

# Natural History of Nonoperatively Treated Symptomatic Rotator Cuff Tears in Patients 60 Years Old or Younger

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**Background:** Rotator cuff tears are the most frequent tendon injury in the adult population. However, the natural history of nonoperatively treated full-thickness tears is poorly defined. Knowledge of the expected evolution in tear size is important when considering nonoperative versus surgical care, especially in relatively young, active patients.

**Purpose:** To evaluate the size change of nonoperatively treated full-thickness rotator cuff tears over 2 to 3 years' follow-up.

**Study Design:** Case series; Level of evidence, 4.

**Methods:** The authors prospectively followed patients 60 years old or younger who had a full-thickness rotator cuff tear equal to or larger than 5 mm, as diagnosed by bilateral shoulder ultrasound, and who were treated nonoperatively. At 2 to 3 years after the index ultrasound examination, a repeat ultrasound examination was performed by the same ultrasonographer. Results of the follow-up ultrasound examinations of both shoulders were compared with those of the index ultrasound examinations for change in rotator cuff tear size. The correlations were examined between these changes and age, sex, history of initial trauma, size of tear on the index ultrasound, and current shoulder symptoms.

**Results:** Fifty-one patients with 61 rotator cuff tears were evaluated. At a follow-up of 25 to 39 months (mean, 29), 49% of the tears (30 tears) increased in size, 43% (26 tears) had not changed, and 8% (5 tears) decreased in size. For 25% (10 shoulders) of initially intact shoulders (41 shoulders), a new full-thickness rotator cuff tear was diagnosed. No correlation was found between the change in tear size and age of the patient ( $P = .85$ ), sex ( $P = .93$ ), existence of a prior trauma ( $P = .63$ ), size of tear at index ultrasound ( $P = .62$ ), and bilateral tears ( $P = 1.00$ ). There was a correlation between the existence of considerable pain at the time of the follow-up ultrasound and a clinically significant increase in tear size ( $P = .002$ ).

**Conclusion:** Full-thickness rotator cuff tears tend to increase in size in about half of patients aged 60 years or younger. Surgery should be initially considered in these patients to prevent a probable increase in size tear. Patients treated nonoperatively should be routinely monitored for tear size increase, especially if they remain symptomatic.

**Keywords:** rotator cuff tear; nonoperative treatment; ultrasound

Rotator cuff tear is the most common tendinous injury in the adult population.<sup>19</sup> Although nonsurgical treatment yields good pain relief and improvement in range of motion in the majority of patients, the exact anatomic natural history of nonsurgically treated tears is poorly defined.<sup>4</sup> This knowledge is especially important in the younger aged group (40-60 years old). For this population, maintaining

shoulder strength is important for the preservation of an active lifestyle. Increase in rotator cuff tear size adversely affects rotator cuff strength.<sup>18</sup> Therefore, understanding the expected anatomic evolution of a tear is important when contemplating nonoperative versus surgical care in these patients. The data available in the literature in regard to the anatomic natural history of these full-thickness rotator cuff tears are limited and generally focused on elderly patients.

Ultrasound and MRI are commonly used to assess rotator cuff tear size, with an accuracy of more than 90% in detecting full-thickness rotator cuff tears.<sup>2,6,8,13,17,20-22</sup> Ultrasound has an advantage over MRI in following the natural history of rotator cuff changes because it can easily be done bilaterally. In the past 20 years, ultrasound has been a primary modality in the imaging of rotator cuff tears in our institution, and sonograms of both shoulders are routinely performed on patients according to a standard protocol.

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The purpose of our study was to evaluate, using bilateral shoulder ultrasound examinations, the change in size of nonoperatively managed full-thickness rotator cuff tears in patients 60 years old or younger over a 2- to 3-year follow-up period.

## MATERIAL AND METHODS

The study was performed between March 2008 and June 2009 and was institutional review board approved. The shoulder ultrasound results of patients 60 years old or younger were reviewed, as performed by the senior musculoskeletal ultrasonographer in our university hospital between May 2005 and December 2006. Patients with ultrasound results who met the following criteria were included in the study: full-thickness rotator cuff tears of 1 or both shoulders, tear size between 5 and 40 mm, and tears that were treated nonsurgically. Patients with partial-thickness tears of either shoulder, patients with isolated subscapularis tears, patients with prior shoulder surgery, and patients with inflammatory joint disease were excluded. Patients who sustained trauma to their shoulders after the index ultrasound examination were also excluded.

