Functional Outcomes following Rotator Cuff Repair based on Tissue Quality: A Pilot Study

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ABSTRACT

Study Design: Prospective nonrandomized descriptive repeated measures design.

Objective: The specific aims of this study were to: (1) determine agreement between magnetic resonance imaging (MRI) and intraoperative soft tissue assessment of the rotator cuff (RC), (2) determine if postoperative range of motion (ROM) and manual muscle test (MMT) gains are different based on severity of RC pathology, and (3) determine if there is a difference in postoperative functional outcomes based on severity of RC pathology.

Background: Successful treatment of RC tears is presumed to be dependent upon surgical intervention and appropriate rehabilitation. Many factors are alleged to have an impact on postoperative functional outcome. Determining whether age, presence of glenohumeral osteoarthritis, duration of symptoms, extent of tear, or presence of muscle atrophy have an influence on outcome may be helpful to the practicing clinician.

Methods and Measures: Ten subjects who had an arthroscopic RC repair underwent preoperative and postoperative examination for pain, range of motion, muscle performance, and function.

Results: Patients with less severe RC pathology had marked increases in postoperative active range of motion (AROM) forward flexion, AROM external rotation at 0° abduction, and increases in manual muscle test (MMT) measures of anterior deltoid, middle deltoid, and internal rotators (all, $p < .042$). No differences in functional outcome were observed based on the extent of tear, presence of atrophy, and duration of symptoms.

Conclusions: Improvements in postoperative AROM and MMT measures appear to be dependent upon severity of pathology.

Key Words: atrophy, extent of tear, rotator cuff, shoulder

INTRODUCTION

Rotator cuff (RC) tears are a common and prevalent condition,[1] with a variable presentation. The presence of a RC tear can cause a vast array of impairments.[2-5] These impairments include pain, loss of motion, and weakness. These impairments eventually lead to disabilities such as the inability to participate in throwing sports or complete occupational tasks of lifting and reaching. Many patients dealing with a full thickness RC tear require surgical intervention in order to restore shoulder function. The conventional management for a painful RC tear that has failed conservative treatment is operative repair with subacromial decompression.[6-8] Postoperative outcomes for patients having undergone a RC repair are quite good.[4,9-19] General health status has been shown to significantly improve in individuals that have undergone surgery for chronic RC disease.[9] Patients who have undergone an arthroscopic RC repair have shown to have a more rapid recovery of function than those whose procedures were performed with an open procedure.[20-22] The biomechanical strength of the repaired RC has been reported to be dependent upon tissue quality, surgical technique, and materials used.[2,23-25] Despite the literature that demonstrates that arthroscopic RC repair leads to good functional results, it is still not known which of the soft tissue variables of the RC have an impact on functional outcome. An increase in postoperative strength and a decrease in pain have been correlated with early surgical repair.[3,26] Patients with smaller tears have had better outcomes.[5,11]

Given the many variables that influence a RC tear, it is understandable that the surgical and rehabilitation process can be a challenge for the orthopaedic surgeon and physical therapist. To date, there is no standard that a surgeon or physical therapist can use to predict outcomes and guide postoperative care. Successful treatment is presumed to be dependent upon surgical intervention and appropriate rehabilitation. In addition, many variables have been presumed to impact the functional outcomes of patients who have undergone a RC repair; these variables include: age of the individual, activity level of an individual, duration of symptoms, extent of the tear, location of tear, number of tendons involved, overall RC tissue quality, presence of muscle atrophy, as well as the presence or absence of other pathology within the shoulder complex. Despite these prognostic indicators there are minimal reports of functional outcome based on classification of these defining RC variables.

Most studies reporting outcomes of patients who have undergone a RC repair have only reported correlation's between size of the tear and/or type of tear and functional outcome.[27-30] In 1994, Gazielly et al[27] found a significant correlation between type of tear and the postoperative functional score; those with a smaller tear had better postoperative shoulder function. In contrast, Pai et al[14] reported that with the exception of massive tears there is no correlation between the size of the cuff tear and functional outcome. Others support this as well.[31] The presence of atrophy and fatty infiltration are very important factors in RC repair success.[32] However, very few studies have described

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the presence of atrophy and its effect on postoperative functional outcomes; yet supraspinatus atrophy is a strong predictive factor of postoperative retearing of RC repairs.[33,34] Postoperative retearing certainly has an impact on function. However, other than the incidence of retearing, there are no reported correlations between the presence of atrophy and functional outcome.

