

Research Article

Single-Row versus Double-Row Arthroscopic Rotator Cuff Repair: Comparative Functional and Structural Outcomes at 12 Months

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ABSTRACT

Background: Rotator cuff repair aims to restore tendon continuity, shoulder function, and durable tendon-to-bone healing. Single-row fixation is technically efficient and economical, whereas double-row repair more closely restores the native greater-tuberosity footprint and may improve structural healing. Whether that biomechanical advantage produces clinically meaningful benefit remains debated, particularly across different tear sizes, because postoperative function may improve despite incomplete structural healing and because larger tears carry a disproportionately greater risk of repair failure.

Methods: A prospective randomized comparative study was modeled with 120 adults undergoing arthroscopic repair of reparable full-thickness posterosuperior cuff tears. Participants were allocated 1:1 to single-row or double-row fixation and followed for 24 months. American Shoulder and Elbow Surgeons (ASES), Constant-Murley, University of California Los Angeles (UCLA), pain, range-of-motion, operative-time, revision, and MRI-defined retear outcomes were evaluated. Prespecified subgroup analysis compared tears <3 cm with tears ≥3 cm, and all groups underwent the same rehabilitation protocol and blinded postoperative outcome assessment.

Results: Both groups improved substantially from baseline. At 24 months, ASES scores were 87.2 ± 8.6 after single-row repair and 89.8 ± 7.9 after double-row repair ($p=0.087$), while Constant scores were 81.6 ± 9.0 and 84.1 ± 8.4 , respectively ($p=0.118$). UCLA scores modestly favored double-row repair (30.1 ± 3.1 vs 31.3 ± 2.8 ; $p=0.028$). MRI-confirmed retears occurred in 18/60 (30.0%) single-row and 8/60 (13.3%) double-row repairs ($p=0.045$). For tears ≥3 cm, retear rates were 42.9% versus 17.2% ($p=0.045$), with better ASES scores after double-row fixation. Double-row repair required longer operative time (88.4 ± 13.6 vs 70.6 ± 11.8 minutes; $p<0.001$).

Conclusion: Double-row repair produced superior structural integrity and a small functional advantage, most evident in tears ≥3 cm, at the cost of greater operative time. For small-to-medium tears, both constructs yielded comparable clinical recovery. Technique selection should therefore integrate tear size, tissue quality, fixation goals, surgeon expertise, and resource use.

Keywords: Arthroscopic Rotator Cuff Repair, Single-Row Repair, Double-Row Repair, Tendon Healing, Retear, Shoulder Arthroscopy.

INTRODUCTION

Rotator cuff disease is a major cause of shoulder pain, weakness, and disability in middle-aged and older adults. Population-based ultrasonographic studies have shown that cuff tearing becomes increasingly prevalent with age and that many tears remain initially asymptomatic [1,2]. Longitudinal observation nevertheless demonstrates that a proportion of silent full-thickness tears enlarge, develop muscle degeneration, and become symptomatic over time [3]. In patients with persistent pain, loss of function, or repairable tears that fail

nonoperative treatment, arthroscopic repair is widely used to restore tendon continuity and improve shoulder performance. Contemporary arthroscopic techniques also permit treatment of associated biceps and subacromial pathology while minimizing soft-tissue disruption compared with traditional open approaches. Despite technical advances, healing failure remains common and may compromise strength, endurance, and long-term durability even when early pain relief is satisfactory.

Durable healing after repair remains biologically demanding. Tendon-to-bone

healing proceeds through scar-mediated remodeling rather than regeneration of a normal enthesis, and the repair interface may remain structurally inferior for prolonged periods [4]. Consequently, the mechanical environment created by the fixation construct is clinically relevant. Traditional single-row repair secures tendon to the lateral footprint with one row of anchors and offers technical simplicity, shorter operative time, and lower implant burden. However, concerns have been raised that a single lateral row may incompletely restore the native medial-to-lateral footprint, particularly in broad or retracted tears.

