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Single-Row Versus Double-Row Rotator Cuff Repair: A Systematic Review and Meta-Analysis of Structural Integrity and Functional Outcomes

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Abstract: *Background:* Double-row rotator cuff repair is often used to improve tendon healing. However, its effect on clinical outcomes is still not clearly established. *Methods:* A systematic review and meta-analysis was performed following PRISMA guidelines. This study compared single-row and double-row repair. Structural integrity and functional outcomes were evaluated. Structural failure was defined as any non-intact repair, including both partial- and full-thickness defects. Odds ratios (ORs) and mean differences (MDs) with 95% confidence intervals (CIs) were calculated using a random-effects model. *Results:* Eight comparative studies were included. Six contributed to structural analysis, and six reported functional outcomes. Among these, four were included in the quantitative synthesis for functional results. Structural failure occurred in 42.7% of shoulders after single-row repair and 26.4% after double-row repair. This corresponds to an absolute reduction of about 16%, which is significant in practice. Double-row repair reduced the risk of structural failure (OR 0.47, 95% CI 0.29 to 0.75; $I^2 = 0\%$). In contrast, postoperative Constant scores were similar between groups (MD −0.08, 95% CI −3.98 to 3.82; $I^2 = 0\%$). *Conclusion:* Double-row repair improves structural integrity. But it does not seem to improve functional outcomes, at least within the current sample size. This indicates that structural healing and clinical recovery may not fully align.

Keywords: Rotator cuff tear; Single-row repair; Double-row repair; Structural integrity; Retear; Constant score; Arthroscopic repair; Meta-analysis

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1. Introduction

Rotator cuff tears are common. They often cause shoulder pain, weakness, and limited function, especially in older patients. When conservative treatment fails, surgery is usually needed. The goal is to repair the tendon and improve function. Even with better arthroscopic techniques, structural failure after surgery is still a concern.

The repair method is an important factor in rotator cuff surgery. Single-row repair is widely used because it is simple and reliable. Double-row repair was developed to better restore the natural tendon footprint. It increases the contact area and pressure between the tendon and bone [1]. Biomechanical studies show that double-row repair provides stronger fixation and better contact properties [2].

However, the clinical value of double-row repair is still unclear. Imaging studies often show better structural healing with double-row repair. But clinical studies do not always show better functional outcomes. This raises a question: Does better healing really lead to better function?

Structural integrity and functional outcome are related, but they are not the same. Imaging mainly reflects tendon healing. Functional recovery depends on many factors, such as pain, range of motion, muscle strength, and rehabilitation [3]. Because of this, better structural results do not always lead to better functional recovery, especially in the short to mid term.

Interpretation of the existing literature is further complicated by heterogeneity in study design, including variation in tear size, patient selection, imaging modality, and follow-up duration. In addition, structural and functional outcomes are often analyzed separately, and few studies have explicitly examined their relationship within a unified analytical framework [4]. Recent comparative studies have continued to report inconsistent findings, and an updated synthesis focusing on the relationship between structural and functional outcomes remains warranted.

This study compares single-row and double-row repair. It focuses on structural integrity and functional outcomes, and how they relate to each other. It is expected that double-row repair reduces structural failure. However, it may not lead to a clear improvement in functional outcomes.

2. Methods

2.1. Study design

This study was conducted as a systematic review and meta-analysis of comparative studies evaluating single-row and double-row rotator cuff repair, in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A study protocol was developed prior to data extraction.

A systematic literature search was conducted in PubMed, Embase, and the Cochrane Library from database inception to April 20, 2026. The search strategy included combinations of Medical Subject Headings (MeSH) and free-text terms related to “rotator cuff,” “single-row,” and “double-row” repair. Only studies published in English were included. Reference lists of included studies were also manually screened to identify additional relevant studies.

2.2. Study selection

Study selection was performed independently by two reviewers based on predefined eligibility criteria. Titles and abstracts were initially screened, followed by full-text review of potentially eligible studies. Discrepancies were resolved through discussion.

2.3. Eligibility criteria

Studies were eligible if they met the following criteria: (1) direct comparison of single-row and double-row rotator cuff repair; (2) reporting postoperative structural integrity assessed by imaging and/or postoperative functional outcomes; and (3) involving human subjects.