There are no reported studies examining all the previously mentioned variables: age of the individual, activity level of an individual, size of the tear, location of tear, number of tendons involved, overall RC tissue quality, the presence or absence of other pathology within the shoulder complex and their correlation to functional outcome. One reason this may be the case is that there is not an established universal grading scale for soft tissue pathology, making it difficult to describe all the characteristics of RC pathology. If one cannot universally describe pathology, it makes it difficult to correctly classify and investigate such pathology and interventions needed to correct the pathology and determine their impact on functional outcome. The specific aims of this study are to: (1) determine agreement between magnetic resonance imaging (MRI) and intraoperative soft tissue assessment of the RC, (2) determine if postoperative range of motion (ROM) and manual muscle test (MMT) gains are different based on severity of RC pathology, and (3) determine if there is a difference in postoperative functional outcomes based on severity of RC pathology.

METHODS

Subject Information and Consent

Approval for this study was granted by the Institutional Review Board of Partners HealthCare System, Inc., Boston, Massachusetts. Subjects were provided written information explaining the purpose of this study. Their rights were protected and consent was received from all subjects prior to participation. Subjects were free to withdraw from the study at any time.

Power Analysis

The subjects in this study were presumed to have better outcomes in comparison to other subjects following RC repair due to the fact that our subjects underwent an arthroscopic procedure. Therefore, there would only likely be 2 groups of subjects: those with good results and those with excellent results. A significance level of 0.05 and a power of 0.9 to detect a change of greater than 10 raw points on the American Shoulder and Elbow Surgeon's Shoulder Evaluation Short Form (ASES)[10] and 8 raw points on the Simple Shoulder Test (SST)[35] would be considered an acceptable difference between the two groups. The sample size based on these factors would need to be 18 people in each of these groups in order to delineate significance between them. Hence, a total sample size of 36 subjects was indicated for this study.

Experimental Design

A prospective nonexperimental descriptive repeated-measures research design was employed in this investigation, with subjects being assessed both preoperatively and 6 months postoperatively in regards to range of motion, muscle performance, pain, and function. Preoperative MRI assessments were conducted along with an intraoperative visual assessment.

Inclusion/Exclusion Criteria

Potential subjects between the ages of 18 and 65 years of age, with a RC tear, as diagnosed by an orthopaedic surgeon, of at least 3 months duration who failed conservative treatment and were electing to undergo an arthroscopic RC repair participated in this study. The exclusion criteria included: an open surgical repair of a RC tear, history of previous RC surgery, previous deformity and/or fracture of the glenohumeral joint, clinically symptomatic cervical spine pathology, previous brachial plexus injury, history of cognitive impairments, progressive neurological disorder, and pending litigation and/or workman's compensation.

Procedure

After informed consent was obtained, preoperative data collection included demographic information of past medical history, age, gender, activity level, and social support. Functional performance as reported by the subject was measured using the Simple Shoulder Test (SST) self-evaluation tool.[35,35] The SST is a quick, subjective questionnaire consisting of 12 yes-no questions pertaining to shoulder function. Pain, range of motion, muscle performance, and functional performance was measured by the American Shoulder and Elbow Surgeon's Shoulder Evaluation Short Form (ASES).[10] This measure includes a visual analog scale and functional ability questions. Shoulder active and passive range of motion as outlined on the ASES was measured using a plastic goniometer using standardized methods of goniometric assessment.[36] Those ROM measurements included: active range of motion (AROM) and passive range of motion (PROM) forward flexion, AROM and PROM external rotation at 0° of abduction, and AROM external rotation at 90° of abduction. Muscle performance, also as outlined on the ASES, was assessed by standardized MMT[37] for the anterior deltoid, middle deltoid, internal rotators, and external rotators. Health related quality of life factors were assessed using the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36). These 3 assessment tools were again used by the physical therapist for follow-up assessments at 6 months postoperatively.

