Symptoms of pain do not correlate with rotator cuff tear severity

Robert H. Brophy  
*Washington University School of Medicine in St. Louis*

Matthew V. Smith  
*Washington University School of Medicine in St. Louis*

Rick W. Wright  
*Washington University School of Medicine in St. Louis*

et al

Follow this and additional works at: https://digitalcommons.wustl.edu/open_access_pubs

Please let us know how this document benefits you.

**Recommended Citation**

https://digitalcommons.wustl.edu/open_access_pubs/2947

This Open Access Publication is brought to you for free and open access by Digital Commons@Becker. It has been accepted for inclusion in Open Access Publications by an authorized administrator of Digital Commons@Becker.  
For more information, please contact vanam@wustl.edu.
Symptoms of Pain Do Not Correlate with Rotator Cuff Tear Severity

A Cross-Sectional Study of 393 Patients with a Symptomatic Atraumatic Full-Thickness Rotator Cuff Tear

Warren R. Dunn, MD, MPH, John E. Kuhn, MD, MS, Rosemary Sanders, BA, Qi An, MS, Keith M. Baumgarten, MD, Julie Y. Bishop, MD, Robert H. Brophy, MD, James L. Carey, MD, MPH, G. Brian Holloway, MD, Grant L. Jones, MD, C. Benjamin Ma, MD, Robert G. Marx, MD, MS, Eric C. McCarty, MD, Sourav K. Poddar, MD, Matthew V. Smith, MD, Edwin E. Spencer, MD, Armando F. Vidal, MD, Brian R. Wolf, MD, MS, and Rick W. Wright, MD,
on behalf of the MOON Shoulder Group

Background: For many orthopaedic disorders, symptoms correlate with disease severity. The objective of this study was to determine if pain level is related to the severity of rotator cuff disorders.

Methods: A cohort of 393 subjects with an atraumatic symptomatic full-thickness rotator-cuff tear treated with physical therapy was studied. Baseline pretreatment data were used to examine the relationship between the severity of rotator cuff disease and pain. Disease severity was determined by evaluating tear size, retraction, superior humeral head migration, and rotator cuff muscle atrophy. Pain was measured on the 10-point visual analog scale (VAS) in the patient-reported American Shoulder and Elbow Surgeons (ASES) score. A linear multiple regression model was constructed with use of the continuous VAS score as the dependent variable and measures of rotator cuff tear severity and other non-anatomic patient factors as the independent variables. Forty-eight percent of the patients were female, and the median age was sixty-one years. The dominant shoulder was involved in 69% of the patients. The duration of symptoms was less than one month for 8% of the patients, one to three months for 22%, four to six months for 20%, seven to twelve months for 15%, and more than a year for 36%. The tear involved only the supraspinatus in 72% of the patients; the supraspinatus and infraspinatus, with or without the teres minor, in 21%; and only the subscapularis in 7%. Humeral head migration was noted in 16%. Tendon retraction was minimal in 48%, midhumeral in 34%, glenohumeral in 13%, and to the glenoid in 5%. The median baseline VAS pain score was 4.4.

Results: Multivariable modeling, controlling for other baseline factors, identified increased comorbidities (p = 0.002), lower education level (p = 0.004), and race (p = 0.041) as the only significant factors associated with pain on presentation. No measure of rotator cuff tear severity correlated with pain (p > 0.25).

Conclusions: Anatomic features defining the severity of atraumatic rotator cuff tears are not associated with the pain level. Factors associated with pain are comorbidities, lower education level, and race.

Level of Evidence: Prognostic Level III. See Instructions for Authors for a complete description of levels of evidence.
For many orthopaedic disorders, such as osteoarthritis, symptoms correlate with disease severity\(^1\)-\(^3\). However, symptoms related to rotator cuff tears are not as predictable. It is well known that many people in the general population have an asymptomatic rotator cuff tear\(^4\)-\(^6\). Patients may become asymptomatic following rotator cuff repair despite evidence that the repair failed on magnetic resonance imaging (MRI) or ultrasound imaging\(^7\). Nonoperative treatment for full-thickness rotator cuff tears is often successful despite a lack of tendon healing\(^8\)-\(^11\). As a result, the link between rotator cuff tears and symptoms is not clearly established. Pain is a frequently cited symptom associated with rotator cuff tears and is often used as an indication for surgery\(^12\)-\(^15\). The objective of this investigation was to determine if the pain level is related to the severity of the rotator cuff disease. We used a cross-sectional design to test the hypothesis that increased pain correlates with greater rotator cuff tear severity.

