Incidence of Retear With Double-Row Versus Single-Row Rotator Cuff Repair

CHONG SHEN, MD; ZHI-HONG TANG, MD; JUN-ZU HU, MD; GUO-YAO ZOU, MD; RONG-CHI XIAO, MD

abstract

Rotator cuff tears have a high recurrence rate, even after arthroscopic rotator cuff repair. Although some biomechanical evidence suggests the superiority of the double-row vs the single-row technique, clinical findings regarding these methods have been controversial. The purpose of this study was to determine whether the double-row repair method results in a lower incidence of recurrent tearing compared with the single-row method. Electronic databases were systematically searched to identify reports of randomized, controlled trials (RCTs) comparing single-row with double-row rotator cuff repair. The primary outcome assessed was retear of the repaired cuff. Secondary outcome measures were the American Shoulder and Elbow Surgeons (ASES) shoulder score, the Constant shoulder score, and the University of California, Los Angeles (UCLA) score. Heterogeneity between the included studies was assessed. Six studies involving 428 patients were included in the review. Compared with single-row repair, double-row repair demonstrated a lower retear incidence (risk ratio [RR]=1.71 [95% confidence interval (CI), 1.18-2.49]; \( P=0.05; I^2=0\% \)) and a reduced incidence of partial-thickness retears (RR=2.16 [95% CI, 1.26-3.71]; \( P=0.05; I^2=26\% \)). Functional ASES, Constant, and UCLA scores showed no difference between single- and double-row cuff repairs. Use of the double-row technique decreased the incidence of retears, especially partial-thickness retears, compared with the single-row technique. The functional outcome was not significantly different between the 2 techniques. To improve the structural outcome of the repaired rotator cuff, surgeons should use the double-row technique. However, further long-term RCTs on this topic are needed.
Arthroscopic instrumentation and techniques are improving rapidly, and arthroscopic rotator cuff repair has become popular in the past few years. The outcomes of arthroscopic rotator cuff repair have been shown to be equivalent to those of open and mini-open techniques, with less morbidity. Nevertheless, the rates of structural failure after arthroscopic rotator cuff repair remain high. Imaging studies have reported retear incidences varying from 29% to 94%, with especially high incidences of recurrence for massive tears and older patients. Some authors have suggested better clinical results of rotator cuff repair when the cuff is intact. Therefore, achievement of cuff integrity may reasonably be considered as a primary objective of the surgery.

One theory for the higher failure of the repair site is that earlier single-row suture anchorage repair techniques could restore only 67% of the original footprint of the rotator cuff. A larger contact area between the tendon and bone might allow more fibers to participate in the healing process, leading to a more stable repair. This problem led some surgeons to use a double-row suture anchor technique, aiming to improve footprint coverage and increase the contact area for healing. Biomechanical and comparative studies have supported the double-row repair technique, confirming that this technique restores 100% of the anatomic footprint, improves initial strength and stiffness, and decreases gap formation compared with single-row suture anchor fixation.

Despite these theoretical advantages, few clinical studies have demonstrated the structural superiority of the double-row technique. Other studies have not been able to show a significant difference between the techniques. Several systematic reviews have compared the techniques, but these reviews included both randomized, controlled trials (RCTs) and non-RCTs. This disadvantage compromised the ability of the reviews to make strong conclusions. In addition, 3 RCTs have been published since these systematic reviews were performed. Thus, it remains unclear what the most appropriate repair method is for tendon healing.

In light of these issues, the current authors performed a meta-analysis with data from RCTs. The authors’ goal was to provide an evidence-based appraisal of the effects of the double-row compared with the single-row technique in patients who underwent arthroscopic rotator cuff repair. The authors postulated that the double-row technique would demonstrate a lower retear incidence compared with the single-row technique.

**Materials and Methods**

**Data Searches**

Electronic databases, including PubMed, EMBASE, and the Cochrane Central Register of Controlled Trials, were searched using the following terms: rotator cuff, single row, double row, and dual row. Reference lists of relevant articles were manually searched for additional trials. The search was not restricted by language. The latest date for this search was May 17, 2013.

**Inclusion Criteria**

Studies eligible for inclusion met the following criteria: (1) RCT, (2) patients underwent arthroscopic repair of rotator cuff tears, (3) both double- and single-row repairs included, (4) follow-up performed for a minimum of 1 year, (5) follow-up examination reported retear outcomes, and (6) included 40 or more patients. The sample size criterion was included to minimize the effects of bias.
All studies that did not meet these criteria were excluded.

