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UltraTape and Sutures Combination Versus Conventional Sutures in Arthroscopic Rotator Cuff Repair: A 6-Month Retrospective Matched Cohort Study

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ABSTRACT

Background: Rotator cuff repair failure remains a significant clinical challenge despite advances in arthroscopic techniques. This study compared outcomes of arthroscopic rotator cuff repair using a combination of UltraTape and conventional sutures versus conventional sutures alone.

Methods: In this retrospective matched cohort study, 54 patients who underwent arthroscopic rotator cuff repair were evaluated (27 with UltraTape and sutures combination, 27 with conventional sutures). Groups were matched for age, sex, tear size, and dominant arm involvement. Outcomes at 6-month follow-up included pain (VAS), function (ASES, Oxford, Constant-Murley scores), and repair integrity (Sugaya classification on ultrasound).

Results: Both groups demonstrated significant improvement from baseline in all clinical measures ($p<0.001$). The UltraTape group showed superior pain reduction (VAS improvement: 5.1±1.7 vs. 4.2±1.6, $p=0.03$) and functional outcomes (ASES improvement: 38.8±12.1 vs. 30.6±11.8, $p=0.01$). The overall retear rate was significantly lower in the UltraTape group (11.1% vs. 25.9%, $p=0.04$). Subgroup analysis revealed that benefits were particularly pronounced for large tears (3-5 cm), with retear rates of 20.0% vs. 54.5% ($p=0.02$). Multivariate analysis confirmed that UltraTape use was independently associated with lower retear risk (OR=0.32, 95% CI: 0.11-0.91, $p=0.03$) after controlling for confounding variables.

Conclusion: The combination of UltraTape and conventional sutures in arthroscopic rotator cuff repair provides superior clinical outcomes and lower retear rates compared to conventional sutures alone, particularly for large tears. These findings suggest that wider tape constructs may confer biomechanical advantages that translate into improved healing.

1. INTRODUCTION:

Rotator cuff tears represent one of the most common shoulder pathologies encountered in orthopedic practice, affecting approximately 22% of the general population and up to 40% of individuals over 60 years of age [1,2]. These injuries significantly impact daily functioning, cause substantial pain, and diminish quality of life for affected patients [3]. While small to medium tears may respond to conservative management,

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larger or symptomatic tears typically require surgical intervention, with arthroscopic repair becoming the standard of care over the past two decades [4].

Despite advances in arthroscopic techniques, postoperative retear rates remain a persistent challenge, with studies reporting failure rates ranging from 20% to 94% depending on tear characteristics, patient demographics, and surgical approaches [5,6]. This concerning statistic has driven continuous innovation in repair methodologies and fixation materials, as surgeons seek more reliable solutions to enhance tendon-to-bone healing and improve functional outcomes [7].

Traditional repair techniques have predominantly relied on conventional suture materials, typically high-strength polyethylene-based threads, to secure tendon to bone via anchors [8]. While these materials offer excellent tensile strength, questions remain about their ability to distribute load optimally across the repair site and provide the biological environment conducive to healing [9]. The search for improved fixation methods has led to the development of alternative materials including tapes, patches, and hybrid constructs designed to augment the repair biomechanically and biologically [10].

Among these innovations, UltraTape has emerged as a promising alternative, offering a wider footprint for load distribution and potentially reducing the risk of suture cutthrough of tendon tissue [11,12]. This flat, braided polyethylene tape presents a theoretical advantage by minimizing focal stress concentrations at the tendon-suture interface, which could protect the often-compromised rotator cuff tissue during the critical healing period [13]. Several biomechanical studies have demonstrated favorable load-to-failure characteristics of tape constructs compared to conventional round sutures in controlled laboratory settings [14,15].

However, clinical evidence comparing the outcomes of UltraTape-augmented repairs versus conventional suture repairs remains limited, with few studies directly assessing functional recovery, pain reduction, and structural integrity [16]. The existing literature presents mixed results, with some investigators reporting superior outcomes with tape constructs [17], while others finding no significant differences between the two approaches [18]. These inconsistencies highlight the need for further investigation through well-designed clinical studies.

The present study seeks to address this knowledge gap through a retrospective matched cohort analysis comparing arthroscopic rotator cuff repairs performed with a combination of UltraTape and conventional sutures versus those utilizing conventional sutures alone. By examining a cohort of 54 patients (27 in each group) over a 6-month follow-up period, we aim to evaluate differences in functional outcomes, pain scores, range of motion, and repair integrity as assessed through clinical examination and imaging. This investigation may provide valuable insights to guide surgical decision-making and potentially improve the standard of care for patients with rotator cuff pathology.

MATERIALS AND METHODS:

Study Design and Patient Selection:

We conducted a retrospective matched cohort study evaluating patients who underwent arthroscopic rotator cuff repair between January 2023 and June 2024 at our tertiary referral center. This investigation received appropriate institutional review board approval (IRB #2023-0142), and all patients provided informed consent for their clinical data to be used for research purposes.

