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Research Article

Arthroscopic Single-Row Repair in Full-Thickness Rotator Cuff Tear: A 60-Case Study of Functional Outcomes and Structural Integration at 2-Year Follow-Up

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Abstract

Background: The aim of this study was to assess practical results and tendon healing in individuals experiencing full-thickness rotator cuff tears handled using single-row arthroscopic rotator cuff repair (SR-ARCR), emphasizing its cost-effectiveness in resource-limited settings. Furthermore, the analysis includes evaluation of fatty muscle degeneration, glenohumeral joint arthritis, the significance of subscapularis tendon repair, and the impact of biceps tenotomy.
Methods: 60 rotator cuff reconstructions with a minimum of 24-month follow-up and all treated by SR-ARCR were evaluated. Functional assessment was done by Constant-Murley Score (CMS) and University of California and Los Angeles (UCLA) Score for shoulder, and structural assessment was performed by Sugaya grading. While CMS and UCLA scores are expressed as unitless numerical scales derived from components involving pain, function, range of motion (ROM) (in degrees), and strength (in kilograms), the Sugaya grading system is a qualitative magnetic resonance imaging (MRI)-based classification without numerical units.
Results: Mean follow-up was 35.93 ± 26.24 months with a minimum of 24 months. We noted a significant increase in post-operative mean CMS (range: 0-100) to 94.83 ± 7.78 ($P < 0.001$) and mean UCLA Score (range: 0-35) to 33.82 ± 6.70 ($P < 0.001$). Active forward flexion increased to 166.50 ± 11.62° ($P < 0.001$), external rotation (in degrees) increased to 79.17 ± 10.13° ($P < 0.001$), muscle strength (in kilograms) (0-25 kg) increased to 22.78 ± 3.32 ($P < 0.001$), and visual analogue scale (VAS) (0-10) decreased to 1.20 ± 0.75 ($P < 0.001$) post-operatively. Patients with Sugaya 1 grading (85% of patients) had CMS of 97.06 ± 5.21 ($P < 0.001$), Sugaya 2 (10%) had score of 82.67 ± 9.42 ($P < 0.001$), and Sugaya 3 or higher (5%) had score of 81.33 ± 6.35 ($P < 0.001$).
Conclusion: SR-ARCR offered excellent outcomes cost-effectively with structural integration of rotator cuff at 24 months when tension-free repair of cuff was done.

Keywords: Rotator Cuff; Cost; Tendons

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Background

The incidence of rotator cuff tear is 4% to 32% and it increases with age, causing shoulder pain, impaired muscle function, and disrupted glenohumeral mechanics. In a developing country like India, management of such tears has its financial issues. While non-surgical approaches are often explored first, patients with an intact rotator cuff generally achieve superior functional results compared to those experiencing re-tears (1). In comparison to open rotator cuff repair, arthroscopic repair has become the first choice for treating the cuff due to its shorter hospitalization, reduced postoperative pain, quicker recovery, and improved cosmetic results (2). Over the last few years, a progression from single-row (SR) to double-row (DR) and "transosseous equivalent" (TOE) techniques has been promoted by some surgeons to restore the anatomic rotator cuff footprint and maximise tendon-bone contact area which increases the implant cost but lacks any significant clinical and functional benefits over SR repair. The purpose of this study was to assess clinical, functional, and structural results in patients who experienced SR-arthroscopic rotator cuff repair (SR-ARCR), which can be executed consistently and effectively at a lower cost. It is hypothesized that SR-ARCR offers good clinical, functional, and structural integrity results in a cost-effective manner.

Methods

This was a retrospective, single-center study (level 4 evidence) based on prospectively collected data from 60 patients who underwent SR-ARCR between July 2017 and January 2023, with a minimum of 2-year follow-up. The mean duration of follow-up was 39 months, and the mean age was 65 years. Mean follow-up was 39 months, as some patients had surgery many years ago, which has increased the mean follow-up duration and has not affected the functional or structural outcome. All participants provided informed consent prior to their inclusion in the study. Complete clinical examination and radiological investigations, including X-rays and magnetic resonance imaging (MRI), were done for all the patients. The acromio-humeral distance (AHD) was measured using the true anteroposterior (AP) view. Tear size, fatty infiltration, and arthritis were recorded and graded accordingly. 7 patients were misplaced to trial and did not come to the hospital for follow-up, as they were from a remote location and showed another orthopedician in their locality, and thus all details were not obtained and were not included in the study. The collected data comprised the patient's age, gender, months of follow-up, related procedures, Constant-Murley Score (CMS), University of California and Los Angeles (UCLA) Score for shoulder, Simple Shoulder

