Full-thickness rotator cuff tear prevalence and correlation with function and co-morbidities in patients sixty-five years and older

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The purpose of this study was to determine full-thickness rotator cuff tear prevalence in patients 65 and older and to correlate tears with comfort, function, and co-morbidities. Two-hundred shoulders without prior surgery were evaluated with a Simple Shoulder Test, a Constant Score, and ultrasound. Full thickness tear prevalence was 22%. Adjusting for age and gender, those with tears had lower scores than those without ($P < .001$ for each). Adjusting for many potential confounders, with a 10-year age increase, the odds of a tear increased 2.69-fold ($P = .005$). For those with tears, scores were no different for those who had seen a physician for their shoulder compared to those who had not. Full-thickness cuff tear prevalence was 22% in those 65 and older. Tear prevalence increased with increasing age. Shoulder scores were poorer for those with tears. (J Shoulder Elbow Surg 2008;17:881-885.)

Based on recent census information, approximately 17 million people in the United Status may be at risk for disabilities due to rotator cuff tendon failure.[12] However, this statement may not be entirely accurate due to a number of variables, including asymptomatic tears.[26,27] Although increasing age has been associated with an increased prevalence of rotator cuff tears, it is not clear how tears correlate with function, particularly in the older patient.[3,20,23] It has been observed that some patients have reasonable shoulder comfort and function despite an untreated rotator cuff tear.[19] In others, shoulder comfort and function improved with nonsurgical treatment of full-thickness rotator cuff tears.[8] In one study, patients older than 60 years had an asymptomatic, full-thickness cuff tear prevalence of 28%.[23] In another, with a mean age of 70, 50% of asymptomatic tears became symptomatic at a mean of 2.8 years.[28] However, it is important to consider that the asymptomatic tears in that study did not occur in asymptomatic patients; all patients had symptomatic tears in the contralateral shoulder. Finally, in addition to aging, rotator cuff tears have been associated with smoking and other co-morbidities as well.[22]

The purpose of this study was to assess the prevalence of full-thickness rotator cuff tears in patients 65 years and older and correlate the findings with shoulder comfort, function, and patient co-morbidities. Our hypotheses were the following: 1) rotator cuff tear prevalence increases with age; 2) shoulder function decreases with rotator cuff tears and increasing tear size; 3) smoking history, heart disease, peripheral vascular disease, and local corticosteroid injections are each associated with an increased cuff tear prevalence (these co-morbidities were chosen because they are common but also may be associated with compromised soft tissues), and 4) those patients with tears in shoulders that required previous medical attention would be more dysfunctional than those who had not sought medical attention. Finally, a secondary goal of this study was to provide baseline shoulder functional status of patients 65 years and older with and without full-thickness rotator cuff tears.

MATERIALS AND METHODS

After obtaining institutional IRB approval, subjects 65 years and older without previous shoulder surgery were recruited from orthopaedic lower extremity clinics (hip and knee, foot and ankle). They were required to have the cognitive ability to understand and complete questionnaires. There were no gender or racial restrictions to study participants. Exclusion criteria included shoulders that had undergone previous shoulder surgery and/or subjects who were unable to sign an informed consent. One or both of the subjects' shoulders were examined, depending on eligibility criteria.

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1. Is your shoulder comfortable with your arm at rest by your side?
2. Does your shoulder allow you to sleep comfortably?
3. Can you reach the small of your back to tuck in your shirt with your hand?
4. Can you place your hand behind your head with the elbow straight out to the side?
5. Can you place a coin on a shelf at the level of your shoulder without bending your elbow?
6. Can you lift one pound (a full pint container) to the level of your shoulder without bending your elbow?
7. Can you lift eight pounds (a full gallon container) to the level of your shoulder without bending your elbow?
8. Can you carry twenty pounds at your side with the affected extremity?
9. Do you think you can toss a softball under-hand twenty yards with the affected extremity?
10. Do you think you can toss a softball over-hand twenty yards with the affected extremity?
11. Can you wash the back of your opposite shoulder with the affected extremity?
12. Would your shoulder allow you to work full-time at your regular job?

Figure 1 Simple Shoulder Test (Yes = 1 or No = 0; max = 12).