Preoperative MRI was used to quantify the presence of supraspinatus atrophy by calculating the occupation ratio (r) of the supraspinatus in the suprascapular fossa as first described by Thomazeau.[38] The occupation ratio of the supraspinatus fossa by its muscle was quantified from I (no atrophy) to III (complete atrophy) along a 3-grade classification. This was calculated from r = S1 (cross section of the supraspinatus muscle)/S2 (cross section of the suprascapular fossa) (Figure 1). This ratio is a highly reliable measure and there is a strong correlation between a decrease in the occupation ratio and the presence

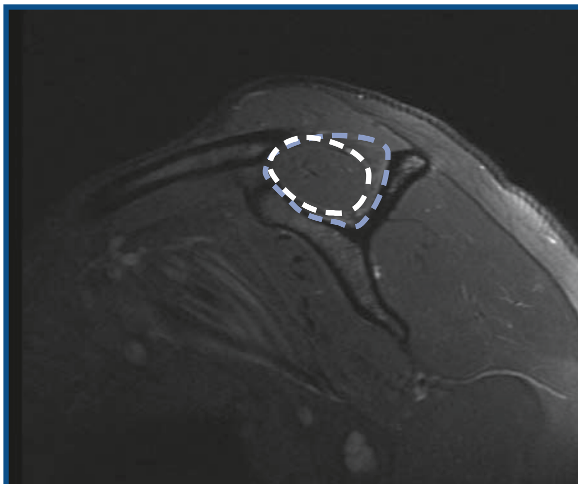

Figure 1. Magnetic resonance imaging schematic representation of a sagittal section through the midportion of the supraspinatus fossa. Landmarks for the occupation ratio of the supraspinatus. Ratio = S1/S2

S1 = cross section of the supraspinatus muscle – – –
S2 = cross section of the suprascapular fossa. — —

of a RC tear.[38] Normative values of each of the 3-grade classifications exist (Table 1). In addition, to the occupation ratio, the RC musculature was graded using the Patte Classification System.[39] The Patte Classification System was devised to classify RC tears during the 1980s through the use of a descriptive study that analyzed the findings of 256 cuff repairs. The classification is based on the: (1) extent of the tear, (2) topography of the tear in the sagittal plane, (3) topography of the tear in the frontal plane, (4) trophic quality of the muscle of the torn tendon, and (5) state of the long head of the biceps. In addition, the presence or absence of glenohumeral osteoarthritis and subluxation was documented based on visual inspection of the MRI. The same radiologist conducted all MRI assessments. Intraoperative assessments were conducted by the orthopaedic surgeon and included the extent and topography of the tear using the Patte classification system and the presence or absence of glenohumeral osteoarthritis and subluxation. All investigators were blinded to the other's measures until after the patients had completed their 6-month postoperative functional assessment.

Table 1. Occupation Ratio of the Supraspinatus Fossa

Stage	Range	Descriptor
I	1>R≥0.6	No Atrophy
II	0.6>R≥0.4	Atrophy
III	R<.04	Complete Atrophy

All subjects received their postoperative physical therapy care at a clinical site of their choice. Their care was guided on an evaluation-based protocol written by the orthopaedic surgeon and physical therapist investigators. The researchers based the protocol on the best available knowledge of basic science, biomechanics, and clinical outcomes.[40]

Data Analysis

Descriptive statistics were calculated and computed for each study variable. Percent agreement between MRI and intraoperative assessment measures were determined. Patients were subdivided into groups based on extent of tear, presence of atrophy, and duration of symptoms. Paired t tests were used to compare all preoperative and postoperative outcome values for the entire sample size and then for each of the subdivided groups. Unpaired t tests were used to describe the relationship between groups of each subdivision. Alpha level = 0.05 was used to determine significance for all statistical tests. Statistical analysis was conducted using Microsoft Excel: Office 2003 (Redmond, Wash) and SAS v 10.0 software package (SAS Institute, Cary, NC).