### Materials and Methods

The MOON (Multicenter Orthopaedic Outcomes Network) Shoulder Group is a team of sixteen fellowship-trained orthopaedic surgeons and research personnel from nine geographically dispersed sites, representing both academic and private practice settings, within the United States. This group was formed to conduct large multicenter studies on conditions of the shoulder. From May 2004 through October 2006, the MOON Shoulder Group met regularly to formulate research questions of interest; develop and standardize radiographic and MRI protocols; assemble validated behavioral and patient-oriented outcome assessment forms for data collection; and conduct validation studies on MRI classification of rotator cuff tears\(^16\), classification of rotator cuff tears based on arthroscopic videos\(^17\), and radiographic findings associated with rotator cuff disease\(^18\). In addition, the group performed systematic reviews of the literature to evaluate rehabilitation following rotator cuff repairs\(^19\), summarize the literature regarding indications for surgical treatment of rotator cuff tears\(^20\), and determine the effectiveness of physical therapy in treating rotator cuff disease while developing an evidence-based protocol\(^21\).

### TABLE I Demographic Features of Cohort

<table>
<thead>
<tr>
<th></th>
<th>No. of Patients</th>
<th>Female (N = 190)</th>
<th>Male (N = 203)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age* (yr)</td>
<td>393</td>
<td>63.2 ± 10.2</td>
<td>62.1 ± 9.9</td>
</tr>
<tr>
<td>BMI* (kg/m(^2))</td>
<td>388</td>
<td>28.3 ± 7.2</td>
<td>29.0 ± 5.1</td>
</tr>
<tr>
<td>Involved side</td>
<td>390</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nondominant</td>
<td>27% (51/188)</td>
<td>35% (70/202)</td>
<td></td>
</tr>
<tr>
<td>Dominant</td>
<td>73% (137/188)</td>
<td>65% (132/202)</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td>389</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>7% (13/187)</td>
<td>4% (9/202)</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>12% (23/187)</td>
<td>4% (8/202)</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>81% (151/187)</td>
<td>92% (185/202)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>392</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school or less</td>
<td>27% (51/189)</td>
<td>35% (72/203)</td>
<td></td>
</tr>
<tr>
<td>Some college</td>
<td>31% (59/189)</td>
<td>21% (43/203)</td>
<td></td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>20% (38/189)</td>
<td>19% (39/203)</td>
<td></td>
</tr>
<tr>
<td>Graduate degree</td>
<td>22% (41/189)</td>
<td>24% (49/203)</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td>391</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5% (10/189)</td>
<td>3% (7/202)</td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>20% (37/189)</td>
<td>9% (18/202)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>48% (90/189)</td>
<td>82% (165/202)</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>10% (18/189)</td>
<td>3% (6/202)</td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>18% (34/189)</td>
<td>3% (6/202)</td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>392</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>38% (72/189)</td>
<td>55% (112/203)</td>
<td></td>
</tr>
<tr>
<td>Part-time</td>
<td>12% (23/189)</td>
<td>7% (14/203)</td>
<td></td>
</tr>
<tr>
<td>Retired</td>
<td>34% (64/189)</td>
<td>32% (65/203)</td>
<td></td>
</tr>
<tr>
<td>Homemaker</td>
<td>9% (17/189)</td>
<td>0% (0/203)</td>
<td></td>
</tr>
<tr>
<td>Not working</td>
<td>7% (13/189)</td>
<td>6% (12/203)</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>390</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>90% (170/188)</td>
<td>90% (182/202)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>10% (18/188)</td>
<td>10% (20/202)</td>
<td></td>
</tr>
</tbody>
</table>

*The values are given as the mean and standard deviation.
The indications for surgery for atraumatic rotator cuff tears are not clear, and our research group could not develop standard indications for surgery by consensus. Therefore, the group conducted a prospective cohort study to assess the nonoperative treatment of atraumatic full-thickness rotator cuff tears with use of the physical therapy protocol derived from the systematic review. We expected that nonoperative treatment would succeed for some patients, who would then decline surgical intervention, while it would fail for others, who would then undergo rotator cuff repair. By identifying features that distinguish these groups, we sought insight into the risk factors for failure of nonoperative management to better define the appropriate indications for surgery. To test the hypothesis that pain correlates with measures of rotator cuff tear severity, we performed a cross-sectional study of data derived from this population when patients initially presented to the treating physician. Sample-size requirements for that study were formulated with the events-per-variable approach, with ten events as the minimum number to avoid overfitting of the model. Baseline data on the first 393 subjects enrolled into the ongoing prospective cohort study were used in the present study.