Pain

None	15
Mild	10
Moderate	5
Severe	0

Activities of Daily Living (circle all that apply)

Full work	4
Full recreation/sport	4
Unaffected sleep	2

Positioning (circle one)

Arm up to waist	2
Arm up to xiphoid	4
Arm up to neck	6
Arm up to top of head	8
Arm above head	10

Forward Elevation (degrees)

0–30	0
31–60	2
61–90	4
91–120	6
121–150	8
151–180	10

Lateral elevation (degrees)

0–30	0
31–60	2
61–90	4
91–120	6
121–150	8
151–180	10

Internal Rotation Scoring (Circle one)

Dorsum of hand to:	
Lateral thigh	0
Buttock	2
Lumbosacral junction	4
Waist (L3)	6
12th dorsal vertebra	8
Interscapular	10

Internal Rotation Scoring (Circle all that apply)

Hand behind head with elbow held forward	2
Hand behind head with elbow held back	2
Hand on top of head with elbow held forward	2
Hand on top of head with elbow held back	2
Full elevation from on top of head	2

Power In pounds (25 maximum) _____

Total score _____

Figure 2 Constant Scoring System (maximum= 100).

Subjects were asked to complete a health history questionnaire to assist in documenting co-morbidities. We then assessed the function of each shoulder with 2 functional assessment metrics: The Simple Shoulder Test[14] (Figure 1) and the Constant-Murley score.[5] The Simple Shoulder Test has been demonstrated to have discriminate and construct validity, to be reproducible, and to be responsive to changes in shoulder function resulting from therapeutic interventions.[1,2,14] The Constant-Murley score (Figure 2), also frequently used as a shoulder functional metric, requires both patient and examiner input.[25] If both shoulders were included, each was assessed with both metrics. Shoulders were then examined with ultrasound to assess their rotator cuff status, as described by Mack et al.[18] We used a GE Healthcare Logiqbook (GE Healthcare, Milwaukee, WI) with a 4-10 MHz linear probe for ultrasonography. This diagnostic method has been validated by Teefy et al.[6,9,15-17,21,24,25]

We included only full thickness tears, which were measured from anterior to posterior at their footprint. The first author, an orthopaedist trained and experienced in rotator cuff untrasonography, performed all functional testing and ultrasounds.

Shoulders were divided into 4 groups, depending on whether the subject had previously presented to a physician for their respective shoulder based on Milgrom et al's definition of asymptomatic cuff tears; ie, "…no history of shoulder problems in the past severe enough to have required medical attention." [20] These 4 groups included: 1) those subjects without rotator cuff tears who had not seen a physician for their respective shoulders (control); 2) those without rotator cuff tears who had seen a physician for their respective shoulders; 3) those with rotator cuff tears who had not seen a physician for their respective shoulders, and 4) those with rotator cuff tears who had seen a physician for their respective shoulders.

Study design and statistical analysis

For *a priori* sample size calculation, we assumed the prevalence of full-thickness rotator cuff tears would be approximately 30%; therefore, a target accrual of 200 shoulders would result in a 95% confidence interval around the full-thickness rotator cuff tear prevalence estimate of approximately +/-7.8%. This calculation was based on a conservative assumption that the 200 shoulders would come from 100 independent subjects and that the 2 shoulders within a subject were correlated, such that the probability of concordant responses was 80% (either both shoulders have a tear or neither shoulder has a tear). A total of 200 shoulders from 100 subjects would result in 80% power, to detect a medium to large standardized effect of 0.65 in the difference in mean shoulder function scores between subjects with and without cuff tears. Assuming 30% of the subjects have cuff tears, 30% of the variability in the presence of cuff tears can be explained by age and gender. The 2 shoulders within a subject were correlated, such that the probability of concordant responses was 80% and a 2-sided type I error of 0.05.[4,7,11]

Descriptive statistics were used to summarize the demographic and clinical characteristics of the study subjects (Table I). Chi-squared test or Fisher's Exact test was used to assess the bi-variate association between categorical variables. A *t* test or Mann-Whitney test was used for association between continuous and categorical variables whenever appropriate. The prevalence of full-thickness rotator cuff tears in patients 65 and older and a corresponding 95% confidence interval was estimated, accounting for the correlation between shoulders within patients using the standard error estimate described in Donner et al, and adjusted for an unequal number of shoulders per subject.[7] The confidence interval tells us the precision of the estimated prevalence;

Table I Demographics and medical history

Male (% yes)	53 (51.0%)
Osteoarthritis (% yes)	64 (61.5%)
Diabetes (% yes)	10 (9.6%)
Heart disease (% yes)	28 (26.9%)
Peripheral vascular disease (% yes)	12 (11.5%)
Smoke now (% yes)	12 (11.5%)
Smoke before (% yes)	66 (63.5%)
Race: white (% yes)	104 (100%)
Age: mean±SD (range)	71.4±5.4 (65, 87)

Table II Median and inter-quartile ranges of Constant and SST scores

	Tear (N = 44)	No tear (N = 156)
Constant score: mean (standard deviation)	68.1 (18.1)	80.4 (15.9)
SST score: median (inter-quartile range)	9.5 (6.0, 11.0)	12.0 (9.5, 12.0)

SST, Simple Shoulder Test.

the wider the confidence interval, the less precise the estimated prevalence.

