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Shoulder Activity Level Is Not Associated With the Severity of Symptomatic, Atraumatic Rotator Cuff Tears in Patients Electing Nonoperative Treatment

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Background: Patient activity level may be an important prognostic variable relating to outcomes in patients with shoulder disorders. Little is known about the predictors of activity level in patients with shoulder disorders.

Hypothesis: Tear size and patient variables would be predictive of shoulder activity level in a cohort of patients who have selected initial nonoperative treatment for a symptomatic, atraumatic rotator cuff tear on magnetic resonance imaging (MRI).

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: Patients with an atraumatic rotator cuff tear on MRI were prospectively enrolled in the Multicenter Orthopaedic Outcomes Network (MOON) shoulder study of nonoperative treatment. As part of routine data collection, these patients were asked to complete a previously validated shoulder activity scale. A regression analysis was performed to assess the association of shoulder activity level to rotator cuff tear characteristics, including tendon involvement and retraction, and patient factors such as age, sex, smoking, and occupation.

Results: A total of 434 patients (220 male, 214 female) with a mean age of 62.7 years (range, 31-90 years) completed the activity scale. Shoulder activity was not associated with severity of the rotator cuff tear, but it was negatively associated with age ($P = .0001$) and female sex ($P = .001$). The only other factor associated with shoulder activity level in this cohort was occupation ($P = .0006$).

Conclusion: Shoulder activity level in patients with an atraumatic rotator cuff tear confirmed on MRI is not associated with severity of the tear but is affected by age, sex, and occupation.

Keywords: shoulder; activity level; rotator cuff tear

Rotator cuff tears are a common clinical problem that can be treated with or without surgery depending on patient

symptoms, health, and expectations. Preoperative shoulder function and/or health-related quality of life in patients with rotator cuff tears are associated with patient age, sex, rotator cuff tear size, and medical and social comorbidities.^{5,10,16,19} Another potentially important variable is patient shoulder activity level, which measures how much a patient does, in contrast to function, which measures how well a patient does certain tasks.

A shoulder-specific activity scale³ has been published using established principles: item generation, item reduction, pretesting, and reliability and validity testing.⁹ This activity scale was found to have excellent reliability and construct validity (when compared with a lower extremity activity rating scale, the Simple Shoulder Test, and self-reported shoulder activity).³ While previous studies have shown that shoulder activity level is associated with patient age and sex,^{4,17} relatively little is known about the predictors of activity level in patients with rotator cuff tears. This may be important in terms of comparing cohorts that undergo rotator cuff repair to control for differences in activity level.

The purpose of the present study was to test the hypothesis that factors such as age, sex, employment, and tear

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Shoulder Activity Scale

Please indicate with an "X" how often you performed each activity in your healthiest and most active state, in the past year.

	Never or less than once a month	Once a month	Once a week	More than once a week	Daily
Carrying objects 8 pounds or heavier by hand (such as a bag of groceries)					
Handling objects overhead					
Weight lifting or weight training with arms					
Swinging motion (as in hitting a tennis ball, golf ball, baseball, or similar object)					
Lifting objects 25 pounds or heavier (such as 3 gallons of water) NOT INCLUDING WEIGHT LIFTING					

For each of the following questions, please circle the letter that best describes your participation in that particular activity.

- 1) Do you participate in contact sports (such as, but not limited to, American football, rugby, soccer, basketball, wrestling, boxing, lacrosse, martial arts, etc)?
 - A No
 - B Yes, without organized officiating
 - C Yes, with organized officiating
 - D Yes, at a professional level (ie, paid to play)
- 2) Do you participate in sports that involve hard overhand throwing (such as baseball, cricket, or quarterback in American football), overhead serving (such as tennis or volleyball), or lap/distance swimming?
 - A No
 - B Yes, without organized officiating
 - C Yes, with organized officiating
 - D Yes, at a professional level (ie, paid to play)

Figure 1. Shoulder activity scale.

size are associated with shoulder activity level in a cohort of patients with a rotator cuff tear demonstrated on magnetic resonance imaging (MRI). We anticipated that larger rotator cuff tears as measured on MRI would be associated with lower activity levels.

MATERIALS AND METHODS

The Multicenter Orthopaedic Outcomes Network (MOON) Shoulder Group was formed to study a prospective cohort of patients with symptomatic, atraumatic, MRI-confirmed, full-thickness rotator cuff tears treated nonoperatively.¹³ The MRI measures of rotator cuff tear severity have been found to have good interobserver agreement by the physicians in this study group.¹⁸ Investigational review board approval was obtained from all participating institutions before study inception. Patients with unilateral, full-thickness, symptomatic, atraumatic rotator cuff tears consented to participate and were prospectively enrolled with time zero data. All tear diagnoses were made by physical examination and MRI. Patients with a history of a specific injury were excluded.

