Purpose: To determine whether patients who require margin convergence would have equivalent postsurgical patient-determined scores compared with patients with standard rotator cuff repair. The secondary purpose of this study was to determine whether the short-term results found for patients with margin convergence repairs would be durable through medium-term follow-up. Methods: A retrospective analysis of patients undergoing arthroscopic rotator cuff repair was performed to examine the effects of marginal convergence on patient-determined outcomes (Western Ontario Rotator Cuff Index, American Shoulder and Elbow Surgeons score, Simple Shoulder Test, Single Assessment Numeric Evaluation, and Shoulder Activity Level). Patient-determined outcomes in patients who had margin convergence repairs were compared with patients who had standard rotator cuff repair. Prospective follow-up of patients that had margin convergence repairs was performed to determine whether patient-determined outcomes deteriorated over time. Results: Two-hundred-seventy-two patients had standard rotator cuff repairs and 9 patients had margin convergence rotator cuff repair (3.2%). All patients had significant improvements in their Western Ontario Rotator Cuff Index, American Shoulder and Elbow Surgeons score, Simple Shoulder Test, and Single Assessment Numeric Evaluation. Patients requiring margin convergence rotator cuff repair had similar preoperative and postoperative scores compared with patients with a standard rotator cuff repair. At a mean follow-up of 7.5 years, there was no change in outcome scores compared with the early follow-up time point (mean 3.3 years) for patients undergoing margin convergence. Conclusions: Arthroscopic margin convergence repair techniques along with the treatment of concomitant pathologies result in similar patient-determined outcomes compared with standard rotator cuff repair techniques. These results appear to be durable and do not deteriorate from short-term to medium-term follow-up. Level of evidence: III: Retrospective comparative study
margin convergence rotator cuff repair as what to expect after surgery both in the short and long term. The aim of this study was to determine whether patients who required margin convergence repairs had similar success rates compared with patients who had standard rotator cuff repair techniques. The primary purpose of this study was to determine whether patients who require margin convergence would have equivalent postsurgical patient-determined scores compared with patients with standard rotator cuff repair. The secondary purpose of this study was to determine whether the short-term results found for patients with margin convergence repairs would be durable through medium-term follow-up.

The primary hypothesis of this study was that patients who require margin convergence would have equivalent postsurgical patient-determined outcome scores compared with patients without margin convergence. The secondary hypothesis was that the short-term results found for patients with margin convergence repairs would be durable through medium-term follow-up.

Methods
Prospective collection of preoperative patient-determined outcomes scores on patients undergoing arthroscopic rotator cuff repair by a single surgeon was begun in December 2008. Quality-of-life outcome scores that were collected include the Western Ontario Rotator Cuff Index (WORC)\textsuperscript{9-11} (a disease-specific outcome score that has been recommended for assessing the results of rotator cuff repair treatment\textsuperscript{12}), the American Shoulder and Elbow Surgeons (ASES) score,\textsuperscript{13-15} the Simple Shoulder Test (SST),\textsuperscript{15,16} (joint-specific outcome scores), and the Single Assessment Numeric Evaluation (SANE)\textsuperscript{17,18} (a general health measure). In addition, the Shoulder Activity Level was the primary activity level score outcome examined in this study since it is a validated, patient-determined outcome score that can be used to measure a patient’s activity level.\textsuperscript{19-21}

Patients who underwent primary arthroscopic rotator cuff repair with a concomitant subacromial decompression and had completed preoperative patient outcome forms had the potential for inclusion in this study. Patients who underwent concomitant acromioclavicular joint resection, biceps tenodesis, and/or labral repair were included to increase the generalizability of the study since they are often performed clinically along with rotator cuff repairs. Exclusion criteria were patients with radiographically apparent osteoarthritis, patients with less than 2 years’ follow-up, patients undergoing revision rotator cuff repair, patients with rotator cuff...
arthropathy or irreparable rotator cuff tears, patients who were deceased before postoperative outcomes measures could be obtained, non–English-speaking patients, and patients with concomitant cervical radiculopathy, adhesive capsulitis, proximal humerus fracture, or a diagnosis of inflammatory arthritis.

In 2014, institutional review board approval was obtained (University of South Dakota 2014:115 and 2019:039.), and patients were mailed the identical outcomes measures that were taken preoperatively by U.S. mail to determine the effect of arthroscopic rotator cuff repair on their scores 2 to 6 years after surgery. To examine hypothesis #1, patients who had margin convergence rotator cuff repair techniques were identified and compared with patients that did not require margin convergence. To answer hypothesis #2, in 2019, patients who had margin convergence repairs were mailed the identical patient outcome forms by U.S. mail to determine whether their postsurgical outcomes remained durable from the initial short-term follow-up period or if there was deterioration of their scores.