Test (SST) score, and visual analogue scale (VAS) score during pre- and post-operative phases. All patients (n = 60) underwent surgery in a beach chair situation (80° incline) under general anaesthesia, supplemented with an interscalene slab for pain relief after the procedure. Intraoperative measurement of tear was done by a probe calibrated for 2 mm intervals up to 10 mm, and the same probe was used in all cases to measure the size of the tear in AP and mediolateral directions. The subacromial space was evaluated via a posterolateral portal, with bursectomy and decompression performed consistently. Adhesions were carefully released to restore full mobility of the rotator cuff, and a cancellous bone surface was prepared using a motorized shaver. The torn cuff margins were refreshed with duckbill forceps and the same shaver system. The cuff was then secured using either double-loaded or triple-loaded suture anchors. Double-loaded anchors were used for supraspinatus and infraspinatus tears, and third anchor was used if subscapularis was torn as well. The deltoid and supraspinatus muscles function as the coronal force couple, while the subscapularis and infraspinatus muscles serve as an axial force couple, necessitating their repair for a stable shoulder joint. Full-thickness cuff tears are commonly associated with lesions of the long head of biceps (LHB), which is considered a constant pain producer, sharing to anterior shoulder ache and dysfunction (3-6). Biceps tenotomy was performed in cases of inflamed biceps tendons, which would be contributing to pain. After mobilisation of the tendon, if it is not possible to perform tension-free repair, then the anatomic footprint is medialized by creating a new site for attachment with < 8 mm medialisation, which does not decrease the moment arm in abduction (7).

The study inclusion parameters were defined as follows:

(1) Traumatic or degenerative tears
(2) Failed conservative treatment
(3) Full-thickness rotator cuff tear
(4) Engagement in follow-up monitoring for at least 24 months.

The exclusion criteria were as follows:

(1) Irreparable full-thickness tears
(2) Partial rotator cuff tear
(3) Revision surgery or prior shoulder surgery
(4) Neurological disorders.

Figure 1 shows arthroscopic view of a full-thickness rotator cuff tear involving supraspinatus and infraspinatus, observed through a lateral portal.

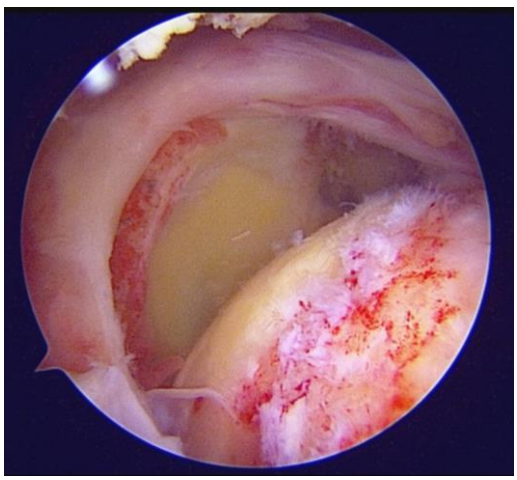

Figure 1. Arthroscopic view of a full-thickness rotator cuff

Figure 2 demonstrates arthroscopic view showing suture way through the retracted rotator cuff tendon at equidistant intervals using a suture passer. Knot tying sequentially reduced and approximated the tendon to its anatomical mark on the superior tuberosity (image captured via lateral portal).

Figure 2. Suture passage and tendon reduction

Figure 3 displays arthroscopic view showing the final construct following SR rotator cuff repair. The tendon was securely reattached and well seated on the greater tuberosity after completion of knot tying.