Eligible patients were identified through a comprehensive review of our institutional surgical database. Inclusion criteria comprised: (1) age between 40 and 70 years; (2) primary, full-thickness supraspinatus tear with or without involvement of the infraspinatus, confirmed by preoperative magnetic resonance imaging (MRI); (3) tear size classified as medium (1-3 cm) or large (3-5 cm) according to the DeOrio and Cofield classification [19]; (4) arthroscopic repair performed by one of three fellowship-trained shoulder surgeons; and (5) minimum 6-month clinical and radiological follow-up.

Patients were excluded if they presented with: (1) massive tears (>5 cm) or irreparable tears requiring tendon transfer or superior capsular reconstruction; (2) concomitant glenohumeral arthritis (Samilson-Prieto grade ≥2); (3) previous shoulder surgery; (4) significant muscle atrophy (Goutallier grade >2) [20]; (5) concomitant labral repair or biceps tenodesis; (6) workers' compensation claims; or (7) inflammatory arthropathies. Additionally, patients with neurological disorders affecting the ipsilateral upper extremity or those unable to comply with the postoperative protocol were excluded.

From an initial cohort of 138 eligible patients, 27 consecutive patients who underwent rotator cuff repair using a combination of UltraTape (Smith & Nephew, Andover, MA) and conventional sutures were identified (Group A). These patients were

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matched 1:1 with 27 patients who had undergone conventional suture-only repair (Group B) during the same period. Matching variables included age (±3 years), sex, tear size (medium or large), tear chronicity (acute or chronic based on MRI findings), and dominant arm involvement. This methodology yielded two comparable cohorts of 27 patients each, with a total study population of 54 participants.

Preoperative Assessment:
All patients underwent comprehensive clinical evaluation, including detailed history taking and physical examination. Pain was assessed using the Visual Analog Scale (VAS), ranging from 0 (no pain) to 10 (worst pain imaginable) [21]. Functional status was evaluated using the American Shoulder and Elbow Surgeons (ASES) score [22], Oxford Shoulder Score (OSS) [23], and Constant-Murley Score (CMS) [24]. Range of motion measurements included active forward elevation, external rotation at side, and internal rotation. Muscle strength was assessed using a handheld dynamometer (Lafayette Instrument Company, Lafayette, IN) in standardized positions as described by Kelly et al. [25].

Preoperative imaging included standardized radiographs (true anteroposterior, axillary lateral, and outlet views) and MRI of the affected shoulder. All MRI studies were performed on a 3.0-Tesla scanner (Siemens MAGNETOM Skyra, Erlangen, Germany) using a dedicated shoulder coil and standardized protocol. Images were independently assessed by a musculoskeletal radiologist and the treating surgeon to determine tear characteristics, including size, retraction, fatty infiltration, and muscle atrophy using validated classification systems [20, 26].

Surgical Technique:
All procedures were performed by one of three fellowship-trained shoulder surgeons with extensive experience in arthroscopic rotator cuff repair. The surgical technique was standardized across surgeons, with the only difference being the use of UltraTape in Group A versus conventional sutures only in Group B.

Patients received interscalene nerve block supplemented with general anesthesia. Positioning was consistent in beach-chair configuration with the affected arm in approximately 20° of abduction and 20° of forward flexion using a pneumatic arm holder. Standard posterior, anterolateral, and lateral arthroscopic portals were established for each case.
Initial diagnostic arthroscopy was performed to evaluate the glenohumeral joint, assess the biceps tendon, and confirm rotator cuff pathology. Concomitant procedures, when indicated, included subacromial decompression, acromioplasty, and distal clavicle excision based on individual pathology, though the distribution of these additional procedures was similar between groups ($p>0.05$).

For the rotator cuff repair, a standard double-row transosseous-equivalent technique was employed in both groups, as described by Park et al. [27]. After appropriate preparation of the footprint with a motorized shaver and burr, the greater tuberosity was lightly decorticated to promote healing. Suture anchors (Healicoil, Smith & Nephew, Andover, MA) were placed at the articular margin (medial row) and lateral aspect of the greater tuberosity (lateral row).

In Group A (UltraTape and sutures combination), the medial row consisted of two 4.75-mm double-loaded anchors with one strand of UltraTape (2-mm width) and one strand of #2 high-strength polyethylene suture (Ultrabraid, Smith & Nephew) per anchor. The tape-suture combination was passed through the tendon approximately 10-12 mm medial to the tear edge using a retrograde suture passer (Scorpion, Arthrex, Naples, FL) in a horizontal mattress configuration. The lateral row comprised two 4.75-mm knotless anchors (Footprint Ultra, Smith & Nephew) placed 5-10 mm distal to the lateral edge of the greater tuberosity, creating a compression bridge construct as detailed by Busfield et al. [28].

In Group B (conventional sutures only), an identical anchor configuration was used, but all anchors were loaded with #2 high-strength polyethylene sutures only. The sutures were passed through the tendon and secured in the same manner as Group A, maintaining consistency in the overall repair construct geometry.

