

Factors Affecting Satisfaction and Shoulder Function in Patients with a Recurrent Rotator Cuff Tear

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Background: It is widely accepted that most patients treated with rotator cuff repair do well regardless of the integrity of the repair. The purpose of this cross-sectional study was to reexamine this concept and identify the factors affecting the outcomes of patients with a recurrent tear.

Methods: A cohort of patients who had been treated with rotator cuff repair completed a survey regarding satisfaction with the operatively treated shoulder, physical activity, and shoulder function. Ultrasonography was performed to determine rotator cuff integrity. Patients were divided into three age categories: younger than fifty-five years, fifty-five to sixty-five years, and sixty-six years or older. The relationships of the outcomes to patient age, repair integrity, and other demographic factors were analyzed.

Results: Forty-seven (26%) of the 180 enrolled patients had a retear, defined as a full-thickness defect. In each age category, the satisfaction, ASES (American Shoulder and Elbow Surgeons), and SST (Simple Shoulder Test) scores in the retear group were significantly poorer than those in the no-retear group ($p < 0.05$). Within the retear group, all three scores were significantly better in the oldest age category ($p < 0.05$); there were no significant differences among the age categories within the no-retear group ($p > 0.05$). Simple regression analysis showed that younger age, a Workers' Compensation claim, and lower education level were significant predictors of poorer scores in patients with a retear ($p < 0.05$). Multiple regression analysis of the retear group showed that (1) lower education level and a Workers' Compensation claim were independent predictors of a poorer satisfaction score; (2) lower education level, younger age, and a Workers' Compensation claim were independent predictors of a poorer ASES score; and (3) lower education level was the only independent predictor of a poorer SST score ($p < 0.01$ for all).

Conclusions: The presence of a retear negatively affected the clinical outcomes following rotator cuff repair. This finding refutes the widely held concept that patients typically do well regardless of the repair integrity following rotator cuff repair. In patients with a retear, nonanatomic factors including younger age, lower education level, and a Workers' Compensation claim were associated with poorer outcomes.

Level of Evidence: Prognostic Level II. See Instructions for Authors for a complete description of levels of evidence.

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Despite the high prevalence of recurrent tears reported in some studies, the overall clinical outcomes following rotator cuff repair are satisfactory¹⁻⁷. Although

studies have shown that improvement of symptoms after rotator cuff repair does not necessarily depend on the integrity of the repair, the presence of an intact repair is associated with

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A commentary by Robert Tashjian, MD, is linked to the online version of this article at jbjs.org.

TABLE I Characteristics of the 180 Enrolled Patients According to Repair Integrity

Integrity	No. of Patients	Age*† (yr)	Satisfaction VAS Score*‡	ASES Score*‡	SST Score*‡	No. with Workers' Compensation Claim§	No. with Revision§
Intact	50 (28%)	58.1 ± 9.6	8.6 ± 1.4	91.0 ± 11.4	10.2 ± 2.7	7 (14%)	2 (4%)
Attenuated	64 (36%)	64.7 ± 9.6	8.6 ± 1.6	86.9 ± 16.4	10.3 ± 2.6	9 (14%)	9 (14%)
Partial-thickness defect	19 (11%)	53.6 ± 7.6	8.2 ± 1.5	89.4 ± 11.2	10.1 ± 2.2	1 (5%)	2 (11%)
Full-thickness defect	47 (26%)	66.3 ± 9.9	5.8 ± 2.8	69.2 ± 25.0	6.5 ± 4.1	8 (17%)	8 (17%)

*The values are given as the mean and the standard deviation. †All differences between groups were significant ($p < 0.01$) except that between the attenuated and full-thickness defect groups ($p > 0.05$) (ANOVA followed by LSD post hoc test). ‡The score for the full-thickness defect group was significantly poorer than those for the other groups ($p < 0.01$); the other three groups did not differ significantly from one another ($p > 0.05$, ANOVA followed by LSD post hoc test). §No significant differences among groups ($p > 0.05$, chi-square test). Percentages are relative to the number of patients in the integrity category.

better strength and active shoulder motion¹⁻¹¹. Various patient factors are associated with the clinical outcomes following rotator cuff repair; these factors include age, sex, tear size, Workers' Compensation status, marital status, employment, preoperative expectations, and medical comorbidities¹²⁻¹⁸.