As previously reported, patients with shoulder symptoms and MRI-documented, atraumatic, full-thickness rotator cuff tears were offered the opportunity to participate in a study of nonoperative treatment.¹³ Of 2233 patients who

presented during the study period with rotator cuff tears, 1280 were excluded because they did not meet eligibility requirements. Of the 953 eligible patients, 452 (47%) elected to participate. Tear characteristics including size and grade were recorded from MRI using a standardized approach.¹⁸

As part of routine data collection at the time of study entry, and at 6 weeks' and 12 weeks' follow-up, patients were asked to complete the previously validated shoulder activity scale (Figure 1). Patients recorded how often they participated in 5 specific activities at their most active state over the previous 12 months, which generates a numeric score ranging from 0 (least active) to 20 (most active). Patients also responded to 2 questions about their involvement in overhead and contact sports. The shoulder activity score is a reliable, valid, and responsive scale that measures shoulder-specific activity with excellent reliability and construct validity.³ Age- and sex-based normative data have been described in patients without shoulder complaints.¹⁷

A regression analysis was performed, testing the association of activity level with a variety of rotator cuff and patient factors, including tendon involvement and retraction, age, sex, smoking, education, race, and occupation (Table 1). Occupation was self-reported as one of the following choices: professional, manual labor, homemaker, unemployed, retired, or other. A χ^2 analysis was performed to compare participation in overhead and contact sports by age and sex.

TABLE 1
Factors Analyzed for Association With Shoulder Activity Level in Patients With Symptomatic, Atraumatic Rotator Cuff Tears

Patient Factors	Shoulder Factors	Socioeconomic Factors
Age	Dominance	Education level
Sex	Number of tendons	Employment status
Race	Retraction	
Smoking		

RESULTS

A total of 434 patients (220 male, 214 female) with a mean age of 62.7 years (range, 31-90 years) completed the activity scale. Eighteen patients did not complete the entire activity scale and were excluded. Shoulder activity level in this cohort ranged from 0 to 20, with a mean of 10.0. Eight patients were involved in workers' compensation claims (1.8% of the cohort).

Rotator cuff tear size and retraction were not associated with shoulder activity level in this cohort of patients. As reported previously, 70% of the tears involved the supraspinatus only, 21% supraspinatus and infraspinatus, 5% supraspinatus and subscapularis, and 2% supraspinatus, infraspinatus, and subscapularis.¹³ Almost half (48%) had minimal retraction, 33.5% retraction to the humerus, 13% retraction to the glenoid, and 5% retraction medial to the glenoid.¹³ Shoulder activity was negatively associated with age ($P = .0001$) and female sex ($P = .001$). The regression model predicted that a 69-year-old patient with a rotator cuff tear would be 1.5 points less active on the 20-point scale compared with an otherwise identical 56-year-old patient with a rotator cuff tear (Figure 2). Female patients with a rotator cuff tear were predicted to be 1.6 points less active compared with a similar male patient. The only other significant predictor of shoulder activity level in this cohort was occupation ($P = .0006$). Unemployed patients with a rotator cuff tear were predicted to be 4.8 points less active than employed patients. There was a variance in mean activity level based on the geographic location where the patient was enrolled in the study, but this did not reach statistical significance.

Overhead sports participation was seen in 13% of the cohort. Younger patients were more likely to participate in overhead sports ($P < .001$). A much smaller percentage of the cohort participated in contact sports (3%). Again, participation was negatively associated with age ($P < .0001$), and male patients were more likely to participate in contact sports than were female patients (5% vs 1%, respectively; $P = .04$).

DISCUSSION

This is the first study to report factors predictive of shoulder activity level in patients with an atraumatic, full-thickness rotator cuff tear confirmed on MRI. Activity level in these patients is associated with their age, sex, and employment status but not the size of the tear or tendon retraction.

Studies reporting on shoulder activity level should account for the effect of differences in these variables to allow for meaningful intrastudy and interstudy comparisons. This is important because of the potential effect of shoulder activity level on outcomes after treatment.⁶

Perhaps surprisingly, activity level did not relate to severity of the tear as we expected in terms of the number of tendons involved, retraction, and involvement of the dominant arm. This would appear to be counterintuitive as a higher degree of injury is typically associated with a greater burden of disease. This may be partly explained in light of a recent study reporting shoulder activity level normative data by age and sex.¹² The healthy patients from that study appear to be less active as a group than the patients in this study with atraumatic rotator cuff tears. In our current study, the mean shoulder activity level was 10.0, in a population with a mean age of 62.7 years, which is higher than the mean shoulder activity level of healthy patients aged 31 to 50 (mean activity level, 9 ± 5), 51 to 70 (8 ± 5), and over 70 (7 ± 4) years. It is conceivable that patients with atraumatic rotator cuff tears develop symptoms when they are more active. It is also possible that a higher activity level contributes to the development of rotator cuff lesions. Conversely, it is also possible that increased activity helps patients with full-thickness rotator cuff tears develop compensatory kinematics and strength, which may prevent symptoms. Unfortunately, these concepts cannot be determined in the current study, but this question clearly warrants further investigation.

