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Patients with Preoperative Clinical Depression Symptomology Experience Significant Improvements in Postoperative Pain, Function, and Depressive Symptoms Following Rotator Cuff Repair
Abstract

Purpose

To determine the impact of clinical depression on outcomes following rotator cuff repair (RCR), as measured by Patient-Reported Outcomes Measurement Information System (PROMIS) Computer Adaptive Test (CAT) health domains.

Methods

RCR patients were given PROMIS CAT assessments for physical function (PROMIS UE), pain interference (PROMIS PI), and depression (PROMIS D) during pre- and postoperative clinic visits. PROMIS D scores ≥ 55 correlate with mild clinical depression; thus, patients with PROMIS D scores ≥ 55 were placed in the “clinical depression” (CD) group, while patients with scores <55 were placed in the “no clinical depression” (NCD) group. Categorical variables were compared at preoperative and postoperative (6m and ≥1y) timepoints using chi-squared tests. Continuous variables were compared using student’s t-tests.

Results

Of the 340 RCR patients included in this study, 65 (19.1%) were found to have mild clinical depression preoperatively, with that number being reduced to 23 (6.8%) at 6m and 19 (5.6%) at ≥1y postoperatively. Compared with preoperative PROMIS scores, CD patients had significant postoperative improvements at 6m and ≥1y in mean PROMIS UE (26.7 vs 35.5 vs 38.9; p<.001) and PROMIS PI (67.6 vs 56.7 vs 56.4; p<.001). NCD patients had similar postoperative improvements at 6m and ≥1y in mean PROMIS UE (30.8 vs 38.6 vs 46.9; p<.001) and PROMIS PI (61.7 vs 53.0 vs 47.6; p<.001). The improvement in PROMIS scores was
similar for the CD and NCD groups in both PROMIS UE (12.2 vs 16.1, respectively) and
PROMIS PI (-11.2 vs -14.1, respectively).

Conclusion

Despite starting with worse PROMIS UE and PROMIS PI scores, patients undergoing
RCR with symptoms of CD experienced significant improvement in function, pain, and
depressive symptoms. Preoperative depression should not be a contraindication to arthroscopic
RCR in patients who are otherwise appropriate operative candidates.

Level of Evidence: III, retrospective comparative trial
Introduction

Rotator cuff tears are frequent causes of shoulder pain and disability, resulting in 250,000 surgeries and 3.8 billion dollars spent each year in the United States alone.\(^1\) In an effort to optimize patient outcomes, it is important to understand all factors that may have an impact on treatment outcomes. Historical assessment of these factors has focused on intrinsic qualities of shoulder pathology, such as chronicity, etiology, and size of the tear, in addition to patient age and medical risk factors.\(^2\)-\(^4\) However, recent investigations have highlighted the impact of patient psychological factors on surgical outcomes.\(^5\)-\(^8\) Depression is a common psychological factor and has been shown to be a potential negative influencer of surgical outcomes, especially in patients with musculoskeletal conditions.\(^8\)-\(^13\)

This increased focus has resulted in an expansion of the body of literature on depression and rotator cuff repair (RCR), with one study showing that up to 26% of patients scheduled for RCR have clinical depression.\(^14\) This has contributed to a better understanding of the relationship between RCR and depression; however, there is no still clear relationship between depression and postoperative outcomes following rotator cuff repair. For example, a 2018 study by Thorpe et al showed that patients who scored poorly on psychological assessments had worse outcomes at all timepoints postoperatively following RCR.\(^15\) In contrast, a 2019 study by Lau et al showed that despite worse functional scores pre- and postoperatively, patients with depression experienced similar relief from RCR as those without depression.\(^16\) Lastly, a recent 2019 systematic review uncovered that out of nine studies, three found no significant difference in outcomes in relation to psychosocial factors, while six studies found a negative association.\(^17\)

The primary purpose of this study was to determine the impact of clinical depression on outcomes following RCR, as measured by Patient-Reported Outcomes Measurement Information
System (PROMIS) Computer Adaptive Test (CAT) health domains. We hypothesize that patients with preoperative clinical depression will have significantly less improvements postoperatively in upper extremity physical function and pain interference scores when compared to non-affected counterparts.
Methods

