Original Article
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Functional Outcomes of Arthroscopic Double-Row Repair Using Single Anchors in Each Row for Massive Rotator Cuff Tears

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Learning Point of the Article:

A single-anchor double-row (SADR) surgical construct provides an effective, bone-preserving, and cost-efficient alternative to traditional multi-anchor repairs for massive rotator cuff tears.

Abstract

Introduction: Massive rotator cuff tears pose a significant surgical challenge due to severe tendon retraction and poor tissue quality. Standard multi-anchor double-row (DR) repairs offer strong biomechanical fixation in laboratories, but they significantly increase healthcare costs, risk anchor crowding, and deplete critical tuberosity bone stock. This raises the question of whether multi-anchor constructs are an absolute clinical necessity.

Materials and Methods: This retrospective cohort study evaluated the functional outcomes of a single-anchor DR (SADR) technique utilizing strictly one medial and one lateral anchor. Thirty-seven patients (n = 37) treated at Malabar Medical College Hospital and Research Centre between January 2021 and January 2023 were included. Outcomes included the American Shoulder and Elbow Surgeons (ASES) score, Constant-Murley score, Visual Analog Scale (VAS) for pain, and range of motion (ROM) assessed at baseline, 6, 12, and 24 months. Data were analyzed using paired t-tests and multivariate Cox proportional hazards regression.

Results: The cohort's mean age was 64.5 ± 6.5 years. ASES scores improved significantly from 38.5 ± 10.5 preoperatively to 82.0 ± 13.5 at 24 months ($P < 0.001$). Constant-Murley, VAS pain, and active ROM scores demonstrated parallel, significant improvements. Clinical survivorship at 24 months was 89.2%. Clinical failure was defined strictly as an ASES drop >20 points from the post-operative peak or the need for revision arthroplasty. Multivariate analysis identified older age (hazard ratios [HR] 1.07, $P = 0.038$) and higher pre-operative VAS (HR 1.22, $P = 0.025$) as independent predictors of failure.

Conclusion: The SADR construct yields profound functional improvements at a minimum 2-year follow-up. This streamlined technique represents a highly viable, bone-preserving, and cost-effective alternative to multi-anchor repairs for massive tears.

Keywords: Massive rotator cuff tear, arthroscopic double-row repair, single-anchor construct, cost-effectiveness, clinical survivorship, bone preservation.

Introduction

Massive rotator cuff tears (MRCTs), generally defined as tears exceeding 5 cm in diameter or involving two complete tendons, remain one of the most persistent challenges in orthopedic shoulder surgery [1,2]. These complex lesions typically feature significant tendon retraction, poor intrinsic tissue quality, altered glenohumeral kinematics, and muscle atrophy [3]. Successful surgical management requires optimal mechanical restoration

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Author's Photo Gallery

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and biological preservation of the healing environment.

The biomechanical superiority of double-row (DR) and transosseous-equivalent suture bridge repairs over single-row techniques is well documented in ex vivo models [4,5]. By maximizing the pressurized contact area between the tendon and the greater tuberosity footprint, DR constructs theoretically enhance tissue healing [6]. However, standard DR repairs frequently require four to six suture anchors [7].

The routine use of multi-anchor constructs in MRCTs introduces several critical clinical and economic concerns [8]. Using numerous anchors significantly increases procedural costs [9,10]. Furthermore, placing multiple large-diameter anchors into the osteoporotic tuberosity, common in older patients, can lead to "anchor crowding." This phenomenon depletes trabecular bone stock, potentially creating stress risers and complicating future revision surgeries [11,12,13]. In addition, repairing degenerative tissue under high tension with a rigid multi-anchor construct may paradoxically induce localized ischemia at the tendon edge, impairing biological healing [14,15,16].

This study is based on the rationale that, following adequate soft tissue mobilization and capsular releases, the remaining tendon defect can be secured securely using a minimalist mechanical construct. We propose that a single-anchor DR (SADR) technique – utilizing exactly one medial anchor and one lateral anchor – provides sufficient stability while maximizing bone preservation and minimizing implant costs. This study aims to evaluate the 24-month patient-reported functional outcomes and clinical survivorship of the SADR technique applied to MRCTs, challenging the prevailing dogma that multi-anchor constructs are universally necessary [17].