Most studies in which improvement of symptoms was reported even in patients with a recurrent tear involved older patients, who may have lower physical activity demands involving work, sports, and activities of daily living compared with a younger population. Because a younger patient population is more likely to engage in more physically demanding activities, an anatomically intact repair may be more important for their satisfaction and function. It is unknown whether there are any differences in patient satisfaction and shoulder function between young and elderly populations following a retear of a rotator cuff repair.

The purpose of this cross-sectional study was to reexamine the concept that patients typically do well regardless of the repair integrity following rotator cuff repair and to identify factors affecting the satisfaction and shoulder function of patients with a recurrent rotator cuff tear. We hypothesized that (1) patients with a recurrent full-thickness tear would have poorer satisfaction and shoulder function compared with those without such a retear, and (2) young and active patients with a retear would have poorer satisfaction and function compared with older patients.

Materials and Methods

Study Subjects

This study was approved by our institutional review board. All patients who had undergone a rotator cuff repair at our institution from July 2007 to June 2011 were identified by means of a search for CPT (Current Procedural Terminology) codes 29827 (arthroscopic rotator cuff repair) and 23412 (open or mini-open rotator cuff repair). All patients who had undergone primary or revision rotator cuff repair during the time period were considered for inclusion. Exclusion criteria were (1) major trauma to the operatively treated shoulder; (2) surgery involving the ipsilateral shoulder after the index procedure (including revision rotator cuff repair); (3) use of the upper extremities for weight-bearing; (4) a substantial subscapularis or teres minor lesion that required surgical repair; (5) other underlying shoulder conditions such as glenohumeral arthritis, traumatic labral tear, instability, deltoid or other muscle injury, or neurologic disorder; and (6) bilateral rotator cuff repair. Patients with a partial-thickness rotator cuff tear were included if the tear was repaired after conversion to a full-thickness tear. Patients with a proximal biceps tendon abnormality were included if the condition had been addressed during the index procedure.

Eligible patients were asked to return for a study visit, at which time they completed a survey regarding their satisfaction, activity level, shoulder function, and demographic information and underwent shoulder ultrasonography. Patients were divided into three age categories on the basis of their age at the time of this study visit: (1) younger than fifty-five years, (2) fifty-five to sixty-five years, and (3) sixty-six years or older. The age divisions were established on the basis of previous studies that either utilized similar age divisions^{12,19} or showed similar differences in mean age among groups of patients defined according to rotator cuff integrity^{20,21}.

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Survey Regarding Satisfaction and Activity Level

A 10-point visual analog scale (VAS) was created to assess patient satisfaction with the operatively treated shoulder. Similarly, patient activity level was assessed with use of a 10-point VAS in each of three domains: (1) activity at work, (2) activity in sports/recreation, and (3) activity at home (see Appendix).

Survey Regarding Subjective Shoulder Function and Demographic Information

Patients were asked to complete the ASES (American Shoulder and Elbow Surgeons) and SST (Simple Shoulder Test) evaluation forms. Patients were also asked questions regarding their age, sex, hand dominance, marital status, employment, education level, smoking, medical comorbidities, and Workers' Compensation status. Employment was categorized as retired for a reason other than illness, currently employed, homemaker, or disabled or unemployed. Education level was categorized as high school (some high school education or a high school graduate), college graduate, or postgraduate. Medical comorbidities were categorized as present or absent. The preoperative tear size was obtained from the operative notes, with tears categorized on the basis of the anteroposterior dimension as small (<1 cm), medium (1 to <3 cm), large (3 to 5 cm), or massive (>5 cm). The biceps tendon treatment was categorized on the basis of the operative notes as a normal biceps, tenotomy, or tenodesis.