Outcome Collection

IRB approval was gained prior to initiation of the study. All patients undergoing arthroscopic RCR by one of three fellowship trained orthopedic surgeons between June 2017 and January 2020 who completed PROMIS forms at both preoperative and postoperative (6m and ≥1y) timepoints were included in this study. RCR patients were identified by reviewing the senior authors’ surgical schedules. PROMIS forms were administered on a tablet computer (Apple iPad, Cupertino, CA) by a qualified research assistant. A secure web-based application service was used for administration and storage of survey results (REDCap, Vanderbilt University, Nashville, TN). Inclusion criteria comprised patients diagnosed with partial-thickness or full-thickness rotator cuff tears who failed to improve following a physical therapy program and were therefore indicated for RCR. Exclusion criteria included patients who declined to complete the PROMIS questionnaires, did not communicate in the English language and/or were unable to physically complete the surveys on the tablet computer.

At their first visit, patients completed questionnaires consisting of basic demographic information, including age, race, sex, body mass index (BMI), and employment status. During each visit, patients were given three separate National Institutes of Health (NIH) Patient-Reported Outcomes Measurement Information System (PROMIS) Computer Adaptive Test (CAT) forms assessing upper extremity physical function (“PROMIS UE”), pain interference (the impact of pain on a patient’s quality of life, “PROMIS PI”), and depression (“PROMIS D”). PROMIS CAT forms have been shown to be responsive across all domains in patients undergoing rotator cuff repair\(^{18,20}\) and compare favorably from a psychometric perspective to legacy patient reported outcome measures (PROMs).\(^{21,24}\) Within any given PROMIS CAT form,
a score of 50 represents that of a healthy reference population. A ten-point differential represents one standard deviation, and higher scores indicate more of that health domain. For example, a score of 60 on PROMIS UE would represent one standard deviation above the mean healthy reference population for upper extremity function, while a score of 60 on PROMIS D would similarly represent one standard deviation above the mean reference population for depressive symptoms. The surveys were collected preoperatively and at each postoperative clinic appointment throughout the course of a standard RCR physical therapy regimen. If a patient did not complete their PROMIS forms during in-person postoperative visits, a research assistant contacted them via email to obtain their PROMIS scores. As previously noted in the literature, a score of 55 or greater on the PROMIS D CAT correlates to symptoms of mild clinical depression. Thus, a threshold score of 55 was used to denote symptomatic depression, and these patients were grouped in the “Clinical Depression” group (CD), while those with PROMIS D scores <55 were placed in the “no clinical depression” group (NCD). Furthermore, the minimally clinically important difference (MCID) and substantial clinical benefit (SCB) for PROMIS UE are defined as an improvement of 4.87 and 7.95, respectively. CD and NCD RCR patients who achieved MCID or SCB at either 6m or ≥1y were identified.

**Statistical Analysis**

Scores from all PROMIS domains were compared between the CD and NCD groups. Demographic and categorical variables were compared using chi-squared tests, and continuous variables were compared using a Student’s t-test. Analyses were conducted using SPSS software (IBM Corp. Released 2017. IBM SPSS Statistics for Mac, Version 25.0. Armonk, NY).
Results

A total of 340 patients met the inclusion criteria for this study, with an average follow-up time of 158 days and 669 days at 6m and ≥1y timepoints, respectively. Preoperatively, 65 (19.1%) patients were placed in the CD group with a score of 55 or higher, while 275 (80.9%) had scores less than 55 and were placed in the NCD group. Between the CD and NCD groups, there was no significant difference in age (59.6 vs 58.4, respectively; \( p=0.32 \)). CD patients had a significantly higher BMI compared to NCD patients (33.1 vs 30.2, respectively; \( p<.001 \)). There were significantly more female patients in the CD group than male patients (37 vs 28, respectively; \( p=0.047 \)) (Table 1).