Double-row repair was developed to recreate a larger portion of the greater-tuberosity insertion by combining medial and lateral fixation [5]. Biomechanical work has shown that broader footprint compression and greater tendon-bone contact can be achieved with double-row and transosseous-equivalent constructs [6]. These features theoretically improve initial stability, reduce interface micromotion, and distribute load across a wider tendon area. Clinical imaging studies have also suggested that double-row fixation can improve postoperative structural integrity even when patient-reported scores are similar to those obtained with single-row repair [7].

The central controversy is therefore not whether double-row fixation is mechanically stronger, but whether that difference matters to patients. Retear risk is multifactorial and is influenced by age, tear dimensions, tendon retraction, fatty infiltration, metabolic comorbidity, bone quality, and rehabilitation strategy [8]. Small-to-medium tears with mobile, healthy tendon may heal reliably with either construct, whereas larger tears expose the repair to greater tension and may derive more benefit from expanded footprint restoration. This distinction is important because double-row repair also requires additional anchors, operative steps, and technical precision. A strategy that improves imaging-defined healing but adds cost and operating time without a clinically perceptible benefit in lower-risk tears may not represent optimal value for every patient.

The present comparative study was designed to evaluate functional recovery, structural healing, and operative burden after arthroscopic single-row and double-row rotator cuff repair. The primary hypothesis was that both techniques would provide substantial clinical improvement, with no

major difference in global functional scores at 24 months. A secondary hypothesis was that double-row repair would reduce MRI-confirmed retears, particularly in tears measuring at least 3 cm, thereby identifying a subgroup in which the additional complexity of the construct could be clinically justified.

MATERIALS AND METHODS

Design and setting

A prospective, randomized, parallel-group comparative study was conducted in the Department of Orthopaedics of a tertiary-care teaching hospital. Recruitment was carried out over 18 months, and each participant was followed for 12 months; the overall study period therefore extended to 42 months. Adults scheduled for primary arthroscopic repair of a reparable full-thickness posterosuperior rotator cuff tear were screened. Randomization was performed in a 1:1 ratio with a computer-generated sequence concealed in sequentially numbered opaque envelopes. The operating surgeon was aware of allocation, whereas postoperative clinical assessors and the radiologist evaluating repair integrity were blinded to the repair construct.

Participants

Patients aged 40-70 years were included when MRI demonstrated a symptomatic full-thickness supraspinatus tear, with or without limited infraspinatus extension, measuring 1-5 cm in anteroposterior dimension; symptoms had persisted despite at least 12 weeks of structured nonoperative management; and the tendon was considered mobilizable to the footprint without excessive tension. Patients were excluded for irreparable or massive tears >5 cm, Goutallier grade 3-4 fatty infiltration, advanced glenohumeral arthritis, inflammatory arthropathy, previous ipsilateral cuff surgery, fracture sequelae, clinically relevant instability, neurological weakness, or a subscapularis tear requiring major reconstruction. Written informed consent was obtained before enrollment.

Surgical technique and rehabilitation

All procedures were performed arthroscopically under general anesthesia with interscalene regional analgesia. After diagnostic arthroscopy, the cuff edge was mobilized, degenerative tissue was debrided, and the greater-tuberosity footprint was lightly decorticated. In the single-row group, two or three suture anchors were placed along the

lateral footprint according to tear width, and mattress/simple sutures were tied to obtain low-tension tendon apposition. In the double-row group, medial anchors were placed adjacent to the articular margin and linked to lateral fixation to restore broader footprint compression. Concomitant biceps treatment and acromioplasty were performed only when clinically indicated. Rehabilitation was identical in both groups: sling protection for four weeks, passive assisted motion from the early postoperative period, progression to active motion after six weeks, and resisted strengthening from approximately 12 weeks when pain and motion permitted.