Data Extraction and Outcome Measures
Two reviewers (C.S., Z.-H.T.) independently extracted data using a standardized extraction form. Disagreements were resolved by discussion until consensus was reached. If the 2 reviewers could not reach a consensus, a third reviewer was asked for a final opinion, resulting in a group consensus. The primary outcome assessed was retear of the repaired cuff. Secondary outcome measures were the American Shoulder and Elbow Surgeons (ASES) shoulder score, the Constant shoulder score, and the University of California, Los Angeles (UCLA) score. These outcome measures were chosen because they were included in most studies.

Quality Assessment
The Cochrane Collaboration’s tool for assessing the risk of bias was used for quality assessment.32 This tool focuses on 7 criteria: (1) sequence generation, (2) allocation concealment, (3) blinding of participants and personnel, (4) blinding of outcome assessment, (5) incomplete outcome data, (6) selective outcome reporting, and (7) other sources of bias. Each item of the included studies was classified as Yes, No, or Unclear.

Statistical Analysis
The incidence of retear was treated as a dichotomous variable and was expressed as the risk ratio (RR) with the 95% confidence interval (CI) for each study. The functional scores (ASES, Constant, and UCLA) were treated as continuous variables. For continuous variables, means and SDs were used to calculate the weighted mean differences (WMDs) and 95% CIs in the meta-analysis. Heterogeneity between studies was quantified using the $I^2$ statistic, which is a quantitative measure of inconsistency across studies. An $I^2$ value of 0% represents no heterogeneity, and values of 25%, 50%, and 75% or more represent low, moderate, and high heterogeneity, respectively.33 An $I^2$ value greater than 50% indicates significant heterogeneity.34 If heterogeneity was significant ($I^2>50\%$), a meta-analysis was conducted with the random-effects model; otherwise, the fixed-effects model was used. A sensitivity analysis was performed by excluding the trials that potentially biased the results to explore possible explanations for heterogeneity. Analysis was conducted using Review Manager version 5.1 software (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark).

RESULTS

Literature Search
Of the 451 potentially relevant studies identified through the literature search (Figure 1), 17 studies were retrieved for full-text assessment, and 6 studies met the authors’ inclusion criteria.20-25 Eleven studies were excluded for the following reasons: 4 studies did not include imaging outcomes, 3 studies were letters to the editor, and 4 studies were not RCTs.

Risk of Bias
Risks of bias results for the studies are summarized in Table 1. All RCTs provided some information about the method of randomization (computer or random-number table), suggesting that randomization was adequate.20-25 One RCT was unclear with respect to allocation concealment.23 No RCT blinded the surgeon to the intervention because of the nature of a surgical trial. Three studies did not mention whether the outcome assessors

<table>
<thead>
<tr>
<th>Study</th>
<th>Random Sequence Generation</th>
<th>Allocation Concealment</th>
<th>Blinding of Participants</th>
<th>Blinding of Outcome Assessment</th>
<th>Incomplete Outcome Data</th>
<th>Selective Reporting</th>
<th>Other Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonel et al30</td>
<td>Yes (statistical software-generated randomization)</td>
<td>Yes (an independent researcher kept the list)</td>
<td>No</td>
<td>Unclear</td>
<td>No</td>
<td>Unclear</td>
<td>Unclear</td>
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<tr>
<td>Ma et al21</td>
<td>Yes (computer-generated randomization)</td>
<td>Yes (sealed envelopes)</td>
<td>No</td>
<td>Unclear</td>
<td>No</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
<tr>
<td>Lapner et al22</td>
<td>Yes (computer-generated randomization)</td>
<td>Yes (sealed envelopes)</td>
<td>No</td>
<td>Yes (blinded investigator)</td>
<td>No</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
<tr>
<td>Koh et al23</td>
<td>Yes (list of random numbers)</td>
<td>Unclear</td>
<td>No</td>
<td>Yes (2 blinded investigators)</td>
<td>No</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
<tr>
<td>Burks et al24</td>
<td>Yes (random-number generator)</td>
<td>Yes (sealed envelopes)</td>
<td>No</td>
<td>Yes (2 blinded investigators)</td>
<td>No</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
<tr>
<td>Franceschi et al25</td>
<td>Yes (random-numbers table)</td>
<td>Yes (sealed envelopes)</td>
<td>No</td>
<td>Unclear</td>
<td>No</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
</tbody>
</table>
were blinded.20-25 No RCT included incomplete outcome data. All studies were unclear about reporting bias and other bias.20-25

