*SVOA Orthopaedics*

**ISSN: 2752-9576**

ScienceVolks Open Access

**Research Article**

# A Comparison of Clinical Outcomes in Patients Undergoing Anterior Cervical Discectomy and Fusion and Rotator Cuff Repair

**Hannah A. Levy, BS[1], Brian A. Karamian, MD[1]*, Paul D. Minetos, MD, MBA[1], Michael J. Gutman, MD[1], Joshua Pezzulo, BS[1], Jose A. Canseco, MD, PhD[1], Barrett I. Woods, MD[1], Mark F. Kurd, MD[1], Jeffrey A. Rihn, MD[1], Alan S. Hilibrand, MD[1], Christopher K. Kepler, MD, MBA[1], Alexander R. Vaccaro, MD, PhD, MBA[1], Daniel E. Davis, MD, MS[1] and Gregory D. Schroeder, MD[1]**

[1]*Department of Orthopaedic Surgery, Rothman Institute, Thomas Jefferson University, Philadelphia, PA, USA*

***Corresponding Author:** Brian A. Karamian, MD, Rothman Orthopaedic Institute at Thomas Jefferson University Hospital 925 Chestnut St, 5th Floor, Philadelphia, PA 19107, USA, ORCID: 0000-0003-0512-6019*

***Received:** April 14, 2022 **Published:** May 24, 2022*

## Abstract

**Purpose:** The purpose of this study was to determine the relative improvements in pain and functional status after ACDF versus RCR.

**Methods:** All patients over 18 years old who underwent primary one- to two-level ACDF for cervical radiculopathy and primary arthroscopic RCR for acute or chronic rotator cuff tears between 2010-2019 were retrospectively identified. Preoperative and one-year postoperative patient reported outcomes measures (PROMs) were extracted including SF-12 Physical and Mental Components (PCS, MCS) and VAS Arm pain after both interventions. Univariate analysis compared clinical outcomes, 90-day readmission rate, and revision rate between patients undergoing ACDF and RCR. Multivariate analysis compared PROM improvement across surgical groups.

**Results:** A total of 201 ACDF patients and 303 RCR patients met the inclusion/exclusion criteria. Patient age, CCI, sex, and smoking status differed significantly between groups. All PROMs improved significantly after ACDF and RCR. There were two readmissions and five revisions after RCR and neither after ACDF. Rotator cuff tear patients, compared to cervical radiculopathy patients, had significantly higher preoperative functional status and lower pain. RCR in comparison to ACDF was associated with significantly greater VAS Arm pain reduction and percent of patients achieving the minimal clinically important difference. Regression found RCR predicted greater VAS Arm pain improvement. However, PCS and MCS improvements were not statistically different across surgical interventions.

**Conclusion:** Rotator cuff repair, relative to ACDF for cervical radiculopathy, was associated with increased upper extremity pain reduction. However, improvements in functional status did not meaningfully differ between ACDF and RCR.

***Keywords:** Patient Outcomes, Arm Pain, Cervical Spine, Rotator Cuff Repair, Anterior Cervical Discectomy and Fusion*

## Introduction

Cervical radiculopathy and rotator cuff tears (RCT) are common age-related degenerative conditions, with an annual incidence 83.2 and 1000 per 100,000 people, respectively.[1,2] The sequalae of cervical and rotator cuff degeneration represent important causes of upper extremity pain, disability, and functional impairment.[1,3–5] While both conditions may initially warrant a trial of non-operative treatment including physical therapy, analgesics, and corticosteroid injections, up to 30% of cervical radiculopathy patients and up to 40% of RCT patients are estimated to fail conversative management.[5–7] For patients with clinically significant foraminal cervical nerve root compression or full thickness rotator cuff tears who have failed non-operative management, surgery is often indicated.[2,3,5] Anterior cervical discectomy and fusion (ACDF) and arthroscopic rotator cuff repair (RCR) represent the gold standard treatments for cervical radiculopathy and RCT, respectively, and have been associated with improvements in physical function and reduction in disability and pain.[4,7,8] While the epidemiology, clinical course, and treatment response of both cervical radiculopathy and RCTs are well researched, the complex inter-relationship between cervical spine and rotator cuff disease is the subject of ongoing investigations.

