Operative versus nonoperative treatment for the management of full-thickness rotator cuff tears: a systematic review and meta-analysis

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Background: Rotator cuff disease is the most common pathology of the shoulder, responsible for approximately 70% of clinic visits for shoulder pain. However, no consensus exists on the optimal treatment. The aim of this study was to analyze level I and II research comparing operative versus nonoperative management of full-thickness rotator cuff tears.

Methods: A literature search was performed, in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, to identify level I and II studies comparing operative versus nonoperative treatment of rotator cuff tears. Two independent researchers reviewed a total of 1013 articles. Three studies qualified for inclusion. These included 269 patients with 1-year follow-up. The mean age ranged from 59 to 65 years. Clinical outcome measures included the Constant score and visual analog scale (VAS) score for pain. Meta-analysis, using both fixed- and random-effects models, was performed on pooled results to determine overall significance.

Results: Statistically significant differences favoring surgery were found in both Constant and VAS scores after 1 year, with mean differences of 5.64 (95% confidence interval, 2.06 to 9.21; \( P = .002 \)) and -1.08 (95% confidence interval, -1.56 to -0.59; \( P < .0001 \)), respectively.

Conclusion: There was a statistically significant improvement in outcomes for patients managed operatively compared with those managed nonoperatively. The differences in both Constant and VAS scores were small and did not meet the minimal difference considered clinically significant. Larger studies with longer follow-up are required to determine whether clinical differences between these treatments become evident over time.

Level of evidence: Level II; Meta-Analysis

Keywords: Rotator cuff tear; atraumatic tears; rotator cuff disease; operative treatment; nonoperative treatment; conservative management; rotator cuff repair; arthroscopy
Despite this wide prevalence, controversy exists over the optimal treatment. Physical therapy is widely used for atraumatic tears, and several studies have demonstrated its reliable and durable success.\textsuperscript{6,11,25} Treatment with physical therapy does not result in healing of the torn rotator cuff, however, and natural history studies have raised concerns about tear progression and irreversible fatty infiltration worsening over time.\textsuperscript{7,22,24}

Operative treatment is also a successful treatment option. The widespread use of arthroscopy has corresponded to a significant increase in rotator cuff repair procedures in recent decades.\textsuperscript{7} Operatively treated patients return to work sooner and incur less cost burden when compared with patients treated nonoperatively.\textsuperscript{17} Successful outcomes following rotator cuff repair do not diminish with midterm and long-term follow-up.\textsuperscript{3}

Several randomized controlled trials have compared operative and nonoperative treatment of full-thickness rotator cuff tears; the results have been mixed. The aim of this study was to analyze level I and II comparisons of operative versus nonoperative management of atraumatic rotator cuff tears through meta-analysis.

Materials and methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.\textsuperscript{19} One independent reviewer systematically searched MEDLINE (via Ovid), PubMed (National Library of Medicine), Scopus (Elsevier, Amsterdam, Netherlands), and the Cochrane Controlled Trials Register (John Wiley & Sons, Hoboken, NJ, USA) from inception to October 2016. The database search was limited to level I and II studies, English-language studies, and human studies. The search strategy applied a combination of MeSH (Medical Subject Headings) and keyword searches using the following search terms: “rotator cuff injury”; “rotator cuff”; “rotator cuff tear”; “non traumatic tears”; “rotator cuff rupture”; “rotator cuff disease” and “surgical procedures, operative”; “general surgery”; “surgery”; “operative treatment”; “non operative treatment”; “conservative management”; “rotator cuff repair”; “orthopedic procedures”; “surgical procedures, operative”; “operative surgical procedures”; “impingement syndrome”; and “arthroscopy.” The references of selected articles were also reviewed, when applicable, to identify additional studies.

Two independent reviewers (C.C.P. and A.J.H.) screened all articles eligible for inclusion. The inclusion criteria were as follows: randomized controlled trial, full-thickness rotator cuff tear, and age 18 years or old. The exclusion criteria included any history of rotator cuff surgery and a follow-up period of less than 1 year.