Postoperatively, the number of patients with CD was reduced to 23 (6.8%) at 6m and 19 (5.6%) at ≥1y postoperatively. Both groups showed a significant decrease in mean PROMIS D scores postoperatively, with CD group scores changing from 61.5 to 51.1 at 6m and 52.6 at ≥1y (\( p<.001 \)) and NCD group scores changing from 44.7 to 41.9 at 6m and 41.4 at ≥1y (\( p<.001 \)) (Table 2). The PROMIS D floor score, defined as the lowest possible score for a particular domain,\(^{27}\) of 34.2 was seen in 61 patients preoperatively (17.9%), and 135 postoperatively (39.7%) (Table 3).

For both CD and NCD groups, PROMIS UE and PROMIS PI showed significant improvements as well. Postoperatively, CD patients showed an improvement in PROMIS UE scores from 26.7 to 35.5 at 6m and 38.9 at ≥1y (\( p<.001 \)) (Table 4), while PROMIS PI scores improved from 67.6 to 56.7 at 6m and 56.4 at ≥1y (\( p<.001 \)) (Table 5). Postoperatively, NCD patients showed an improvement in PROMIS UE scores from 30.8 to 38.6 at 6m and 46.9 at ≥1y (\( p<.001 \)), while PROMIS PI scores improved from 61.7 to 53.0 at 6m and 46.9 at ≥1y (\( p<.001 \)).
While both groups experienced significant improvements, there were significant differences between CD and NCD groups at both preoperative and postoperative time points. Preoperatively, mean PROMIS UE scores for CD and NCD patients were 26.7 and 30.8, respectively (p<.001). At 6m postoperatively, mean PROMIS UE scores for CD and NCD patients were 35.5 and 38.6, respectively (p<.001). At ≥1y postoperatively, mean PROMIS UE scores for CD and NCD patients were 38.9 and 46.9, respectively (p<.001). Preoperatively, PROMIS PI scores for CD and NCD patients were 67.6 and 61.7, respectively (p<.001). At 6m postoperatively, mean PROMIS PI scores for CD and NCD patients were 56.7 and 53.0, respectively (p<0.001). At ≥1y postoperatively, mean PROMIS PI scores for CD and NCD patients were 56.4 and 47.6, respectively (p<0.001).

In regards to PROMIS UE following RCR, 64.6% of CD patients achieved MCID and 55.4% achieved SCB, while 80.0% of NCD patients achieved MCID and 66.0% achieved SCB. At 6m postoperatively, 37/65 (56.9%) of CD patients achieved MCID for PROMIS UE, while 157/265 (57.1%) NCD patients achieved MCID for PROMIS UE (p=0.98). At ≥1y postoperatively, 5/65 (7.7%) of CD patients achieved MCID for PROMIS UE, while 55/265 (20.0%) of NCD patients achieved MCID for PROMIS UE (p=0.02). At 6m postoperatively, 29/65 (44.6%) of CD patients achieved SCB for PROMIS UE, while 125/265 (45.5%) NCD patients achieved SCB for PROMIS UE (p=0.86). At ≥1y postoperatively, 7/65 (10.8%) of CD patients achieved SCB for PROMIS UE, while 50/265 (18.1%) of NCD patients achieved SCB for PROMIS UE (p=0.26).
Discussion

The results of this study indicate that patients with preoperative depression symptoms, as measured by PROMIS D CAT, demonstrate improvements in physical function, pain interference, and even depressive symptoms following arthroscopic RCR. These improvements were similar to those RCR patients without depressive symptoms. The outcomes for patients in both cohorts are clinically significant as well. An improvement of 12.2 in mean PROMIS UE scores for the CD cohort is a larger improvement than the established MCID of 4.87, and SCB of 7.95.26 Although CD patients may experience inferior outcomes in function and pain compared to the NCD group, they are still achieving a clinically significant improvement.