RESULTS

Demographic Data

Twenty-four of 34 patients referred for study enrollment were excluded based on the inclusion and exclusion criteria; 3 due to previous RC tear, 10 because they were 65 or older, 1 had symptomatic cervical spine pathology, 8 with pending litigation, and 2 that declined consent. Ten patients (7 males and 3 females) between the ages of 18 and 65 years of age (mean age ± SD, 52.1 ± 5.2 years), with a RC tear, as diagnosed by an orthopedic surgeon, of at least 3 months duration despite conservative treatment who were electing to undergo an arthroscopic RC repair participated in this study. The mean (± SD) duration of symptoms was 15.8 ± 12.46 months. The dominant arm was involved in 7 subjects, while the nondominant arm was involved in 3 subjects. All subjects completed the study assessments without difficulty.

MRI and Intraoperative Rotator Cuff Characteristics

Nine of the 10 subjects had a preoperative MRI. Of the 13 common soft tissue variables assessed both by MRI and intraoperatively the mean (± SD) number of variables that were scored exactly was 8.56 ± 3.61 per subject. The status of the glenohumeral joint matched with 83% (15/18) of variables scored exactly the same, with the muscle bulk of the 4 RC muscles matching with exactly 83% (30/36) of the time. The status of the long head of the biceps was scored the same a majority of the time (62%, 17/27), while the extent and topography of the tear was consistent 44% (12/27) of the time. Operative findings of the status of RC pathology, based on the Patte Classification system, consisted of 2 subjects having an Ia tear, 1 having a Ib tear, 4 having an Ia and Ib tear, and 3 having a type III tear. All subjects except those with a type III tear had normal muscle bulk of the RC.

Preoperative Scores

There was a large degree of variability in preoperative AROM and PROM. Preoperative muscle performance as measured by MMT also demonstrated variability in all muscles tested. Preoperative shoulder ROM and muscle performance are outlined in Table 2. Preoperatively, all subjects had significant impairment of upper extremity function as determined by both of shoulder specific measures, the SST and the ASES total scores. In addition, all patients demonstrated general health status impairment as measured by both sections of the SF-36 questionnaire, the physical health component and the mental health component. As compared to the general population, normative values for the SF-36[41] physical health component scores for this subject group were significantly lower ($p = 0.017$); however, the mental health component was not statistically different than normative data ($p = 0.350$).

Table 2. Range of Motion and Muscle Performance (n=10)

	Mean	SD	Range
AROM Forward Flexion			
Initial	146.60	23.74	85-160
6 Months	164.00	10.22	160-180
PROM Forward Flexion			
Initial	160.30	7.23	150-171
6 Months	166.50	9.44	165-189
AROM External Rotation (at 0° abduction)			
Initial	53.30	17.13	35-80
6 Months	73.00	10.32	60-90
AROM External Rotation (at 90° abduction)			
Initial	52.00	32.68	0-90
6 Months	81.00	10.02	60-90
PROM External Rotation (at 0° abduction)			
Initial	58.80	17.29	35-85
6 Months	76.00	9.94	60-90
MMT: Anterior Deltoid			
Initial	3.80	0.79	2-5
6 Months	4.70	9.94	4-5
MMT: Middle Deltoid			
Initial	3.30	0.95	2-5
6 Months	4.40	0.52	4-5
MMT: External Rotation			
Initial	3.60	0.84	2-5
6 Months	4.50	0.53	4-5
MMT: Internal Rotation			
Initial	3.70	0.95	2-5
6 Months	4.60	0.51	4-5

Postoperative Scores

The subject sample as a whole did not demonstrate significant improvements in postoperative ROM (all, p > .083); however, there was a large degree of variability in most postoperative ROM measures. Postoperative improvements (all, p < .0001) in muscle performance of the anterior deltoid, middle deltoid, external rotators, and internal rotators was seen. Postoperative shoulder ROM and muscle performance are outlined in Table 2. All postoperative functional outcome scores were higher than the preoperative scores. The shoulder specific measures showed the greatest of improvement. The mean SST score improved from 43% to 89% (p = 0.0002), the mean ASES total scores rose from 54.4 to 89.5 (p = 0.0001), the mean ASES pain score improved from 26 to 43.75 (p = 0.0022), and the mean ASES function score improved from 28.5 to 45.75 (p = 0.0001). In addition, all patients' demonstrated improvement in general health status impairment as measured by the SF-36 questionnaire. The mean physical health component score improved from 41.5 to 48 (p = .0001), and the mean mental health component score rose from 54 to 60 (p = .0001).