Shoulder Ultrasonography

Shoulder ultrasonography was performed in real time by a single experienced examiner with use of a portable ultrasonography scanner (M-Turbo; SonoSite, Bothell, Washington) and a linear transducer (HFL50x [15-6 MHz]; SonoSite) as described previously²². The examiner was blinded to the survey results of the

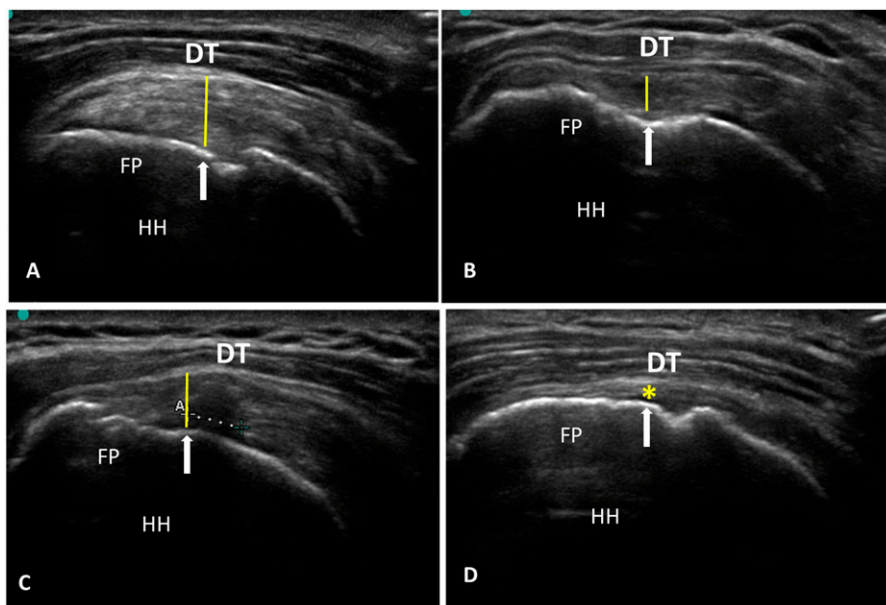


Fig. 1

Figs. 1-A through 1-D Shoulder ultrasonographs showing the four categories of rotator cuff integrity. DT = deltoid muscle, FP = footprint, and HH = humeral head. The yellow line indicates the thickness of the rotator cuff tendon over the anatomic neck (white arrow). **Fig. 1-A** An intact repair has an intact attachment of all of the tendons to the footprint and no defects or thinning of the tendons, which have the normal convex outline. **Fig. 1-B** An attenuated repair has an intact rotator cuff attachment to the footprint but substantial tendon thinning or loss of the normal convex outline. **Fig. 1-C** A partial-thickness defect has a distinct hypoechoic or mixed hypoechoic and hyperechoic area (dotted line) without a complete gap between the tendon and footprint. **Fig. 1-D** A full-thickness defect has a complete detachment of the tendon from the footprint and creation of a gap by retraction of the torn tendon ends. The yellow asterisk indicates a gap filled with bursal tissue, with no discernible tendon tissue.

patient until he had completed recording the ultrasonography findings, and the patient was instructed to not give the examiner any information about how the shoulder was doing prior to that time. The integrity of the rotator cuff repair was categorized as intact, attenuated, partial-thickness defect, or full-thickness defect (Fig. 1). An attenuated repair had an intact rotator cuff attachment to the footprint but substantial thinning of the tendon, defined as a loss of >50% of the normal tendon thickness. The normal thickness of the supraspinatus and infraspinatus tendons has been reported to be approximately 10 mm²³. A full-thickness defect was considered a retear. The defect size was measured in both the longitudinal and transverse planes.