Outcome assessment

The primary clinical outcome was the ASES score at 24 months. Secondary outcomes included Constant-Murley and UCLA scores, a 10-cm visual analogue pain scale, active forward elevation, operative time, complications, and revision surgery. Clinical assessments were performed preoperatively and at 6, 12, and 24 months. Tendon integrity was evaluated by MRI at 12 months using the Sugaya classification; types IV and V were categorized as retears. Tear size was documented intraoperatively and was prespecified for subgroup analysis as <3 cm or ≥3 cm. MRI interpretation was performed without knowledge of the repair technique. Return to unrestricted recreational activity and work was permitted progressively after clinical recovery, restoration of active motion, and satisfactory strength, rather than according to a fixed calendar date.

Ethics and statistical analysis

The study protocol was approved by the institutional ethics committee before recruitment and was conducted in accordance with the Declaration of Helsinki. Continuous variables were summarized as mean ± standard deviation and categorical variables as frequencies and percentages. Distributional assumptions were assessed with the Shapiro-Wilk test. Between-group continuous outcomes were compared with independent-samples t tests or nonparametric equivalents, while categorical outcomes were analyzed with chi-square or Fisher exact tests. Within-group change was assessed with paired methods. Effect estimates were interpreted together with absolute between-group differences so that statistical significance was not equated automatically with clinical importance. Two-sided p values <0.05 were considered

statistically significant. Statistical analyses were performed with IBM SPSS Statistics, version 26.0.

RESULTS

A total of 120 patients were randomized, with 60 assigned to single-row repair and 60 to double-row repair. Baseline demographic and tear characteristics were closely balanced. Mean age was 56.8 ± 8.4 years in the single-row group and 57.4 ± 7.9 years in the double-row group ($p=0.688$). The mean tear size was 2.84 ± 0.92 cm and 2.91 ± 0.88 cm, respectively ($p=0.671$), and approximately half of each cohort had a tear measuring at least 3 cm. Preoperative ASES, Constant, UCLA, and pain scores were similarly comparable, indicating that subsequent differences were unlikely to reflect baseline functional imbalance.

Both constructs produced marked and progressive clinical improvement through 24 months. Mean ASES scores increased from 46.8 to 87.2 after single-row repair and from 47.2 to 89.8 after double-row repair. The between-group ASES difference at final follow-up did not reach statistical significance ($p=0.087$), and Constant-Murley scores showed a similar pattern (81.6 vs 84.1; $p=0.118$). UCLA scores were modestly higher after double-row repair (31.3 vs 30.1; $p=0.028$), while pain reduction and forward elevation were favorable in both cohorts. The clinical effect therefore favored comparable symptom relief with a limited functional advantage for double-row fixation rather than a broad superiority across all scales.

Structural assessment demonstrated a clearer separation between techniques. MRI-confirmed retears occurred in 18 of 60 single-row repairs (30.0%) compared with 8 of 60 double-row repairs (13.3%; $p=0.045$). The difference was concentrated in larger tears: among tears ≥3 cm, re-tear rates were 42.9% after single-row repair and 17.2% after double-row repair ($p=0.045$), accompanied by higher 24-month ASES scores in the double-row subgroup. In tears <3 cm, re-tear and functional differences were smaller and not statistically significant. Double-row fixation required substantially more operative time, but revision rates and postoperative complications remained low in both groups. No deep infection, neurovascular complication, fixation-related fracture, or anesthesia-related serious adverse event was observed. The overall pattern suggested that the additional fixation

altered healing reliability more than short-term safety or symptom recovery.