Table 3. Postoperative Range of Motion and Muscle Performance, Extent of Tear

	Mean	SD	Range	n
AROM Forward Flexion				
Group 1	167.8	6.36	160-180	7
Group 2	155	13.2	140-165	3
PROM Forward Flexion				
Group 1	170.7	5.34	165-180	7
Group 2	156.6	10.4	145-165	3
AROM External Rotation (at 0° abduction)				
Group 1	77.14	9.06	65-90	7
Group 2	66.3	5.77	60-70	3
AROM External Rotation (at 90° abduction)				
Group 1	77.14	10.74	60-90	7
Group 2	66.6	5.77	60-70	3
PROM External Rotation (at 0° abduction)				
Group 1	80	8.66	60-90	7
Group 2	66.6	5.77	60-70	3
Strength: Anterior Deltoid				
Group 1	4.85	0.377	4-5	7
Group 2	4.33	0.577	4-5	3
Strength: Middle Deltoid				
Group 1	4.42	0.534	4-5	7
Group 2	4.33	0.577	4-5	3
Strength: External Rotation				
Group 1	4.57	0.534	4-5	7
Group 2	4.33	0.577	4-5	3
Strength: Internal Rotation				
Group 1	4.57	0.534	4-5	7
Group 2	4.66	0.577	4-5	3

Group 1 consisted of individuals who had either a Ia or Ib tear, which is a partial or full-substance tear measuring less than 1 cm on the articular or bursal surface.

Group 2 consisted of those subjects who had a full thickness tear involving more than one tendon, classified as a type III tear.

Table 4. Postoperative Range of Motion and Muscle Performance, Atrophy

	Mean	SD	Range	n
AROM Forward Flexion				
Group 1	169	6.51	165-180	5
Group 2	158.7	13.14	140-170	4
PROM Forward Flexion				
Group 1	171	5.47	165-180	5
Group 2	161.2	12.5	145-175	4
AROM External Rotation (at 0° abduction)				
Group 1	78	10.36	65-90	5
Group 2	65	5.77	60-70	4
AROM External Rotation (at 90° abduction)				
Group 1	78	12.54	60-90	5
Group 2	67.5	5	60-70	4
PROM External Rotation (at 0° abduction)				
Group 1	80	10	70-90	5
Group 2	68.75	6.29	60-75	4
Strength: Anterior Deltoid				
Group 1	5	0	5	5
Group 2	4.5	0.577	4-5	4
Strength: Middle Deltoid				
Group 1	4.6	. 547	4-5	5
Group 2	4.25	0.5	4-5	4
Strength: External Rotation				
Group 1	4.33	0.577	4-5	5
Group 2	4.5	0.577	4-5	4
Strength: Internal Rotation				
Group 1	4.6	0.547	4-5	5
Group 2	4.75	0.5	4-5	4

Group 1 consisted of individuals who had no atrophy, who were classified as having an occupation ratio of I.

Group 2 consisted of 4 subjects who demonstrated atrophy, classified as having an occupation ratio of either a II or III.

Subdivision of groups based on severity of pathology

The subject sample was divided based on the extent of tear as determined by the intraoperative Patte classification. Seven subjects formed group 1 which consisted of individuals who had either an Ia or Ib tear, which is a partial or full-substance tear measuring less than 1 cm on the articular or bursal surface, respectively. Group 2 consisted of 3 subjects who had a full thickness tear involving more than one tendon, classified as a type III tear. Those in group 1 demonstrated a postoperative improvement in AROM forward flexion (p = 0.005), PROM forward flexion (p = 0.003), AROM external rotation at 0° of abduction (p = 0.011), and PROM external rotation at 0° of abduction (p = 0.025). Those individuals in group 2, with larger RC tears, had no significant improvements in ROM (all, p > 0.053). Improvements in muscular performance were seen in group 1 for MMT of anterior deltoid (p < 0.001), middle deltoid (p = .003), and internal rotation (p = 0.003). Muscular performance improvements were not significant for those in group 2 (all, p > 0.061) (Table 3).