Studies without a direct comparison group were excluded to avoid indirect comparisons across heterogeneous populations. Postoperative imaging was required for inclusion in the structural analysis, as tendon integrity was defined as the primary structural endpoint [5]. Studies reporting only intraoperative findings were excluded, as these do not reflect healing status.

No restrictions were placed on tear size, repair configuration, or imaging modality in order to maximize study inclusion and reflect real-world clinical variability.

Review articles, case reports, biomechanical studies, cadaveric studies, and studies without sufficient extractable data were excluded. When multiple publications involved overlapping cohorts, the report with the most complete outcome data or longest follow-up was included to avoid duplication.

2.4. Data extraction

Data extraction was performed independently by two reviewers using a predefined collection form. Discrepancies were resolved through discussion and verification against the original reports.

The following information was recorded when available: first author, year of publication, study design, sample size, follow-up duration, tear size, repair technique, imaging modality, and reported outcomes.

For structural analysis, the number of postoperative failures and the number of shoulders assessed by imaging were extracted for each group. Structural failure was defined as any non-intact repair, including both partial-thickness defects and full-thickness retears, to ensure consistency across studies despite potential differences in clinical relevance. When tendon integrity was reported in multiple categories, these were collapsed into intact versus non-intact repair to allow consistent pooling across studies.

For functional analysis, postoperative Constant scores were extracted together with measures of variance. Postoperative values were prioritized over change scores to allow comparison of final functional status between techniques. Studies reporting normalized Constant scores relative to the contralateral shoulder were described separately and not pooled with raw scores in the primary meta-analysis due to differences in scale and interpretability.

For studies reporting different sample sizes for structural and functional outcomes, data were extracted separately for each endpoint based on the most appropriate reported population.

For structural outcomes, the denominator was defined as the number of shoulders that underwent postoperative imaging rather than the number initially treated to reduce bias associated with incomplete imaging follow-up.

Missing variance data were recorded during extraction. Studies without sufficient variance data were not included in the quantitative synthesis of continuous outcomes.

2.5. Risk of bias assessment

Risk of bias in randomized controlled trials was assessed using the Cochrane Risk of Bias tool. Nonrandomized comparative studies were evaluated using the Newcastle–Ottawa Scale.

Differences in imaging modality and reporting criteria were considered potential sources of measurement bias for structural outcomes. For functional outcomes, variability related to follow-up duration and evaluator-dependent scoring was considered.

Studies were categorized as having low, moderate, or high risk of bias based on their overall methodological profile. Studies were not excluded solely on the basis of risk of bias, but study quality was considered during interpretation. Sensitivity analysis was performed to evaluate the influence of nonrandomized studies.

2.6. Statistical analysis

Quantitative synthesis was performed using a random-effects model to account for expected clinical and methodological variability across studies. For structural outcomes, odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. For functional outcomes, mean differences (MDs) with 95% CIs were used for postoperative Constant scores. Statistical heterogeneity was assessed using the I^2 statistic.

For dichotomous outcomes, event counts were derived from reported healing categories when necessary. For continuous outcomes, means and standard deviations were extracted when available. Studies that reported mean postoperative Constant scores without corresponding variance data were described qualitatively but were not included in the pooled mean-difference analysis.

Sensitivity analysis was performed by excluding nonrandomized studies to assess the robustness of the pooled estimates. Statistical significance was defined as a two-sided *P*-value < 0.05.

Publication bias was not formally assessed due to the limited number of included studies (<10), as funnel plot-based methods are not considered reliable in small meta-analyses.

All statistical analyses were performed using Review Manager (RevMan, version 5.4; The Cochrane Collaboration).

3. Results

A total of 168 records were identified through database searching, with an additional four records identified through manual screening. After removal of duplicates, 140 records remained for title and abstract screening, of which 120 were excluded. Twenty full-text articles were assessed for eligibility, and 14 were excluded after full-text review, primarily due to lack of direct comparison, absence of postoperative imaging outcomes, or insufficient extractable data. In total, eight studies were included in the systematic review, with six contributing to the structural integrity analysis and six reporting functional outcomes, of which four were included in the quantitative synthesis.