### Institutional Review Board Approval

Institutional review board approval was obtained at all participating sites before enrollment of the first patient.

### Inclusion and Exclusion Criteria

All patients eighteen to 100 years old with an MRI-documented full-thickness atraumatic symptomatic rotator cuff tear were invited to participate. Exclusion criteria included an injury that precipitated the pain, pain determined to be related to the cervical spine, scapular pain, previous shoulder surgery, glenohumeral arthritis, inflammatory arthritis, adhesive capsulitis, a previous proximal humeral fracture, a symptomatic contralateral rotator cuff tear, and dementia.

### Protocol

Patients were recruited over a four-year period (January 2007 to January 2011). At the initial visit, patients completed a questionnaire that detailed demographic information and associated pain and functional outcomes. From these data, we identified several features that correlated with measures of rotator cuff tear severity. These features are presented in Table II, which details the cohort's characteristics.

The indications for surgery for atraumatic rotator cuff tears are not clear, and our research group could not develop standard indications for surgery by consensus. Therefore, the group conducted a prospective cohort study to assess the nonoperative treatment of atraumatic full-thickness rotator cuff tears with use of the physical therapy protocol derived from the systematic review. We expected that nonoperative treatment would succeed for some patients, who would then decline surgical intervention, while it would fail for others, who would then undergo rotator cuff repair. By identifying features that distinguish these groups, we sought insight into the risk factors for failure of nonoperative management to better define the appropriate indications for surgery. To test the hypothesis that pain correlates with measures of rotator cuff tear severity, we performed a cross-sectional study of data derived from this population when patients initially presented to the treating physician. Sample-size requirements for that study were formulated with the events-per-variable approach, with ten events as the minimum number to avoid overfitting of the model. Baseline data on the first 393 subjects enrolled into the ongoing prospective cohort study were used in the present study.

