Does the Rotator Cuff Tear Pattern Influence Clinical Outcomes After Surgical Repair?

Scott Watson,*† MD, Benjamin Allen,† MD, Chris Robbins,† PhD, Asheesh Bedi,† MD, Joel J. Gagnier,†‡ ND, MSc, PhD, and Bruce Miller,† MD, MS

Investigation performed at the University of Michigan, Ann Arbor, Michigan, USA

Background: Limited literature exists regarding the influence of rotator cuff tear morphology on patient outcomes.

Purpose: To determine the effect of rotator cuff tear pattern (crescent, U-shape, L-shape) on patient-reported outcomes after rotator cuff repair.

Study Design: Cohort study; Level of evidence, 3.

Methods: Patients undergoing arthroscopic repair of known full-thickness rotator cuff tears were observed prospectively at regular intervals from baseline to 1 year. The tear pattern was classified at the time of surgery as crescent, U-shaped, or L-shaped. Primary outcome measures were the Western Ontario Rotator Cuff Index (WORC), the American Shoulder and Elbow Surgeons (ASES), and a visual analog scale (VAS) for pain. The tear pattern was evaluated as the primary predictor while controlling for variables known to affect rotator cuff outcomes. Mixed-methods regression and analysis of variance (ANOVA) were used to examine the effects of tear morphology on patient-reported outcomes after surgical repair from baseline to 1 year.

Results: A total of 82 patients were included in the study (53 male, 29 female; mean age, 58 years [range, 41-75 years]). A crescent shape was the most common tear pattern (54%), followed by U-shaped (25%) and L-shaped tears (21%). There were no significant differences in outcome scores between the 3 groups at baseline. All 3 groups showed statistically significant improvement from baseline to 1 year, but analysis failed to show any predictive effect in the change in outcome scores from baseline to 1 year for the WORC, ASES, or VAS when tear pattern was the primary predictor. Further ANOVA also failed to show any significant difference in the change in outcome scores from baseline to 1 year for the WORC (P = .96), ASES (P = .71), or VAS (P = .86).

Conclusion: Rotator cuff tear pattern is not a predictor of functional outcomes after arthroscopic rotator cuff repair.

Keywords: rotator cuff tear pattern; outcomes; shoulder; arthroscopic surgery

The outcomes of rotator cuff repair have been studied extensively. The classification and descriptions of rotator cuff tears date back to 1944 when McLaughlin described 3 groups of tears: transverse ruptures, vertical splits, and retracted tears. Although this system never gained great popularity, it was the basis for the geometric classification that is commonly used today by surgeons describing tears in 4 main patterns: crescent, U-shaped, L-shaped, and massive, contracted immobile tears. The crescent tear has a medial-to-lateral length that is less than the anterior-to-posterior width and usually good medial-to-lateral mobility that can be repaired directly to bone. The U-shaped tear extends farther medial than the crescent tear, with its apex more medial, often adjacent to the glenoid rim. These tears are long and narrow, with the medial-to-lateral depth being greater than the anterior-to-posterior width. These tears are sometimes repaired with margin convergence or “side-to-side” sutures to reduce tension before the repair to bone. The L-shaped tear is similar to the U-shaped tear; however, one side of the tear is more mobile than the other and thus easier to bring to bone. The apex of the “L” is identified, and the longitudinal split is often sutured in a side-to-side fashion. The fourth tear type commonly described is the massive, contracted immobile tear, which is usually not amenable to repair because of a lack of medial-to-lateral mobility. It is estimated that over 90% of rotator cuff tears fall within the first 3 categories, with crescent and U-shaped tears being the most common.

The ability to reproducibly classify rotator cuff tear shapes at the time of arthroscopic surgery allows for...
consistency in communication between physicians as well as predictability in tracking outcomes. While there have been studies evaluating the different biomechanical properties associated with tear patterns, very little evidence correlates the tear pattern with clinical outcomes. The objective of this study was to determine the influence of rotator cuff tear pattern on patient-reported outcomes after rotator cuff repair. Our hypothesis was that patients with crescent tears would show more favorable outcome scores after rotator cuff repair compared with patients with U- and L-shaped tears.