The characteristics of the included studies are summarized in **Table 1**. Eight comparative studies were identified, including five randomized controlled trials and three nonrandomized comparative studies. Sample sizes varied across studies, and follow-up duration ranged from 12 to 24 months.

Structural integrity was assessed using magnetic resonance imaging (MRI), magnetic resonance arthrography (MRA), ultrasonography, and computed tomography (CT) arthrography. Functional outcomes were primarily reported using the Constant score.

Table 1. Characteristics of included studies

Study	Year	Design	Sample size(SR/DR)	Follow-up	Imaging modality	Outcomes
Franceschi	2007	RCT	30/30 (26/26 analyzed)	24 m	MRA	Structural
Burks	2009	RCT	20/20	12 m	MRI	Structural + Constant
Koh	2011	RCT	24/23	24 m	MRI	Structural + Constant
Lapner	2012	RCT	48/42 (39/37 analyzed)	24 m	US/MRI	Structural + Constant
Ma	2012	RCT	27/26	24 m	MRA	Structural
Charousset	2007	Comparative	35/31	24 m	CT arthrography	Structural + Constant
Grasso	2009	Comparative	37/35	24 m	MRI	Constant
Aydin	2010	Comparative	34/34	24 m	MRI	Constant

Risk of bias assessment is summarized in **Table 2**. Among randomized studies, most showed low risk of selection bias, although allocation concealment and blinding were not consistently reported. Nonrandomized studies demonstrated a higher risk of bias, particularly with respect to selection and comparability between groups.

Table 2. Risk of bias assessment

Study	Study design	Selection bias	Comparability	Outcome assessment	Follow-up completeness	Overall
Franceschi	RCT	Low	Low	Low	Low	Low
Burks	RCT	Low	Unclear	Unclear	Low	Moderate
Koh	RCT	Low	Unclear	Unclear	Low	Moderate
Lapner	RCT	Low	Low	Low	Low	Low
Ma	RCT	Unclear	Unclear	Unclear	Low	Moderate
Charousset	Comparative	High	Moderate	Low	Low	High
Grasso	Comparative	Moderate	Moderate	Low	Low	Moderate
Aydin	Comparative	Moderate	Moderate	Low	Low	Moderate

Structural failure was reported in all six studies included in the structural analysis. Across the pooled sample, failure occurred in 73 of 171 shoulders (42.7%) in the single-row group and 43 of 163 shoulders (26.4%) in the double-row group, corresponding to an absolute reduction of approximately 16%.

At the study level, failure rates in the single-row group ranged from 10% to 60%, whereas rates in the double-row group ranged from 10% to 39% (**Table 3**). Most studies reported lower failure rates in the double-row group, although the magnitude of difference varied across studies. Greater absolute differences were observed in studies with higher baseline failure rates, although this observation was not formally tested. Pooled analysis showed that double-row repair reduced structural failure (OR 0.47, 95% CI 0.29–0.75; I^2 = 0%), with no evidence of statistical heterogeneity (**Table 4**).

Table 3. Study-level data for structural failure

Study	DR events	DR total	SR events	SR total
Franceschi	8	26	12	26
Burks	2	20	2	20
Koh	7	23	15	24
Lapner	8	37	13	39
Ma	6	26	10	27
Charousset	12	31	21	35

Table 4. Pooled analysis of structural failure

Outcome	Studies	Patients (SR/DR)	Events (SR/DR)	OR	95% CI	I^2
Re-tear	6	171/163	73/43	0.47	0.29–0.75	0%

After exclusion of the nonrandomized study, the pooled estimate remained similar (OR 0.48, 95% CI 0.28–0.83; I^2 = 0%), indicating that the overall result was stable (**Table 5**).

Table 5. Sensitivity analysis

Outcome	Studies	OR	95% CI	I²	Interpretation
Re-tear (excluding Charousset)	5	0.48	0.28–0.83	0%	Stable

Functional outcomes were reported in six studies using the Constant score; however, only four provided sufficient variance data for inclusion in the pooled analysis. Two studies reported mean values without standard deviations and were therefore summarized qualitatively but not included in the quantitative synthesis (**Table 6**).