Our findings indicate that patients with clinical depression experience significant improvement in their outcomes following RCR, despite experiencing worse preoperative function and pain when compared to NCD patients, which parallels the findings in recently published research. In a study by Lau et al., patients with preoperative depression and/or anxiety were found to experience significant improvement in postoperative physical function.16 However, this study used American Shoulder and Elbow Surgeons (ASES) scores to assess functional outcomes. Our study used PROMIS CAT forms for the assessment of both functional outcomes and depressive symptoms, and was specific to depression. By using PROMIS CAT forms for outcome assessment, we are updating the literature using a patient-reported outcome measure that is becoming more commonplace in clinical practice. Furthermore, Lau et al. used a pre-existing diagnosis of depression and/or anxiety to categorize their depressive cohort, which is substantially different from the methodology of this study. Although identifying patients with depression and anxiety through chart review is thorough, using PROMIS D to identify patients experiencing depressive symptomology is more efficient than conducting a chart review, making
it a more realistic approach in the clinic setting. It also ensures that patients are included in the CD cohort who may not have a history of depression, but are experiencing depressive symptoms due to their injury. Lastly, PROMIS D allows for a higher specificity as it is assessing depressive symptoms only, and not anxiety.

Our study also found that CD RCR patients experience significant improvements in pain and depressive symptoms postoperatively. These results strengthen and expand on the findings of recent observational studies, which is important, since there still does not appear to be consensus on the subject. A 2019 review by Kennedy et al. found that only three of nine studies showed significant improvements in postoperative pain and function in patients with psychosocial confounders. A 2018 review by Coronado et al. found no association between depression and postoperative function or pain.

Differences in study findings could be due to varying methodologies, both in how outcomes were measured and how a RCR patient was determined to have depression. For measuring outcomes, previous studies used a combination of various PROMs commonly seen in orthopedic practice for the assessment of physical function and patient status following RCR. For measurement of depression, previous studies reported factors such as a previous diagnosis of depression, HADS scores, and SF-36 scores, among others. This study differs in that it uses the PROMIS CAT assessment of depression among RCR patients, which is an important implementation for a few key reasons. Firstly, PROMIS has been validated in the assessment of physical function and depression, making it a valuable tool for increasing the body of research on RCR and depression. Secondly, with PROMIS forms becoming more widely used in clinical orthopedic practice, it is increasingly important to assess outcomes and conduct research with the same PROMs in order to effectively compare and analyze data across studies.
that report PROMs.\textsuperscript{31,32} Lastly, both the collection and interpretation of PROMIS surveys are more streamlined and easier to understand given that they are normed to a reference population.\textsuperscript{33-37}
Limitations

This study is not without limitations. The first is that PROMIS D scores were used as a proxy for clinical depression, as opposed to an official diagnosis by a trained clinician. As mentioned previously, however, PROMIS D has been validated to measure the mental health of patients, and it serves as an effective and efficient way for physicians in the clinical setting to identify patients who fall into the category of CD. Secondly, specific details pertaining to each patient’s rotator cuff tear, including tear type, size, and location were not collected due to inconsistent reporting within the patients’ charts. Thirdly, we excluded patients who were non-English speakers and those who were unable to use a tablet computer. However, our health system is a large, multi-center, and geographically diverse practice that serves a racially diverse population, which helps mitigate this limitation. Despite these limitations, this study simplifies the collection and comparison of postoperative outcomes in patients with and without symptoms of CD.
Conclusions

Despite starting with worse PROMIS UE and PROMIS PI scores, patients undergoing RCR with symptoms of CD experienced significant improvement in function, pain, and depressive symptoms. Preoperative depression should not be a contraindication to arthroscopic RCR in patients who are otherwise appropriate operative candidates.


34. Papuga MO, Dasilva C, McIntyre A, Mitten D, Kates S, Baumhauer JF. Large-scale clinical implementation of PROMIS computer adaptive testing with direct incorporation into the electronic medical record. *Health Syst (Basingstoke).* 2018;7:1-12.


Table 1: Descriptive Characteristics of Included Rotator Cuff Repair Patients.

