected final outcome following shoulder arthroplasty. Studies are required to examine the effect of these factors, such as muscle strength, on clinical outcomes after surgery.

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