The effect of employment status on shoulder activity level was a novel finding in the current study. Employment status could affect shoulder activity level in a number of ways. First, employment could affect activity level directly if jobs involved physical labor. Work will obviously not have contributed to shoulder activity level in patients who are not employed. Patients who are working in active jobs such as construction, distribution, or baggage handling, for example, could have received a significant impact to shoulder activity from their employment. Work status could also influence shoulder activity level indirectly by affecting a person's ability to participate in leisure-related shoulder activities such as weight training, swimming, or golf. More study is needed to better characterize the effect of employment on shoulder activity level in patients with rotator cuff tears and other shoulder disorders. This could be particularly relevant for the treatment of patients covered under workers' compensation.

Our findings are consistent with those of a prior study demonstrating that shoulder activity level varies by age and shoulder diagnosis.⁴ A total of 157 patients (95 male, 62 female) with isolated shoulder instability, osteoarthritis, or rotator cuff disease (diagnosed clinically as impingement, partial-thickness cuff tear, or full-thickness cuff tear), based on history, physical examination, and imaging studies, were enrolled in the study. There were 86 patients with rotator cuff disease (47 male, 39 female), 40 with osteoarthritis (26 male, 14 female), and 31 with instability (22 male, 9 female). The median age of patients with rotator cuff disease was 52.5 ± 13.7 years (range, 26-80 years),

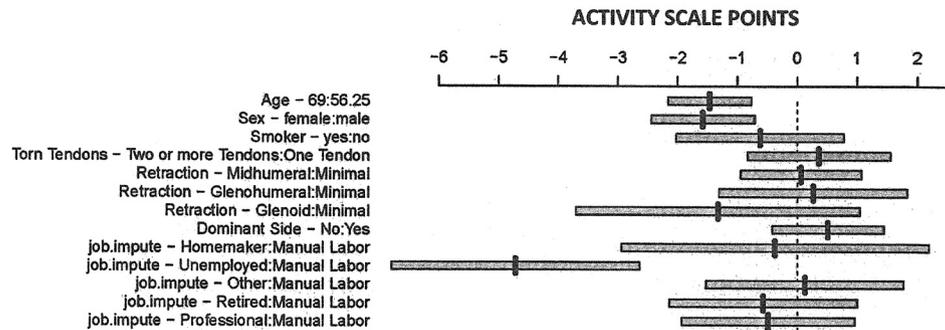


Figure 2. Association of patient characteristics and rotator cuff tear factors with shoulder activity level.

which is, on average, 10 years younger than the age of the patients in the current cohort. Linear regression of activity level on patient age and diagnosis demonstrated a statistically significant relationship between activity level and both independent variables ($P < .001$). The median activity level was significantly higher in patients with instability (14 ± 5.2 ; range, 1-20) than in patients with rotator cuff disease (10 ± 5.1 ; range, 0-20) ($P = .027$) or osteoarthritis (7 ± 4.7 ; range, 0-18) ($P < .001$). Patients with rotator cuff disease were significantly more active than were patients with osteoarthritis ($P < .01$).

Another study of shoulder activity level in patients undergoing surgery for rotator cuff tears also found that shoulder activity level was associated with age ($P = .03$).¹⁷ In addition, this study reported a significant effect of sex on shoulder activity level, with male patients more active than female patients ($P < .0001$). Patients with severe comorbidities resulting in disability were also found to have significantly lower shoulder activity ($P = .005$).

In conjunction with our findings, these studies demonstrate that shoulder activity level is clearly affected by age and sex in patients with rotator cuff tears. Decreased shoulder activity level with increasing age makes intuitive sense. Older patients are likely to be less active for a number of reasons including overall health and mobility as well as overall and shoulder-specific strength. It is also not surprising that female patients are less active than male patients, again for a number of possible reasons such as differences in work, sports, and recreational activities.^{4,12,17} The relationship between these variables and shoulder activity level likely confounds studies of patients with rotator cuff tears. For example, patient age has been shown to predict the progression of symptoms and poor prognosis with nonoperative management of rotator cuff tears.¹⁴ Age has been shown to affect healing^{2,7,11,20} and change in clinical symptoms^{1,8,15,21} after rotator cuff repair. Activity level is likely a confounding factor for both effects, which suggests that more study is needed to assess this issue.

The findings in this study are limited to the cohort studied: patients with symptomatic, atraumatic rotator cuff tears. Patients with traumatic rotator cuff tears may have a different distribution of shoulder activity level. Furthermore, the patients studied in this cohort elected to participate in a study of nonoperative treatment for their

rotator cuff tear. It is possible that more active patients elected out of this study to undergo surgery if they perceived a benefit from operative treatment. The minimal clinically significant difference in shoulder activity is not known, which makes it difficult to interpret the findings. Finally, it is important to recognize that this study focuses on shoulder-specific activity, which may be low in very active populations such as cyclists and marathon runners.

Despite these limitations, this study demonstrates that shoulder activity does not correlate with tear size but is correlated with age, sex, and employment status in patients with atraumatic rotator cuff tears who have elected initial nonoperative treatment. Further investigation is warranted to better understand how activity relates to symptoms, treatment choice, and outcomes. Establishing the relationship of shoulder activity level to patient factors, physical examination results, and MRI findings in patients with rotator cuff tears will facilitate the use of this scale in future studies.

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