Of the 677 ultrasound results reviewed, 69 met our criteria. Fourteen patients could not be reached. Of the 55 patients who were contacted, 51 agreed to participate in the study (93%). There were 28 men and 23 women. Their ages ranged from 35 to 60 years (mean,  $54 \pm 5.1$  years). After signing an informed consent form, patients were asked to undergo another ultrasound evaluation of their shoulders (follow-up ultrasound). The mean interval between the initial and follow-up ultrasound was 29 months (range, 25-39 months). Using the DASH questionnaire (Disabilities of the Arm, Shoulder and Hand), patients were asked to grade their current shoulder symptoms as *none/negligible* versus *considerable*. The patients were also asked whether a significant traumatic event had occurred in the year before their initial ultrasound examination.

Initial and follow-up ultrasound was done according to the following examination protocol:

1. Both examinations were performed by the same senior musculoskeletal ultrasonographer. At the time, he had 18 years of experience in shoulder ultrasonography and had performed approximately 1200 shoulder ultrasound examinations per year.
2. The ultrasound examinations were performed using a HDI 5000 ultrasound device (Philips Medical Company, Bothell, Washington) with sono-CT and harmonic imaging capabilities. A linear transducer (5-12 MHz) was employed.
3. The examinations were bilateral and performed in a standard manner, with additional views and dynamic evaluation conducted as needed.
4. A full-thickness rotator cuff tear was recorded when the rotator cuff could not be visualized because of complete avulsion and retraction under the acromion or when a focal defect in the rotator cuff was created

by a variable degree of retraction of the torn tendon edges. If no tear was visualized, the deltoid muscle was compressed against the cuff with a transducer, in an attempt to separate the torn edges at the side of a nonretracted tear. Total tear size (subscapularis, supraspinatus, and infraspinatus) was calculated for each shoulder.

5. In the follow-up ultrasound examination, the ultrasonographer was blinded to the patient's initial ultrasound results.
6. Results of the follow-up ultrasound examinations of both shoulders were thereafter compared with those of the index ultrasound examination for change in rotator cuff tear size.

The correlations were then examined between these changes and age, sex, history of initial trauma, size of tear in index ultrasound examination, and current shoulder symptoms.

## STATISTICAL METHODS

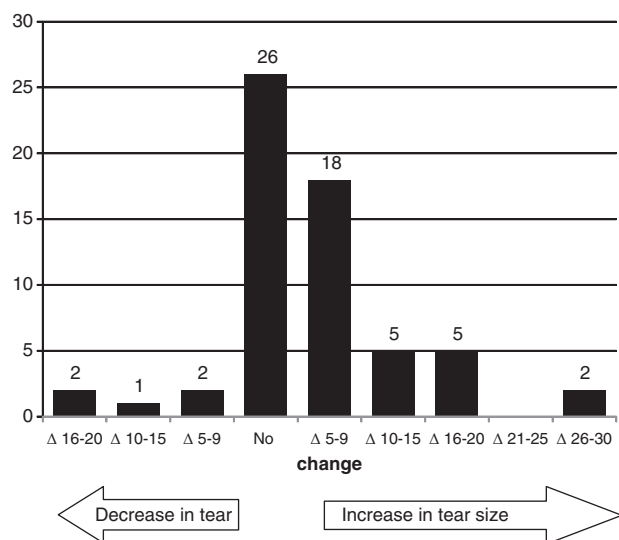
To assess the intraobserver variation in rotator cuff tear measurements, the same ultrasonographer performed 2 ultrasound examinations in 10 patients with 14 rotator cuff tears. The interval between these 2 examinations ranged from 3 to 46 days (mean, 22 days). The ultrasonographer was blinded to tear size when he performed the repeated examination. The difference in tear size between the 2 measurements was found to be 0 to 3 mm in 13 tears and 5 mm in 1 tear (mean change, 1.8 mm). Therefore, we decided that a change of 5 mm or more in tear size, from index ultrasound examination to follow-up, should be considered clinically significant in the analysis of the data.

Chi-square or Fisher exact test was used to assess the association between 2 categorical variables. Pearson correlation coefficient was used to assess the correlation between 2 quantitative variables. The *t* test, as well as the nonparametric Mann-Whitney test, was used for the comparison of quantitative variables between 2 independent groups. An analysis of variance, as well as the nonparametric Kruskal-Wallis test, was used for comparison of quantitative variables among 3 independent groups or more. All applied tests were 2-tailed, and a *P* value of 5% or less was considered statistically significant.

## RESULTS

Of 51 patients, 27 (53%) reported that a traumatic event initiated their symptoms in the year before their initial ultrasound examination; 24 (47%) denied any clinically significant trauma to the shoulder. At the time of the follow-up ultrasound, 33 patients (65%) reported considerable pain. In sum, 19 patients had right shoulder pain, 5 had left shoulder pain, and 9 had pain in both shoulders; 18 (35%) reported no or only negligible pain.