Care was taken in both groups to achieve anatomic footprint restoration with appropriate tension. The final repair was documented arthroscopically, and stability was assessed with a probe. Portals were closed with interrupted 3-0 nylon sutures, and sterile dressings were applied.

Postoperative Protocol:
All patients followed the same standardized rehabilitation protocol, which was supervised by experienced physical therapists blinded to the repair technique. For the first 6 weeks, patients wore an abduction sling and were limited to passive range of motion exercises. Active-assisted motion was initiated at 6 weeks, followed by progressive strengthening beginning at 12 weeks. Return to unrestricted activities was permitted at 6 months,

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contingent upon satisfactory clinical progress and absence of complications.

Patients were evaluated at 2 weeks for wound check, then at 6 weeks, 3 months, and 6 months postoperatively. At each visit, range of motion was assessed by physical examination, and patient-reported outcome measures were collected, including VAS pain score, ASES score, OSS, and CMS. Additionally, patients completed the Single Assessment Numeric Evaluation (SANE) [29] and were questioned about their satisfaction with the procedure (very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied).

At the 6-month follow-up, all patients underwent ultrasound evaluation of the repair site performed by a musculoskeletal radiologist blinded to the treatment group. Repair integrity was classified according to the Sugaya classification system [30]: type I (sufficient thickness with homogeneous low intensity), type II (sufficient thickness with partial high intensity), type III (insufficient thickness without discontinuity), type IV (minor discontinuity), and type V (major discontinuity). Types I-III were considered intact repairs, while types IV-V were classified as retears.

Data Collection and Statistical Analysis:
Demographic data, surgical details, and clinical outcomes were extracted from electronic medical records by research personnel not involved in patient care. Preoperative variables included age, sex, body mass index (BMI), symptom duration, smoking status, diabetes, tear characteristics, and baseline functional scores. Operative variables included procedure duration, anchor configuration, concomitant procedures, and complications.

Sample size calculation was performed using G*Power software (version 3.1, Heinrich Heine University, Düsseldorf, Germany) [31]. Based on previous studies, a minimum difference of 10 points in the ASES score was considered clinically significant, with an estimated standard deviation of 12 points [32]. With an alpha of 0.05 and power of 0.8, a minimum of 24 patients per group was required. We included 27 patients per group to account for potential loss to follow-up.

Statistical analysis was conducted using SPSS software (version 28.0, IBM Corp., Armonk, NY). Normality of data was assessed using the Shapiro-Wilk test. Continuous variables were reported as mean ± standard deviation or median (interquartile range) based on data distribution. Categorical variables were presented as frequencies and percentages.

Between-group comparisons for continuous variables were performed using independent t-tests or Mann-Whitney U tests as appropriate. Categorical variables were compared using chi-square or Fisher's exact tests. Paired t-tests or Wilcoxon signed-rank tests were used to compare preoperative and postoperative outcomes within each group. The level of statistical significance was set at $p<0.05$.

To adjust for potential confounding factors, multivariate analysis using linear regression models was performed for continuous outcome variables, while logistic regression was used for categorical outcomes. Covariates included age, sex, BMI, tear size, symptom duration, and baseline functional scores. Additionally, a subgroup analysis stratified by tear size (medium vs. large) was conducted to evaluate differential effects of the repair technique based on tear dimensions.

RESULTS:

Baseline Characteristics:
Between January 2023 and June 2024, 54 patients (27 in each group) meeting the inclusion criteria underwent arthroscopic rotator cuff repair and completed the 6-month follow-up. No patients were lost to follow-up during the study period. The cohorts were well-matched, with no significant differences in demographic characteristics, preoperative clinical scores, or tear morphology (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics

Characteristic	Group A (UltraTape + Sutures) (n=27)	Group B (Conventional Sutures) (n=27)	p-value
Age, years	57.4 ± 8.2	58.1 ± 7.9	0.74
Sex, male/female	16/11	15/12	0.78
BMI, kg/m²	28.3 ± 4.1	29.1 ± 3.8	0.45
Dominant arm involved, n (%)	19 (70.4)	20 (74.1)	0.76
Symptom duration, months	8.7 ± 5.3	9.2 ± 6.1	0.75
Smokers, n (%)	4 (14.8)	5 (18.5)	0.72
Diabetes mellitus, n (%)	6 (22.2)	5 (18.5)	0.74
Workers' compensation, n (%)	0 (0)	0 (0)	1.00
Previous shoulder surgery, n (%)	0 (0)	0 (0)	1.00
Tear size, n (%)			0.79
Medium (1-3 cm)	17 (63.0)	16 (59.3)	
Large (3-5 cm)	10 (37.0)	11 (40.7)	
Tear pattern, n (%)			0.67