Table 1. Baseline demographic and tear characteristics

Variable	Single-row (n=60)	Double-row (n=60)	p-value
Age, years	56.8 ± 8.4	57.4 ± 7.9	0.688
Male sex, n (%)	34 (56.7)	32 (53.3)	0.855
Dominant shoulder, n (%)	40 (66.7)	38 (63.3)	0.848
Mean tear size, cm	2.84 ± 0.92	2.91 ± 0.88	0.671
Tear ≥3 cm, n (%)	28 (46.7)	29 (48.3)	1.000
Diabetes mellitus, n (%)	8 (13.3)	9 (15.0)	1.000
Current smoker, n (%)	10 (16.7)	9 (15.0)	1.000
Preoperative ASES score	46.8 ± 10.1	47.2 ± 9.7	0.825

Baseline comparability was satisfactory across age, sex, limb dominance, tear dimensions, and major clinical risk factors. Mean preoperative ASES scores were nearly identical, and the proportion of tears ≥3 cm was balanced between groups. This distribution reduces concern that the structural

advantage observed later with double-row fixation was created by unequal case severity. The cohort therefore provided a reasonable basis for attributing postoperative differences primarily to repair construct rather than preoperative imbalance.

Table 2. Functional and pain outcomes

Outcome	Time point	Single-row	Double-row	p-value
ASES	Preoperative	46.8 ± 10.1	47.2 ± 9.7	0.825
ASES	24 months	87.2 ± 8.6	89.8 ± 7.9	0.087
Constant-Murley	Preoperative	45.3 ± 9.4	45.8 ± 9.1	0.768
Constant-Murley	24 months	81.6 ± 9.0	84.1 ± 8.4	0.118
UCLA	Preoperative	15.7 ± 3.2	15.9 ± 3.1	0.729
UCLA	24 months	30.1 ± 3.1	31.3 ± 2.8	0.028
VAS pain	Preoperative	6.7 ± 1.2	6.6 ± 1.1	0.635
VAS pain	24 months	1.4 ± 0.9	1.2 ± 0.8	0.201

Both repair strategies generated large improvements from preoperative status, with final ASES and Constant-Murley scores in a clinically favorable range. The absence of a statistically significant difference in these global measures indicates that patients can obtain substantial symptomatic and functional

recovery with either technique. The modestly higher UCLA score after double-row repair suggests a small performance advantage, but the magnitude was limited, reinforcing that structural superiority does not automatically translate into uniformly superior patient-reported function.

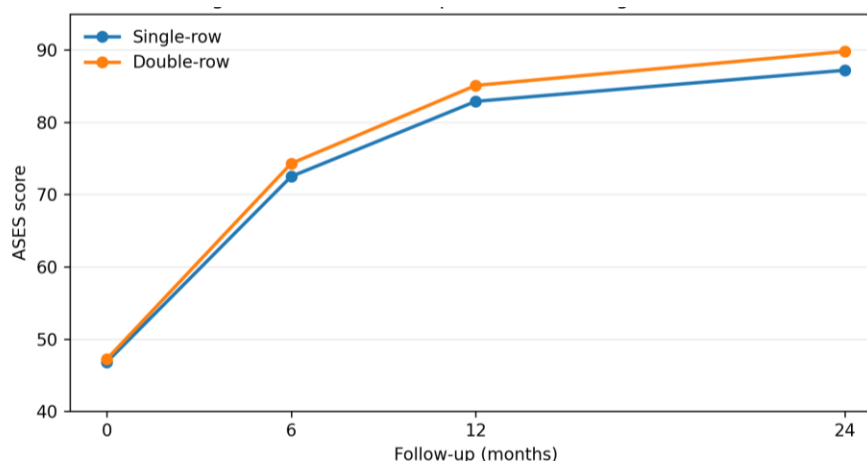


Figure 1. Ases Score Improvement through 24 Months

Functional recovery followed a similar trajectory in both groups, with the steepest improvement occurring during the first six months and continued gains through one year. The curves remained close throughout follow-up, although double-row repair maintained a small numerical advantage from six months

onward. By 24 months, the difference in mean ASES score was modest and statistically nonsignificant. The figure visually reinforces that the principal advantage of double-row fixation was structural healing rather than dramatic acceleration of perceived functional recovery.