Statistical Methods

The primary outcome variable of interest was the patient satisfaction VAS score. As there was no established minimal clinically important difference (MCID) for this score in patients with a rotator cuff tear at the time of the study, it was proposed (on the basis of an expert opinion) that a 2.5-point difference would reasonably represent the MCID. An a priori sample size calculation showed that twelve patients with a retear would be needed in each age category to detect a 2.5-point difference with a power of 0.8. Studies have shown retear rates following rotator cuff repair that ranged from 5% for small and medium-sized tears⁷ to 94% for large and massive tears¹. Using conservative estimates of a 20% retear rate in patients younger than fifty-five years, 30% in patients fifty-five to sixty-five years of age, and 40% in patients older than sixty-five years, it was determined that at least 130 patients would need to be enrolled. Continuous variables were compared with use of appropriate parametric or non-parametric tests, depending on the normality. The least significant difference (LSD) test or Mann-Whitney U test was used for the post hoc analysis following analysis of variance (ANOVA) or the Kruskal-Wallis test, respectively. The chi-square test was used for the comparison of categorical variables among the age categories. The Spearman rho value was used to assess correlations between

variables. Simple regression analysis was performed to identify significant predictors of the outcome scores; this was followed by multiple regression analysis to identify independent predictors after controlling for other confounding factors. A p value of <0.05 was considered significant. Data are reported as the mean and the standard deviation.

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This study was aided by an OREF/ASES/Rockwood Clinical Research Grant in Shoulder Care from the Orthopaedic Research and Education Foundation and the American Shoulder and Elbow Surgeons.

Results

Study Subjects and Shoulder Ultrasonography

The database search identified 562 patients who had undergone rotator cuff repair during the four-year period, and 375 were considered eligible on the basis of the inclusion criteria. Of these, 281 had correct contact information and could be contacted, and 189 arrived for the study visit. Nine of the patients were deemed ineligible at that time and were excluded, and the remaining 180 eligible patients (180 shoulders) completed both the survey and shoulder ultrasonography.

The mean age of the 180 patients in the study group was 62.1 ± 10.4 years, and ninety-five (53%) were male. The mean elapsed time since the index surgery was 35.3 ± 20.1 months (range, twelve to fifty-nine months). Forty-seven (26%) of the patients were younger than fifty-five years, sixty-six (37%) were fifty-five to sixty-five years of age, and sixty-seven (37%) were

TABLE II Outcomes According to Demographics of the Patients with a Full-Thickness Defect (N = 47)

Characteristic	No.	Satisfaction Score*	ASES Score*	SST Score*
Sex				
M	22	6.5 ± 3.0	78.1 ± 23.1†	8.1 ± 3.8†
F	25	5.3 ± 2.5	61.3 ± 24.4	5.0 ± 3.9
Workers' Compensation				
Y	8	3.9 ± 1.9†	50.8 ± 22.8†	4.6 ± 3.8
N	39	6.2 ± 2.8	72.9 ± 24.0	6.9 ± 4.1
Revision				
Y	8	4.9 ± 1.8	62.1 ± 25.4	5.4 ± 4.4
N	39	6.0 ± 2.9	70.6 ± 25.0	6.7 ± 4.0
Involvement of dominant shoulder				
Y	34	5.5 ± 2.7	67.9 ± 23.7	6.2 ± 4.1
N	13	6.6 ± 2.9	72.4 ± 28.9	7.1 ± 4.3
Education level				
Some high school or high school graduate	27	4.9 ± 2.7‡	57.8 ± 23.8‡	4.4 ± 3.8‡
College graduate	8	7.0 ± 2.7	75.2 ± 22.0	8.4 ± 2.5
Postgraduate school	12	7.1 ± 2.4	90.7 ± 11.2	9.8 ± 2.3
Employment status				
Retired for reason other than illness	13	8.0 ± 1.9‡	89.6 ± 12.5‡	9.2 ± 3.0‡
Currently employed	13	5.6 ± 2.6	68.8 ± 28.0	6.8 ± 3.8
Homemaker	9	4.9 ± 3.1	62.2 ± 22.4	4.1 ± 4.5
Disabled or unemployed	12	4.4 ± 2.4	52.6 ± 19.8	4.9 ± 3.6

*The values are given as the mean and the standard deviation. †Significantly different ($p < 0.05$, independent-samples t test). ‡Significantly different ($p < 0.05$, ANOVA followed by LSD post hoc test).

older than sixty-five years. Twenty-one (12%) of the patients had undergone a revision rotator cuff repair, and twenty-five (14%) had had a Workers' Compensation claim. The mean age (62.9 ± 12.4 years) and sex distribution (52% male) of the 195 nonparticipants were not significantly different from those of the 180 participants ($p > 0.05$ for both).