**Study Characteristics**

General data of the 6 RCTs included in the meta-analysis are presented in Table 2. The operative characteristics of each included trial are described in Table 3. The RCTs randomized a total of 216 patients to the single-row group and 212 patients to the double-row group. All 6 studies reported retear events,20-25 4 studies reported the incidence of partial-thickness retears,20,21,23,25 and 5 studies reported the incidence of full-thickness retears.20-23,25 Four studies reported the ASES shoulder score,21,24 3 studies reported the Constant shoulder score,22-24 and 4 studies reported the UCLA shoulder score.21,23-25

**Primary Outcome: Retear**

Meta-analysis of the total retear incidence showed a difference favoring the double-row compared with the single-row technique (RR=1.71 [95% CI, 1.18 to 2.49]; P=.005; I²=0%) (Figure 3). The study by Lapner et al22 provided information on full-thickness but not partial-thickness retears; therefore, the study could not be included. Subgroup analysis according to the retear type showed a lower incidence of retears in the partial-thickness retear subgroup compared with the single-row group (RR=2.16 [95% CI, 1.26 to 3.71]; P=.005; I²=26%). For the full-thickness retear subgroup, there was no difference between the double- and single-row groups (RR=1.38 [95% CI, 0.83 to 2.28]; P=.21; I²=0%) (Figure 4).

**Secondary Outcome: Functional Scores**

Meta-analysis demonstrated no significant difference between the 2 techniques at final follow-up in terms of ASES score (WMD, -0.04 [95% CI, -1.06 to 1.07]; P=.94; I²=0%), Constant score (WMD, 3.60 [95% CI, -1.63 to 8.83]; P=.18; I²=0%), or UCLA score (WMD, -0.80 [95% CI, -1.68 to 0.08]; P=.07; I²=47%). The authors performed sensitivity analyses to explore the potential source of heterogeneity in the UCLA score. The exclusion of 1 study that only enrolled patients with large and massive tears yielded similar results (WMD, 0.24 [95% CI, -1.02 to 1.51]; P=.70), with no heterogeneity (P²=0%).25

**Discussion**

Several review articles have compared single-row and double-row rotator cuff repair techniques. Two systematic reviews published in 200926 and 201027 examined data on clinical and radiographic outcomes; however, they did not statistically pool the data to provide comparative treatment effects. Another study published in 2010 reviewed data from several observational studies and 1 RCT examining the healing rate28; it found that the double-row repair technique led to significantly lower retear incidences compared with the single-row technique for tears greater than 1 cm. Three previous systematic reviews or meta-analyses pooled data on the retear incidence and showed no significant difference between single-row and double-row repair techniques.29,31 However, these meta-analyses included cohort and RCT data, complicating the interpretation of their results. The current study provides evidence based exclusively on RCTs to avoid the possible bias associated with cohort studies.

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**Table 2: Study Characteristics**

<table>
<thead>
<tr>
<th>Study</th>
<th>Single-row Follow-up, y</th>
<th>Double-row Follow-up, y</th>
<th>Imaging Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonel et al20</td>
<td>35</td>
<td>33</td>
<td>MRI</td>
</tr>
<tr>
<td>Fraceschi et al25</td>
<td>31</td>
<td>11</td>
<td>MRI</td>
</tr>
<tr>
<td>Koh et al23</td>
<td>30</td>
<td>9</td>
<td>MRI</td>
</tr>
<tr>
<td>Ma et al21</td>
<td>15</td>
<td>14</td>
<td>MRI</td>
</tr>
<tr>
<td>Lapner et al22</td>
<td>35</td>
<td>29</td>
<td>MRI</td>
</tr>
<tr>
<td>Burks et al24</td>
<td>37</td>
<td>34</td>
<td>MRI</td>
</tr>
<tr>
<td>MRI only</td>
<td></td>
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</tbody>
</table>