METHODS

After institutional review board approval, patients undergoing arthroscopic repair of a full-thickness rotator cuff tear were observed prospectively from baseline and at multiple time points to 1 year. The Western Ontario Rotator Cuff Index (WORC), American Shoulder and Elbow Surgeons (ASES), and visual analog scale (VAS) for pain were obtained at each time point. Baseline demographic data were collected, including a number of variables pertinent to patients with rotator cuff tears (age, sex, tear size, smoking, diabetes). The rotator cuff tear size was recorded from preoperative magnetic resonance imaging studies. The cuff tear index (CTI) was calculated according to previous descriptions by multiplying the anteroposterior dimension of the tear by the mediolateral dimension. The CTI functions to provide a comparison between patients of the total area of the rotator cuff tear and has been reliable in previous studies comparing all types of tears.

All patients who underwent arthroscopic posterosuperior rotator cuff repair with at least 1-year follow-up were included in the study population. Exclusion criteria included open rotator cuff repair, subscapularis repair, massive rotator cuff tears with only partial repair, debridement without repair of a massive or partial-thickness tear, concomitant labral repair at the time of rotator cuff repair, and unavailability of images for review when the tear pattern was not clearly defined in the operative report.

Classification of Rotator Cuff Tear Pattern

The rotator cuff tear pattern was classified by the surgeon at the time of repair on the basis of the arthroscopic characteristics of the tear as crescent, U-shaped, or L-shaped, as previously described. The 3 groups were created based on documentation of the tear pattern in the operative report. For the 27 patients whose tear pattern was not clearly defined in the operative report, the arthroscopic images were reviewed independently by 2 orthopaedic surgeons (S.W. and A.B.) to classify the tear into one of the 3 groups. Interobserver reliability was recorded and demonstrated agreement in the classification of tear types in all 27 patients (100%). Only posterosuperior (supraspinatus and/or infraspinatus) rotator cuff repairs that clearly fit into one of the above 3 categories were included in the present study. Reverse, or anterior L-shaped, tears were excluded because of their small number (7 patients). Patients who had undergone subscapularis repair in addition to the posterosuperior repair were excluded.

Surgical Repair

All arthroscopic rotator cuff repairs were performed by one of 3 fellowship-trained shoulder surgeons at our institution and included subacromial decompression in all cases. The mean time to surgery was 8.9 weeks from study enrollment. The repair technique utilized was at the discretion of the surgeon based on the characteristics of the tear in each individual case. Repair to bone was carried out only after adequate mobilization and temporary reduction of the rotator cuff tissue demonstrated adequate mobility of the tear without excessive tension.

Once the decision to proceed with repair was made, the anatomic footprint of the rotator cuff was debrided of all soft tissue and gently decorticated in preparation for anchor placement. When indicated at the discretion of the surgeon, single-row repair consisted of a single row of anchors (PITON; Tornier and Corkscrew; Arthrex) placed in the rotator cuff footprint and a combination of simple and horizontal mattress sutures with arthroscopic knots tied to repair the rotator cuff tissue to the tuberosity. All double-row techniques were transosseous-equivalent repairs with knotless Arthrex or Smith & Nephew anchors in the lateral row. In this repair technique, mattress sutures were tied at the medial row, and a suture limb from each medial anchor was applied to the anterior and posterior lateral-row implants in a crossing pattern, or a speed-bridge technique was utilized with FiberTape (Arthrex) and a knotless mattress configuration medially crossed to 2 knotless lateral anchors. When indicated, margin convergence, or “side-to-side” sutures, was utilized to decrease the gap and tension in the longitudinal portion of the tear and facilitate the repair to bone. All repairs included in the study were repaired to bone with anchors.

All patients were immobilized in an abduction sling for 4 weeks (UltraSling III AB 45; DJO Global), after which a standardized, supervised physical therapy protocol was initiated. The postoperative protocol was standardized based on the tear size: small (<1 cm), medium (1-3 cm), large (3-5 cm), and massive (>5 cm). For the first 4 weeks after surgery, patients were instructed to remove the abduction sling only for daily bathing and dressing needs and to include a daily home exercise program consisting of gentle passive range of motion in the scapular plane as well as pendulums. The rehabilitation protocol included passive range of motion from weeks 4 to 6, with active and active-assisted range of motion thereafter. The sling was discontinued after 4 to 6 weeks. A focused strengthening program was initiated at 12 weeks.