Meta-analyses were performed comparing outcomes after operative versus nonoperative treatment of rotator cuff tears. Differences in Constant scores and pain scores (as rated by a visual analog scale [VAS]) before and after intervention (surgery or physical therapy) were selected outcomes measured because they were included in all studies. Pooled mean differences were calculated using fixed- and random-effects models.\textsuperscript{11} We tested the significance of heterogeneity between studies using the $Q$ test and $F$ statistic.\textsuperscript{11,32} Fixed-effects models were chosen if the $Q$ test was not significant and $F$ was low ($<20\%$). Otherwise, random-effects models were applied. Forest plots were used for presentation of the mean differences in outcomes and confidence intervals from individual studies along with the pooled mean difference and test for homogeneity.

Results

The initial database search yielded 1472 abstracts. After removal of duplicates, 1013 articles remained for review, of which 5 met the criteria for inclusion in the study. Of these 5 articles, 2 were excluded because they were follow-up studies on articles already chosen for review; these patient populations could not be considered separately from their original studies for statistical review purposes and were excluded (Fig. 1). Thus, 3 studies with a total of 269 patients with 1-year follow-up were included.\textsuperscript{12,15,20} Patient demographic data and study characteristics are displayed in Table I. All studies had similar follow-up intervals and a minimum of 12 months’ follow-up.

One study included 3 subgroups of patients for analysis, 1 of which underwent physical therapy and subacromial decompression without rotator cuff repair.\textsuperscript{15} This cohort of patients (57 patients) was excluded. This same study used a subscale of the Constant score (scale of 0-15) to measure pain instead of a VAS (scale of 0-10). These pain scores were plotted on a graph from which no numerical data could accurately be extracted. This study was not included in the analysis of VAS scores. The $Q$ test was not significant, and

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<thead>
<tr>
<th>Table I</th>
<th>Study characteristics</th>
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<tr>
<td></td>
<td>Kukkonen et al\textsuperscript{15}</td>
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<tr>
<td>Total patients</td>
<td>110*</td>
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<tr>
<td>Sex, n</td>
<td></td>
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<tr>
<td>Men</td>
<td>50</td>
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<td>Women</td>
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<td>Operative</td>
<td>55</td>
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<tr>
<td>Average age, yr</td>
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<tr>
<td>Follow-up, mo</td>
<td>3, 6, and 12</td>
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</table>

* One-third of patients (n = 57) received physical therapy and subacromial decompression without rotator cuff repair and were excluded from this study.
$I^2$ equaled 0 for both outcomes, implying low between-study heterogeneity. Therefore, our results were derived from mean differences calculated using fixed-effects models (Figs. 2 and 3).

A greater improvement in Constant score was found in operative patients relative to patients treated nonoperatively, and this was statistically significant. The mean difference between operatively treated patients and nonoperatively treated patients was 5.64 (95% confidence interval, 2.06-9.21; $P = .002$). Patients treated operatively had significantly decreased pain scores at 1-year follow-up as compared with the nonoperative cohort, with a mean difference in VAS score of $−1.08$ (95% confidence interval, $−1.56$ to $−0.59$; $P < .0001$).

**Discussion**

The combined analysis of the 3 randomized controlled trials showed a statistically significant benefit in both Constant and VAS scores for the operative cohort compared with the...
nonoperative cohort. However, both values were below the minimal clinically important differences of 10.4 and 1.4 for the Constant and VAS scores, respectively.\textsuperscript{16,23} The clinical significance of this statistical advantage is therefore limited. Many studies have evaluated the success of surgical and non-surgical management of small- and medium-sized rotator cuff tears, but high-level direct comparisons are few. In the short term, there is not a significant clinical advantage to operative treatment. Whether longer-term follow-up will demonstrate clinical superiority of either treatment cannot be determined from the current data. Two-year follow-up of the patients studied by Kukkonen et al\textsuperscript{15} showed clinical equivalence persisted between all treatment groups. Five-year follow-up reported by Moosmayer et al\textsuperscript{20} showed 37\% of patients treated without surgery had tear progression on ultrasound imaging, and this correlated with worsening clinical outcome scores. Of 52 patients, 12 opted to undergo later surgical repair, but clinically significant differences between the 2 treatment groups were not present at later time points.