The precise etiologies of neck and shoulder pain can prove difficult to isolate, where cervical spondylosis may result in neck pain while simultaneously referring pain to the shoulder in the C5 and C6 dermatomal distributions. Similarly, pain resulting from RCTs may be restricted to the shoulder or travel along the course of the scapular and trapezius muscles to mimic axial neck pain.[9–15] The shared upper extremity pain qualities and distributions in cervical radiculopathy and RCTs imparts diagnostic uncertainty.[10–12,16] Furthermore, cervical radiculopathy and RCTs commonly co-occur as indicated by a national database study demonstrating 16% of cervical spine and 13% of rotator cuff tear patients to have concomitate cervical spine and rotator cuff disease.[9,10,17] While neck and shoulder conditions can arise simultaneously or subsequently, to date the evidence for causality is mostly speculative. However, emerging research suggests cervical radiculopathy may exacerbate rotator cuff disease.[14,18,19] Additional studies have demonstrated progression of shoulder pain after ACDF, for which rotator cuff tear was the predominate finding.[10,15,20] Given the likely co-existence of cervical and rotator cuff diseases and scenarios where one condition intensifies the symptomatology of the other, it is not uncommon for patients to undergo both ACDF and RCR throughout their lifetime.

Although the independent clinical efficacies of ACDF and RCR are well supported, there is a paucity of literature to directly compare the patient outcomes, complications, and revision rates after each respective surgery. Exploration of comparative outcomes after ACDF and RCR will be critical to inform patients of expectations for postoperative recovery, which has been shown to improve patient outcomes and overall satisfaction.[21] The purpose of this study was to determine the relative improvements of patient reported pain and functional status after ACDF compared to RCR.

## Methods

All patients over 18 years of age who underwent primary one- and two-level ACDF for cervical radiculopathy and primary arthroscopic RCR for acute or chronic rotator cuff tears at a single academic institution between 2010 - 2019 were retrospectively identified. Additional inclusion criteria required complete patient demographic profiles, surgical characteristics, record of postsurgical complications and revisions, and preoperative and postoperative patient-reported outcomes measures (PROMs) with minimum one-year follow-up. Spine patients in the ACDF cohort were excluded in the scenarios of traumatic injury, infection, malignancy, or if the surgery was indicated for myelopathy, utilized a combined anterior/posterior approach, and involved greater than two surgical levels. Shoulder patients were excluded if there was evidence of shoulder joint infection or they underwent open or mini-open rotator cuff repairs. Patients in both groups were also excluded if their medical records or outcome measures were incomplete.

Patient demographic and medical data including age, sex, smoking status (never, former, current), body mass index (BMI), Charlson Comorbidity Index (CCI), and duration of follow-up were recorded via chart review. The primary study outcome was preoperative and postoperative health-related quality of life outcomes and upper extremity pain. Short Form-12 (SF-12) Physical Component (PCS) and Mental Component (MCS) Scores and Visual Analogue Scale (VAS) Arm pain were recorded in both surgical intervention groups. Neck Disability Index (NDI) and VAS Neck pain were additionally recorded for only ACDF patients. Likewise, American Shoulder and Elbow score (ASES), Single Assessment Numeric Evaluation (SANE), and Simple Shoulder Test (SST) were detailed in patients undergoing RCR. Outcome scores at greater than one-year follow-up were obtained from the institution's recording software (OBERD, Columbia, MO). Achievement of Minimum Clinically Important Differences (MCID) was determined according to established procedure specific values for the PROMs studied when literature MCID standards were available. Threshold values included 2.6 points for VAS Neck Pain, 4.1 points for VAS Arm Pain, 17.3% for NDI, 8.1 points for SF-12 PCS, and 4.7 points for SF-12 MCS after ACDF and 2.4 points for VAS Arm Pain, 11.1 points for ASES, and 16.9 points for SANE after RCR.[22–25] All cause 30- and 90-day readmissions complications were assessed for each surgical group. Revision spine and shoulder surgical interventions occurring after the primary surgery involving the previously operated spinal level(s) after ACDF or the same shoulder laterality after RCR were noted along with the indication for revision surgery.

## Statistical Methods

Patient demographic and clinical outcomes were compared between groups undergoing ACDF and RCR. Individual patient delta (D) outcome scores were calculated by subtracting their preoperative score from postoperative score upon which a recovery ratio (RR) was calculated (Dscore/ [optimal score – preoperative score]). Descriptive statistics were used to compare patient characteristics, PROMs (including D, RR, and proportion of patients meeting the MCID [% MCID]), complications, and revisions in terms of mean and standard deviation or number of occurrences and percent of total. Continuous and categorical variables were analyzed with t-tests and chi-square tests or the corresponding non-parametric tests, respectively. Paired univariate analysis tested for significant preoperative to postoperative changes in PROMs. A multivariate linear regression model was developed to compare PROM improvement across surgical groups while controlling for patient demographics and comorbidities. All statistical analysis was performed with R Studio Version 4.0.2 (Boston, MA). A P-value $< 0.05$ was considered statistically significant.