### TABLE II Features of Rotator Cuff Disease in the Cohort

<table>
<thead>
<tr>
<th>Feature</th>
<th>No. of Patients</th>
<th>Female (N = 190)</th>
<th>Male (N = 203)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of symptoms</td>
<td>390</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 mo</td>
<td></td>
<td>6% (12/189)</td>
<td>9% (18/201)</td>
</tr>
<tr>
<td>1-3 mo</td>
<td></td>
<td>22% (41/189)</td>
<td>22% (44/201)</td>
</tr>
<tr>
<td>4-6 mo</td>
<td></td>
<td>22% (41/189)</td>
<td>18% (37/201)</td>
</tr>
<tr>
<td>7-12 mo</td>
<td></td>
<td>18% (34/189)</td>
<td>11% (23/201)</td>
</tr>
<tr>
<td>&gt;12 mo</td>
<td></td>
<td>32% (61/189)</td>
<td>39% (79/201)</td>
</tr>
<tr>
<td>Involved tendons</td>
<td>383</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supraspinatus</td>
<td></td>
<td>75% (139/186)</td>
<td>70% (137/197)</td>
</tr>
<tr>
<td>Supraspinatus + infraspinatus ± teres minor</td>
<td></td>
<td>20% (37/186)</td>
<td>22% (44/197)</td>
</tr>
<tr>
<td>Subscapularis</td>
<td></td>
<td>5% (10/186)</td>
<td>8% (16/197)</td>
</tr>
<tr>
<td>Retraction</td>
<td>390</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimal</td>
<td></td>
<td>49% (92/188)</td>
<td>48% (96/202)</td>
</tr>
<tr>
<td>Midhumeral</td>
<td></td>
<td>34% (63/188)</td>
<td>35% (70/202)</td>
</tr>
<tr>
<td>Glenohumeral</td>
<td></td>
<td>13% (25/188)</td>
<td>12% (25/202)</td>
</tr>
<tr>
<td>Glenoid</td>
<td></td>
<td>4% (8/188)</td>
<td>5% (11/202)</td>
</tr>
<tr>
<td>Superior migration</td>
<td>380</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>87% (163/187)</td>
<td>82% (158/193)</td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td>13% (24/187)</td>
<td>18% (35/193)</td>
</tr>
<tr>
<td>Rotated tendons</td>
<td>384</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>75% (139/186)</td>
<td>70% (139/198)</td>
</tr>
<tr>
<td>≥2</td>
<td></td>
<td>25% (47/186)</td>
<td>30% (59/198)</td>
</tr>
<tr>
<td>MRI quantity of supraspinatus</td>
<td>387</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td></td>
<td>40% (74/186)</td>
<td>53% (107/201)</td>
</tr>
<tr>
<td>&lt;25% atrophy</td>
<td></td>
<td>31% (58/186)</td>
<td>22% (45/201)</td>
</tr>
<tr>
<td>25-50% atrophy</td>
<td></td>
<td>22% (40/186)</td>
<td>13% (27/201)</td>
</tr>
<tr>
<td>50-75% atrophy</td>
<td></td>
<td>6% (12/186)</td>
<td>7% (15/201)</td>
</tr>
<tr>
<td>Complete atrophy</td>
<td></td>
<td>1% (2/186)</td>
<td>3% (7/201)</td>
</tr>
<tr>
<td>Acromion shape</td>
<td>377</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type I</td>
<td></td>
<td>13% (23/182)</td>
<td>10% (20/195)</td>
</tr>
<tr>
<td>Type II</td>
<td></td>
<td>70% (127/182)</td>
<td>73% (142/195)</td>
</tr>
<tr>
<td>Type III</td>
<td></td>
<td>18% (32/182)</td>
<td>17% (33/195)</td>
</tr>
<tr>
<td>Acromiohumeral interval* (mm)</td>
<td>339</td>
<td>8.0, 10.0, 11.0 (9.8 ± 6.8)</td>
<td>8.0, 10.0, 11.0 (10.2 ± 7.2)</td>
</tr>
</tbody>
</table>

*The values are given as the lower quartile, median, upper quartile (mean and standard deviation).
data and included the following validated patient-reported outcome measures: the Short Form-12 (SF-12)\textsuperscript{23}, American Shoulder and Elbow Surgeons (ASES) score\textsuperscript{24}, Western Ontario Rotator Cuff (WORC) Index\textsuperscript{25}, Self-Assessment Numeric Evaluation (SANE) score\textsuperscript{26}, and the Shoulder Activity Scale\textsuperscript{28}. Patient demographic information including age, sex, race, employment status, Workers’ Compensation or automobile insurance claims, and tobacco use history were also collected at the time of enrollment.

Physicians at each site examined patients and images and recorded information regarding shoulder motion, strength, tenderness, provocative signs, and descriptors of radiographs and MRI scans. The following MRI features used to assess the severity of a rotator cuff tear had reasonably high interobserver agreement when studied by our research group\textsuperscript{16} and were used in this analysis: (1) the rotator cuff tendons that were seen to be involved by the tear on MRI (72% agreement, kappa = 0.55), (2) retraction in the sagittal plane seen on MRI as described by Patte\textsuperscript{29} (63% agreement, kappa = 0.44), (3) presence of superior humeral head migration on standing anteroposterior radiographs (52% agreement, kappa = 0.26), and (4) amount of supraspinatus atrophy\textsuperscript{30} seen on MRI (59% agreement, kappa = 0.25).

**Statistical Methods**

To evaluate the association between shoulder pain and other baseline factors, a multivariable linear multiple regression model was fit with use of a continuous visual analog scale (VAS) pain score (item 3 from the ASES patient form\textsuperscript{24}) as the dependent variable. Independent variables included in the model were age, sex, body mass index (BMI), duration of symptoms, activity level, handedness, education, occupation, race, smoking status, patient expectations, tendons torn, retraction, humeral head migration, and amount of atrophy in the supraspinatus.