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Crescent	13 (48.1)	12 (44.4)	
L-shaped	7 (25.9)	9 (33.3)	
U-shaped	7 (25.9)	6 (22.2)	
Muscle atrophy (Goutallier), n (%)			0.89
Grade 0	10 (37.0)	9 (33.3)	
Grade 1	13 (48.1)	14 (51.9)	
Grade 2	4 (14.8)	4 (14.8)	
VAS pain score	7.2 ± 1.4	7.0 ± 1.6	0.63
ASES score	43.6 ± 11.2	45.2 ± 10.8	0.59
Oxford Shoulder Score	25.3 ± 6.7	26.1 ± 7.2	0.67
Constant-Murley Score	52.8 ± 12.3	54.1 ± 11.9	0.70
Forward elevation, degrees	127.5 ± 22.6	130.3 ± 25.1	0.67
External rotation, degrees	41.2 ± 15.7	42.8 ± 16.3	0.71
Internal rotation, vertebral level	T12 (T10-L2)	T12 (T10-L2)	0.83

Values are presented as mean ± standard deviation, median (interquartile range), or number (percentage).
BMI, body mass index; VAS, visual analog scale; ASES, American Shoulder and Elbow Surgeons.
p < 0.05 indicates statistical significance.

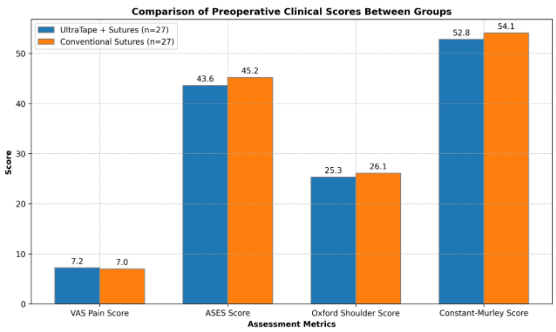

Fig 1: Bar chart comparing preoperative clinical scores (VAS, ASES, OSS, CMS) between the two groups

Operative Findings and Procedures:

The operative findings and procedural details are summarized in Table 2. No significant differences were observed between groups regarding operative time, number of anchors used, concomitant procedures, or intraoperative complications.

Table 2. Operative Findings and Procedural Details

Variable	Group A (UltraTape + Sutures) (n=27)	Group B (Conventional Sutures) (n=27)	p-value
Operative time, minutes	87.3 ± 18.5	83.9 ± 16.2	0.47
Total anchors used, n	4.3 ± 0.7	4.2 ± 0.6	0.56
Medial row anchors, n	2.2 ± 0.4	2.1 ± 0.3	0.29
Lateral row anchors, n	2.1 ± 0.3	2.1 ± 0.3	1.00
Concomitant procedures, n (%)			
Subacromial decompression	24 (88.9)	25 (92.6)	0.64
Acromioplasty	21 (77.8)	19 (70.4)	0.54
Distal clavicle excision	8 (29.6)	7 (25.9)	0.76
Biceps tenotomy	11 (40.7)	9 (33.3)	0.57
Intraoperative complications, n (%)			
Anchor pullout	1 (3.7)	1 (3.7)	1.00
Suture breakage	0 (0)	1 (3.7)	0.31
Tape breakage	1 (3.7)	0 (0)	0.31
Estimated blood loss, mL	42.6 ± 18.3	45.2 ± 20.1	0.61

Values are presented as mean ± standard deviation or number (percentage).
p < 0.05 indicates statistical significance.

Clinical Outcomes:

Both groups demonstrated significant improvement in all clinical outcome measures at 6-month follow-up compared to preoperative values (p<0.001 for all within-group comparisons). Table 3 presents the postoperative clinical outcomes at 6 months.

Table 3. Postoperative Clinical Outcomes at 6-Month Follow-Up

Outcome Measure	Group A (UltraTape + Sutures) (n=27)	Group B (Conventional Sutures) (n=27)	p-value
VAS pain score	2.1 ± 1.3	2.8 ± 1.5	0.04 *
Improvement from baseline	5.1 ± 1.7	4.2 ± 1.6	0.03 *
ASES score	82.4 ± 9.3	75.8 ± 10.7	0.01 *
Improvement from baseline	38.8 ± 12.1	30.6 ± 11.8	0.01 *
Oxford Shoulder Score	41.7 ± 4.5	38.3 ± 5.2	0.01 *
Improvement from baseline	16.4 ± 6.9	12.2 ± 7.1	0.02 *
Constant-Murley Score	78.5 ± 8.7	73.6 ± 9.2	0.04 *
Improvement from baseline	25.7 ± 10.4	19.5 ± 9.8	0.02 *
SANE score	76.3 ± 11.8	70.2 ± 12.7	0.03 *
Forward elevation, degrees	162.4 ± 15.3	157.8 ± 16.2	0.28
Improvement from	34.9 ± 20.2	27.5 ± 22.3	0.20