To determine clinically meaningful improvements from arthroscopic rotator cuff repair, the percentage of shoulders that had improvements equal to or greater than the minimal clinically important difference (MCID) of the WORC, the ASES score, and the SANE was reported.12,18,22,23 These studies suggested the MCID of the WORC was 11.7%, the SANE was 15%, and the MCID of the ASES ranged from 6.4 to 17.

Statistical analysis was performed using Microsoft Excel 2010 (Microsoft, Inc., Redmond, WA) and an open-source statistical calculator.24 A paired samples t test was conducted, on pre- and post-test scores to determine statistically significant improvements in quality of life scales and the Shoulder Activity Level. $\chi^2$ testing was used to analyze discrete variables. The level of significance was determined to be .05. To try to accommodate the biases of small sample sizes (margin convergence group) on the findings and conclusions of this study, 95% confidence intervals were calculated.25 To further examine the clinical significance of the findings, effect sizes (Cohens d) were determined.26 Small effect sizes were defined as 0.2 ≤ d < 0.5, medium effect sizes were defined as 0.5 ≤ d < 0.8, and large effect sizes were defined as d ≥ 0.8.27

Results

From January 1, 2008, to December 31, 2012, the author (K.M.B.) identified 307 shoulders that met the inclusion criteria. Twenty-seven shoulders (8.8%) were lost to follow-up and were unable to provide postoperative patient-determined outcome scores. None of the patients who were lost to follow-up underwent margin convergence repair. Therefore, 281 shoulders were included from 273 patients who completed their postoperative patient-determined outcome scores at a mean follow-up of 3.7 years after surgery (range 2.01-7.47 years). Of the 281 shoulders enrolled in our rotator cuff repair database, 9 (3.2%) required margin convergence techniques for rotator cuff repair. Six patients had U-shaped tears (66.7%) and 3 patients had L-shaped tears (33.3%). The remaining 272 shoulders had standard rotator cuff repair techniques performed in a transosseous-equivalent repair fashion using both medial and lateral suture anchors without side-to-side suturing of the rotator cuff.

Patients with margin convergence repairs had similar ages compared with patients without margin convergence repairs (57.4 vs 58.9 years; $P = .57$). There were fewer women in the margin convergence group (1 woman; 11%) compared with the group that did not require margin convergence (96 females; 35%; $P = .06$). The length of initial follow up was statistically different between groups with a slightly shorter follow-up in the margin convergence group (3.3 vs 3.7 years; $P = .05$). There was no difference in the percentage of shoulders undergoing concomitant labral repair (0% vs 11%; $P = .27$), biceps tenodesis (33% vs 47%; $P = .43$), or acromioclavicular joint resection (44% vs 57%; $P = .44$) in the margin convergence group compared with the standard repair group.

There were statistically significant improvements in postoperative scores in all quality-of-life scores (WORC, ASES, SST, and SANE) for both the standard rotator cuff repair group and the margin convergence repair group ($P \leq .002$). However, there was no change in SAL for the margin convergence group (12.6 ± 3.8 vs 12.6 ± 5.1; $P = 1.00$) and a deterioration of the SAL in the non-margin convergence group (11.6 ± 4.5 vs 10.3 ± 4.8; $P < .0001$). Patients requiring margin convergence rotator cuff repair had similar preoperative and postoperative scores compared with patients without margin convergence repair (Table 1).

There were no clinical differences between the groups in the percentage of shoulders achieving at least the MCID in postoperative improvement in any of the patient outcome scores (Table 2). Although there was a statistical difference between the percentages of patients achieving the MCID of the WORC, this is likely an effect of the small sample size of patients requiring margin convergence.

There was no difference between patients requiring margin convergence and those who did not have margin convergence in the percentage of patients requiring supraspinatus repair (100% vs 92%; $P = .36$), infraspinatus repair (0% vs 13%; $P = .26$), and subscapularis repair (22% vs 38%; $P = .35$). The margin convergence group had a similar number of tendons requiring repair as the non-margin convergence group (1.2 vs 1.4; $P = .23$).

Shoulders that required margin convergence repair had larger supraspinatus and/or infraspinatus tears (coronal
## Table 1. Preoperative and Initial Postoperative Patient-Determined Outcome Scores

| Preoperative Scores | Postoperative Scores |
|---------------------|----------------------|
| Margin Convergence  | Standard Rotator Cuff Repair |
|                     | P-Value | 95% Confidence Interval | Effect Size |
| WORC                | 44/6   | 44 ± 15 to 66 ± 21   | 0.13  |
| ASES                | 14/6   | 14 ± 15 to 24 ± 15   | 0.02  |
| SST                 | 14/6   | 14 ± 15 to 24 ± 15   | 0.06  |
| SANE                | 31/6   | 31 ± 15 to 41 ± 15   | 0.06  |
| SAL                 | 12.6   | 12.6 ± 3.8 to 22.2 ± 3.8 | 0.21  |
|                     | ASES, American Shoulder and Elbow Surgeons; SST, Simple Shoulder Test; SANE, Single Assessment Numeric Evaluation; SAL, Shoulder Activity Level |

For a surgical technique that was published in 1996, there is not an abundance of studies that examine margin convergence rotator cuff repair, with most of the literature published by the author and institution that popularized the technique.\(^2\)-\(^4\),\(^6\)-\(^8\),\(^30\) Biomechanical studies have shown that margin convergence techniques

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**Discussion**

This study demonstrated that patients undergoing margin convergence repairs had similar patient-determined outcomes compared with patients who did not require margin convergence techniques, thus supporting our primary hypothesis. In addition, our secondary hypothesis was supported by this study since there was no deterioration of patient-determined outcome scores from a short-term follow-up of 3.3 years to a mid-term follow up of 7.5 years.