Materials and Methods

Study design and patient selection

This retrospective, single-Center cohort study was conducted at the Department of Orthopaedics, Malabar Medical College Hospital and Research Centre. Institutional Ethics Committee approval was obtained on 13 November 2025 (Reference Number: MMCH&RC/IEC/2025/Nov/602) for the retrospective review of clinical records. The study evaluated patients treated between January 2021 and January 2023.

Inclusion criteria were

(1) Adults aged 45–80 years; (2) intraoperative arthroscopic confirmation of an MRCT (>5 cm or involving the complete supraspinatus and infraspinatus); (3) primary repair using the SADR technique; and (4) a minimum of 24 months of clinical follow-up.

Exclusion criteria included

(1) Prior ipsilateral shoulder surgeries; (2) concomitant labral pathology requiring independent repair; (3) advanced osteoarthritis (Kellgren-Lawrence grade III/IV); (4) partial footprint coverage; and (5) active systemic neurovascular or rheumatologic diseases. To evaluate purely functional clinical survivorship and avoid the confounding influence of asymptomatic imaging abnormalities, routine post-operative radiological imaging magnetic resonance imaging (MRI), was excluded from the outcome analysis.

Sample size calculation

An a priori power analysis was conducted based on the American Shoulder and Elbow Surgeons (ASES) score [18]. The established minimum clinically important difference (MCID) for the ASES score is 12.0–17.5 points [19]. Using a conservative MCID of 12.0 points, an estimated standard deviation (SD) of 15.0, an alpha level of 0.05, and a statistical power (1-β) of 0.80 for a paired t-test, the minimum required sample size was calculated at 26 patients. To account for potential data loss and support multivariate regression modeling, we included 37 patients (n = 37), yielding a statistical power exceeding 0.90 for the primary endpoint.

Surgical technique

Surgeries were performed in the lateral decubitus position under general anaesthesia and an interscalene block. Following comprehensive diagnostic arthroscopy, soft tissue releases, and subacromial bursectomy, the tuberosity footprint was lightly decorticated [20]. Extensive capsular releases were performed to mobilize the retracted tendon. The SADR technique was then applied. One 5.5 mm double-loaded medial anchor was placed at the articular margin at the midpoint of the mobilized tendon. The suture limbs were passed through the tendon and tied. One limb from each knot was brought laterally, and a single lateral anchor was inserted into the lateral greater tuberosity, capturing and tensioning all bridging limbs to compress the tendon against the footprint (Fig. 1).

Post-operative rehabilitation

An early active rehabilitation protocol was utilized. Patients were provided an abduction sling for comfort but were encouraged to wean off its use as tolerated within the first 3–4 weeks. Immediate passive range of motion (ROM) and gentle active-assisted ROM exercises were initiated within the 1st week postoperatively. Active range of motion (AROM) was introduced early, starting at 3–4 weeks, progressing within pain-free limits. Light isotonic strengthening began at 8 weeks, with a