The subject sample was also divided based on the presence of muscle atrophy as determined by the occupation ratio of the supraspinatus as measured by MRI (Table 4). Five subjects formed group 1, which consisted of individuals who had no atrophy, who were classified as having an occupation ratio of I. Group 2 consisted of 4 subjects who demonstrated atrophy, classified as having an occupation ratio of either a II or III. Those in group 1 demonstrated a postoperative improvement in AROM forward flexion ($p = 0.023$), PROM forward flexion ($p = 0.031$), AROM external rotation at 0° of abduction ($p = 0.020$), and PROM external rotation at 0° of abduction ($p = 0.022$). Those individuals in group 2, with RC atrophy, had significant improvements in AROM external rotation at 0° of abduction ($p = 0.022$) all other ROM improvements were not significant. (all, $p > 0.091$). Improvements in muscle performance were seen in group 1 for MMT of anterior deltoid ($p < 0.001$), middle deltoid ($p = 0.003$), and internal rotation ($p = 0.034$). Muscle performance improvements were not significant for those in group 2 (all, $p > 0.057$) (Table 4).

Finally, the subject sample was divided based on the length of duration of symptoms. Six subjects formed group 1 which consisted of individuals who had experienced symptoms ≤ 12 months, with group 2 consisting of 4 subjects who had symptoms of > 12 months. Those in group 1 demonstrated a postoperative improvement in AROM forward flexion ($p = 0.032$), AROM external rotation at 0° of abduction ($p = 0.038$), and PROM external rotation at 0° of abduction ($p = 0.042$). Those individuals in group 2, whose symptoms were > 12 months, had significant improvements in AROM forward flexion ($p = 0.040$) and AROM external rotation at 0° of abduction ($p = 0.042$) all other ROM improvements were not significant. (all, $p > 0.072$). Improvements in muscle performance were seen in group 1 for MMT of anterior deltoid ($p = 0.042$), middle deltoid ($p = 0.040$), and internal rotation ($p = 0.004$). Muscle performance improvements were seen in MMT of anterior deltoid ($p < .001$) and middle deltoid ($p = .015$) for those in group 2.

No difference in functional outcomes, as measured by the SST and ASES, were seen between individuals based on the extent of their tear, presence of atrophy, or duration of symptoms (all, $p > 0.061$)

DISCUSSION

In this pilot study, it was found that there was good agreement between MRI and intraoperative soft tissue classification of the RC, with the best agreement seen in the area of rating the status of glenohumeral joint and the degree of muscle bulk. This finding is consistent with other published radiology work.[42-44] There are very few studies that compare MRI findings with operative findings. Yamakawa et al[45] compared MRI to operative findings, and found that MRI correctly identified 85% (46/54) of full-thickness tears and 83% (5/ 6) of the partial thickness tears. The comparison of MRI and operative findings in full-thickness tears showed a sensitivity of 85%, a specificity of 83%, and a positive predictive value (PPV) of 99%. A sensitivity of 83%, a specificity of 85%, and a PPV of 39% was demonstrated in a comparison of the partial thickness tears compared to the operative findings. They calculated a linear regression, which showed an excellent correlation between the operative findings and the MRI assessment ($r = 0.90$, $P < 0.01$). Hence, MRI may be helpful in determining large and medium sized RC tears, but less helpful in delineating a small full-thickness tear from partial thickness tears. Magnet resonance imaging is the primary diagnostic tool for the evaluation of the shoulder due to its superior soft-tissue contrast and ability to delineate structures in multiple planes.[46,47] The use of MRI has been shown to be accurate for detecting or ruling out RC tears, measuring the size of tears, and differentiation of partial from full-thickness tears.[42,43,48] In addition, MRI using atrophy specific imaging parameters are ideal for optimal postoperative management of the patient with a RC repair.[34] Most subjects in our study did not have RC atrophy as measured by the occupation ratio of the supraspinatus. Those individuals that did have atrophy had minimal gains in ROM and muscle performance at the 6-month follow up assessment point. One has to question whether their minimal ROM and MMT gains are the result of atrophy and/or the presence of a significant type III tear. The occupation ratio has not been reported to be used for directly predicting postoperative impairment or functional measures. The occupation ratio has been used to predict postoperative retearing of the RC, which certainly impacts function, and it has been shown that there is a 25% to 85% chance of retearing if one has significant atrophy as determined by a high occupation ratio.[33] Schaefer et al[34] also reported that the presence of preoperative atrophy of the supraspinatus was the primary predictive factor for a postoperative retear. The use of validated and standardized MRI assessments of the soft tissue characteristics of the RC should assist both the surgeon and patient in operative planning as well as the surgeon, therapist, and patient in devising the most optimal postoperative rehabilitation plan.