Outcome Measures

The primary outcome measures were the WORC, ASES, and VAS for pain. The total possible raw WORC score is 2100, with higher scores indicating worse symptoms and function. The WORC has been proven to be valid, reliable, and responsive. The ASES is divided into 3 domains:
pain, instability, and activities of daily living, with higher scores indicating better function on a 100-point scale. Construct validity, internal consistency, and reliability of the score have been shown to be good.\(^1\)\(^9\)\(^12\) Pain intensity was indicated via a 100-point VAS, with higher scores indicating greater pain.

**Statistical Analysis**

Descriptive and inferential statistical analyses were conducted using SPSS v22.0 (IBM). Differences in baseline data for between-group comparisons were obtained using univariate analysis of variance (ANOVA) for continuous data and the chi-square test for categorical data. Data are presented as the mean ± SD or a percentage within groups. A mixed linear regression model was used, with tear pattern employed as the primary predictor and surgeon as a random variable and adjusting for covariates. Covariates included demographic and clinical variables known to influence outcomes, including age, sex, body mass index, cause of injury, tear size, CTI, dominant side, duration of symptoms, diabetes, and smoking.

Three models were created, with the change in scores from baseline to 1 year for the ASES, VAS for pain, and WORC as the primary outcome while adjusting for demographic, clinical, and tear morphology variables. ANOVA was used to evaluate the 3 outcome measures in the 3 tear pattern groups as well. An independent \(t\) test was employed to evaluate the effect of single- and double-row repair and side-to-side suture techniques in the population as a whole and within the groups. An a priori power and sample size analysis using a moderate effect size estimate yielded a requirement of 78 patients for a power of 0.80 at 95% CI.

**RESULTS**

Patients were excluded from the study cohort for the following indications: subscapularis repair either in isolation or during posterosuperior rotator cuff repair (\(n = 16\)), debridement without repair of a partial-thickness tear or a massive irreparable tear (\(n = 13\)), simultaneous labral repair (\(n = 1\)), open rotator cuff repair (\(n = 1\)), partial repair of a massive tear (\(n = 3\)), or unavailable images for review when the tear pattern was not clearly defined in the operative report (\(n = 2\)). As mentioned above, the reverse or anterior L-shaped group had only 7 patients and was not included in the analysis. These exclusions from the original study population of 128 patients resulted in 85 patients included in this study cohort (Figure 1). Three patients were lost to follow-up without 1-year outcome scores available, leaving 82 of the 85 eligible patients to be included in the analysis at 1-year follow-up (96%). With regard to patient age, sex, dominant side of surgery, diabetes, and smoking, the 3 groups were evenly distributed (Table 1).

Using univariate ANOVA with a post hoc test, the mean CTI, representing tear size, was significantly greater in the L-shaped group than in the crescent group (\(P = .016\)). While the mean CTI was larger in the L-shaped group compared with the U-shaped group (4.9 vs 3.7, respectively), this did not reach significance. Although the mean CTI was larger in the L-shaped group, based on chi-square analysis, the categorical distribution (small, medium, large) of tear sizes was not significantly different among the groups (\(P = .10\)). There was no significant difference in WORC (\(P = .50\)), ASES (\(P = .95\)), or VAS (\(P = .17\)) scores among the 3 groups at baseline. The L-shaped group had the lowest baseline scores, and the U-shaped group had the highest in all 3 measures, although these were not significant. Table 1 shows the baseline patient demographics, rotator cuff tear characteristics, and WORC, ASES, and VAS scores for each of the 3 groups.

All 3 groups showed statistically significant improvement in all 3 outcome measures at 1 year. Using a mixed linear regression model with tear pattern as the predictor for outcomes, there was no predictive effect of tear pattern on clinical outcomes. With the U-shaped group set as the reference, the \(P\) values of the crescent group for the WORC (\(P = .45\)), ASES (\(P = .62\)), and VAS (\(P = .96\)) failed to reach significance. Similar results were seen in the L-shaped group for the WORC (\(P = .76\)), ASES (\(P = .63\)), and VAS (\(P = .41\)). Tear size, surgeon, and tear pattern were evaluated as independent variables to ensure that these factors did not influence outcomes. None of these were found to be predictive of outcome scores in the model. Male sex and diabetes were predictors of less improvement in ASES and WORC scores from baseline to 1-year follow-up. These results are displayed in Table 2.

Further ANOVA between the 3 tear pattern groups failed to show any significant difference in the change in outcome scores from baseline to 1 year for the WORC (\(F_{2,81} = 0.420, P = .96\)), ASES (\(F_{2,81} = 0.347, P = .71\)), or VAS (\(F_{2,81} = 0.149, P = .86\)). The L-shaped group showed the greatest improvement in both the WORC and VAS scores at 1-year follow-up, whereas the crescent group had the greatest improvement in the ASES score, but neither reached significance. These results are displayed in Table 3.