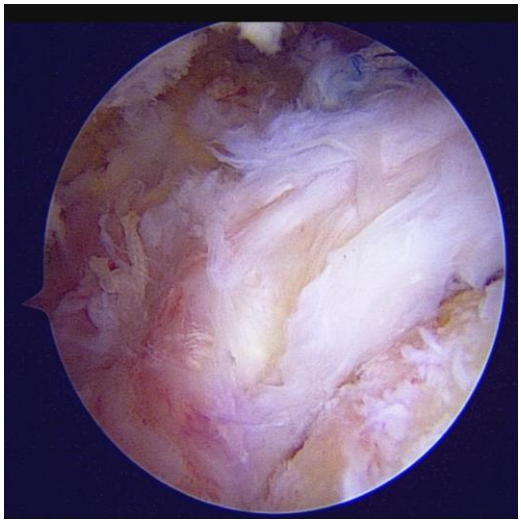

Figure 3. Final construct after cuff repair

Post-Operative Rehabilitation Protocol

The shoulder rehabilitation protocol following rotator cuff repair focused on initial dynamic glenohumeral flexibility and potential. During the session, excessive strain on the tissues has been prevented by achieving a stability between restoring shoulder flexibility and facilitating easy tissue recovery.

As soon as the patients felt comfortable, pendulum and scapula stabilizer exercises were started, and a shoulder arm pouch sling was advised for 6 weeks postoperatively. Active movements were restricted for the initial six weeks, while assisted passive exercises commenced after four weeks.

Table 1. Comparing functional outcomes in different sizes of tears (Cofield classification: small < 1 cm, medium: 1-3 cm, large: 3-5 cm, massive > 5 cm)

	CMS (0-100)				UCLA Shoulder score (0-35)			
	Small	Medium	Large	Massive	Small	Medium	Large	Massive
Excellent	7	37	3	1	7	27	2	1
Good	0	3	9	0	0	13	6	0
Fair	0	0	0	0	0	0	4	0
P-value	< 0.001				< 0.001			

CMS: Constant-Murley Score; UCLA: University of California and Los Angeles

Isometric deltoid strengthening exercises were initiated at 3 weeks post-op. External rotation as tolerated by patients was advised between 3-6 weeks, and at 6 weeks, active movements were permitted. After 6 weeks, rotator cuff strengthening with gradually increasing range of motion (ROM) was focused on. Individuals with diabetes were kept in 30-degree abduction and neutral rotation, and exercise was continuously monitored for all cases.

Assessment of Cuff Integrity

At the two-year follow-up, a single senior musculoskeletal radiologist with over 20 years of experience conducted ultrasonographic (US) evaluations for Sugaya grading and re-tear detection. A 14 MHz broad-spectrum linear matrix array transducer (Mindray Resona) was used uniformly across the entire study sample to ensure consistency.

Statistical Tests

Data were recorded and organized using Microsoft Excel. Descriptive statistical methods were employed to present the baseline data. Paired t-tests compared preoperative and postoperative outcomes. One-way analysis of variance (ANOVA) was used to assess the Sugaya grading with other variables. A significance threshold of $P < 0.05$ was applied, with data analysis conducted using SPSS software.

Results

CMS (0-100 points) increased from 55.03 to 94.80 ($P < 0.001$), UCLA score (0-35) improved from 21.58 to 33.80 ($P < 0.001$), and SST score (0-12) improved from 6.03 to 11.20 post-operatively ($P < 0.001$).

The results of comparing functional outcomes in different sizes of tears are visible in table 1.

80% of patients had excellent CMS, and 20% had good CMS. According to UCLA Score, 61.66% of patients had excellent results, 31.66% had good results, and 6.66% had fair results.

Glenohumeral Arthritis by Hamada Classification

1- Acromio humeral distance (AHD) > 6 mm, 2- AHD < 5 mm, 3- 2 + acetabulization of acromion, 4- narrowing of glenohumeral space with/without acetabulization, 5- 4 + humeral head collapse with functional scoring.

Hamada 1 (13 cases): 100% excellent results in CMS and 86.66% excellent results, 13.33% good results in UCLA Score

Hamada 2 (22 cases): 76.47% excellent results, 23.52% good results in CMS and 53% excellent results, 41.17% good results, and 5.58% fair results in UCLA Score

Hamada 3 (15 cases): 60% excellent outcomes and 40% good outcomes in CMS, 60% excellent outcomes and 40% fair results in UCLA Score

Hamada 4 (10 cases): 66.66% excellent results, 33.33% good results in CMS and 50% excellent results, 50% good results in UCLA Score.

This showed that as the grade of arthritis increases, the functional outcomes decrease. Fisher's exact test was used for analysis with a P-value < 0.05.