The initial ultrasound examination identified 61 tears in 51 patients: 38 had a right rotator cuff tear with an



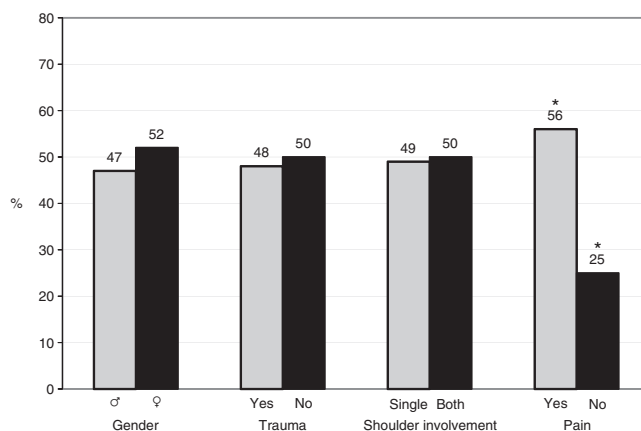
**Figure 1.** The change in tear size (in mm) from index to follow-up ultrasound examination.

intact left rotator cuff; 3 had a left rotator cuff tear with an intact right rotator cuff; and 10 had bilateral rotator cuff tears. The mean size of the tears was  $12 \pm 7$  mm (range, 5-39 mm).

The follow-up ultrasound identified 66 tears in these 51 patients: 31 (61%) had a right rotator cuff tear with an intact left rotator cuff; 5 (10%) had left rotator cuff tear with an intact right rotator cuff; and 15 (29%) had bilateral rotator cuff tears. The mean size of the tears was  $19 \pm 10$  mm (range, 5-50 mm).

Regarding interval rotator cuff tear change, of the 61 tears found on the index ultrasound, 30 (49%) had increased by 5 mm or more ( $12 \pm 6.4$  mm); 26 (43%) did not change; and 5 (8%) decreased ( $12 \pm 5.9$  mm), 4 (6.5%) of which were not found in the follow-up ultrasound examination. Figure 1 presents the change in size tear from index to follow-up ultrasound examination (change increments, 5 mm). There were 10 new tears found on the follow-up ultrasound with a mean size of  $10.5 \pm 5.3$  mm (range, 5-22 mm). These new tears accounted for 24% of the intact rotator cuff in the initial ultrasound examination.

No correlation was found between the change in tear size and age of the patient ( $P = .85$ ), sex ( $P = .93$ ), existence of a prior trauma ( $P = .63$ ), size of tear at index ultrasound ( $P = .62$ ), and bilateral tears ( $P = 1.00$ ). There was a correlation between the existence of considerable pain at the time of the follow-up ultrasound and an increase in tear size ( $P = .002$ ). Patients suffering pain at the time of the follow-up examination had a higher probability (56%) of increase in the tear size than did pain-free patients (25%). No correlation was found between the appearance of new rotator cuff tears in the follow-up ultrasound and sex ( $P = .91$ ), existence of trauma to the shoulder before the index ultrasound ( $P = .61$ ), or pain at the time of the follow-up ultrasound examination. Figure 2 presents the percentage of patients who were found to have a clinically



**Figure 2.** Percentage of patients who had a clinically significant increase in tear size according to the subgroups of sex, prior trauma, initial involvement of one or both shoulders, and existence of pain at the time of the follow-up ultrasound examination. \* $P < .05$ .

significant increase in rotator cuff tear size (5 mm or more) among the different subsets.

## DISCUSSION

This study followed the natural progression in the size of nonoperatively treated rotator cuff tears in a population 60 years old and younger. In the study's follow-up period of 2 to 3 years, almost half the tears increased by 5 mm or more. Neither initial tear size nor a history of a trauma preceding the original tear were found to predict tear size change. The presence of pain at the time of the follow-up examination was the only predictor of tear size change. A limitation of our study is that we do not know how the decision was made to treat these patients nonoperatively; therefore, we do not know if these results represent all patients in this age group with rotator cuff tears.