We did not assume linearity of covariate effects but only assumed smoothed relationships, using restricted cubic regression splines. Missing values of predictor variables were imputed with use of multiple imputation incorporating predictive mean matching and flexible additive imputation models as implemented in the `aregImpute` function available in the `Hmisc` package in R\textsuperscript{31}. This procedure involves predicting missing values on the basis of nonmissing observed data—essentially finding matches for the missing values. A regression model is fit to the observed data, then the missing values for a particular covariate are matched to the closest set of observed values on the basis of the regression fit, and then missing values are imputed on the basis of the closest set of observed values. This process was repeated ten times; hence, the imputed values were averaged over ten imputations. Pooling of low-prevalence categories was performed for data reduction to preserve degrees of freedom in the model, and to avoid convergence problems with the model. Specifically, American Indian, Asian, and Hawaiian were collapsed into an “other” category for race; disabled and unemployed were combined into a “not working” category for employment status; and no high school and some high school were collapsed into a “high school or less” category for education. Statistical analysis was performed with free open-source R statistical software (www.r-project.org).

**Population and Rotator Cuff Demographics**

The group evaluated 2233 patients who presented with a rotator cuff tear during the enrollment period; 1280 of these patients were excluded because of a traumatic tear (38%), previous surgery (11%), bilateral disease (8%), neck disorder (6%), frozen shoulder (2%), glenohumeral dislocation (3%), rheumatoid disease (1%), or fracture (1%). Of the remaining 953 patients eligible to enroll in the study, 452 (47%) elected to do so. The first 393 patients in this cohort were included in the present cross-sectional study, in which we used data from the first visit at the time of the initial enrollment in the study.

The average age of the patients who enrolled was sixty-two years, whereas the average age of those who did not was fifty-eight years (p < 0.001).

---

**Fig. 1**

Plot of the effects of the significant predictors in the model. The gray bars represent the 95% CI for the mean effect. The mean effect of comorbidity on pain was determined by comparing those with an SCQ score of 2 with those with a score of 10; the VAS pain score (ases3) was increased by 1.07 (95% CI: 0.31, 1.83) in the latter group. HS = high school, Grad = graduate, and Bach = Bachelor’s.
Equal numbers of men and women enrolled, whereas 63% of those who did not enroll were male; this was a significant difference \( p < 0.001 \).

**Demographic Data for the Study Population**
The median age of the study population was sixty-one years (range, thirty-one to ninety years), and 52% were male. The dominant arm was affected in 69% of the subjects; 90% were nonsmokers. Other demographic features, including race, education level, and employment status, are listed in Table I stratified by sex. Twenty-three percent of the patients had already tried some physical therapy, 40% had received injections, and 80% had tried nonsteroidal anti-inflammatory drugs. The median baseline VAS pain score was 4.4.

**MRI Features of the Rotator Cuff Tears**
The tears involved only the supraspinatus in 72% of the patients. Retraction was minimal in 48% of the patients and was to the midpoint of the humeral head in 34%. Superior humeral head migration was present in 16% of the patients. Tear characteristics stratified by sex are listed in Table II.

**Source of Funding**
Sources of funding included an unrestricted gift from the Arthrex Corporation, and a research funding grant specific to the investigation from the National Football League (NFL) Foundation, which were used to support research personnel and pay for supplies and computer hardware and software. Career development grants from the National Institutes of Health (NIH) and the American Orthopaedic Society for Sports Medicine (AOSSM) supported Dr. Dunn.

**Results**

**Factors Associated with Pain**
Greater pain was associated with an increased number of comorbidities \( p = 0.002 \), a lower education level \( p = 0.004 \), and race \( p = 0.041 \). Measures of tear severity, including the tendons involved \( p = 0.5 \), amount of retraction \( p = 0.9 \), presence of humeral head migration \( p = 0.3 \), and amount of fatty degeneration of the supraspinatus \( p = 0.4 \), were not associated with pain. These findings were adjusted for the other covariates included in the model—specifically, duration of symptoms, occupation, smoking status, activity level, BMI, dominant arm, and patient expectations. A summary-of-effects plot is shown in Figure 1 with the 95% confidence intervals (CIs) for the mean effects.