Patient characteristics according to repair integrity are summarized in Table I. According to the ultrasonography, six (13%) of the shoulders in the youngest age category, fifteen

(23%) in the middle category, and twenty-six (39%) in the oldest category had a full-thickness retear. To simplify the data analysis, patients with an intact repair, an attenuated rotator cuff, or a partial-thickness defect were pooled into a single group termed the no-retear group, and the patients with a full-thickness defect were termed the retear group (see Appendix).

A subgroup analysis of the forty-seven patients in the retear group was also performed. With the sample size available, no significant differences were found among the three age

TABLE III Multiple Regression Analysis of Potential Predictors of Satisfaction and Shoulder Function in Patients with a Full-Thickness Defect*

Characteristic	Satisfaction VAS Score†			ASES Score‡			SST Score§		
	β	T	P Value	β	T	P Value	β	T	P Value
Age	NS			0.314	2.465	0.018#	NS		
Education	0.339	2.525	0.015#	0.393	3.141	0.003#	0.592	4.934	0.001#
Workers' Compensation	-0.287	-2.137	0.038#	-0.242	-2.166	0.040#	NS		

* β = standardized regression coefficient, NS = not significant, and R^2 = coefficient of determination. † $R^2 = 0.216$, $p = 0.005$. ‡ $R^2 = 0.477$, $p < 0.001$. § $R^2 = 0.351$, $p < 0.001$. #Significant independent predictor of the variable.

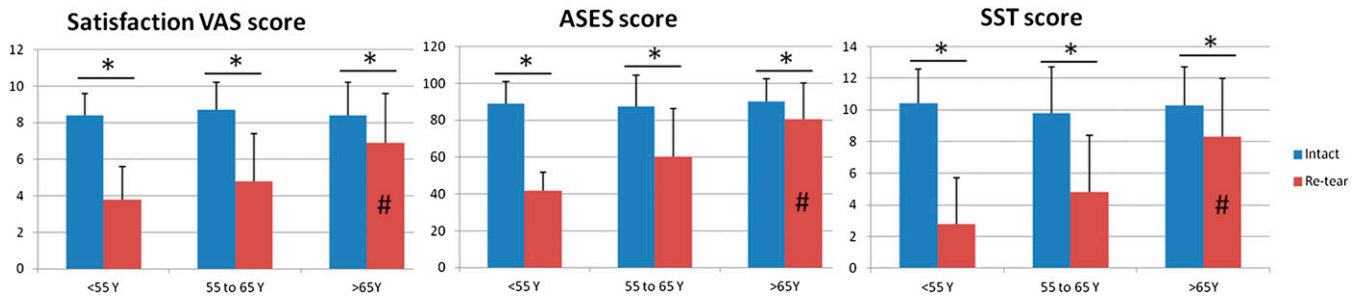


Fig. 2

Comparisons of patient satisfaction and shoulder function scores between the no-retear and retear groups according to age category. The no-retear group showed significantly better scores compared with the retear group in each age category ($p < 0.05$, indicated by *). The difference between the no-retear and retear groups decreased gradually with increasing age category, and the effect of age on this difference was significant ($p = 0.003$, two-way ANOVA test). Within the no-retear group, there were no significant differences among the age categories ($p > 0.05$). In contrast, within the retear group, the scores were significantly better in the oldest age category compared with the two younger categories ($p < 0.05$, indicated by #).

categories with respect to sex, preoperative tear size, recurrent tear size, Workers' Compensation status, proportion of revisions, education level, employment status, presence of a medical comorbidity, or involvement of the dominant shoulder ($p > 0.05$, see Appendix).