No significant difference was found in the population as a whole when comparing single- versus double-row repair for...
When comparing outcomes within the 3 groups for single-versus double-row repair, L-shaped tears that were repaired with the single-row technique showed significantly greater improvement in the WORC ($P = .02$) and VAS ($P = .04$) scores but not the ASES score ($P = .15$). No significant differences were found between single- and double-row repair when comparing the 2 techniques within the crescent and U-shaped groups. Moreover, 64% of the crescent group underwent double-row repair (28 patients vs 16 for single row), 57% of the U-shaped group underwent double-row repair (12 patients vs 9 for single row), and 65% of the L-shaped group underwent double-row repair (11 patients vs 6 for single row). The side-to-side, or “margin convergence,” repair technique did not have a significant effect on the WORC ($P = .96$), ASES ($P = .96$), or VAS ($P = .66$) scores of the population as a whole at 1 year. Additionally, no significant difference in outcome scores

### TABLE 1

Descriptive Data and Functional Scores at Baseline for Tear Shape Groups ($N = 82$)$^a$

|                          | Crescent (n = 44) | L-Shaped (n = 17) | U-Shaped (n = 21) | $P$ Value |
|--------------------------|------------------|------------------|------------------|-----------|
| Age, mean ± SD, y        | 58.0 ± 7.7       | 58.0 ± 8.6       | 58.6 ± 8.0       | .957      |
| Sex                      |                  |                  |                  | .839      |
| Male                     | 28 (63.6)        | 12 (70.6)        | 13 (61.9)        |           |
| Female                   | 16 (36.3)        | 5 (29.4)         | 8 (38.1)         |           |
| Body mass index, mean ± SD, kg/m$^2$ | 29.2 ± 5.8 | 29.0 ± 6.1 | 29.1 ± 5.6 | .941      |
| Cuff tear index, mean ± SD | 2.4 ± 2.1 | 4.9 ± 4.2 | 3.7 ± 3.2 | .016      |
| Tear size                |                  |                  |                  | .101      |
| Small                    | 10 (22.7)        | 3 (18.8)         | 3 (14.3)         |           |
| Medium                   | 27 (61.4)        | 6 (37.5)         | 16 (76.2)        |           |
| Large                    | 6 (13.6)         | 7 (43.8)         | 2 (9.5)          |           |
| Massive                  | 1 (2.3)          | 0 (0.0)          | 0 (0.0)          |           |
| Side of surgery          |                  |                  |                  | .548      |
| Left                     | 19 (43.2)        | 10 (58.8)        | 10 (47.6)        |           |
| Right                    | 25 (56.8)        | 7 (41.2)         | 11 (52.4)        |           |
| Dominant side            |                  |                  |                  | .567      |
| Opposite of injury       | 15 (34.1)        | 7 (41.2)         | 4 (19.0)         |           |
| Same as injury           | 29 (65.9)        | 10 (58.8)        | 17 (81.0)        |           |
| Diabetes                 |                  |                  |                  | .198      |
| No                       | 37 (84.1)        | 17 (100.0)       | 19 (90.5)        |           |
| Yes                      | 7 (15.9)         | 0 (0.0)          | 2 (9.5)          |           |
| Smoking                  |                  |                  |                  | .918      |
| No                       | 37 (84.1)        | 15 (88.2)        | 18 (85.7)        |           |
| Yes                      | 7 (15.9)         | 2 (11.8)         | 3 (14.3)         |           |
| VAS pain score, mean ± SD | 54.9 ± 26.5 | 65.1 ± 20.3 | 49.7 ± 25.8 | .173      |
| ASES score, mean ± SD    | 54.2 ± 19.3 | 53.4 ± 16.2 | 55.2 ± 15.6 | .950      |
| WORC score, mean ± SD    | 1203.7 ± 435.6  | 1284.7 ± 335.9  | 1130.5 ± 370.0  | .501      |

$^a$Data are shown as n (%) unless otherwise indicated. Bolded value indicates statistical significance ($P < .05$). ASES, American Shoulder and Elbow Surgeons; VAS, visual analog scale; WORC, Western Ontario Rotator Cuff Index.