<table>
<thead>
<tr>
<th></th>
<th>Total Cohort (N = 340)</th>
<th>Clinical Depression (N = 65)</th>
<th>No Clinical Depression (N = 275)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>59.4 ± 9.1</td>
<td>58.4 ± 9.1</td>
<td>59.6 ± 9.1</td>
<td>0.320</td>
</tr>
<tr>
<td>BMI (kg/m^2)</td>
<td>30.8 ± 5.9</td>
<td>33.1 ± 6.7</td>
<td>30.2 ± 5.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>184 (54.1%)</td>
<td>28 (43.1%)</td>
<td>156 (56.7%)</td>
<td>0.047</td>
</tr>
<tr>
<td>Female</td>
<td>156 (45.9%)</td>
<td>37 (56.9%)</td>
<td>119 (43.3%)</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>213 (62.6%)</td>
<td>36 (55.4%)</td>
<td>177 (64.6%)</td>
<td>0.526</td>
</tr>
<tr>
<td>Black</td>
<td>97 (28.6%)</td>
<td>23 (35.4%)</td>
<td>74 (27.0%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>30 (8.8%)</td>
<td>6 (9.2%)</td>
<td>23 (8.4%)</td>
<td></td>
</tr>
</tbody>
</table>

Continuous variables given as mean ± standard deviation. Categorical variables given as value with percentage in parenthesis.
### Table 2: PROMIS D

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>6m Post-op</th>
<th>≥1y Post-op</th>
<th>Improvement</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD</td>
<td>61.5</td>
<td>51.1</td>
<td>52.6</td>
<td>-8.9</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>NCD</td>
<td>44.7</td>
<td>41.9</td>
<td>41.4</td>
<td>-3.3</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Values given as mean values. P-values associated with comparison of means for preoperative vs postoperative in both CD and NCD cohorts. Delta calculated by subtracting the preoperative score from the postoperative score.
Table 3: PROMIS D Floor Patients

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>Post-op</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cohort</td>
<td>61</td>
<td>135</td>
</tr>
<tr>
<td>CD</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>NCD</td>
<td>61</td>
<td>124</td>
</tr>
</tbody>
</table>

Table 3 shows all patients with a PROMIS D scores of 34.2.
Table 4: PROMIS UE

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>6m Post-op</th>
<th>≥1y Post-op</th>
<th>Improvement</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cohort</td>
<td>30.0 (14.7-45.9)</td>
<td>38.0 (14.7-61.0)</td>
<td>45.4 (22.3-61.0)</td>
<td>+15.4</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>CD</td>
<td>26.7 (14.7-43.1)</td>
<td>35.5 (17.5-61.0)</td>
<td>38.9 (22.3-61.0)</td>
<td>+12.2</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>NCD</td>
<td>30.8 (14.7-45.9)</td>
<td>38.6 (14.7-61.0)</td>
<td>46.9 (26.3-61.0)</td>
<td>+16.1</td>
<td>p&lt;.001</td>
</tr>
</tbody>
</table>

Values given as average values with 95% confidence interval in parentheses. P-values associated with comparison of means for preoperative vs postoperative in both CD and NCD cohorts. Delta calculated by subtracting the preoperative score from the postoperative score.
Table 5: PROMIS PI

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>6m Post-op</th>
<th>≥1y Post-op</th>
<th>Improvement</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cohort</td>
<td>62.8 (46.6-80.1)</td>
<td>53.7 (38.7-76.4)</td>
<td>49.3 (38.7-76.4)</td>
<td>-13.5</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>CD</td>
<td>67.6 (58.5-80.1)</td>
<td>56.7 (38.7-76.4)</td>
<td>56.4 (38.7-76.4)</td>
<td>-11.2</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>NCD</td>
<td>61.7 (46.6-74.1)</td>
<td>53.0 (38.7-73.0)</td>
<td>47.6 (38.7-71.6)</td>
<td>-14.1</td>
<td>p&lt;.001</td>
</tr>
</tbody>
</table>

Values given as average values with 95% confidence interval in parentheses. P-values associated with comparison of means for preoperative vs postoperative in both CD and NCD cohorts. Delta calculated by subtracting the preoperative score from the postoperative score.