Satisfaction and Shoulder Function

The satisfaction VAS, ASES, and SST scores were significantly poorer in the patients with a full-thickness defect ($p < 0.01$); with the sample size available, the scores did not differ significantly among the other three repair integrity categories (Table I). When the patients without a full-thickness defect were combined into a single no-retear group, that group showed significantly better scores compared with the retear group in all age categories ($p < 0.05$, Fig. 2). The difference between the no-retear and retear groups decreased gradually with increasing age category, and the effect of age on this difference was significant ($p = 0.003$, two-way ANOVA). Within the no-retear group, the scores did not differ significantly among the age categories ($p > 0.05$). In contrast, within the retear group, all three scores were significantly better in the oldest category than in the two younger categories ($p < 0.05$, Fig. 2). The satisfaction score showed significant positive correlations with the ASES and SST scores ($\rho = 0.768$ and 0.682 , respectively; $p < 0.001$ for both).

Activity Levels of Patients with a Full-Thickness Defect

The mean VAS scores for the work, sports, and home activity levels of the patients in the retear group were 2.8 ± 2.7 , 3.7 ± 2.5 , and 5.2 ± 3.2 , respectively. The work activity score showed significant negative correlations with the ASES, SST, and satisfaction scores ($\rho = -0.289$ and $p = 0.044$, $\rho = -0.346$ and $p = 0.017$, and $\rho = -0.284$ and $p = 0.049$, respectively). The sports activity score showed significant positive correlations with the ASES ($\rho = 0.371$, $p = 0.01$) and SST ($\rho = 0.451$, $p = 0.001$) scores but not with the satisfaction score ($\rho = 0.081$, $p = 0.59$). The home activity score showed significant positive correlations with the ASES, SST, and satisfaction scores ($\rho = 0.396$ and $p = 0.006$, $\rho = 0.432$ and $p = 0.002$,

and $\rho = 0.378$ and $p = 0.009$, respectively). None of these activity scores differed significantly among the age categories ($p > 0.05$).

Demographic Data and Multivariate Analysis of Patients with a Full-Thickness Defect

The eight patients in the retear group who had a Workers' Compensation claim showed significantly poorer satisfaction ($p = 0.029$) and ASES ($p = 0.021$) scores compared with those without such status (Table II). With the sample size available, none of the outcome scores differed significantly between the eight patients who had undergone revision rotator cuff repair and the thirty-nine who had undergone primary repair ($p > 0.05$). The male patients had significantly better ASES ($p = 0.020$) and SST ($p = 0.009$) scores compared with the female patients. However, with the sample size available, the satisfaction score did not differ significantly according to sex ($p = 0.13$). Patients whose education level was limited to high school showed significantly poorer scores compared with those with a college or postgraduate degree ($p < 0.05$). Patients who had retired for a reason other than illness showed significantly better scores compared with those with a different employment status ($p < 0.05$). With the sample size available, marital status, the presence of medical comorbidities, biceps tendon treatment, involvement of the shoulder on the dominant side, preoperative and postoperative tear sizes, activity level, and smoking did not show any significant association with the outcome variables ($p > 0.05$).

In the simple regression analysis, only younger age, lower education level, and a Workers' Compensation claim significantly predicted poorer satisfaction, ASES, and SST scores ($p < 0.05$). In the multiple regression analyses involving these three factors, (1) lower education level ($p = 0.015$) and a Workers' Compensation claim ($p = 0.038$) were independent predictors of a poorer satisfaction score; (2) lower education level ($p = 0.003$), younger age ($p = 0.018$), and a Workers' Compensation claim ($p = 0.040$) were independent predictors of a poorer ASES score; and (3) lower education level ($p < 0.001$) was the only independent predictor of a poorer SST score (Table III).

Discussion

We demonstrated that patients with a full-thickness recurrent rotator cuff tear experienced significantly poorer satisfaction and subjective shoulder function compared with those without such a retear. Patients older than sixty-five years showed fairly high satisfaction and subjective shoulder function even in the presence of a retear, but younger patients showed distinctly inferior outcomes compared with older patients when a retear was present. For each outcome measure, the difference between the patients with and without a retear was larger in younger patients and decreased gradually with increasing age category. Age had a significant effect on this difference.