### TABLE 2

Mixed Linear Regression With Change in Outcome Scores From Baseline to 1 Year and Covariates$^a$

|              | VAS Pain | ASES | WORC |
|--------------|----------|------|------|
| Beta         | P Value  | 95% CI | Beta | P Value  | 95% CI | Beta | P Value  | 95% CI |
| Tear shape   |          |       |      |          |       |      |          |       |
| Crescent     | 0.41     | .960  | −15.94 to 16.76 | 3.26 | .622  | −9.91 to 16.43 | 101.03 | .450  | −165.19 to 367.24 |
| L-shaped     | 9.38     | .409  | −13.25 to 32.02 | −4.38 | .632  | −22.62 to 13.84 | −56.37 | .760  | −424.85 to 312.10 |
| U-shaped (referent) | 0     | 0  |      | 0  |      |      |      |      |
| Sex (male)   | −13.57   | .080  | −28.84 to 1.68 | −19.64 | .002  | −31.93 to −7.34 | −324.67 | .011  | −573.12 to −76.23 |
| Age          | −0.29    | .546  | −1.23 to 0.66 | −0.28 | .461  | −1.04 to 0.48 | −10.96 | .009  | −26.34 to 4.42 |
| Cuff tear index | −0.36 | .776  | −2.86 to 2.14 | 0.21 | .835  | −1.80 to 2.23 | 29.59  | .151  | −11.14 to 70.32 |
| Body mass index | −0.48 | .469  | −1.80 to 0.84 | −0.07 | .903  | −1.13 to 1.00 | −5.01  | .642  | −26.49 to 16.47 |
| Diabetes     | −5.19    | .708  | −32.78 to 22.40 | −29.93 | .009  | −52.16 to −7.71 | −462.21 | .044  | −911.38 to −13.04 |
| Smoking      | 6.66     | .532  | −14.56 to 27.89 | −0.02 | .998  | −17.11 to 17.07 | −77.52 | .655  | −422.99 to 267.95 |

$^a$ASES, American Shoulder and Elbow Surgeons; VAS, visual analog scale; WORC, Western Ontario Rotator Cuff Index.
was found within the crescent, U-shaped, or L-shaped groups when comparing the side-to-side suture technique with those who were simply repaired to bone. These results are also displayed in Table 4.

**DISCUSSION**

While there has been extensive research on outcomes after rotator cuff repair, very little evidence exists on the influence of tear pattern on functional outcomes. This is the first study, to our knowledge, comparing the clinical outcomes of 3 major rotator cuff tear types after arthroscopic repair. The results did not support our hypothesis that crescent tears would have improved outcomes compared with L- and U-shaped tears. Tear pattern was not found to be a significant predictor of functional outcomes at 1-year follow-up. Our study controlled for tear size, surgeon, and other factors known to influence outcomes by using a mixed linear regression model to isolate the tear pattern as the primary variable influencing the statistical results. This model isolated tear size, surgeon, and other possible confounding variables as independent predictors as well, making us confident in the results.

Park et al superscript15 retrospectively evaluated the results of large rotator cuff tears divided into “mobile” (crescent and L-shaped) and U-shaped tears. Their study failed to find a difference between the groups in clinical outcome scores or retear rates. While we found similar results with no difference in outcomes among tear types, there are several key differences that distinguish our study from theirs. Our study is more generalizable and clinically applicable in the respect that it includes 3 distinct groups and all sizes of tears. Park et al superscript15 evaluated only large (3-5 cm) rotator cuff tears and excluded repairs that had margin convergence.

While some authors have cautioned against the use of side-to-side sutures in U-shaped tears, superscript6,13,19 others have shown it to be an effective repair technique to decrease tension and gap formation in U- and L-shaped tears. They propose that omitting the side-to-side sutures results in excess tension on the repair site and potentially results in a high incidence of failure. superscript3,7,14 In our U-shaped group, only 3 of 21 tears had side-to-side sutures employed, and this group still showed similar improvement to the other groups at 1-year follow-up. The Park et al superscript15 study was not designed to detect a difference in the 2 techniques of repair of the mobile leaflet versus the margin convergence method. Although the present study was not designed to compare the 2 techniques, we also did not find a significant difference in outcome scores in patients who had side-to-side sutures as a component of their repair in any of the 3 groups or in the population as a whole. Burkhart et al superscript15 did not find a significant difference in the outcomes of 2 groups: crescent tears repaired directly to bone and U-shaped tears repaired by margin convergence with little or no mobilization. Their group of margin convergence was split between...
isolated side-to-side sutures and those combining anchors into the repair site to bone. Burkhart et al\(^6\) included much more variability in the repair technique compared with our study, as all techniques included in our study ultimately consisted of repair to bone using anchors. However, we also did not find a significant difference in outcomes within our crescent, L-shaped, or U-shaped groups when comparing side-to-side sutures combined with suture anchors and suture anchor–to-bone repair techniques.

