The Effect of Subscapularis Specific Rehabilitation Following Total Shoulder Arthroplasty: A Prospective, Double-Blinded, Randomized Controlled Trial

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INTRODUCTION: The classic deltopectoral approach to the shoulder for arthroplasty consists of a subscapularis takedown to access the joint. For the purpose of anatomic total shoulder arthroplasty, the subscapularis is often repaired following implantation of the prosthesis. Following surgery, patients undergo a period of immobilization followed by passive range of motion and eventually progressing to a traditional rehabilitation protocol at our institution. Given the attention paid to the subscapularis tendon during surgey, the purpose of this study was to assess whether the addition of a subscapularis specific exercises added to the traditional physical therapy rehabilitation protocol would result in improved subscapularis strength, range of motion and function following anatomic total shoulder arthroplasty.

METHODS: Patients aged 18 or older undergoing anatomic total shoulder arthroplasty for the treatment of primary glenohumeral osteoarthritis were recruited for participation in the study. Patients were excluded if they had an insufficient subscapularis or rotator cuff tendon, were undergoing a revision surgery or had an ipsilateral shoulder surgery in the past, or had a contralateral shoulder surgery within a year, or if the etiology of their ipsilateral shoulder osteoarthritis was secondary to infection, inflammatory arthropathy or rotator cuff deficiency. After patient-informed consent, patients were randomized into either the traditional rehabilitation (TR) control group or the subscapularis rehabilitation group (SR), which consisted of the traditional therapy along with additional subscapularis exercises. Randomization and de-identification of data was performed by an independent member of the research team who did not participate in administering therapy or collecting data. All other members of the surgical and rehabilitation team were blinded to therapy allocation. Baseline demographics, patient reported outcome metrics, range of motion (ROM), functional tests, and subscapularis strength using a handheld dynamometer were measured preoperatively at the initial clinic visit (ICV) as well as 3 months, 6 months, and one year post-operatively. The primary outcome of interest was a comparison of subscapularis strength between cohorts, while secondary outcomes of interest were functional, ROM and patient reported outcomes (PROs).

RESULTS:

Results: Sixty-six patients were included in final analysis (32 TR vs 34 SR). There was no statistically significant difference when evaluating demographic characteristics such as, age (p=0.153), body mass index (p=0.183), sex (p=0.836), laterality of injury (p=0.952), and dominant hand (p=0.444), between cohorts at the ICV (Table 1). There was also no significant difference in subscapularis strength testing at the ICV, including peak subscapularis strength (74% ± 21% vs 81% ± 28%, p=0.275) and average subscapularis strength (45% ± 29% vs 81% ± 17%, p=0.594). There was similar ROM, subscapularis provocative testing, and PROs between groups at the ICV (Table 2). Subscapularis strength testing was similar between TR and SR groups at 3-months, 6-months, and 12-months postoperatively (p>0.05, Table 3). Additionally, peak and average subscapularis strength testing at 3-months, 6-months, and 12-months postoperatively were similar to baseline ICV testing in both groups, without any significant changes in strength between groups during postoperative rehabilitation. Patients in both groups returned to baseline ICV strength in similar fashion (Figure 1). ROM measurements in both the TR and SR groups improved postoperatively at the 3-month, 6-month, and 12-month postoperative measurements as compared to baseline ICV testing (Table 4). When comparing ROM of the operative shoulder as a percentage of the contralateral shoulder at each timepoint, there were no significant differences between TR and SR groups (Table 5). When evaluating PROs, there were significant improvements in PROMIS upper extremity function and pain, QUICKDASH disability, and ASES scores at every postoperative timepoint in both the TR and SR groups, as compared to baseline ICV values (Table 6).

DISCUSSION AND CONCLUSION:

Patients undergoing anatomic total shoulder arthroplasty return to baseline internal rotation strength by 3-months postoperatively and demonstrate significant improvements in function, range of motion, and several patient reported outcome measures. The addition of subscapularis strengthening exercises to traditional rehabilitation programs does not appear to improve internal rotation strength, shoulder range of motion, or patient reported outcomes.

Table 3. Subscapularis Strength Between Cohorts at each timepoint

	Group	Mean ± SD	P-Value	Effect Size
Average Force ICV	Rehab	72% ± 20%	0.179	-2.12
	Control	104% ± 25%		
Peak Force ICV	Rehab	74% ± 21%	0.275	-0.28
	Control	81% ± 28%		
Average Force 3 months	Rehab	45% ± 29%	0.594	-1.51
	Control	81% ± 17%		
Peak Force 3 months	Rehab	79% ± 31%	0.679	-0.13
	Control	82% ± 18%		
Average Force 6 months	Rehab	47% ± 20%	0.506	-1.51
	Control	85% ± 23%		
Peak Force 6 months	Rehab	83% ± 14%	0.551	-0.19
	Control	87% ± 22%		
Average Force 1 year	Rehab	80% ± 25%	0.053	-1.37
	Control	115% ± 26%		
Peak Force 1 year	Rehab	79% ± 21%	0.052	-0.84
	Control	100% ± 3a%		

Continuous variables are presented using Adjusted Mean ± Standard Deviation
P-values with significance P< 05 are indicated by Bold text
Abbreviations: ICV, initial clinic visit; preop, preoperative