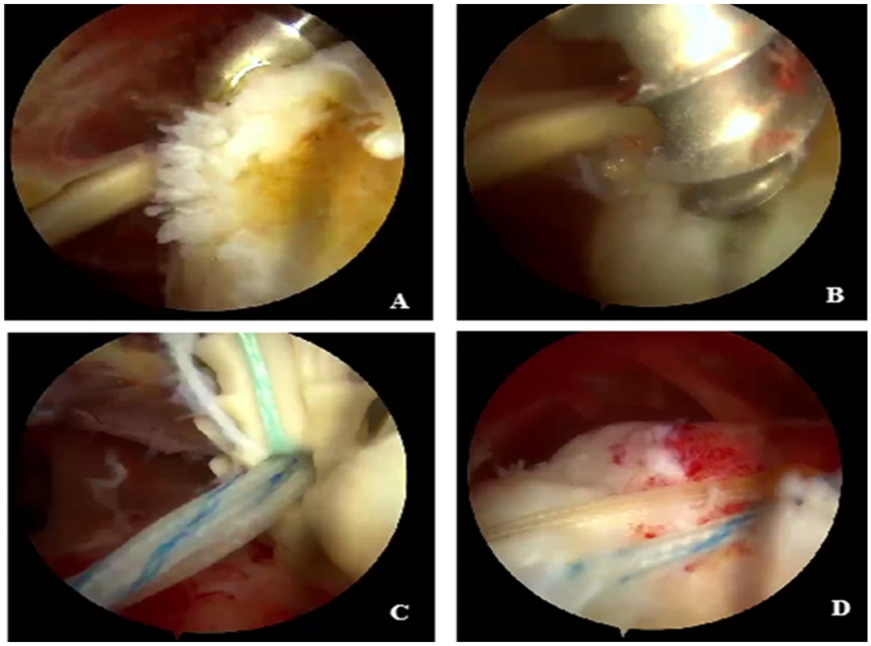

Figure 1: Intraoperative arthroscopic steps of the single-anchor double-row (SADR) Technique. Arthroscopic views demonstrating the key steps of the SADR repair. (a) Decortication of the greater tuberosity to prepare the footprint (b) Placement of the single medial anchor at the articular margin. (c) Insertion of the single knotless lateral anchor, capturing the bridging sutures from the medial row. (d) The final SADR construct demonstrating tissue compression against the footprint using a minimalist two-anchor configuration.

return to heavy labor or overhead activities restricted until 6 months postoperatively.

Clinical evaluation and definition of failure

Patients were evaluated preoperatively and at 6, 12, and 24 months. The primary outcome was the ASES score (0–100). Secondary outcomes included the Constant-Murley score (0–100), Visual Analog Scale (VAS) for pain (0–10), and active forward flexion (FF) and external rotation (ER) in degrees.

Clinical failure was strictly defined as

(1) a post-operative drop in the ASES score of >20 points from the patient's peak score, or (2) the necessity for revision shoulder arthroplasty due to intractable pain or pseudo-paralysis.

Statistical analysis

Continuous variables were reported as means ± SD. Paired t-tests were used to compare baseline and 24-month scores. Survivorship analysis utilized the Kaplan-Meier method. A multivariate Cox proportional hazards regression model was constructed to identify independent predictors of clinical failure, presenting hazard ratios (HR) and 95% confidence intervals [21]. A multiple linear regression model evaluated predictors of the final ASES score [22]. Significance was set at $P < 0.05$.

Results

Demographics and baseline characteristics

The final cohort consisted of 37 patients who completed the 24-month follow-up. The cohort included 21 males (56.8%) and 16 females (43.2%), with a mean age of 64.5 ± 6.5 years. The mean anteroposterior tear size was 5.3 ± 0.5 cm. Detailed patient demographics and pre-operative characteristics are summarized in Table 1.

Longitudinal functional outcomes

Patients demonstrated significant functional improvements from baseline to the 24-month endpoint. The mean ASES score improved from a pre-operative 38.5 ± 10.5 to an excellent 82.0 ± 13.5 at 24 months ($P < 0.001$). The Constant-Murley score similarly increased from 35.0 ± 10.0 to 78.0 ± 12.5 ($P < 0.001$). VAS pain scores dropped from 7.3 ± 1.2 to 1.2 ± 1.0 ($P < 0.001$). AROM also recovered significantly. FF improved from 106° ± 22° to 154° ± 14° postoperatively ($P < 0.001$). ER increased from 26° ± 10° to 44° ± 9° ($P < 0.001$). These comprehensive clinical measures are documented in Table 1.