## Results

### *Demographics and Surgical Factors*

A total of 201 ACDF patients and 303 RCR patients were included in the final study cohort. Patient age (P<0.001), CCI (P<0.001), sex (P= 0.004), and smoking status (P= 0.016) differed significantly between groups (Table 1). Patients undergoing RCR, as compared to those undergoing ACDF, were older (RCR: 59.1 vs ACDF: 51.3), had fewer medical comorbidities (RCR CCI: 0.32 vs ACDF CCI: 0.92), and were more likely to be male (RCR: 60.4% male vs ACDF: 46.8% male). While a greater proportion of shoulder patients were current smokers (RCR: 29.0% vs ACDF: 19.9%), a greater percentage of spine patients were former smokers (RCR: 14.9% vs ACDF: 22.9%). Patient BMI did not differ significantly (P= 0.217) across surgical interventions.

Two patients were readmitted after RCR for rotator cuff capsular sprain within 30-days and rotator cuff re-tear within 90-days. In comparison, no patients were readmitted within 90-days of ACDF. Five patients requiring revision operations after RCR; one a revision rotator cuff repair and reverse four underwent a total shoulder arthroplasty. In contrast, no ACDF patients required revision surgery during the study interval.

**Table 1:** Patient Demographics and Surgical Factors by Surgical Intervention.

| Patient Parameter | RCR | ACDF | P-Value |
|---|---|---|---|
| | N=303 | N=201 | |
| **Age** | 59.1 (8.99) | 51.3 (10.3) | **<0.001** |
| **Sex:** | | | **0.004** |
| **Female** | 120 (39.6%) | 107 (53.2%) | |
| **Male** | 183 (60.4%) | 94 (46.8%) | |
| **BMI** | 29.8 (5.44) | 29.2 (5.36) | 0.217 |
| **Smoking:** | | | **0.016** |
| **Never** | 170 (56.1%) | 115 (57.2%) | |
| **Former** | 45 (14.9%) | 46 (22.9%) | |
| **Current** | 88 (29.0%) | 40 (19.9%) | |
| **CCI** | 0.32 (0.63) | 0.92 (0.90) | **<0.001** |
| **Readmission rate (90 day)** | 0.66% | 0% | |
| **Revision rate** | 5 (1.65%) | 0% | |

### *Patient Reported Outcomes*

Rotator cuff tear patients, compared to cervical radiculopathy patients, had significantly higher PCS (P<0.001) and MCS (P<0.001) scores and significantly lower VAS Arm pain scores (P= 0.002) preoperatively (Table 2). Statistically significant improvement was demonstrated in all PROMs for ACDF (MCS: P<0.001, PCS: P<0.001, VAS Arm: P<0.001, VAS Neck: P<0.001, NDI: P<0.001) and RCR (MCS: P=0.012, PCS: P<0.001, VAS Arm: P<0.001, ASES: P<0.001, SANE: P<0.001, SST: P<0.001). Delta scores and recovery ratios for each PROM studied are presented in Table 2.

Rotator cuff repair, in comparison to ACDF, was associated with significantly greater VAS Arm pain reduction (RCRΔ: -3.82 vs ACDFΔ: -2.67, P<0.001, RCR RR: 0.69 vs ACDF RR: 0.28, P<0.001) and VAS Arm %MCID achievement (RCR: 72.9% vs ACDF: 56.2%, P<0.001). Regression analysis found RCR (ß=0.93, P=0.009) and decreased CCI (ß= -0.40, P=0.047) to be significant predictors of VAS Arm pain improvement (Table 3). However, ΔPCS (P= 0.955), PCS RR (P= 0.734), ΔMCS (P= 0.072), MCS RR (P= 0.073), were not statistically different across the respective surgical interventions.