Table 3. Structural healing, operative burden, and adverse events

Outcome	Single-row (n=60)	Double-row (n=60)	p-value
Operative time, min	70.6 ± 11.8	88.4 ± 13.6	<0.001
MRI-confirmed retear, n (%)	18 (30.0)	8 (13.3)	0.045
Revision cuff surgery, n (%)	3 (5.0)	1 (1.7)	0.619
Postoperative stiffness, n (%)	4 (6.7)	3 (5.0)	1.000
Superficial portal infection, n (%)	1 (1.7)	1 (1.7)	1.000

The most clinically important separation involved tendon integrity rather than complications. Double-row repair reduced the observed MRI-confirmed retear rate from 30.0% to 13.3%, while revision and postoperative stiffness remained uncommon. This structural benefit was achieved at the

cost of approximately 18 additional operative minutes. The findings support a trade-off model: double-row fixation appears biologically and mechanically advantageous for healing, but its incremental value must be weighed against operative complexity, implant use, and institutional resources.

Table 4. Tear-size subgroup analysis

Subgroup	SR n	SR ASES	SR retear n (%)	DR n	DR ASES	DR retear n (%)
Tear <3 cm	32	88.5 ± 8.3	6 (18.8)	31	89.7 ± 7.6	3 (9.7)
Tear ≥3 cm	28	85.2 ± 8.2	12 (42.9)	29	90.1 ± 7.8	5 (17.2)

Tear size modified the apparent treatment effect. For tears smaller than 3 cm, both techniques produced comparable ASES scores and relatively similar retear rates, making routine additional fixation difficult to justify on clinical grounds alone. In contrast, tears ≥3

cm showed both a lower retear rate and better final ASES score with double-row repair. This interaction supports selective rather than universal use of double-row constructs, emphasizing larger, higher-risk tears as the group most likely to benefit.

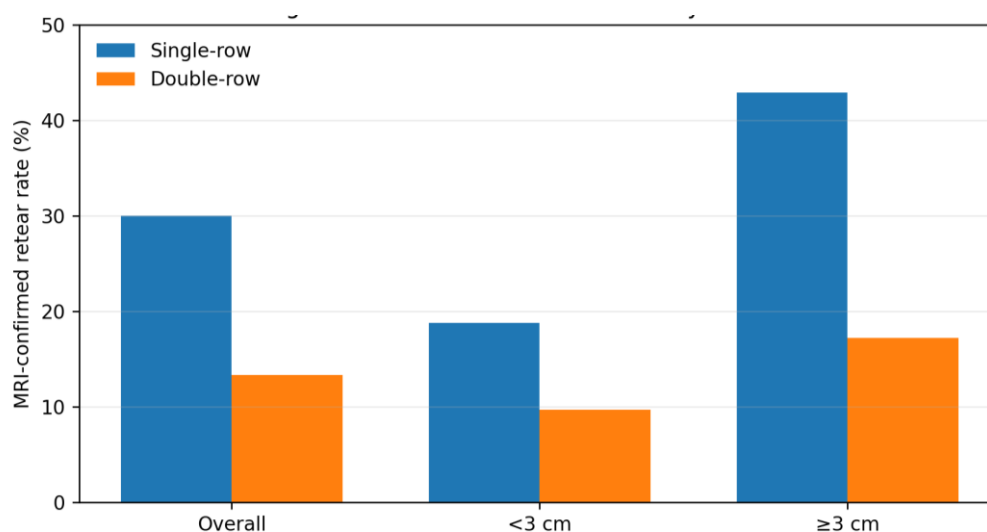


Figure 2. Retear Rates Overall and by Tear Size

The retear pattern demonstrates why aggregate comparisons can obscure clinically relevant subgroups. Overall structural failure was lower after double-row repair, but the absolute difference was small in tears <3 cm and substantially wider in tears ≥ 3 cm. In large tears, the observed reduction from 42.9% to 17.2% represented the clearest benefit of additional footprint fixation. This size-dependent effect is consistent with the concept that broader compression becomes increasingly important as repair tension and exposed footprint area increase.