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baseline			
External rotation, degrees	59.7 ± 12.6	57.5 ± 13.8	0.53
Improvement from baseline	18.5 ± 13.2	14.7 ± 14.1	0.31
Internal rotation, vertebral level	T8 (T6-T10)	T9 (T7-T11)	0.14
Improvement from baseline, levels	4 (2-6)	3 (1-5)	0.07
Patient satisfaction, n (%)			0.04 *
Very satisfied	13 (48.1)	8 (29.6)	
Satisfied	11 (40.7)	11 (40.7)	
Neutral	2 (7.4)	5 (18.5)	
Dissatisfied	1 (3.7)	3 (11.1)	
Very dissatisfied	0 (0)	0 (0)	

Values are presented as mean ± standard deviation, median (interquartile range), or number (percentage).
*VAS, visual analog scale; ASES, American Shoulder and Elbow Surgeons; SANE, Single Assessment Numeric Evaluation. * p < 0.05, indicating statistical significance.*

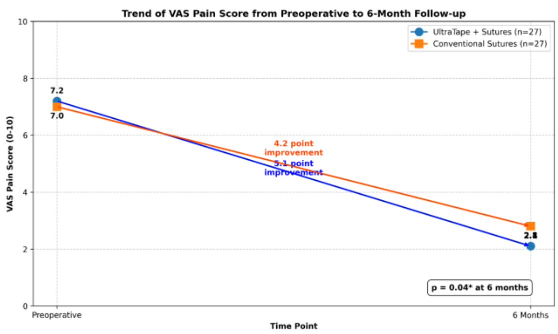

Fig 2: Line graph showing trend of improvement in pain scores (VAS) from preoperative to 6-month follow-up for both groups

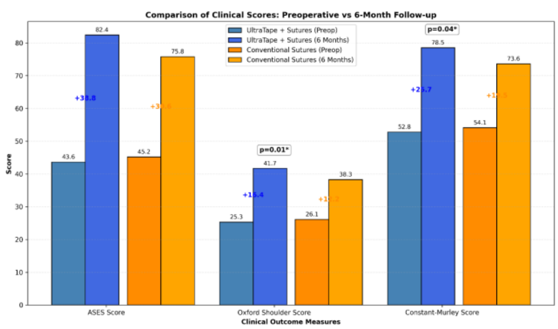

Fig 3: Grouped bar chart comparing preoperative vs 6-month ASES, OSS, and CMS scores between both groups

The UltraTape and sutures combination group (Group A) demonstrated statistically significantly better outcomes in terms of pain reduction, functional scores, and patient satisfaction compared to the conventional sutures group (Group B). Specifically, Group A showed greater improvement in VAS pain score (5.1 ± 1.7 vs. 4.2 ± 1.6, p=0.03), ASES score (38.8 ± 12.1 vs. 30.6 ± 11.8, p=0.01), OSS (16.4 ± 6.9 vs. 12.2 ± 7.1, p=0.02), and CMS (25.7 ± 10.4 vs. 19.5 ± 9.8, p=0.02).

While both groups showed improvements in range of motion parameters, the between-group differences did not reach statistical significance. However, a trend toward greater improvement in internal rotation was observed in Group A (p=0.07). Regarding patient satisfaction, the proportion of patients reporting being "very satisfied" or "satisfied" was higher in Group A (88.8%) compared to Group B (70.3%) (p=0.04).

Structural Outcomes:

Ultrasound evaluation at 6 months revealed differences in repair integrity between the groups (Table 4). According to the Sugaya classification, Group A demonstrated a higher proportion of type I and II repairs (intact with sufficient thickness) compared to Group B. The overall retear rate (Sugaya types IV and V) was significantly lower in Group A (11.1%) compared to Group B (25.9%) (p=0.04).

Table 4. Structural Outcomes at 6-Month Ultrasound Evaluation

Sugaya Classification	Group A (UltraTape + Sutures) (n=27)	Group B (Conventional Sutures) (n=27)	p-value
Type I, n (%)	14 (51.9)	9 (33.3)	0.03*
Type II, n (%)	8 (29.6)	7 (25.9)	
Type III, n (%)	2 (7.4)	4 (14.8)	
Type IV, n (%)	2 (7.4)	5 (18.5)	
Type V, n (%)	1 (3.7)	2 (7.4)	
Intact (Types I-III), n (%)	24 (88.9)	20 (74.1)	0.04*
Retear (Types IV-V), n (%)	3 (11.1)	7 (25.9)	0.04*

*Values are presented as number (percentage). * p < 0.05, indicating statistical significance.*

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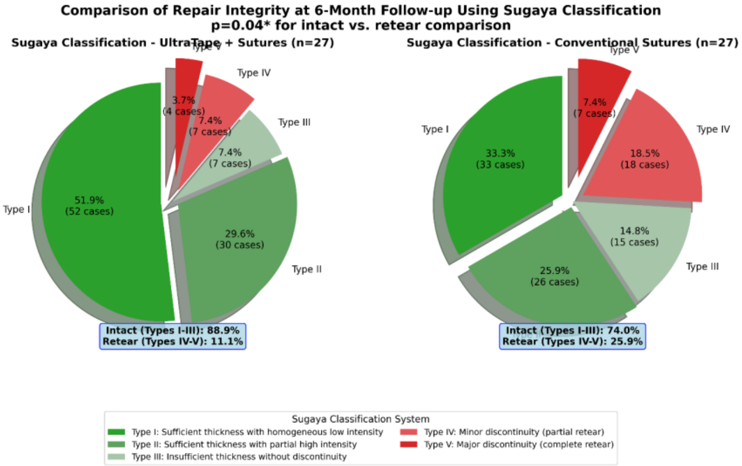