**Table 2:** Patient Outcome Comparison by Surgical Intervention.

| Patient Outcome | | RCR N=303 | ACDF N=201 | P-Value |
|---|---|---|---|---|
| VAS Arm | Preop | 5.22 (2.45) | 5.95 (2.72) | **0.002** |
| | Postop | 1.41 (2.29) | 3.28 (2.58) | **<0.001** |
| | Δ | -3.82 (3.04) | -2.67 (3.42) | **<0.001** |
| | RR | 0.69 (0.76) | 0.28 (1.02) | **<0.001** |
| | % MCID | 72.9% | 56.2% | **<0.001** |
| PCS | Preop | 38.5 (7.69) | 33.6 (7.46) | **<0.001** |
| | Postop | 46.6 (10.5) | 41.7 (10.9) | **<0.001** |
| | Δ | 8.12 (10.9) | 8.17 (10.3) | 0.955 |
| | RR | 0.12 (0.18) | 0.12 (0.16) | 0.734 |
| | % MCID | | 47.3% | |
| MCS | Preop | 52.8 (10.8) | 47.4 (11.4) | **<0.001** |
| | Postop | 54.3 (9.22) | 50.9 (10.3) | **<0.001** |
| | Δ | 1.52 (11.3) | 3.47 (12.3) | 0.072 |
| | RR | 0.00 (0.22) | 0.04 (0.22) | 0.073 |
| | % MCID | | 39.3% | |
| VAS Neck | Preop | | 5.85 (2.53) | |
| | Postop | | 2.54 (2.38) | |
| | Δ | | -3.32 (2.92) | |
| | RR | | 0.52 (0.54) | |
| | % MCID | | 63.5% | |
| NDI | Preop | | 42.55 (18.27) | |
| | Postop | | 25.19 (18.98) | |
| | Δ | | -17.35 (22.76) | |
| | RR | | 0.17 (2.01) | |
| | % MCID | | 56.8% | |
| ASES | Preop | 44.68 (20.31) | | |
| | Postop | 84.69 (19.93) | | |
| | Δ | 40.01 (26.05) | | |
| | RR | 0.68 (0.55) | | |
| | % MCID | 86.5% | | |
| SANE | Preop | 37.31 (23.48) | | |
| | Postop | 79.60 (24.80) | | |
| | Δ | 42.29 (30.33) | | |
| | RR | 0.64 (0.45) | | |
| | % MCID | 81.5% | | |
| SST | Preop | 40.43 (24.38) | | |
| | Postop | 80.42 (24.49) | | |
| | Δ | 40.00 (28.49) | | |
| | RR | 0.66 (0.47) | | |

**Table 3:** Multivariate Regression of VAS Arm Pain.

| Predictor | ΔVAS Arm Pain Improvement | |
|---|---|---|
| | ß- Estimate | P-Value |
| Surgery: | | |
| ACDF | Reference | |
| RCR | 0.93 | **0.009** |
| Age | -0.001 | 0.968 |
| Sex | -0.29 | 0.324 |
| BMI | 0.02 | 0.391 |
| Smoking: | | |
| Never | Reference | |
| Former | -0.28 | 0.557 |
| Current | 0.30 | 0.379 |
| CCI | -0.40 | **0.047** |

## Discussion

Cervical radiculopathy and rotator cuff tears represent two important causes of upper extremity pain and disability managed surgically.[1,2,4,8] The clinical efficacy of both ACDF and RCR has been demonstrated in literature.[7,16] Though cervical radiculopathy and RCT coincide in over 20% of patients over age 60, there is a dearth of research to compare their respective postsurgical outcomes, complications, and revision rates.[17] The results of our study demonstrate significant clinical improvement for patients after both procedures, where functional improvement did not meaningfully differ between ACDF and RCR. However, RCR was associated with significantly greater postoperative arm pain relief.

Shoulder-spine pain is mediated locally by mechanical stimulation of nociceptive fibers and is referred outside the immediate zone of disease by the actions of associated inflammatory mediators.[16,26] Structural defects in cervical discogenic tissue results in nociceptive fiber growth and release of immunoinflammatory mediators along the dorsal root ganglion resulting in both localized and referred pain.[27] Likewise, RCT triggers sensitization of local nociceptors as well as release of neuropeptides outside the initial zone of injury to mimic symptoms of axial neck pain.[28] The combined mechanical and inflammatory mechanisms result in overlapping anatomic distributions of pain and analogous clinical presentations for patients with cervical radiculopathy and RCT.[16,28] Prior research has demonstrated subacromial impingement pain to consistently result in lateral neck and trapezius pain.[29] Conversely, facet stimulation and cervical discogram has been shown to result in referred shoulder and trapezius pain.[30]

The intimate relationship between cervical and shoulder diseases has prompted previous comparison of outcomes for patients undergoing operative treatment for upper extremity/shoulder pain between cervical spondylosis and shoulder dysfunction cohorts.[31] Previous investigation demonstrated that patient reported success, numerical rating scale pain score, NDI, and Focus on Therapeutic Outcomes did not differ meaningfully when comparing spine and shoulder surgery groups. However, the utility of this comparative study was limited by heterogenous cohorts as statistical comparisons were not specific to diagnosis or surgical intervention. The present study compared only patients with a single preoperative diagnosis (cervical radiculopathy or RCT) to isolate and better compare outcomes after ACDF or RCR, as preoperative diagnoses have been shown to have a significant effect on outcomes following surgery.[25,32,33] Our results suggest that functional improvement is no different across interventions. Likewise, the revision rates were low regardless of surgery type. Patients in our ACDF cohort demonstrated lower baseline function, and as a result also demonstrated worse postoperative mental and physical function scores. Despite patients undergoing RCR being older, the ACDF cohort demonstrated increased comorbidity burden. These differences are important to take into consideration when evaluating outcomes after surgery and were incorporated into our regression model. Accordingly, it may be reasonable to counsel patients familiar with either procedure that postoperative functional recovery is not dissimilar between interventions and the likelihood of revision remains low. However, given that patients undergoing ACDF were associated with worse baseline function, these patients can similarly expect worse absolute functional scores after recovery.