Abbreviations: MRA, magnetic resonance arthrography; MRI, magnetic resonance imaging; NR, not reported.
In the current investigation, structural failures, deemed as a partial- and full-thickness retears at final follow-up, were recorded in 5 studies. Two different techniques were used to determine the retear incidence: 3 studies used magnetic resonance imaging and 2 studies used magnetic resonance arthrography. When combining the 5 studies, the authors found a lower total retear incidence, including full- and partial-thickness retears, in patients who had double-row fixation. Although none of the individual studies found a significant difference, the combined treatment effect demonstrated a significant and homogeneous difference favoring the double-row technique. However, although different methods were used to diagnose tendon

### Table 3

Surgical Techniques Used in Included Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Tear Size</th>
<th>No. of Sutures</th>
<th>Surgical Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonel et al&lt;sup&gt;20&lt;/sup&gt;</td>
<td>SR: 51 tears=1-3 cm, 29 tears=3-5 cm; DR: 53 tears=1-3 cm, 27 tears=3-5 cm</td>
<td>SR: mean, 1.83 (range, 1-3); DR: mean, 2.99 (range, 2-4)</td>
<td>SR: Double-loaded Bio-Corkscrew (Arthrex, Naples, Florida) DR: Double-loaded Bio-Corkscrew; Suture: FiberWire No. 2 (Arthrex); Knot tying: Margin convergence suture before fixation to bone (SR); mattress sutures (DR)</td>
</tr>
<tr>
<td>Ma et al&lt;sup&gt;21&lt;/sup&gt;</td>
<td>SR: 19 tears=3 cm, 8 tears=3 cm; DR: 17 tears=3 cm, 9 tears=3 cm</td>
<td>SR: mean, 2.37 (range, 2-4); DR: mean, 3.38 (range, 3-5)</td>
<td>SR: Double-loaded Super Revo anchor (Linvatec, Largo, Florida) DR: Double-loaded Super Revo anchor; Suture: Braided polyester sutures No. 2; Knot tying: Locking, sliding knot with backup half-hitches (SR and lateral row of DR) and mattress sutures (medial of DR)</td>
</tr>
<tr>
<td>Lapner et al&lt;sup&gt;22&lt;/sup&gt;</td>
<td>SR: 21.4±9.4 mm (coronal oblique), 18.9±8.5 mm (sagittal oblique); DR: 23.8±10.8 mm (coronal oblique), 18.9±6.6 mm (sagittal oblique)</td>
<td>SR: median, 1 (IQR, 1-2); DR: median, 2 (IQR, 2-3)</td>
<td>SR: Double-loaded Super Revo anchors and Duet anchors (Linvatec) DR: Double-loaded Super Revo anchors and Duet anchors; Suture: High-tensile-strength No. 2; Knot tying: Sliding-locking knots and alternating half-hitches</td>
</tr>
<tr>
<td>Koh et al&lt;sup&gt;23&lt;/sup&gt;</td>
<td>SR: 21.0±6.3 mm (coronal oblique), 17.2±5.7 mm (sagittal oblique); DR: 20.8±5.6 mm (coronal oblique), 17.5±6.2 mm (sagittal oblique)</td>
<td>Not reported</td>
<td>SR: Metal suture anchors (Arthrex) in the first 11 cases, Bio-Corkscrew suture anchor in the next 26 DR: Metal suture anchors (Arthrex) in the first 13 cases, Bio-Corkscrew suture anchor in the next 21; Suture: Not reported; Knot tying: Simple stitches (SR and lateral row of DR) and mattress sutures (medial of DR)</td>
</tr>
<tr>
<td>Burks et al&lt;sup&gt;24&lt;/sup&gt;</td>
<td>SR: 18 tears=1-3 cm, 2 tears=3 cm; DR: 15 tears=1-3 cm, 5 tears=3 cm</td>
<td>SR: mean, 2.25; DR: mean, 3.2</td>
<td>SR: Double-loaded Bio-Corkscrew FT anchors DR: Double-loaded Bio-Corkscrew FT anchors; Suture: FiberWire No. 2; Knot tying: Locking, sliding knot with backup half-hitches</td>
</tr>
<tr>
<td>Franceschi et al&lt;sup&gt;25&lt;/sup&gt;</td>
<td>SR: 18 tears=3-5 cm, 8 tears=3 cm; DR: 21 tears=3-5 cm, 5 tears=3 cm</td>
<td>SR: mean, 1.9 (range, 1-2); DR: mean, 2.3 (range, 2-4)</td>
<td>SR: Double-loaded Bio-Corkscrew DR: Double-loaded Bio-Corkscrew; Suture: FiberWire No. 2; Knot tying: Margin convergence suture before fixation to bone</td>
</tr>
</tbody>
</table>

Abbreviations: DR, double-row; IQR, interquartile range; SR, single-row.