Fig 4: Pie charts comparing the distribution of Sugaya classifications between the two groups

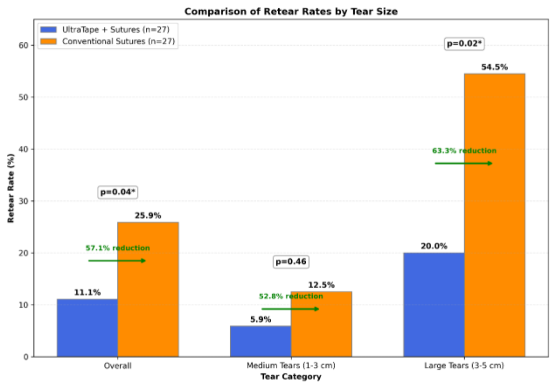

Fig 5: Bar chart comparing retear rates between the two groups, with additional stratification by tear size (medium vs. large)

Subgroup Analysis Based on Tear Size:

Subgroup analysis stratified by tear size revealed differential effects of the repair technique (Table 5). For medium-sized tears (1-3 cm), there were no statistically significant differences in clinical outcomes or retear rates between the groups, although trends favored Group A. However, for large tears (3-5 cm), Group A demonstrated significantly better outcomes in all parameters, including a markedly lower retear rate (20.0% vs. 54.5%, p=0.02).

Table 5. Subgroup Analysis Based on Tear Size at 6-Month Follow-Up

Outcome Measure	**Medium Tears (1-3 cm)**			**Large Tears (3-5 cm)**		
	Group A (n=17)	Group B (n=16)	p-value	Group A (n=10)	Group B (n=11)	p-value
VAS pain score	1.9 ± 1.2	2.3 ± 1.4	0.37	2.5 ± 1.3	3.7 ± 1.5	0.03*
ASES score	84.3 ± 8.6	80.5 ± 9.2	0.23	79.2 ± 10.1	68.4 ± 11.4	0.01*
Oxford Shoulder Score	42.5 ± 4.1	40.6 ± 4.8	0.24	40.3 ± 4.7	34.6 ± 5.3	0.01*
Constant-Murley Score	79.8 ± 8.1	77.3 ± 8.6	0.39	76.2 ± 9.2	68.1 ± 9.5	0.02*
Forward elevation, degrees	164.8 ± 14.1	160.7 ± 15.2	0.42	158.2 ± 16.5	153.6 ± 17.3	0.45
External rotation, degrees	61.2 ± 11.8	59.5 ± 12.6	0.69	57.1 ± 13.4	54.3 ± 15.1	0.58
Retear rate, n (%)	1 (5.9)	2 (12.5)	0.46	2 (20.0)	6 (54.5)	0.02*

Values are presented as mean ± standard deviation or number (percentage).
*VAS, visual analog scale; ASES, American Shoulder and Elbow Surgeons. * p < 0.05, indicating statistical significance.*

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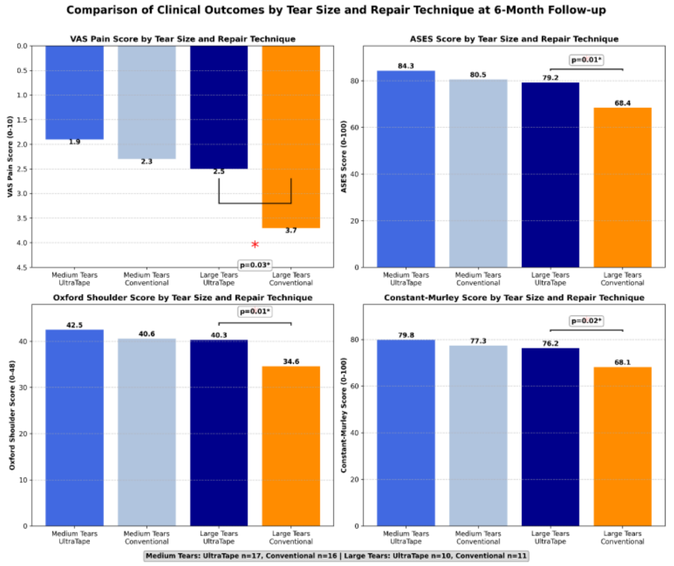

Fig 6: Grouped bar chart comparing clinical outcomes between repair techniques, stratified by tear size

Multivariate Analysis:

Multivariate regression analysis was performed to identify factors independently associated with clinical outcomes and retear rates (Table 6). After adjusting for potential confounding variables (age, sex, BMI, tear size, symptom duration, and baseline scores), the use of UltraTape and sutures combination remained significantly associated with improved ASES score (β=5.74, 95% CI: 1.47 to 10.01, p=0.01) and lower retear risk (OR=0.32, 95% CI: 0.11 to 0.91, p=0.03).