While the SCQ score, a lower level of education, and race were significant factors, the respective point estimates shown in Figure 1 do not represent a clinically meaningful difference in the VAS pain score, which is 1.4 cm for subjects with rotator cuff disease. However, using the nomogram in Figure 2, one can estimate the cumulative effects of the predictors on pain. For instance, the nomogram can be used to estimate the effect of race, education level, and comorbidity (allowing the other factors depicted on the nomogram to default to the left-most category, which contributes no points to the calculation) as follows. A sum

![Fig. 2](image_url)

Nomogram for the model predicting an individual patient’s VAS pain score. First, each variable is marked on the appropriate scale, and the number of points for each is derived from the ‘‘Points’’ scale at the top of the nomogram. Then the points are totaled, and the total value is marked on the ‘‘Total Points’’ scale. Viewing down, one then derives the predicted pain score on the scale labeled ‘‘Linear Predictor.’’ For ease of interpretation not all predictors included in the model are shown in the nomogram. HS = high school, Grad = graduate, Bach = Bachelor’s, and SS = supraspinatus.
of the points for a subject of black race, an SCQ of 10, and a high-
school education (~45 points for black race, ~40 points for an
SCQ of 10, and 29 points for a high-school education) equals 114
total points, with a predicted VAS pain score of 5.6. When this
is compared with a subject of white race who has an SCQ of 2 and a
graduate degree (~25 points for white, ~12 points for an SCQ of
2, and ~2 points for a graduate degree equals a total of 39 points,
with a predicted VAS pain score of ~3.3, the difference in the
predicted VAS pain scores is 2.3, which would be considered a
clinically meaningful difference.

Discussion

This cross-sectional study demonstrated no correlation be-
tween the level of pain reported by patients and any ana-
tomic measure of rotator cuff tear severity. The level of pain did
correlate with nonanatomic features, including increased num-
ber of comorbidities, race, and lower education level.

There are several study limitations, the foremost of which is
the cross-sectional design using only baseline data from a pro-
spective cohort, which made causal inferences difficult. Other
limitations include the potential for selection bias, as patients
who were less willing to have surgery may have been more in-
clined to participate and patients may have self-selected on the
basis of their level of symptoms, and performance bias, as some
patients may have received medications, acupuncture, or other
pain-relieving treatments that we did not examine. Also, gener-
alizability may be limited as many patients presented with a
history of trauma and were excluded from the study. Despite
these potential limitations, our study included nearly 400 sub-
jects from multiple practices across the United States. Thus, the
results of this study may be generalizable to the symptomatic
patients with a rotator cuff tear in the United States population
within the limitations described above.

Patients with atraumatic orthopaedic conditions typi-
cally present with pain, and that pain often correlates with the
severity of the disorder1-3. This does not appear to be the case
with rotator cuff tears as our data suggest that there is no
relationship between pain severity and rotator cuff tear severity.
There are abundant data to suggest that the relationship be-
tween pain and rotator cuff tears is not robust. Nonoperative
treatment of symptomatic, atraumatic, full-thickness rotator
cuff tears is successful in approximately 75% of patients4-11. Patients
who have a failed repair of a rotator cuff tear are often pain-
free, and their outcomes may be indistinguishable from those in patients with an intact repair5. Finally, the prevalen-
ty of asymptomatic rotator cuff tears is high. If one uses a con-
servative estimate that 10% of the population over the age of
sixty-five years in the United States has a full-thickness rotator
cuff tear5, then on the basis of 2010 census data12 more than
four million citizens in the United States have a full-thickness
rotator cuff tear. With this very large number as a denominator and the approximately 250,000 rotator cuff surgical procedures
performed each year in the United States13 as a numerator, only
6% of patients with a full-thickness rotator cuff tear have sur-
gery each year. These different lines of evidence suggest that many
rotator cuff tears are not associated with pain.

Natural history studies have demonstrated that, in some
patients, pain may be associated with enlargement of an asymptom-
tic rotator cuff tear. Yamaguchi et al. studied progression of
asymptomatic rotator cuff tears in twenty-three patients with a
contralateral symptomatic rotator cuff tear. The asymptomatic
shoulder became symptomatic over a period averaging 2.8 years
after the initial ultrasound study14. Nine of the twenty-three re-
main asymptomatic, and fourteen became symptomatic. Of
the nine who remained asymptomatic, two had progression of
the asymptomatic rotator cuff tear. Of the fourteen who became
symptomatic, seven had rotator cuff tear progression. While this
study demonstrated that those with tear progression are more likely
to develop pain, it also showed that tear progression can develop
without pain and that pain can develop without tear progression.
The average 10-cm VAS pain score in the symptomatic group was
2.9 cm higher than that in the asymptomatic group.