Conversely, when considering other patient reported metrics of postoperative improvement, VAS Arm pain reduction was more favorable for RCR patients compared to ACDF patients on univariate and multivariate analysis. Likewise, a greater percentage of RCR patients achieved the MCID which may suggest that RCR is more likely to be a clinically effective intervention for reduction in arm and shoulder pain. In shoulder and spine specific PROMs, though direct comparison was not possible, MCID thresholds were achieved more frequently after RCR than after ACDF. However, the heterogeneity of MCID PROM metrics limits the generalizability of this finding and requires further comparison with additional identical PROM questionnaires for both the shoulder and spine groups.

When evaluating similar ACDF and RCR cohort studies in the literature, aggregating PROMs across each surgical intervention increased the generalizability of our comparative outcome findings.[32,34–40] Analogous with the findings of our study, weighted mean age and sex distributions differed significantly between surgical interventions, where RCR patients in comparison to ACDF were older and a greater portion were males (Table 4). Likewise, the aggregated preoperative and postoperative PCS and MCS did not differ significantly by surgical intervention, further supporting the lack of difference in functional improvement between each operation. Comparison of literature derived weighted means supported our finding that VAS Arm pain reduction was greater after RCR relative to ACDF, with a significantly lower aggregate postoperative VAS Arm pain associated with RCR.

**Table 4:** Meta-analysis of ACDF vs RCR PROMs in Literature.

| Study | | Study Characteristics | | | | | | | VAS Arm | | | PCS | | | MCS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Study Year | Study Inclusion Criteria | Patient n-value | Age | Sex (%Male) | BMI | Smoking Status (%Current) | Preop | One-year | Δ | Preop | One-year | Δ | Preop | One-year | Δ |
| ACDF | *Stull et al* | 2020 | Cervical radiculopathy, 1-3 level primary ACDF | 117 | 49 (48-51) | 46% | 29.1 (28.1-30.2) | 28.2% | 5.5 (4.9-6.1) | 3.2 (3-4.1) | -2.3 | 32.8 (31.5-34.1) | 40 (37.9-42.1) | 7.2 | 46.2 (43.9-48.4) | 47.9 (45.8-50) | 1.7 |
| | *Siemionow et al* | 2016 | Cervical radiculopathy, cervical fusion | 53 | 52.8 (40-75) | 33.9% | - | - | 7.4 (0.9) | 2.3 (2.4) | -5.1 | 34.3 (6) | 45.5 (8.6) | 11.2 | 40.3 (7.6) | 51.3 (7.5) | 11.0 |
| | *Tarazona et al* | 2019 | Cervical radiculopathy, ACDF | 86 | 51 (41-61) | 47.7% | 29.6 (23.4-35.8) | 12.4% | 5.4 (3.1) | 2.2 (2.8) | -3.2 | 34.5 (8.0) | 43.5 (11.7) | 9.0 | 45.2 (12.2) | 50.3 (10.7) | 5.1 |
| | *Elsamadicy et al* | 2016 | Cervical radiculopathy, primary ACDF | 115 | 52 (38-66) | 49.6% | 28.6 (21.9-35.3) | 26.1% | 4.75 (3.29) | 2.1 (2.6) | -2.65 | 32.8 (8.9) | 36.1 (15.8) | 3.3 | 44.1 (12.5) | 46.03 (12.0) | 1.93 |
| | *Levy et al (Current study)* | 2021 | Cervical radiculopathy, primary 1-2 level ACDF | 201 | 51.3 (10.3) | 46.8% | 29.2 (5.36) | 5.36% | 5.94 (2.69) | 3.68 (2.73) | -2.26 | 46.02 (13.6) | 50.26 (11.7) | 4.24 | 32.52 (9.12) | 40.95 (11.7) | 8.43 |
| | Weighted Mean Outcome | - | - | - | 51.21 (49.69-52.72) | 46.15% (42.10-50.26%) | 29.80 (29.18-30.41) | 21.24% (12.69-33.35%) | 5.81 (4.88-6.75) | 2.74 (2.20-3.28) | - | 36.03 (32.23–39.83) | 43.11 (38.33–47.89) | - | 41.64 (35.27–48.02) | 47.25 (44.24– 50.26) | - |
| RCR | *Cole et al* | 2007 | Full-thickness RCT, RCR | 47 | 57 (34-80) | 59.6% | - | - | 5.9 | 1.8 | -4.1 | 40 | 40 | 0 | 50 | 53 | 3 |
| | *McIntyre et al* | 2019 | Partial- or full-thickness RCT, RCR with biologic | 173 | 54.2 (9.8) | 56.7% | - | 14.5% | 5.2 | 1.2 | -4.0 | 34.5 | 45.7 | 11.2 | 48.8 | 53 | 4.2 |
| | *Monesi et al* | 2018 | Degenerative or traumatic RCT, arthroscopic RCR | 49 | 59.5 (8.1) | 59.6% | - | - | 1.7 (1.9) | 0.2 (0.6) | -1.5 | 39 (8.9) | 46.3 (6.3) | 7.3 | 36 (9.3) | 43.8 (8.2) | 7.8 |
| | *Menon et al* | 2015 | Full-thickness RCT, RCR | 153 | 55 | 59.5% | - | - | 5.6 | 0.6 | -4.0 | 38.0 | 51.1 | 13.1 | 54.6 | 54.6 | 0 |
| | *Levy et al (current study)* | 2021 | Acute or chronic RCT, primary arthroscopic RCR | 303 | 59.1 (9.0) | 60.4% | 29.8 (5.44) | 29.8% | 5.22 (2.45) | 1.41 (2.28) | -3.82 | 38.52 (7.67) | 46.64 (10.5) | 8.12 | 52.75 (10.8) | 54.28 (9.21) | 1.52 |
| | Weighted Mean Outcome | - | - | - | 57.38 (55.45-59.30) | 59.31% (55.69-62.83%) | 29.11 (28.63-29.59) | 21.24% (12.69-33.35%) | 3.46 (0.01-6.91) | 0.800 (0.38-1.98) | - | 38.57 (37.75-39.38) | 46.53 (45.55-47.51) | - | 44.41 (28.00-60.83) | 49.09 (38.82-59.36) | - |
| ACDF vs RCR Group Comparison: P-value | | - | - | - | **<0.0001** | **<0.0001** | 0.0839 | 0.9393 | 0.1974 | **0.0035** | - | 0.2008 | 0.1691 | - | 0.7580 | 0.7369 | - |