The association between the Constant scores and the presence and size of rotator tears was evaluated by fitting linear mixed models to adjust for the correlation between shoulders from the same subject and the confounding factors, including age and gender. To correlate the Simple Shoulder Test (SST) total score with the presence and size of rotator tears, SST scores were categorized into 3 categories: 1 (SST score of 8 or less), 2 (SST score between 9 and 11), and 3 (SST score of 12). Proportional odds logistic regression[10] was used to model the odds of high SST score, and generalized estimating equations (GEE) were applied to account for the correlation between shoulders within a subject.[13]

The association between the odds of full-thickness rotator cuff tears and the presence of co-morbidities was described by fitting a logistic regression model[10] adjusted for the following covariates: age, gender, heart disease (Yes/No), peripheral vascular disease (Yes/No), smoking (Yes/No), and cortisone injections (Yes/No). GEE was applied to adjust for dependence among shoulders from the same patient. Statistical analyses were carried out in SAS 9.1 (SAS, Cary, NC).

RESULTS

One-hundred and four subjects, 65 years or older, were recruited to obtain 200 shoulders, as 8 had undergone previous shoulder surgery in 1 of their shoulders. Full-thickness rotator cuff tear prevalence was 22% (44/200) with a 95% confidence interval (15.5%, 28.5%). Nine patients had bilateral tears. The other 26 tears were in patients who had a unilateral tear.

Table II shows the median and inter-quartile range (25^{th} percentile, 75^{th} percentile) of SST scores and the mean (standard deviation) of Constant scores, for those with and without tears. Those without tears tended to have higher scores than those with tears.

Table III Estimated effects of covariates on Constant-Murley scores

Variable	Estimated effect	Standard error	*P* value	95% CI
Age	−0.22	0.23	0.35	(-0.67, 0.24)
Gender (female vs male)	−9.16	2.41	0.0002	(-13.9, -4.38)
Tear (yes vs no)	−12.0	2.81	0.0003	(-17.8, -6.22)

As shown in Tables III and IV, after adjusting for potential co-founders age and gender, shoulders with full-thickness rotator cuff tears had significantly lower scores than those that did not for both the Constant-Murley and SST scores. Mean Constant scores were 12.0 points lower for those with full thickness tears than for those without ($P = .0003$). For those without tears, the odds of having a SST score of 9 or greater were 0.22 times of those with tears ($P < .0001$).

For the 44 shoulders with tears, the mean tear size was 2.2 cm (S.D. +/-1.0 cm). A linear relationship between tear size and Constant or SST scores was explored. After adjusting for age and gender, we found no significant correlation between tear size and either Constant or SST score for those with tears. However, this finding could also be due to lack of power with only 44 shoulders having a tear or the means by which the tears were measured. As noted in the Materials and Methods section, tears were measured from anterior to posterior at their footprint.

Table V shows that after adjusting for age and gender, none of the co-morbidities was significantly correlated with tears. We tested for a linear trend for age in the logistic model (grouping was not used) and found that the odds ratio (OR) of a full-thickness tear for subjects 10 years older was 2.69 times (95% CI is [1.35, 5.47]) that for younger subjects. No other co-morbidity or condition measured, other than age ($P = .005$), correlated with increasing tear prevalence.

Scores were not statistically different for those with tears in shoulders for which the patient had not seen a physician (group 3) compared to those with tears in shoulders for which the patient had seen a physician (group 4). Group 1 (those without rotator cuff tears that had not seen a physician) had significantly greater scores than groups 2-4 after adjusting for age and gender. Of the 44 shoulders with tears, there were 21 in group 3 and 23 in group 4. When comparing groups 3 and 4, there was no difference in age, gender, SST score, or Constant scores. In the comparison between group 1 and groups 2-4, age and gender were adjusted in the model. A possible explanation for group 2 having significantly lower scores than group 1 is that group 2 patients may have had shoulder symptoms attributable to something other than rotator cuff tears. Group 2 had higher scores than groups 3 and

Table IV Estimated effects of covariates on simple shoulder test scores

Variable	Estimated effect	Standard error	*P* value	95% CI
Age	−0.0079	0.026	.76	(-0.058, 0.042)
Gender (female vs. male)	−0.33	0.31	.29	(-0.92, 0.27)
Tear (yes vs. no)	−1.50	0.37	< .0001	(-2.22, -0.78)