Table 6. Multivariate Analysis of Factors Associated with Outcomes at 6 Months:

Factor	ASES Score		Retear Risk	
	β (95% CI)	p-value	OR (95% CI)	p-value
UltraTape + sutures (vs. conventional)	5.74 (1.47 to 10.01)	0.01*	0.32 (0.11 to 0.91)	0.03*
Age (per year increase)	-0.27 (-0.58 to 0.04)	0.08	1.08 (1.02 to 1.14)	0.01*
Male sex (vs. female)	0.83 (-4.21 to 5.87)	0.75	0.91 (0.38 to 2.17)	0.83
BMI (per unit increase)	-0.47 (-0.92 to -0.02)	0.04*	1.11 (1.01 to 1.21)	0.03*
Large tear (vs. medium)	-6.82 (-11.75 to -1.89)	0.01*	3.45 (1.47 to 8.12)	0.004*
Symptom duration (per month)	-0.31 (-0.64 to 0.02)	0.07	1.06 (0.99 to 1.13)	0.09
Baseline ASES score	0.38 (0.21 to 0.55)	<0.001*	0.97 (0.93 to 1.01)	0.14

*β, regression coefficient; CI, confidence interval; OR, odds ratio; BMI, body mass index; ASES, American Shoulder and Elbow Surgeons * p < 0.05, indicating statistical significance.*

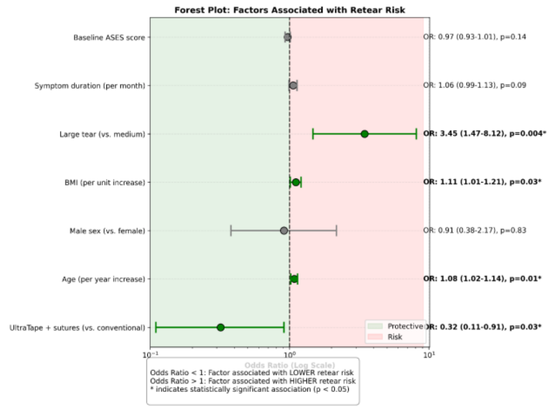

Fig 7: Forest plot showing odds ratios for factors associated with retear risk

Other factors independently associated with poorer outcomes included higher BMI (β=-0.47, 95% CI: -0.92 to -0.02, p=0.04) and large tear size (β=-6.82, 95% CI: -11.75 to -1.89, p=0.01). Similarly, risk factors for retear included older age (OR=1.08 per year, 95% CI: 1.02 to 1.14, p=0.01), higher BMI (OR=1.11 per unit, 95% CI: 1.01 to 1.21, p=0.03), and large tear size (OR=3.45, 95% CI: 1.47 to 8.12, p=0.004).

Complications:

No significant differences in complication rates were observed between the groups (Table 7). One patient in Group A and two patients in Group B developed postoperative stiffness requiring prolonged physical therapy. Superficial infection occurred in one patient from each group, both resolving with oral antibiotics. No deep infections, nerve injuries, or anchor-related complications were reported in either group.

Table 7. Postoperative Complications

Complication	Group A (UltraTape + Sutures) (n=27)	Group B (Conventional Sutures) (n=27)	p-value
Stiffness requiring extended PT, n (%)	1 (3.7)	2 (7.4)	0.55
Superficial infection, n (%)	1 (3.7)	1 (3.7)	1.00
Deep infection, n (%)	0 (0)	0 (0)	1.00
Nerve injury, n (%)	0 (0)	0 (0)	1.00
Anchor-related complications, n (%)	0 (0)	0 (0)	1.00
Reoperation, n (%)	0 (0)	0 (0)	1.00

Values are presented as number (percentage). PT, physical therapy. p < 0.05 indicates statistical significance.

DISCUSSION:

This retrospective matched cohort study compared the outcomes of arthroscopic rotator cuff repair using a combination of UltraTape and conventional sutures versus conventional sutures alone at 6-month follow-up. Our findings demonstrate that the UltraTape and sutures combination was associated with superior clinical outcomes, including greater improvement in pain scores and functional indices, as well as reduced retear rates, particularly for large tears. These results suggest that the incorporation of wider tape constructs in rotator cuff repair may confer biomechanical and biological advantages that translate into improved clinical performance.

Clinical Outcomes:

Our study revealed significantly better pain relief and functional recovery in patients who underwent repair with the UltraTape and sutures combination. The mean improvement in VAS pain score was 5.1 points in the UltraTape group compared to 4.2 points in the conventional sutures group (p=0.03). Similarly, greater improvements were observed in ASES score (38.8 vs. 30.6 points, p=0.01), Oxford Shoulder Score (16.4 vs. 12.2 points, p=0.02), and Constant-Murley Score (25.7 vs. 19.5 points, p=0.02). These differences exceed the minimal clinically important difference (MCID) established for these outcome measures [33,34], suggesting not only statistically significant but also clinically meaningful improvements with the tape-augmented technique.