**Figure 2:** Forest plot of total retears. Individual studies are listed on the left, with retear events as well as the number of patients in each study arm. A visual representation of the risk ratio for each study is plotted on the right with a diamond. The large diamond at the bottom represents the pooled treatment effect of all studies. It lies exclusively to the right and does not cross the midline, representing a significant difference favoring the double-row technique.
retear postoperatively, the heterogeneity in these studies could not be proven ($I^2=0\%$). Furthermore, subgroup analysis by imaging method revealed no heterogeneity, thus verifying the robustness of the authors’ results.

The authors’ meta-analysis also showed that the double-row technique yielded a significantly lower incidence of partial-thickness retears compared with the single-row technique in the short term. This finding suggests that the double-row technique may be effective at preventing delaminated tearing in repaired rotator cuff tears. To the best of the authors’ knowledge, this is the first study to explore the role of the double-row technique in preventing partial-thickness retears in arthroscopic rotator cuff repair. A retrospective study by Kurtus et al\textsuperscript{35} demonstrated that 35% of the partial-thickness tears developed into full-thickness rotator cuff tears by 5 years. Zumstein et al\textsuperscript{36} suggested that although the repair of cuff tears yielded excellent results with high patient satisfaction at almost 10 years postoperatively, the mean retear size had increased over time, and patients with an intact repair had better results than those with a retear. Therefore, the current authors speculate that more patients with partial-thickness retears in the single-row group than in the double-row group may progress into full-thickness tears with longer follow-up.

The functional scores (ASES, Constant, and UCLA) consider many important aspects in a patient’s daily life and serve as the most useful way to evaluate patient outcome. Each individual study included in this meta-analysis found no significant differences in functional score improvements between single- and double-row techniques. The authors’ meta-analysis showed that the double-row technique yielded significantly more intact cuffs compared with the single-row technique in the short term; however, these structural advantages did not translate into superior clinical performance.

Some long-term studies of functional outcomes have reported better results in patients with intact rotator cuff repairs. Vastamaki et al\textsuperscript{9} reported that cuff integrity correlated well with functional results at a minimum of 16 years. Kluger et al\textsuperscript{8} found that patients with a healed tendon showed significantly higher Constant scores.

Figure 3: Forest plot of total retears showing magnetic resonance imaging (MRI) and magnetic resonance arthrography (MRA) subgroups. Individual studies are listed on the left and divided by subgroups. Pooled treatment effects of each subgroup are represented on the right with each black diamond. The overall pooled treatment effect, represented by the bottom-most black diamond on the right, demonstrates a significant difference favoring the double-row technique.

Figure 4: Forest plot of total retears showing partial-thickness and full-thickness retear subgroups. Individual studies are listed on the left and divided by subgroups. Pooled treatment effects of each subgroup are represented on the right with each black diamond. Only the top-most subgroup, representing the pooled effects of partial-thickness retear, shows a significant difference favoring the double-row technique (because it does not cross the midline). Another subgroup (full-thickness retear) shows pooled treatment effects that cross the midline and demonstrates no significant difference.
and ASES scores compared with patients with retears at 84 months. Kyrölä et al. showed that a normal appearance of the rotator cuff correlated with good clinical outcome, whereas retear and tendinosis were associated with pain during long-term follow-up. Thus, the lack of a significant difference in functional outcomes between the 2 techniques could have been because of the short follow-up periods.

The current meta-analysis has several potential limitations that should be taken into account. First, more anchors seemed to be used per case with double-row repair compared with single-row repair, and the difference was consistent for each study. This factor may have an effect on the results. Future studies should compare the same number of anchors. Second, most of the published literature has consisted of short-term studies. Burks et al. had a follow-up of only 1 year, whereas the other studies had follow-ups of approximately 2 years. Longer-term studies will be critical for determining the relationship between the structural and functional outcomes.

**Conclusion**

The current limited evidence suggests that use of the double-row technique for rotator cuff repair decreases the incidence of retears, especially partial-thickness retears, compared with the single-row technique. There was no significant difference in functional outcome between the 2 techniques. To improve the structural outcome of the repaired rotator cuff, surgeons should use the double-row technique. Nevertheless, future long-term RCTs on this topic are needed.

**References**