Table V Co-morbidities and correlation with increasing tear prevalence

Variable	Estimated effect	Standard error	*P* value	95% CI
Age	0.099	0.035	.005	(0.03, 0.17)
Gender (female vs. male)	0.38	0.41	.36	(-0.43, 1.18)
Heart disease (yes vs. no)	0.81	0.47	.08	(-0.11, 1.72)
Diabetes (yes vs. no)	−0.11	0.56	.85	(-1.21, 0.99)
Osteoarthritis (yes vs. no)	0.021	0.37	.95	(-0.70, 0.75)
Peripheral vascular disease (yes vs. no)	−0.12	0.54	.83	(-1.18, 0.94)
Cortisone injection (yes vs. no)	0.13	0.48	.79	(-0.81, 1.07)
Smoking (yes vs. no)	0.29	0.44	.52	(-0.58, 1.16)

4, but it is also possible that those shoulders in group 2 may have had shoulder problems other than tears; yet, their scores were still higher than in the shoulders that had tears (groups 3 and 4). Our small sample size may also not have provided enough power to detect the differences, even if they did exist.

DISCUSSION

Rotator cuff disease affects shoulder comfort and function in many older patients; however, they often have variable shoulder symptoms. Some with shoulder dysfunction undergo MRI scans that identify large rotator cuff tears, which are more extensive than anticipated and/or are not well-explained by recent trauma. Although studies have shown that rotator cuff tears increase with age[20,23] and that some older patients with larger tears have shoulders that function well despite an untreated rotator cuff tear,[8] no study has looked specifically at patients 65 years and older to correlate full-thickness rotator cuff tears with age, function, and co-morbidities. In fact, 2 frequently referenced studies on rotator cuff tears and their association with aging include one that focused on patients aged 19 to greater than 60[23] (46 patients greater than 60 years old) and another with patients aged 30-99 (23 patients greater than 60 years old).[20] The purpose of our study was to assess the prevalence of full-thickness rotator cuff tears in 200 shoulders of patients 65 years and older and correlate the findings with shoulder comfort, function, and patient co-morbidities.

In this study, full-thickness rotator cuff tear prevalence was 22% in patients 65 years and older. Increased age correlated with increased rotator cuff tear prevalence. Adjusting for age and gender, those with intact rotator cuffs had better scores than those with torn cuffs, based on their SST and Constant scores. Finally, for those shoulders with full-thickness rotator cuff tears (44 shoulders total), there was no significant difference in shoulder scores between those for whom the patient had not seen a physician for their respective shoulder (21 shoulders) and those who had (23 shoulders). Having seen a physician may not be a good indicator of shoulder scores for those 65 years and older with full-thickness rotator cuff tears. This finding may deserve further study.

The interpretation of our data has several important limitations. First, our patients were recruited from lower extremity orthopaedic clinics (hip/knee and foot/ankle). This method of recruitment does not yield a true cross-section of the population and may result in a selection bias toward less healthy patients and those with demographics reflecting only those of the study and/or practice locale. Second, both shoulders were included in this study. It is possible that those with or without rotator cuff disease in one shoulder may have had comparable cuff status on the opposite shoulder. Our statistical methods should account for this; however, an alternative would have been to include only 1 shoulder from each patient. Third, our data may not be adequately powered to exclude relationships of co-morbidities. Fourth, diagnoses such as heart disease and diabetes are difficult to answer with a "yes-no" format. It is challenging to define these diagnoses crisply; therefore, our results were likely affected because of it. Fifth, the 12 functions assessed in the SST do not represent the full spectrum of shoulder function. Factors extrinsic to the shoulder may affect the patients' self-assessment of their shoulder function. Sixth, selection bias could have been introduced by including patients who had had previous surgery on the contralateral shoulder. Lastly, a second ultrasonographer would have made our methods more robust. These limitations may diminish the value of this attempt to define full-thickness rotator cuff tear prevalence in patients 65 and older, to assess shoulder comfort and function in these shoulders and to identify other co-morbidities possibly associated with tears.

In conclusion, full-thickness rotator cuff tear prevalence in this study was 22% in patients 65 years and older whose shoulders had not been operated on previously. Increased age correlated with increased full-thickness cuff tear prevalence. Shoulder scores were poorer for those with tears than for those without tears. For those patients with full-thickness tears, shoulder scores in those who had not seen a physician for their respective shoulder were comparable to the scores of those who had. In addition, for those with no tears, scores were better for those who had not seen a physician than for those who had. Having seen a physician may not be a good indicator of shoulder scores in this patient population.

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