Rotator cuff tears are a frequent cause for morbidity in patients older than 40 years.<sup>15</sup> Symptoms frequently associated with cuff tear, such as shoulder pain and limited range of motion, frequently subside after nonoperative treatment.<sup>1,3,4</sup> Although the symptoms may subside, it is generally accepted that full-thickness rotator cuff tears do not heal. However, this has not been well documented in the current literature. We found only 2 studies in the English literature on the anatomic natural history of full-thickness rotator cuff tears. Yamaguchi et al<sup>23</sup> sonographically evaluated the change in full-thickness rotator cuff tear size in 23 patients (mean age, 70 years). They found that after a 5-year period, 39% of the tears increased by more than 5 mm, while no rotator cuff tear had healed. A recent study by Maman et al<sup>16</sup> retrospectively examined the change in rotator cuff tear size in 33 symptomatic full-thickness rotator cuff tears in patients treated nonoperatively. Using MRI scans performed at least 6 months apart, they found that 52% had an increase in tear size ( $>2$  mm),

36% had no change, and 12% had decreased in size in a median follow-up period of 18 months (range, 7-58 months). Older patients had a greater probability of increasing their tear size than did younger patients. The results of our study, in a younger patient population, similarly showed an increase in tear size in about half of all tears over a 2- to 3-year follow-up period. Because our patient population was considerably younger, the study indicates that younger patients are prone to a clinically significant increase in tear size after a relatively short time.

Many patients with rotator cuff tears are expected to experience recurrent symptoms in the years to come, some of which will no longer respond to nonoperative treatment. A clinically significant increase in tear size may lower the chances for a complete and successful repair of the tear.<sup>5,10,14</sup> Because a clinically significant increase in tear size is expected in about half these full-thickness tears, this prognosis should be taken into consideration during the initial evaluation of and decision making for these patients. This is especially true for the younger, more active patients with rotator cuff tears who exert their shoulders and are therefore more likely to experience recurrent symptoms.

An important finding of this study is that 5 of the 61 full-thickness rotator cuff tears (8%) decreased by 5 mm or more during the follow-up period. Maman et al<sup>16</sup> found a decrease in tear size in 4 of 33 patients (12%) with full-thickness tears. Yamanaka and Matsumoto<sup>24</sup> reported that a decrease in tear size was usually seen in partial-thickness tears. Jost et al<sup>12</sup> followed patients with failed rotator cuff repairs and found that 8 of 20 retears (40%) could no longer be identified on a repeat MRI scan. The rotator cuff was in continuity without any detectable full-thickness structural defect, and the bridging tissue had a signal intensity ranging from that of scar tissue to that of normal tendon tissue. Fukuda<sup>9</sup> described synovial proliferation that may mask small rotator cuff defects at the time of surgery. From the combined observations of our study and those of the Maman and Jost studies, it is apparent that rotator cuff tears can in some cases decrease in size and that the commonly accepted notion that rotator cuff lesions always fail to heal spontaneously is not completely accurate.<sup>11</sup> The quality of the tissue forming in the tear site (synovial proliferation, scar tissue, or normal tendon tissue) in full-thickness tears has yet to be determined.

Pain at the follow-up ultrasound examination was found to be a predictor for a clinically significant increase in tear size. Because we do not have the pain evaluation at the time of the index ultrasound examination, we cannot compare the pain scoring change between the 2 ultrasound examinations. However, we can assume that the patients were in pain at the time of the initial ultrasound, given that they were indicated for initial ultrasound examination by their treating physicians. A similar connection between pain and tear size propagation was reported by Yamaguchi et al,<sup>23</sup> who found that of 14 previously asymptomatic patients who became symptomatic, 7 had a clinically significant increase in their tear size, whereas of 9 patients who remained pain-free, only 2 had tear progression.

Therefore, we can consider patients who have their symptoms resolved or almost completely resolved to have lower probability of an increase in tear size. Patients who remain symptomatic should be more carefully followed and monitored for increase in tear size.

Ultrasound examination of the shoulder has been repeatedly shown to be accurate in the diagnosis of full-thickness rotator cuff tears.<sup>2,6,8,13,17,20-22</sup> Its accuracy was found to be equivalent to MRI in the diagnosis and sizing of these tears. Ultrasound has several advantages over MRI, including its higher availability in many countries, the ability to use it as an office-based device by the treating physician,<sup>11</sup> and the ability to image the shoulders in the same session. This makes the ultrasound a good instrument for the follow-up of patients with symptomatic rotator cuff tears.

Currently, only younger patients sustaining a full-thickness tear after a significant trauma are advised to undergo surgical repair of the tear.<sup>7</sup> Because patients with and without preceding trauma were found in this study to have similar increases in their tear sizes, we suggest that the surgical option be contemplated early in most symptomatic younger patients. We also suggest that follow-up imaging might be beneficial in patients who are treated nonoperatively and who have continued pain, to monitor their tear size. A surgical repair may be warranted for those in whom a clinically significant increase in tear size is observed.

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