## Conclusion

This study is not without limitations including those inherent to retrospective cohort generation. Although patients were included in the investigation in a systematic method, potentially relevant cases were identified based on availability of PROMs introducing a selection bias. The ACDF and RCR groups inherently differ in patient demographics which may lead to outcome differences that remain incompletely controlled for in multivariate regression. Furthermore, the heterogeneity of PROMs collected in spine and shoulder limited direct comparison of all outcome metrics. Comparison of these condition-specific outcome metrics including NDI, VAS Neck, ASES, SANE, and SST was limited to MCID and RR as the questions used to derive each of these assessments are unique. While the readmission rates were low in both interventions, additional complications that did not require hospital readmission may not be accounted for in this study.

Rotator cuff repair, relative to ACDF for cervical radiculopathy, was associated with greater upper extremity pain reduction. However, improvements in functional status did not meaningfully differ between ACDF and RCR. The findings of this study may aid in patient understanding of expectations for recovery and improvement after the aforementioned surgical procedures.

## Conflict of Interest

The authors declare no conflict of interest.

## References


1. Wani, Z, Abdulla, M, Habeebullah, A, Kalogriantis, S: Rotator cuff tears: Review of epidemiology, clinical assessment and operative treatment. *Trauma* 2016; 18:190–204.

2. Iyer, S, Kim, HJ: Cervical radiculopathy. *Curr Rev Musculoskelet Medicine* 2016;9:272–280.

3. Woods, BI, Hilibrand, AS: Cervical Radiculopathy. *J Spinal Disord Tech* 2015;28:E251–E259.

4. Tashjian, RZ: Epidemiology, Natural History, and Indications for Treatment of Rotator Cuff Tears. *Clin Sport Med* 2012;31:589–604.
5. Schmidt, CC, Jarrett, CD, Brown, BT: Management of Rotator Cuff Tears. *J Hand Surg* 2015;40:399–408.
6. Ontario, HQ: Artificial discs for lumbar and cervical degenerative disc disease -update: an evidence-based analysis. *Ont Heal Technology Assess Ser* 2006;6:1–98.