A total of 16 patients of 60 had pre-operative fatty atrophy of 2 or above. Out of them, 43.7% of cases showed excellent outcomes, 43.7% showed good outcomes, while 12.5% showed fair outcomes when assessed by the UCLA Score. Table 2 depicts clinical outcomes following cuff repair.

Table 2 shows improved clinical outcomes following cuff repair with a decrease in pain and an increase in shoulder strength.

Structural Integrity Assessment

The Sugaya classification is a well-recognized system used to evaluate the integrity of the rotator cuff tendon following surgical repair. US has recently become a cost-effective and useful tool for assessing the post-operative structural properties of the rotator cuff (4).

Figure 4 below shows a comparison of functional results with different Sugaya grades.

Out of 60 patients, 85% reported Sugaya grade 1 (70% of patients had excellent while 30% had good results). 8.33% of patients reported Sugaya grade 2 (of them, 16.66% had excellent, 33.33% had good, and 50% had fair results). 3.33% of patients reported Sugaya grade 3 (50% of patients had good and 50% had fair results).

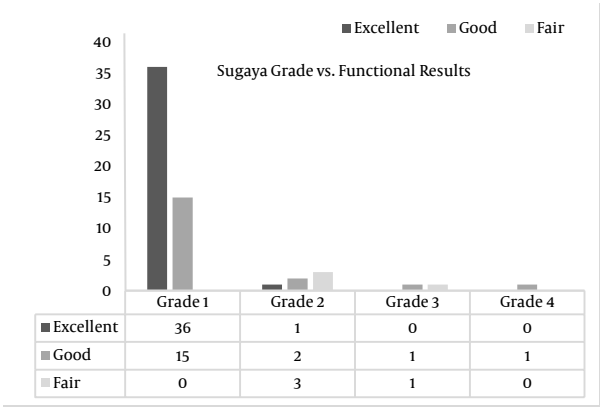

Figure 4. Comparison of functional results with different Sugaya grades

1.6% of patients reported Sugaya grade 4 and showed a good functional outcome. It is clear from the above chart that a healed cuff shows a better satisfaction level.

Table 3 below compares different functional parameters with Sugaya grading.

The above results emphasize the role of healing and structural integration of the rotator cuff, as better functional scores were noted in lower grade Sugaya.

Active forward flexion increased from 97.86 ± 24.24 to 165.00 ± 14.01 ($P < 0.001$), and VAS score decreased from 7.07 ± 1.33 to 1.00 ± 0.88 ($P < 0.001$) following biceps tenotomy, highlighting better shoulder function.

Table 2. Clinical outcomes following cuff repair

Serial number	Parameter	Pre-operative	Post-operative	P-value
1	Active forward flexion (0-180°)	96.50 ± 20.98	166.50 ± 11.62	< 0.001
2	External rotation (0-90°)	57.83 ± 12.63	79.16 ± 10.13	< 0.001
3	VAS (0-10)	7.30 ± 1.14	1.20 ± 0.75	< 0.001
4	Strength (max: 0-25 kg)	10.95 ± 2.56	22.78 ± 3.32	< 0.001

VAS: Visual analogue scale

Table 3. Different functional parameters with Sugaya grading

Parameters	Sugaya 1	Suagaya 2	Suagaya ≥ 3	P-value
VAS score (0-10)	1.02 ± 0.62	2.16 ± 0.75	2.33 ± 0.58	< 0.001
CMS (0-100)	97.06 ± 5.21	82.67 ± 9.42	81.33 ± 6.35	< 0.001
UCLA Shoulder score (0-35)	34.10 ± 1.66	28.66 ± 3.67	30.67 ± 4.04	< 0.001
Muscle strength (0-25 kg)	23.63 ± 2.51	18.50 ± 4.04	17.00 ± 2.00	< 0.001

VAS: Visual analogue scale; CMS: Constant-Murley Score; UCLA: University of California and Los Angeles

Twenty-one cases of subscapularis repair showed an increase in CMS to 94.83 from 55.52 (P < 0.001) with a mean increase of 39.31.