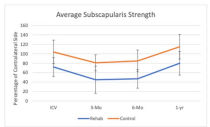

Figure 1. Average subscapularis strength as a percentage of the non-operative extremity across each clinic visit. Significant value p<0.05 denoted by asterisk*

Table 4. ROM between cohorts at each time point

Cohort	ROM	Time Point		P-Value
		ICV	3Mo	
	ER	35.3 ± 17.1	49.0 ± 19.3	**2.99880E-07**
	Abd	82.1 ± 25.9	96.3 ± 22.0	**0.043905458**
	FF	87.2 ± 32.1	108.6 ± 28.3	**0.015460556**
	Ab IR	28.4 ± 21.0	30.3 ± 17.2	0.739383763
	Ab ER	43.9 ± 28.4	56.7 ± 20.8	0.093913595
		ICV	6Mo	
Rehab	**ER**	35.3 ± 17.1	58.1 ± 14.6	**0.00036649**
	Abd	82.1 ± 25.9	136.9 ± 20.6	**2.89732E-08**
	FF	87.2 ± 32.1	140.9 ± 12.8	**2.46273E-07**
	Ab IR	28.4 ± 21.0	45.0 ± 23.8	**0.000498101**
	Ab ER	43.9 ± 28.4	79.9 ± 11.7	**1.99215E-05**
		ICV	1Yr	
	ER	35.3 ± 17.1	58.1 ± 14.6	**0.000293508**
	Abd	82.1 ± 25.9	136.1 ± 20.6	**1.40103E-07**
	FF	87.2 ± 32.1	140.9 ± 12.8	**3.41806E-06**
	Ab IR	28.4 ± 21.0	45.0 ± 23.8	**0.034705516**
	Ab ER	43.9 ± 28.4	79.9 ± 11.7	**0.00021661**
		ICV	3Mo	
	ER	31.7 ± 15.7	46.2 ± 16.8	**7.41434E-07**
	Abd	81.8 ± 31.1	97.9 ± 31.4	0.068620182
	FF	93.4 ± 31.9	104.1 ± 28.7	0.217547948
	Ab IR	25.9 ± 20.7	35.5 ± 19.4	0.098157628
	Ab ER	41.7 ± 27.2	59.9 ± 18.0	**0.010537324**
		ICV	6Mo	
Control	**ER**	31.7 ± 15.7	51.9 ± 16.9	**2.40791E-09**
	Abd	81.8 ± 31.1	117.3 ± 26.9	**2.49766E-07**
	FF	93.4 ± 31.9	122.3 ± 24.5	**2.67265E-08**
	Ab IR	25.9 ± 20.7	39.0 ± 23.9	**6.00160E-06**
	Ab ER	41.7 ± 27.2	74.4 ± 14.8	**1.06421E-07**
		ICV	1Yr	
	ER	31.7 ± 15.7	58.7 ± 15.5	**7.65403E-07**
	Abd	81.8 ± 31.1	121.5 ± 26.2	**5.78174E-05**
	FF	93.4 ± 31.9	137.3 ± 44.5	**0.000235788**
	Ab IR	25.9 ± 20.7	50.9 ± 22.4	**0.000403358**
	Ab ER	41.7 ± 27.2	70.3 ± 13.2	**0.000240341**

Table 5. Range of Motion Between Cohorts at each timepoint as a percentage of non-operative arm

Time Point	ROM	Rehab	Control	P-Value
	ER	57.8% ± 29.6%	66.3% ± 63.1%	0.484
	Abd	65.1% ± 29.7%	62.7% ± 21.2%	0.730
ICV	FF	68.7% ± 23.7%	64.9% ± 28.2%	0.658
	Ab IR	58.7% ± 33.2%	60.4% ± 32.2%	0.841
	Ab ER	62.2% ± 28.9%	62.9% ± 33.6%	0.924
	ER	82.8% ± 27.6%	83.9% ± 56.7%	0.940
	Abd	72.3% ± 23.6%	70.8% ± 15.1%	0.814
3 Months	FF	73.3% ± 22.9%	76.3% ± 18.1%	0.648
	Ab IR	63.9% ± 36.5	66.6% ± 58.8%	0.862
	Ab ER	69.9% ± 32.6%	63.8% ± 29.6%	0.528
	ER	82.9% ± 33.6%	146.1% ± 169.6%	0.109
	Abd	92.8% ± 36.3%	93.8% ± 33.9%	0.935
6 Months	FF	84.5% ± 16.3%	88.0% ± 21.4%	0.574
	Ab IR	80.4% ± 41.7%	66.9% ± 41.4%	0.331
	Ab ER	93.5% ± 24.8%	97.8% ± 42.4%	0.704
	ER	96.0% ± 32.1%	106.5% ± 26.3%	0.387
	Abd	89.8% ± 16.2%	99.3% ± 29.9%	0.275
1 Year	FF	91.1% ± 21.8%	100.3% ± 27.3%	0.349
	Ab IR	81.9% ± 43.4%	78.2% ± 21.4%	0.809
	Ab ER	99.1% ± 45.1%	116.3% ± 54.4%	0.385