Although our study was not designed to evaluate single-versus double-row repair, there was no significant difference in the outcomes of the groups when the 2 techniques were compared overall in the population, which is consistent with previous systematic reviews and meta-analyses.\(^4\)\(^,\)\(^18\)

When the 2 techniques were compared within the tear pattern groups, there was no difference in the crescent and U-shaped groups between single- and double-row repairs. However, patients with an L-shaped tear that was repaired with a single-row technique showed significantly more favorable outcomes at 1 year for the WORC (\(P = .02\)) and VAS (\(P = .04\)) compared with those repaired with a double row of anchors. Interestingly, the mean CTI was larger in the patients who underwent single-row repair compared with the patients in whom the double-row technique was utilized (6.6 vs 3.7, respectively).

We are not aware of another study evaluating the outcomes of single- and double-row repairs in different tear patterns. These results suggest that L-shaped tears have better outcomes when they are repaired to bone with a single-row repair technique, whether margin convergence sutures are employed or not. While there is no clear answer, one theory based on our results may be that these tears are overtensioned with an attempted double-row repair. We acknowledge that the sample of only 17 patients in our L-shaped group is insufficient to draw definitive conclusions, and further studies with larger numbers are needed to delineate if one repair technique is superior in certain tear patterns.

One limitation of this study is a component of subjectivity in the classification of tears. Not all tears were classified clearly at the time of surgery, with 27 tears being classified retrospectively by 2 independent reviewers. While we acknowledge that there could be errors in classifying these tears, these categories are clearly defined, and interobserver reliability demonstrated perfect agreement, with the same classification selected in all 27 tears. The absence of tear size measured intraoperatively is another limitation but was not documented in all cases, so tear size on preoperative magnetic resonance imaging was used to calculate the CTI in our study. Other possible concerns are that the repair technique was not standardized, and there was variability in rehabilitation protocols. Rehabilitation protocols were standardized based on tear size and applied across all 3 groups, not specific to the tear type.

While the data analysis may have been more straightforward if a single repair technique had been used for each tear type, the results are more generalizable to the practicing surgeon. Multiple factors in repairing these tears were evaluated, and only the single-row repair of L-shaped tears showed significantly more favorable outcomes. Single- or double-row repair and side-to-side sutures did not affect outcomes in the population as a whole. This suggests that standardizing the repair technique would not have affected the findings. We also acknowledge that the tear pattern groups may be underpowered to detect a difference dependent on repair technique within the groups.

Three surgeons participated in this study, and the statistical model controlled for surgeon as a variable, which again makes the results more generalizable. Patient-reported outcome measures were chosen to evaluate the effects of tear pattern on outcomes in this study, but follow-up imaging to evaluate the healing of these repairs may be of value to further investigate the effect of tear pattern and repair characteristics on rotator cuff healing. The lack of postoperative imaging to evaluate the healing of repairs in this study is acknowledged as a limitation of this study and may limit the interpretation of our results to an extent. Repairs that did not heal may confound the patient-reported outcomes in each group, which we cannot fully identify with our study design dependent solely on patient-reported outcome measures.

CONCLUSION

This study revealed that tear pattern was not a significant predictor of patient-reported outcomes after arthroscopic rotator cuff repair. L-shaped tears demonstrated more favorable VAS for pain and WORC scores at 1 year when repaired with a single-row technique. Rotator cuff tear pattern does not appear to have a significant influence on patient outcomes after rotator cuff repair.