Clinical survivorship and predictors of failure

Table 1: Baseline demographics and clinical outcomes at 24 months (n=37)

Variable	Baseline/pre-operative value	24-month follow-up value	*P*-value (pre vs. 24 m)
Age (years)	64.5±6.5	-	-
Sex (male/female)	21 (56.8%)/16 (43.2%)	-	-
BMI (kg/m^2)	28.2±4.0	-	-
Dominant Arm involvement	26 (70.3%)	-	-
Pre-operative tear size (AP, cm)	5.3±0.5	-	-
ASES score	38.5±10.5	82.0±13.5	<0.001
Constant-Murley score	35.0±10.0	78.0±12.5	<0.001
VAS pain (0–10)	7.3±1.2	1.2±1.0	<0.001
Forward flexion (°)	106±22	154±14	<0.001
External rotation (°)	26±10	44±9	<0.001

BMI: Body mass index, VAS: Visual Analog Scale, ASES: American Shoulder and Elbow Surgeons, AP: Anteroposterior

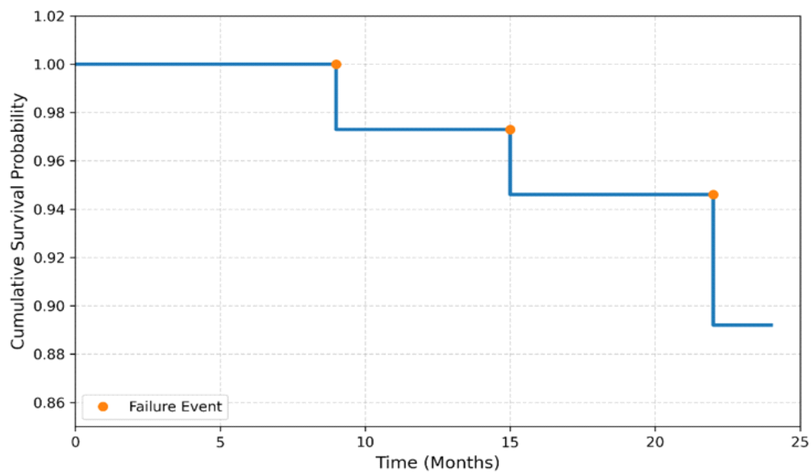

Figure 2: Kaplan-Meier survivorship curve. A Kaplan-Meier step plot visualizing clinical survivorship at an overall 89.2% probability at 24 months. The curve drops exclusively when a defined clinical failure, an American Shoulder and Elbow Surgeons score drop >20 points, or the need for reverse total shoulder arthroplasty occurs.

During the 24-month study period, 4 of the 37 patients (10.8%) met the strict criteria for clinical failure. Two patients required revision to a reverse total shoulder arthroplasty (RTSA), and two experienced a significant functional decline (ASES drop >20 points) without pursuing revision. Consequently, the overall clinical survivorship of the SADR technique at 2 years was 89.2%, as shown in Fig. 2.

A multivariate Cox proportional hazards regression model identified that increasing patient age (HR = 1.07 per year, P = 0.038) and a higher pre-operative VAS pain score (HR = 1.22 per point, P = 0.025) were independent predictors of clinical failure (Table 2). Pre-operative tear size (HR = 1.10, P = 0.601) and body mass index (BMI) (HR = 1.04, P = 0.485) did not significantly predict clinical failure.

Finally, a multiple linear regression analysis indicated that male sex was associated with a 5.8-point higher final ASES score (P = 0.042), whereas variables like age (P = 0.510), BMI (P = 0.215), and concomitant biceps tenodesis (P = 0.480) did not significantly predict the final score (Table 2).

Discussion

The primary finding of this retrospective analysis is that arthroscopic repair of MRCTs utilizing a minimalist SADR construct yields profound functional improvements and an 89.2% clinical survivorship rate at 2 years. This success highlights the viability of a bone-preserving, cost-effective alternative to multi-anchor repairs.

The debate over the optimal mechanical construct for MRCTs is ongoing [23]. While laboratory studies consistently favor rigid multi-anchor constructs for their high ultimate load to failure [4,6], translating this mechanical rigidity to clinical biology remains contentious. "Stress-shielding" suggests that overly rigid constructs might eliminate the mechanical micro-motion necessary to stimulate tenocyte proliferation [5,13,16]. Furthermore, inserting four to six anchors damages the tuberosity's delicate micro-vascularity [11].