For a surgical technique that was published in 1996, there is not an abundance of studies that examine margin convergence rotator cuff repair, with most of the literature published by the author and institution that popularized the technique.\(^2\)-\(^4\),\(^6\)-\(^8\),\(^30\) Biomechanical studies have shown that margin convergence techniques
decrease gap formation and may provide a better mechanical environment for rotator cuff healing. Mazzocca et al. demonstrated that margin convergence may decrease strain across the rotator cuff by up to 58%. When reviewing the literature that examined clinical outcomes after margin convergence rotator cuff repair techniques that incorporated tendon to bone repair similar to our study, we could only identify 2 studies. In 2001 Burkhart et al. demonstrated comparable clinical outcomes (UCLA scores) in patients requiring margin convergence repair to patients who did not require margin convergence repair. Like our study, they had only a small sample size of patients who underwent margin convergence repair to bone (10 patients) and their follow-up (mean 3.5 years) was similar to our short-term follow-up period. In 2010, Kim et al. published a non-comparative study of 15 patients undergoing margin convergence repair that showed improvements in visual analog scales and Constant scores. This study was limited by a short-term follow-up of 18 months (range 12-25 months).

Limitations

Our study was limited by the small sample size, since only 3.2% of shoulders in our cohort required margin convergence. The small effect sizes found in this study suggest that it is less likely that increasing sample size of the margin convergence group would demonstrate clinically relevant differences. An additional limitation was the inclusion of a large number of patients who underwent procedures concomitant to the rotator cuff repair (biceps tenodesis, acromioclavicular joint resection, etc.). Inclusion of these procedures does not allow us to determine whether the satisfactory outcomes found in this study was due to rotator cuff repair alone or due to the concomitant procedures or a combination of both. However, since there were similar percentages of concomitant procedures between the groups, the inclusion of concomitant procedures should not confound the interpretation of the data and the conclusions of this study. Another limitation of this study was that patients did not return to clinic at final follow-up for a physical examination or radiologic assessment of rotator cuff healing. Whereas this would have made the study more comprehensive, it did not prevent this study from exploring the hypotheses that (1) margin convergence repairs would have comparable patient-determined outcomes to standard rotator cuff repair and (2) these results would be durable from short- to medium-term follow-up.

Conclusions

Arthroscopic margin convergence repair techniques along with the treatment of concomitant pathologies result in similar patient-determined outcomes compared with standard rotator cuff repair techniques. These results appear to be durable and do not deteriorate from short-term to medium-term follow-up.

Table 2. Percentage of Patients Achieving at Least the MCID in Postoperative Improvement After Rotator Cuff Repair With and Without Margin Convergence

|                  | Margin Convergence | No Margin Convergence | P Value |
|------------------|--------------------|-----------------------|---------|
| WORC (MCID 11.7%)| 100%               | 89%                   | .0002   |
| ASES (MCID 6.4)  | 89%                | 94%                   | .56     |
| ASES (MCID 17)   | 78%                | 89%                   | .28     |
| SANE (MCID 15)   | 89%                | 90%                   | .96     |

ASES, American Shoulder and Elbow Surgeons; MCID, minimal clinically important difference; SANE, Single Assessment Numeric Evaluation; WORC, Western Ontario Rotator Cuff Index.

Table 3. Comparison of Initial Postoperative Follow-up Compared to Final Follow-up for Patients Requiring Margin Convergence Repair

|                  | Initial Follow-up (Mean 3.3 Years) | Final Follow-up (Mean 7.5 Years) | P Value |
|------------------|------------------------------------|----------------------------------|---------|
| WORC             | 86 ± 17                            | 88 ± 12                          | .50     |
| ASES             | 86 ± 20                            | 92 ± 8                           | .34     |
| SST              | 10.9 ± 1.7                         | 10.2 ± 1.8                       | .36     |
| SANE             | 91 ± 11                            | 89 ± 14                          | .75     |
| SAL              | 12.6 ± 5.1                         | 11.8 ± 4.9                       | .51     |

ASES, American Shoulder and Elbow Surgeons; SAL, Shoulder Activity Level; SANE, Single Assessment Numeric Evaluation; SST, Simple Shoulder Test; WORC, Western Ontario Rotator Cuff Index.

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