Previous studies have identified a number of factors affecting clinical outcomes following rotator cuff repair^{12-19,24-26}. However, to our knowledge, repair integrity was not investigated in such previous studies, and the influence of the repair integrity was thus not considered. In the present study, simple regression analysis of the patients with a recurrent full-thickness tear showed that younger age was associated with poorer satisfaction and subjective shoulder function. Younger age was associated with inferior clinical outcomes in previous studies that included no repair integrity information^{12,14,19}. Similar to the overall results in previous studies²⁴⁻²⁶, Workers' Compensation status was associated with inferior satisfaction and shoulder function in the retear group in the present study. Higher education level of patients in the retear group was also a significant predictor of better satisfaction and subjective function. Lastly, employment status showed a significant influence; even in the presence of a recurrent rotator cuff tear, patients who had retired for a reason other than illness demonstrated the best satisfaction and subjective function, whereas those who were unemployed or disabled showed the poorest scores. The latter finding suggests that the burden of socioeconomic and physical hardship may play an important role in a patient's subjective evaluation of the operatively treated shoulder. Tashjian et al.¹⁴ reported that patients who had been disabled or unemployed preoperatively showed poorer satisfaction following rotator cuff repair compared with those who had not been. In the patients with a retear in the present study, the subsequent multiple regression analysis showed that (1) lower education level and a Workers' Compensation claim were independent predictors of a poorer satisfaction score; (2) lower education level, younger age, and a Workers' Compensation claim were independent predictors of a poorer ASES score; and (3) lower education level was the only independent predictor of a poorer SST score. This finding suggests that, in the presence of a rotator cuff retear, patients with younger age, with lower education level, and with a Workers' Compensation claim feel less satisfied and less functional.

The work activity level in the retear group showed a significant negative correlation with satisfaction and shoulder function, whereas the sports and home activity levels showed a positive correlation with these outcomes. This differed from our expectation that the patients with a retear would be less satisfied if they were subjected to any type of environment with

high physical demands. Although the reason for this discrepancy is not clear, one possible explanation is that the patients may have changed their sports and home activity levels following the rotator cuff repair and subsequent retear, and their answers to the survey questions reflect these changed activity levels. Another possible explanation is that the measurement method of the study may not have been sensitive enough to accurately detect the changes that occurred.

This study has a number of limitations. First, the VAS systems used have not been validated, and their one-dimensional (linear) scale may not have accurately reflected the multidimensional psychometric nature of patient satisfaction. Second, only one examiner performed all of the ultrasonography. Although that examiner had had extensive experience with shoulder ultrasonography and use of a single examiner can increase the test consistency, it is possible that this introduced bias due to repeated testing errors by the examiner. Third, preoperative shoulder function data were not obtained. Tashjian et al.²⁷ reported that the retrospectively collected outcome measures had much stronger correlations with patient satisfaction than the prospectively collected measures did. This suggests that use of only the final outcome measures in the present study may have reflected the actual patient satisfaction reasonably well even though the exact influence of the preoperative function on the postoperative function is unknown. Fourth, only 48% of all eligible patients were examined, and thus the data obtained may not reflect the retear rate of the entire population. The only demographic data obtained for the nonparticipants were age and sex, and thus the participants and nonparticipants may not have been equivalent. Fifth, the MCID of the satisfaction VAS score was determined solely on the basis of an expert opinion, and its validity has not been tested. Sixth, the shortest follow-up duration was twelve months, which may not have been sufficiently long. Lastly, the insurance status, preoperative activity level, and preoperative rotator cuff muscle quality were not investigated but could all be important factors to consider. The strengths of this study include (1) a sample size large enough to achieve the statistical power needed to test the study hypotheses, (2) blinding of the patients to the rotator cuff status at the time that they answered the survey, and (3) blinding of the ultrasonography examiner to the patient survey results at the time of the ultrasonography.

In conclusion, the present study demonstrated that the presence of a recurrent full-thickness tear negatively affected the clinical outcomes following rotator cuff repair. This finding refutes the widely held concept that patients typically do well regardless of the repair integrity following rotator cuff repair. Among the patients with a recurrent tear, nonanatomic factors including younger age, lower education level, and a Workers' Compensation claim were associated with poorer outcomes.

Appendix

eA Tables comparing the retear and no-retear groups and comparing the age categories within the retear group as well as figures showing the VAS instruments are available

with the online version of this article as a data supplement at jbjs.org. ■

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