Our findings challenge purely mechanical dogmas, demonstrating that the biological environment can be optimized with minimal implants. Through extensive capsular releases and mobilization, our approach aims to eliminate the destructive tension associated with retracting massive tears. Once tension is managed, the SADR construct – one anchor approximating the tissue and one compressing it laterally – achieves "Goldilocks" fixation: Stable enough to prevent macroscopic failure but flexible enough to permit essential osteotendinous micro-motion and prevent anchor-induced ischemia [14].

Economically, the SADR technique holds substantial value [10]. Using strictly two anchors instead of four to six significantly reduces upfront procedural implant costs, an essential consideration in value-based healthcare [17].

Comparing our 89.2% survivorship to traditional multi-anchor cohorts [2] validates the SADR approach. The decision to exclude routine post-operative imaging aligns with historical observations that objective functional outcomes frequently do not correlate with structural MRI integrity. As noted by Denard et al., many patients with asymptomatic retears remain functionally satisfied [8]. Treating an asymptomatic MRI

Table 2: Multivariate and linear regression analyses for clinical failure and ASES scores

Predictor variable	Hazard ratio (HR) for clinical failure (95% CI)	*P*-value (failure)	Linear beta (β) for final ASES score	*P*-value (ASES)
Age	1.07 (1.01–1.14)	0.038	−0.14	0.51
Sex (male vs. female)	-	-	5.8	0.042
Pre-operative VAS	1.22 (1.02–1.45)	0.025	-	-
Initial tear size	1.10 (0.75–1.50)	0.601	-	-
BMI	1.04 (0.90–1.18)	0.485	−0.42	0.215
Concomitant biceps tenodesis	-	-	2.05	0.48

CI: Confidence interval, ASES: Active-assisted range of motion, BMI: Body mass index, VAS: Visual Analog Scale

finding often leads to unnecessary revision surgery and patient anxiety [24]. By strictly defining failure through ASES score drops or the clinical need for RTSA, our data reflects genuine patient-centered value. However, we acknowledge our survivorship rate may appear high as benign, asymptomatic structural retears were excluded from the failure definition.

Our regression models identified advanced age and high pre-operative pain as significant predictors of failure, aligning with established literature linking age to diminished tissue regenerative capacity and high pain to chronicity and central sensitization [1,3]. Importantly, initial tear size did not predict failure, validating the mechanical efficacy of the minimalist construct in adequately mobilized tears.

This study has several limitations. It is a retrospective, single-arm study lacking a randomized, parallel control group. While the sample size (n = 37) was adequately powered for clinical outcomes, it remains relatively small for modeling rare complications. Most notably, the lack of post-operative radiologic imaging prevents assessment of exact structural healing or asymptomatic retear rates. Finally, a 24-month follow-up is sufficient to capture the initial functional plateau, but longer-term studies (5–10 years) are necessary to determine the long-term durability of this minimalist construct.

Conclusion

The use of a minimalist SADR mechanical construct is a highly effective evolutionary step in treating MRCTs. This approach preserves vulnerable tuberosity bone stock, substantially reduces implant costs, and prioritizes biological optimization through tension reduction over maximal biomechanical stiffness. The SADR technique yields excellent 2-year clinical survivorship and functional outcomes, offering a patient-Centered, cost-effective alternative that warrants further exploration in prospective, multi-Center trials.

Clinical Message

The management of massive rotator cuff tears can be highly successful without the traditional reliance on densely implanted surgical constructs. By prioritizing extensive soft-tissue mobilization and employing a minimalist, single-anchor DR technique, surgeons can establish a stable repair while actively preserving vulnerable tuberosity bone stock and mitigating implant-induced ischemia. This streamlined approach highlights that optimizing the biological healing environment through thoughtful implant conservation and tension reduction is just as critical as mechanical rigidity, offering a highly practical and cost-efficient strategy for everyday orthopedic practice.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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