Preoperatively, it was found that patients with RC tears have a significant level of impairment as measured by goniometry and MMT. Strength impairments are typical in the presence of tendinopathy and RC tears.[3,49-51] Our data suggests that those subjects with a larger extent of tear had less preoperative ROM than those with smaller tears. This is consistent with Post et al[52] who reported that patients with larger tears typically have a decrease in AROM forward flexion. However, Hawkins et al[5] reported no correlation between tear size and shoulder AROM or PROM.

In addition, our results found that overall shoulder function was impacted in the presence of RC pathology. This is consistent with other reports.[4,9-19,41] Extent of a RC tear, atrophy, and duration of symptoms appear to have an impact on such impairment measures of ROM and MMT at 6 months postoperatively. Our data demonstrates that those individuals with less of an extent of tear, no atrophy, and less duration of symptoms had a significant improvement in certain ROM and MMT measures as compared to those with larger tears, muscle atrophy, and longer duration of symptoms, respectively. This is consistent with other reports of patients with smaller tears having had better outcomes.[5,11,27-30] However, it has been reported that with the exception of massive tears there is no correlation between the size of the cuff tear and functional outcome.[14,31] In the present study, no difference in postoperative functional outcomes based on the extent of tear, presence of atrophy, or duration of symptoms was seen. This may be an accurate finding; however, it may also be a result of the limitations of this pilot study.

The small sample size, which fell short of the prestudy power analysis sample size, may have lead to a large variability between subjects in terms of impairment outcomes and relatively small variability in terms of functional outcomes. The exclusion criteria of an upper age limit of 65 and only including those individuals that underwent an arthroscopic RC repair selectively enrolled only those individuals that likely had the least pathologic RC tears, leading to the potential skewed variability between subjects. In addition, enrolling only those patients who underwent RC repair by only 1 surgeon also contributed to the potential distorted variability between subjects because of the lack of variability in surgical techniques for RC. A short follow-up time of only 6 months may not have been enough time for those individuals with the larger tears or more atrophy to have reached their maximal outcome, since most patients require 7 months to 1 year postoperatively to return to preinjury levels of activity.[4,9,11,13-16,53] Future work should include a larger sample size of subjects of any age who are electively undergoing RC repair regardless of arthroscopic or open procedures referred from various surgeons. This would reduce the likelihood of such variability in impairment and functional measures, allowing for a more diverse and truly representative sample of subjects with varying degrees of RC pathology. In addition, a longer follow-up of at least 1 to 2 years should allow for accurate assessment of postoperative functional outcome.

CONCLUSION

Improvements in postoperative ROM and MMT measures appear to be dependent upon severity of cuff injury. No differences in functional outcome were observed based on the extent of tear, presence of atrophy, and duration of symptoms. Despite some correlations between variables of the RC and functional outcome, the variables of the RC tear did not predict functional outcome. Further work is needed with a larger sample size to attempt to describe functional outcomes following RC repair based on tissue quality.

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