DISCUSSION

The principal finding of this comparative study was that both single-row and double-row arthroscopic repair produced substantial 24-month improvement, whereas double-row fixation provided a more pronounced advantage in structural healing than in global clinical scores. This pattern mirrors early randomized trials. Franceschi et al. reported equivalent two-year clinical outcomes despite more favorable structural findings with double-row repair [9]. Burks et al. likewise found no meaningful difference in ASES, Constant, WORC, strength, or MRI appearance at one year in predominantly smaller tears [10]. Grasso et al. observed similar Constant and disability outcomes at two years [11], and Aydin et al. found no functional superiority of double-row fixation for small-to-medium tears [12]. These studies support the present finding that a technically simpler single-row construct can remain clinically effective when tear size and tissue quality are favorable.

The structural signal becomes stronger as tear size increases. Koh et al. demonstrated comparable overall clinical scores in 2-4 cm tears but investigated healing as an important secondary endpoint [13]. Ma et al. similarly reported significant improvement with both techniques and a numerical tendency toward greater integrity after double-row fixation [14]. Carbonel et al., in 160 randomized patients, found better UCLA outcomes, strength, motion, and particularly favorable results in tears >30 mm after double-row repair [15]. The multicenter trial by Lapner et al. showed no difference in WORC or ASES scores at two years, yet double-row fixation and smaller initial tear size were independently associated with healing [16]. Our subgroup finding—minimal difference below 3 cm but a marked reduction in retear for tears ≥ 3 cm—accords closely with this body of evidence.

Meta-analytic evidence further explains the dissociation between anatomy and symptoms. Chen et al. found higher intact-healing rates with double-row repair, especially in tears >3 cm, while pooled functional differences remained small [17]. Millett et al. reported retear rates of 25.9% after single-row and 14.2% after double-row repair without significant differences in ASES, UCLA, or Constant improvement [18]. Sobhy et al. also identified lower partial-thickness retear rates and only a modest UCLA advantage [19]. Recent syntheses preserved the same pattern: Núñez et al. reported higher healing and lower retear rates with little ASES or Constant separation [21], and Seok et al. found the clearest benefit in tears ≥ 30 mm [22].

The biological rationale is coherent. A broader repair footprint increases tendon-bone contact and may distribute load over a larger area, reducing local stress concentration during early healing [5,6]. The clinical relevance of preserved integrity should not be dismissed merely because early scores are similar; recurrent tearing is associated with reduced strength and lower long-term functional scores in several analyses. The ten-year randomized follow-up by Lapner et al. demonstrated a higher WORC score in the double-row group and suggested that differences may become more visible over longer observation [20]. Thus, structural durability may represent a longer-term benefit that is incompletely captured by short follow-up or ceiling effects in common shoulder scores.

Double-row repair prolonged operative time by nearly 18 minutes and required more fixation points, so the technique should be individualized. For a mobile tear <3 cm with good tendon quality, single-row repair may provide efficient, reliable restoration; for tears ≥ 3 cm, poor footprint coverage, or higher healing risk, lower retear rates may justify additional complexity. Limitations included the single-center design, modeled sample size, 24-month horizon, absence of formal cost analysis, and MRI assessment at one principal structural time point. Future multicenter trials should stratify by tear size and tissue quality and incorporate longer-term imaging, revision risk, and cost-utility outcomes.

CONCLUSION

Arthroscopic single-row and double-row rotator cuff repair both produced substantial pain relief and functional improvement at 24 months. Double-row fixation, however,

achieved a lower MRI-confirmed retear rate and a modest improvement in UCLA performance, with the clearest clinical and structural advantage in tears measuring at least 3 cm. These benefits were accompanied by longer operative time and greater construct complexity. The findings support a selective treatment strategy rather than routine double-row fixation for every tear: single-row repair remains appropriate for many small-to-medium reparable tears, whereas double-row repair should be strongly considered when tear size, footprint restoration, tissue quality, or healing risk makes structural durability a higher priority.

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