Pooled analysis excluding the study reporting normalized Constant scores (Grasso *et al.*, 2009) showed no difference between techniques (MD −0.08, 95% CI −3.98 to 3.82; $I^2 = 0\%$). The pooled estimate was centered near zero, indicating no detectable difference in functional outcome. One study (Grasso, 2009) reported normalized Constant scores rather than raw values, which may affect comparability with other studies.

Table 6. Study-level data for Constant score

Study	DR n	DR mean	DR SD	SR n	SR mean	SR SD
Grasso*	35	104.9	21.8	37	100.5	17.8
Burks	20	74.4	18.4	20	77.8	9.0
Koh	31	82.5	21.9	31	85.4	13.8
Lapner	42	86.3	14.2	48	85.6	14.0
Aydin	34	78.8	NA	34	82.2	NA
Charousset	31	82.7	NA	35	80.7	NA

Normalized Constant score; not included in pooled analysis.

NA indicates that standard deviation was not reported in the original study. Studies without variance data were not included in the pooled mean-difference analysis.

Values for Grasso (2009) were reported as normalized Constant scores relative to the contralateral shoulder and may exceed 100. These data were not included in the pooled meta-analysis due to a lack of comparability with raw Constant scores (**Table 7**).

Table 7. Pooled analysis of Constant score

Outcome	Studies	MD	95% CI	I^2
Constant score	4	-0.08	−3.98 to 3.82	0%

Double-row repair was associated with a reduction in structural failure compared with single-row repair. No statistically significant difference was observed in functional outcome as measured by the Constant score, although this finding should be interpreted in the context of limited sample size in the functional analysis.

4. Discussion

4.1. Principal findings

The principal finding of this meta-analysis is that double-row rotator cuff repair was associated with a lower rate of postoperative structural failure compared with single-row repair, whereas no statistically significant difference was observed in functional outcome, which may reflect limited statistical power rather than true equivalence as measured by the Constant score, although this finding should be interpreted in the context of limited sample size in the functional analysis. The structural advantage was consistent in magnitude and direction across studies, and the pooled estimate remained stable after sensitivity analysis.

The observed reduction in structural failure corresponds to an absolute difference of approximately 16%, indicating a clinically meaningful effect. However, this structural advantage was not accompanied by a detectable improvement in functional outcome, which may reflect limited statistical power rather than true equivalence [6]. These findings suggest that structural integrity and clinical recovery represent related but distinct endpoints after rotator cuff repair and should be interpreted separately.

4.2. Structural success versus clinical success

Clinical scores reflect overall shoulder function rather than tendon healing alone. As a composite outcome, the Constant score integrates pain, motion, and strength, and may improve despite the presence of structural defects. Conversely, an anatomically intact repair does not uniformly translate into superior clinical performance, particularly within short- to mid-term follow-up.

The present analysis demonstrates a consistent reduction in structural failure with double-row repair, yet without a corresponding improvement in postoperative Constant score. Rather than representing a contradiction, this finding may reflect a fundamental dissociation between anatomical healing and early functional recovery.

Functional outcomes after rotator cuff repair are determined by a composite of factors including pain relief, restoration of range of motion, neuromuscular compensation, and strength recovery. Among these, early improvements in pain and mobility may dominate patient-reported outcomes, potentially masking the contribution of tendon integrity within short- to mid-term follow-up. Consequently, structural failure—particularly when partial—may not translate into measurable deficits in composite functional scores.

This interpretation is further supported by the observation that structural failure was defined as a binary composite endpoint encompassing both partial defects and full-thickness retears [7]. These entities likely differ in biomechanical consequence and clinical relevance. Pooling them into a single category may attenuate the observable association between tendon integrity and functional outcome, thereby biasing results toward functional equivalence.

In addition, the relationship between structural integrity and function is likely time-dependent. While early functional recovery is driven primarily by pain resolution and mobility, the long-term trajectory may be more strongly influenced by tendon durability, muscle strength preservation, and prevention of tear progression [8]. The follow-up duration of the included studies (12–24 months) may therefore be insufficient to capture delayed functional divergence between repair constructs.