7. Hattrup, SJ, Cofield, RH: Rotator cuff tears with cervical radiculopathy. *J Shoulder Elb Surg* 2010;19:937–943.

8. Gutman, G, Rosenzweig, DH, Golan, JD: Surgical Treatment of Cervical Radiculopathy. *Spine* 2018;43:E365–E372.

9. Cannon, DE, Dillingham, TR, Miao, H, Andary, MT, Pezzin, LE: Musculoskeletal Disorders in Referrals for Suspected Cervical Radiculopathy. *Arch Phys Med Rehab* 2007;88:1256–1259.

10. Hawkins, RJ, Bilco, T, Bonutti, P: Cervical Spine and Shoulder Pain. *Clin Orthop Relat R* 1990;258:142–146.

11. Sembrano, JN, Yson, SC, Kanu, OC, Braman, JP, Santos, ERG, Harrison, AK, Polly, DW: Neck-shoulder crossover: how often do neck and shoulder pathology masquerade as each other? *Am J Orthop Belle Mead N J* 2013;42:E76-80.

12. Roberson, TA, Jew, NB, Azar, FM, Mauck, BM, Dockery, JD, Throckmorton, TW: Cervical radiculitis presenting as shoulder pain. *Curr Orthop Pract* 2015;26:521–525.

13. Bokshan, SL, DePasse, JM, Eltorai, AEM, Paxton, ES, Green, A, Daniels, AH: An Evidence-Based Approach to Differentiating the Cause of Shoulder and Cervical Spine Pain. *Am J Medicine* 2016;129:913–918.

14. Date, ES, Gray, LA: Electrodiagnostic evidence for cervical radiculopathy and suprascapular neuropathy in shoulder pain. *Electromyo Clin Neur* 1996;36:333–9.

15. Khan, S, Hameed, N, Mazar, S, Hashmi, IA, Rafi, MS, Shah, MI, Baloch, NA: Persistent Shoulder Pain After Anterior Cervical Discectomy and Fusion (ACDF): Another Dual Pathology. *Cureus* 2021;13:e13709.

16. Katsuura, Y, Bruce, J, Taylor, S, Gullota, L, Kim, HJ: Overlapping, Masquerading, and Causative Cervical Spine and Shoulder Pathology: A Systematic Review. *Global Spine J* 2020;10:195–208.

17. Zhang, AL, Theologis, AA, Tay, B, Feeley, BT: The Association Between Cervical Spine Pathology and Rotator Cuff Dysfunction. *J Spinal Disord Tech* 2015;28:E206–E211.

18. Vad, VB, Southern, D, Warren, RF, Altchek, DW, Dines, D: Prevalence of peripheral neurologic injuries in rotator cuff tears with atrophy. *J Shoulder Elb Surg* 2003;12:333–336.

19. Ochiai, N, Hashimoto, E, Sasaki, Y, Akimoto, K, Sugaya, H, Takahashi, N, Matsuki, K: 7 Prevalence of concomitant neuropathy in large to massive rotator cuff tear using needle electromyography. *J Shoulder Elb Surg* 2017;26:e111.

20. Kholinne, E, Kwak, J, Sun, Y, Lee, H, Koh, KH, Jeon, I: Risk Factors for Persistent Shoulder Pain After Cervical Spine Surgery. *Orthop Surg* 2019;11:845–849.

21. Eastwood, D, Manson, N, Bigney, E, Darling, M, Richardson, E, Paixao, R, Underwood, T, Ellis, K, Abraham, E: Improving postoperative patient reported benefits and satisfaction following spinal fusion with a single preoperative education session. *Spine J* 2019;19:840–845.

22. Parker, SL, Godil, SS, Shau, DN, Mendenhall, SK, McGirt, MJ: Assessment of the minimum clinically important difference in pain, disability, and quality of life after anterior cervical discectomy and fusion: Clinical article. *J Neurosurg Spine* 2013;18:154–160.

23. Cvetanovich, GL, Gowd, AK, Liu, JN, Nwachukwu, BU, Cabarcas, BC, Cole, BJ, Forsythe, B, Romeo, AA, Verma, NN: Establishing clinically significant outcome after arthroscopic rotator cuff repair. *J Shoulder Elb Surg* 2019;28:939–948.

24. Tashjian, RZ, Shin, J, Broschinsky, K, Yeh, C-C, Martin, B, Chalmers, PN, Greis, PE, Burks, RT, Zhang, Y: Minimal clinically important differences in the American Shoulder and Elbow Surgeons, Simple Shoulder Test, and visual analog scale pain scores after arthroscopic rotator cuff repair. *J Shoulder Elb Surg* 2020;29:1406–1411.