Tear progression remains a concern with nonoperative treatment because spontaneous healing of a torn rotator cuff tendon is not thought to occur.\textsuperscript{14} Tear size may increase in most patients over a period of 2 or more years.\textsuperscript{20,24} Whether the progression of rotator cuff tearing is a sufficient risk to warrant prophylactic tendon repair remains unknown. Although rotator cuff repair may halt further tear progression, fatty infiltration, and muscle atrophy, even the most successful repair cannot reverse pre-existing degenerative changes within the rotator cuff.\textsuperscript{10} Dunn et al\textsuperscript{16} showed that patient expectations are the most significant factor influencing the success of nonoperative treatment, and patients who choose to undergo surgery after initial nonoperative treatment typically do so in the first 12 weeks. This would suggest that tear progression and its clinical sequela, which are unlikely to change during such a short time, do not affect a patient’s decision for surgery. Structural factors such as tear size and retraction were, in fact, not predictors for choosing surgery in this cohort.

The limitations of this meta-analysis are directly related to the inherent characteristics of the 3 studies included. Although these were well-designed trials, there were differences among them that made their grouping imperfect. There was variation in the types of rotator cuff tears included. Kukkonen et al\textsuperscript{15} limited their inclusion criteria to isolated supraspinatus tears, whereas Heerspink et al\textsuperscript{12} included both infraspinatus and subscapularis tears in addition to tears of the supraspinatus. Whereas both Moosmayer et al\textsuperscript{20} and Kukkonen et al\textsuperscript{15} were clear in their exclusion of massive cuff tears, maximum tear size was not explicitly limited by Heerspink et al. Tear size has consistently been shown to be inversely proportional to treatment success of tendon repair.\textsuperscript{10} Although appropriate randomization should ensure that this variable is equally distributed between treatment groups within a single trial, the effect on the intertrial comparison is unknown. A subset of traumatic rotator cuff tears was also included in the study by Moosmayer et al. These patients were not subdivided from the atraumatic cuff tear group in the analysis and may have influenced the findings that more strongly favored surgery than the other trials.

Lack of uniformity in treatment modalities among the 3 studies was another limitation. Heerspink et al\textsuperscript{12} used a standardized physical therapy protocol, but the other studies did not. Heerspink et al also offered a maximum of 3 corticosteroid injections to the control group in addition to formal physical therapy sessions. The duration of physical therapy was not controlled and was left to the patient’s discretion. Surgical technique also lacked uniformity between studies. Two of the three studies performed cuff repair via an open or mini-open approach, whereas the other study used arthroscopy. These techniques have been shown to be equivalent for most tear sizes and are unlikely to substantially alter outcomes.\textsuperscript{7} Supplemental procedures such as acromioplasty and biceps procedures were left to the discretion of the surgeon, and their effect on clinical outcomes remains a matter of controversy.\textsuperscript{9}

## Conclusion

On the basis of the results of this meta-analysis, there is a statistically significant advantage in both objective and subjective outcomes for patients treated with surgery for a full-thickness rotator cuff tear. However, this statistical advantage is not a clinically significant one. The most remarkable finding of this study is the paucity of high-level evidence available to guide treatment of full-thickness rotator cuff tears. Both operative management and nonoperative management reliably improve func-

<table>
<thead>
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<th>Study</th>
<th>Operation Total</th>
<th>Non-operation Total</th>
<th>Mean difference</th>
<th>MD</th>
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<td>Moosmayer 2010</td>
<td>52</td>
<td>51</td>
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<tr>
<td>Heerspink 2015</td>
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<td>31</td>
<td>-1.08 [-1.56; -0.59]</td>
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<td>Fixed effect model</td>
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<td>82</td>
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<td>Random effects model</td>
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Figure 3 Forest plot for visual analog scale (VAS) scores. SD, standard deviation; MD, mean difference; CI, confidence interval.
tional outcome and pain scores and are reasonable initial treatment choices. Longer-term follow-up and larger studies are needed to determine whether the risk of tear progression and irreversible degeneration of the rotator cuff are sufficiently high to warrant early tendon repair.

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Disclaimer

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References