Taken together, these findings suggest that structural integrity and clinical outcome should not be interpreted as interchangeable endpoints, but rather as related yet temporally and mechanistically distinct dimensions of treatment effect.

4.3. Interpretation of functional equivalence: Absence of evidence versus evidence of absence

The lack of a statistically significant difference in Constant score should be interpreted with caution. The pooled analysis included a limited number of studies with available variance data, resulting in relatively wide confidence intervals. As such, the present findings should be considered as an absence of evidence for a functional difference rather than definitive evidence of equivalence. Future studies with larger sample sizes and longer follow-up are required to determine whether subtle but clinically meaningful differences exist.

Implications for surgical decision-making: toward a goal-oriented framework

The dissociation between structural and functional outcomes has direct implications for surgical decision-making. Rather than favoring a uniform repair strategy, the choice between single-row and double-row fixation may be better conceptualized as goal-dependent.

When the primary objective is to maximize structural durability—such as in larger tears, compromised tissue quality, or patients with higher functional demands—double-row repair may be preferred due to its lower risk of structural failure [9]. Conversely, when the clinical priority is short-term functional recovery, the current evidence does not demonstrate a measurable advantage of double-row repair, suggesting that single-row fixation remains a reasonable and potentially more efficient option.

This goal-oriented framework highlights the importance of aligning surgical technique with the intended outcome domain, and underscores the need for future studies to stratify patients according to factors such as tear size, tissue quality, and functional demand [10].

4.4. Strengths of the present study

This study has several strengths. Structural and functional outcomes were analyzed separately, preserving conceptual clarity in a field where these endpoints are often combined. The structural findings were consistent across studies, with low statistical heterogeneity and stable sensitivity analysis, strengthening confidence in the robustness of the observed effect. In addition, the analysis was restricted to comparative studies, improving interpretability relative to indirect comparisons across heterogeneous populations.

4.5. Limitations

Several limitations should be considered. First, structural failure was defined as a binary outcome by grouping partial-thickness defects and full-thickness retears as non-intact repairs. These conditions differ in biological and clinical significance, and this classification may have attenuated the relationship between structural integrity and functional outcome.

Second, important effect modifiers such as tear size, tissue quality, and chronicity were not consistently reported across studies and could not be accounted for in the analysis. As a result, the pooled estimates likely represent an average treatment effect across heterogeneous patient populations.

Third, structural integrity was assessed using different imaging modalities (MRI, MRA, ultrasonography, and CT arthrography), which have variable sensitivity for detecting partial defects and may have introduced measurement heterogeneity.

Fourth, the functional analysis was based on a limited number of studies with incomplete variance reporting, resulting in reduced statistical power and relatively wide confidence intervals. Therefore, the absence of a statistically significant difference should be interpreted with caution.

Finally, most included studies reported short- to mid-term follow-up (12–24 months). Any potential long-term functional benefits associated with improved structural integrity, particularly in terms of strength preservation or prevention of tear progression, may not have been captured.

Future studies should focus on stratifying patients according to key clinical variables and incorporating longer-term follow-up to better define the relationship between structural integrity and functional outcome.

5. Conclusion

Double-row rotator cuff repair is associated with a lower rate of structural failure compared with single-row repair; however, this structural advantage does not translate into a measurable improvement in short- to mid-term functional outcome based on the available evidence.

These findings highlight that structural integrity and clinical recovery represent complementary but non-equivalent dimensions of outcome after rotator cuff repair. While anatomical healing reflects the durability of the repair construct, functional recovery is influenced by a broader set of factors, including pain, mobility, and neuromuscular adaptation.

From a clinical perspective, the choice of repair technique should therefore be aligned with the primary treatment objective. Double-row repair may be preferred when structural durability is a priority, whereas single-row repair remains a reasonable option when the focus is on short-term functional recovery and procedural efficiency.

Future research should aim to clarify the long-term functional implications of improved structural integrity and to identify patient subgroups most likely to benefit from more complex repair strategies.

Disclosure statement

The authors declare no conflict of interest.

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