REFERENCES

1. Beaton D, Richards RR. Assessing the reliability and responsiveness of 5 shoulder questionnaires. J Shoulder Elbow Surg. 1998;7(6):565-572.
2. Burkhart SS, Danaceau SM, Pearce CE Jr. Arthroscopic rotator cuff repair: analysis of results by tear size and by repair technique-margin convergence versus direct tendon-to-bone repair. Arthroscopy. 2001;17(9):905-912.
3. Burkhart SS, Lo IK. Arthroscopic rotator cuff repair. J Am Acad Orthop Surg. 2006;14(6):333-346.
4. Chen M, Xu W, Dong Q, Huang Q, Xie Z, Mao Y. Outcomes of single-row versus double-row arthroscopic rotator cuff repair: a systematic review and meta-analysis of current evidence. Arthroscopy. 2013;29(8):1437-1449.
5. Davidson J, Burkhart SS. The geometric classification of rotator cuff tears: a system linking tear pattern to treatment and prognosis. Arthroscopy. 2010;26(3):417-424.
6. Galatz LM, Ball CM, Teefey SA, Middleton WD, Yamaguchi K. The outcome and repair integrity of completely arthroscopically repaired large and massive rotator cuff tears. J Bone Joint Surg Am. 2004;86-A(2):219-224.
7. Kim KC, Rhee KJ, Shin HD, et al. Modified margin convergence technique using suture anchors for footprint reconstruction of rotator cuff tears. Orthopedics. 2010;33(1):26-29.
8. Kirkley A, Alvarez C, Griffin S. The development and evaluation of a disease-specific quality-of-life questionnaire for disorders of the rotator cuff: the Western Ontario Rotator Cuff Index. Clin J Sport Med. 2003;13(2):84-92.
9. Koche MS, Horan MP, Briggs KK, Richardson TR, O’Holleran J, Hawkins RJ. Reliability, validity, and responsiveness of the American...
Shoulder and Elbow Surgeons subjective shoulder scale in patients with shoulder instability, rotator cuff disease, and glenohumeral arthritis. *J Bone Joint Surg Am*. 2005;87(9):2006-2011.

10. Lopes AD, Ciconelli RM, Carrera EF, Griffin S, Faloppa F, Dos Reis FB. Validity and reliability of the Western Ontario Rotator Cuff Index (WORC) for use in Brazil. *Clin J Sport Med*. 2008;18(3):266-272.

11. McLaughlin HL. Lesions of the musculotendinous cuff of the shoulder, I: the exposure and treatment of tears with retraction. *J Bone Joint Surg*. 1944;26:31-49.

12. Michener LA, McClure PW, Sennett BJ. American Shoulder and Elbow Surgeons standardized shoulder assessment form, patient self-report section: reliability, validity, and responsiveness. *J Shoulder Elbow Surg*. 2002;11(6):587-594.

13. Mochizuki T, Sugaya H, Uomizu M, et al. Humeral insertion of the supraspinatus and infraspinatus: new anatomical findings regarding the footprint of the rotator cuff. *J Bone Joint Surg Am*. 2008;90(5):962-969.

14. Nguyen ML, Quigley RJ, Galle SE, et al. Margin convergence anchor to bone for reconstruction of the anterior attachment of the rotator cable. *Arthroscopy*. 2012;28(9):1237-1245.

15. Park JY, Jung SW, Jeon SH, Cho HW, Choi JH, Oh KS. Arthroscopic repair of large U-shaped rotator cuff tears without margin convergence versus repair of crescent- or L-shaped tears. *Am J Sports Med*. 2014;42(1):103-111.

16. Sallay PI, Hunker PJ, Lim JK. Frequency of various tear patterns in full-thickness tears of the rotator cuff. *Arthroscopy*. 2007;23(10):1052-1059.

17. Sano H, Hatta T, Yamamoto N, Itoi E. Stress distribution within rotator cuff tendons with a crescent-shaped and an L-shaped tear. *Am J Sports Med*. 2013;41(10):2262-2269.

18. Sheibani-Rad S, Giveans MR, Arnoczky SP, Bedi A. Arthroscopic single-row versus double-row rotator cuff repair: a meta-analysis of the randomized clinical trials. *Arthroscopy*. 2013;29(2):343-348.

19. Sugaya H, Maeda K, Matsuki K, Moriishi J. Repair integrity and functional outcome after arthroscopic double-row rotator cuff repair: a prospective outcome study. *J Bone Joint Surg Am*. 2007;89(5):953-960.

20. Tauro JC. Arthroscopic repair of large rotator cuff tears using the interval slide technique. *Arthroscopy*. 2004;20(1):13-21.

21. Tauro JC. Stiffness and rotator cuff tears: incidence, arthroscopic findings, and treatment results. *Arthroscopy*. 2006;22(8):881-886.