In the study by Moosmayer et al., fifty patients with an
asymptomatic rotator cuff tear and a contralateral symptomatic
rotator cuff tear were followed over three years15. Eighteen pa-
tients (36%) developed symptoms, with an increase of 3.3 cm in
the 10-cm VAS pain score, and the increase in tear size over time was
greater in the newly symptomatic group than in the asymptomatic
group. Confounding this was the finding that the long head of the
biceps tendon developed more pathologic changes in the newly
symptomatic group than in the asymptomatic group. What is not
known is whether the increase in pain with rotator cuff tear pro-
gression diminishes with exercise or with time. One might expect
that patients with larger rotator cuff tears would report a longer
duration of symptoms, but this is not the case16.

It appears that the majority of rotator cuff tears are
asymptomatic. Rotator cuff tears can progress in some patients;
this progression may occur without symptoms in some but will be
associated with symptoms in many. The amount of pain associ-
ated with tear progression (approximately 3 cm on a 10-cm pain
VAS) is less than the median value seen in our study (4.4 cm),
suggesting that the pain with cuff tear progression may not be
great enough to drive patients to seek medical attention. The data
also suggest that patients with a rotator cuff tear may develop pain
without tear progression, suggesting that other sources of pain,
such as the long head of the biceps, may be present17,18.

Indications for surgical repair of chronic, atraumatic
rotator cuff tear failures are not clearly defined and have little uni-
formity19,20,21, which may explain the widespread geographic
variation in rotator cuff surgery rates20. Patients in whom a
rotator cuff repair has failed report outcome scores that are not
significantly different from those for patients whose repair has
healed, unless the outcome score includes a large component
for strength, in which case those with a healed repair have
better scores22. Weakness or loss of function may be a better
indication for rotator cuff repair than pain in patients with an
atraumatic symptomatic rotator cuff tear.

In conclusion, patients who present with shoulder pain
without a history of an injury and with MRI evidence of a
rotator cuff tear present a dilemma to physicians as the liter-
ature lacks high-level evidence to help us make decisions
regarding appropriate treatment. In this large cross-sectional
study of patients with an atraumatic, symptomatic full-thickness rotator cuff tear, the patient’s pain had no correlation with anatomic measures of the severity of the rotator cuff tear. Because the relationship between pain and the presence of a rotator cuff tear is not robust, when a patient presents with pain as the primary symptom, it may not be accurate to assume that the accompanying rotator cuff tear is responsible for the pain.

Note: The authors acknowledge the following research personnel from their respective institutions: Vanderbilt University: Brooke Rode, BA; Washington University in St. Louis: Linda Burnworth, Amanda Haas, MA, and Deb Hanson; University of Iowa: Carla Britton, PhD; Hospital for Special Surgery: Samuel Chu, Jessica Ryu, Patrick Grimm, Kaitlyn Lilemme, and Brian Boyle; Ohio State University: Angela Pedrazza, BS; University of California-San Francisco: May Shishido; Orthopaedic Institute: Kari Caspers; and Knoxville Orthopaedic Clinic: Lori Sharp, PA-C, and Jeff Jarnigan, PA-C.

Warren R. Dunn, MD, MPH
University of Wisconsin,
Research Park Clinic Sports Medicine Clinic,
621 Science Drive,
Madison, WI 53711

John E. Kuhn, MD, MS
Rosemary Sanders, BA
Vanderbilt University Medical Center,
4200 MCE South Tower,
1215 21st Avenue South,
Nashville, TN 37232.
E-mail address for J.E. Kuhn: j.kuhn@vanderbilt.edu

Qi An, MS
St. Jude Children’s Research Hospital,
262 Danny Thomas Place,
Memphis, TN 38105-3768

Keith M. Baumgarten, MD
Sports Medicine & Shoulder Surgery Orthopedic Institute,
810 East 23rd Street,
Sioux Falls, SD 57117

Julie Y. Bishop, MD
Grant L. Jones, MD
OSU Sports Medicine Center,
2050 Kenny Road, Suite 3300,
Columbus, OH 43221-3502

Robert H. Brophy, MD
Matthew V. Smith, MD
Department of Orthopaedic Surgery,

References


7. Slabaugh MA, Nho SJ, Grumet RC, Wilson JB, Seroyer ST, Frank RM, Romeo AA, Provencen MT, Verma NN. Does the literature confirm superior clinical results in...