25. Dabija, DI, Jain, NB: Minimal Clinically Important Difference of Shoulder Outcome Measures and Diagnoses. *Am J Phys Med Rehab* 2019;Publish Ahead of Print:NA;

26. Myers, RR, Campana, WM, Shubayev, VI: The role of neuroinflammation in neuropathic pain: mechanisms and therapeutic targets. *Drug Discov Today* 2006;11:8–20.

27. Risbud, MV, Shapiro, IM: Role of cytokines in intervertebral disc degeneration: pain and disc content. *Nat Rev Rheumatology* 2013;10:44–56.

28. Bachasson, D, Singh, A, Shah, SB, Lane, JG, Ward, SR: The role of the peripheral and central nervous systems in rotator cuff disease. *J Shoulder Elb Surg* 2015;24:1322–1335.

29. Dwyer, A, Aprill, C, Bogduk, N: Cervical Zygapophyseal Joint Pain Patterns I. *Spine* 1990;15:453–457.

30. Grubb, SA, Kelly, CK: Cervical Discography: *Spine* 2000;25:1382–1389.

31. Malige, A, Morton, PN, Carolan, GF, Sokunbi, G: The operative treatment of shoulder pain in patients with a concurrent diagnosis of cervical spondylosis and shoulder dysfunction. *J Spine Surg* 2019;5:207–214.

32. Stull, JD, Goyal, DKC, Mangan, JJ, Divi, SN, McKenzie, JC, Casper, DS, Okroj, K, Kepler, CK, Vaccaro, AR, Schroeder, GD, *et al.*: The Outcomes of Patients With Neck Pain Following ACDF: A Comparison of Patients With Radiculopathy, Myelopathy, or Mixed Symptomatology. *Spine* 2020;45:1485–1490.

33. Crawford, CH, Carreon, LY, Bydon, M, Asher, AL, Glassman, SD: Impact of preoperative diagnosis on patient satisfaction following lumbar spine surgery. *J Neurosurg Spine* 2017;26:709–715.

34. Monesi, R, Benedetti, M, Zati, A, Vigna, D, Romanello, D, Monello, A, Rotini, R: The Effects of a Standard Postoperative Rehabilitation Protocol for Arthroscopic Rotator Cuff Repair on Pain, Function, and Health Perception. *Joints* 2018;06:145–152.

35. Menon, J, Cappelleri, J, Mardekian, J, Vendetti, N, Mychaskiw, M, III, J: Psychometric Properties of the SF-12, Penn Shoulder Score, and Visual Analogue Scale-Pain for Rotator Cuff Retears. *Appl Medical Res* 2015;1:109.

36. Elsamadicy, AA, Adogwa, O, Cheng, J, Bagley, C: Pretreatment of Depression Before Cervical Spine Surgery Improves Patients' Perception of Postoperative Health Status: A Retrospective, Single Institutional Experience. *World Neurosurg* 2016;87:214–219.

37. Siemionow, K, Janusz, P, Phillips, F, Youssef, J, Isaacs, R, Tyrakowski, M, McCormack, B: Clinical and Radiographic Results of Indirect Decompression and Posterior Cervical Fusion for Single-Level Cervical Radiculopathy Using an Expandable Implant with 2-Year Follow-Up. *J Neurological Surg Part Central European Neurosugery* 2016;77:482–488.

38. Tarazona, D, Boody, B, Hilibrand, AS, Stull, J, Bell, K, Fang, T, Goyal, D, Galetta, M, Kaye, D, Kepler, CK, *et al.*: Longer Preoperative Duration of Symptoms Negatively Affects Health-Related Quality of Life After Surgery for Cervical Radiculopathy. *Spine* 2018;Publish Ahead of Print:NA;

39. Cole, BJ, McCarty, LP, Kang, RW, Alford, W, Lewis, PB, Hayden, JK: Arthroscopic rotator cuff repair: Prospective functional outcome and repair integrity at minimum 2-year follow-up. *J Shoulder Elb Surg* 2007;16:579–585.

40. McIntyre, LF, Bishai, SK, Brown, PB, Bushnell, BD, Trenhaile, SW: Patient-Reported Outcomes After Use of a Bioabsorbable Collagen Implant to Treat Partial and Full-Thickness Rotator Cuff Tears. *Arthrosc J Arthrosc Relat Surg* 2019;35:2262–2271.

**Citation:** Levy HA, Karamian BA, Minetos PD, Gutman MJ, Pezzulo J, Canseco JA, Woods BI, Kurd MF, Rihn JA, Hilibrand AS, Kepler CK, Vaccaro AR, Davis DE, Schroeder GD. "A Comparison of Clinical Outcomes in Patients Undergoing Anterior Cervical Discectomy and Fusion and Rotator Cuff Repair". *SVOA Orthopaedics 2022,* 2:3, 61-68.