Discussion

SR repair reduces the quantity of suture anchors deployed, effectively halving the implant cost, while still providing good functional and clinical outcomes. Although no formal cost analysis was performed, other expenses, such as rehabilitation or hospital stay, were not significantly impacted. All 60 SR-ARCR cases in this study showed a significant increase in CMS, UCLA Score, SST score, as well as an increase in active forward flexion, external rotation, and muscle strength and a decrease in VAS score. de Jesus et al. (8), Huang et al. (9) and Severud et al. (10) in his systematic meta-analysis review, compared mini open versus ARCR, concluding that both had similar clinical outcomes and ARCR had a lower incidence of fibrous ankylosis and increased forward flexion.

Mazzocca et al., in his cadaveric investigation, found no distinction between SR fixation and DR fixation in terms of displacement with cyclic loading and load to failure, and both repair groups failed at greater than 250N force (11). In a level 2 evidence randomized controlled trial (RCT), Nicholas et al. reported favorable outcomes with both SR and DR rotator cuff repair techniques (12) and Faulkner et al., in his meta-analysis, showcased that type 2 failures close to musculotendinous junction occurred more frequently in DR than SR and also showed that SR repairs utilizing triple-loaded anchors exhibited greater resistance to gap formation compared to DR constructs (13). These studies highlight that DR repair has no significant advantage and increases the cost and burden on patients in developing countries. In as many as 40% of instances, the subscapularis tear is not reported on MRI, and even clinical examination is normal, which highlights the function of arthroscopic methods in handling rotator cuff injuries (14). Repair of the subscapularis balances the forces couple and decreases tension on the adjacent supraspinatus tendon. Our study had 21 subscapularis tendon repairs done, and they showed a significant increase in constant score and internal rotation of the shoulder comparable to current literature (15). In the present study, 14 patients who were treated with biceps tenotomy, which is a simple and efficient method, showed improved VAS scores and active forward flexion, with no reported cosmetic abnormality (16, 17). Good clinical and functional results in higher fatty atrophy highlight that it should not be considered a contraindication for repair (18). Even large or massive tears with fatty infiltration can be successfully managed by SR repair as long as a tension-free complete repair is done, which will give good osseous integration of the cuff (19). In our study, 9 cases were treated with medialized repair and showed satisfactory functional outcomes. Furthermore, to stop the progression of arthritis, the rotator cuff needs to be repaired, and the AHD needs to be restored. Similar outcomes are shown by Herve et al. that less arthritis occurs when the rotator cuff remains intact (20).

US: Structural reintegration of the cuff at 2 years was assessed by Sugaya grading. 85% of patients recorded Sugaya grade 1, 10% Sugaya grade 2, and 5% Sugaya grade 3 or above in post-operative US. As we advanced in Sugaya grading, functional scores decreased. This finding indicated that the cases without residual tendinopathy had more satisfactory outcomes (21, 22). In this study, functional scores and muscle strength decreased, and VAS increased as we moved from Sugaya 1 to 2 to 3 or more. Sugaya's classification demonstrated a strong association with muscle strength scores shown by Yoshida et al. in his 62-patient study with full-thickness tear (23). Galatz et al. showed that recurrent defects were observed in approximately 94% of SR-ARCR repairs, but the present study differs from the above as it showed only 1 re-tear case at 2 years of follow-up, and the reason could be due to the selection of other imaging modalities like MRI in the study by Galatz et al. (24). Russell et al. meta-analysis revealed that patients with intact repairs exhibited markedly superior strength in forward flexion and external rotation compared to those with re-tears (25).

Strengths: This was a monocentric study with full thickness tears operated by a single author using the SR repair technique. Data collection and evaluation were done by a third person. Complete functional and clinical scores analysis was done along with US to correlate radiological and functional outcomes in a large number of patients. No other study compares parameters like subscapularis repair, LHB tenotomy, fatty atrophy, arthritis, and medialized repair with functional and structural outcomes.

Weaknesses: It is a retrospective study with the selection of those patients who came for regular follow-up at 24 months. This led to the omission of 7 cases who were staying far away in a remote location, but did not cause any recall bias or selection bias, as all patients in the time period mentioned were included in the study. Functional and radiological assessments were done at the end of 24 months and not periodically at every six months, which could give valuable insights on healing progression.

Conclusion

It is clear from the above discussion that SR-ARCR offered excellent outcomes, with good healing and structural integration of the rotator cuff at 24 months.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgements

The study has followed the Declaration of Helsinki's principles (2013). The patients have consented to participate in the study. Local ethical committee approval was not needed as it was a retrospective study.

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