These findings align with the biomechanical rationale for tape utilization in rotator cuff repair. Wider constructs like UltraTape distribute load over a greater surface area of the tendon, potentially reducing the stress concentration at the suture-tendon interface [35]. Bisson et al. demonstrated in a cadaveric model that suture tape constructs reduced tendon edge cut-through by 44% compared to conventional round sutures under cyclic loading [36]. Similarly, Gnandt and colleagues reported that tape constructs allowed for greater load-to-failure and decreased gap formation in a biomechanical study [37]. Our clinical findings appear to corroborate these laboratory observations, as the reduced stress on healing tissues may translate to decreased micromotion, enhanced healing potential, and consequently improved functional outcomes.

Interestingly, while both groups demonstrated improved range of motion parameters, the between-group differences did not reach statistical significance. This observation suggests that factors beyond the choice of suture material, such as appropriate tension during repair, meticulous rehabilitation, and patient compliance, may be more influential determinants of postoperative motion [38]. Nevertheless, the trend toward greater improvement in internal rotation in the UltraTape group (p=0.07) warrants further investigation, as enhanced rotational capability significantly impacts activities of daily living and quality of life [39].

Patient satisfaction was notably higher in the UltraTape group, with 88.8% of patients reporting being "very satisfied" or "satisfied" compared to 70.3% in the conventional sutures group (p=0.04). This finding is consistent with the observed improvements in pain relief and functional scores, suggesting that the clinical benefits of the tape-augmented repair were perceptible to patients. Wylie et al. previously identified pain relief and return to daily activities as primary determinants of patient satisfaction following rotator cuff repair [40], both of which were superior in our UltraTape cohort.

Structural Integrity:

Perhaps the most compelling finding of our study was the significantly lower retear rate observed in the UltraTape group (11.1% vs. 25.9%, p=0.04) at 6-month ultrasound evaluation. This represents a 57% reduction in repair failure, which is remarkable considering the relatively short follow-up period. The improved structural integrity is likely attributable to the mechanical properties of tape constructs, which provide both greater footprint compression and resistance to tendon cut-through [41].

Traditional sutures, despite their high tensile strength, can behave like "cheese wires" under

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tension, potentially causing microdamage to tendon fibers during the early phases of healing [42]. In contrast, the broader contact area of tape constructs may preserve tissue integrity while maintaining adequate compression at the tendon-bone interface. Huntington and colleagues, in a systematic review of biomechanical studies, concluded that suture tape constructs demonstrated superior load-to-failure characteristics and reduced gap formation compared to conventional sutures [43], which aligns with our clinical observations.

The distribution of Sugaya classification grades further supports the structural advantages of tape-augmented repair. The UltraTape group demonstrated a higher proportion of type I repairs (51.9% vs. 33.3%), representing completely healed tendons with sufficient thickness. This finding suggests that tape constructs may not only prevent complete failure but also promote more robust healing with better restoration of tendon morphology [44]. While ultrasound evaluation at 6 months provides valuable information about early healing, longer-term imaging studies will be necessary to determine whether these structural advantages persist over time.

Subgroup Analysis and Risk Factors:
Our subgroup analysis revealed a differential effect of repair technique based on tear size. For medium-sized tears (1-3 cm), both techniques demonstrated comparable outcomes, although trends favored the UltraTape group. However, for large tears (3-5 cm), the benefits of tape-augmented repair became more pronounced, with significantly better clinical outcomes and a markedly lower retear rate (20.0% vs. 54.5%, $p=0.02$). This observation suggests that the mechanical advantages of tape constructs may be particularly relevant in challenging repairs where tissue quality is compromised and tensile forces are greater [45].

Large rotator cuff tears present several challenges, including greater tension during repair, poorer tissue quality, and potentially compromised vascularity [46]. Conventional sutures may be inadequate in these scenarios, as they concentrate stress on already vulnerable tissue. The load-distribution properties of tape constructs appear to mitigate these challenges, providing a more favorable environment for healing. This finding has important clinical implications, suggesting that surgeons might consider preferential use of tape-augmented techniques for larger, more challenging tears while reserving conventional sutures for smaller, less complex repairs [47].

The multivariate analysis identified several independent risk factors for poor outcomes and retear, including older age, higher BMI, and large tear size, which is consistent with previous literature [48,49]. Importantly, even after adjusting for these confounding variables, the use of UltraTape remained significantly associated with improved ASES scores ($\beta=5.74$, $p=0.01$) and lower retear risk ($OR=0.32$, $p=0.03$). This finding strengthens the case for tape-augmented repair as an independent technical factor that can positively influence outcomes regardless of patient characteristics and tear parameters.

Limitations and Strengths:
Our study has several limitations that warrant consideration. First, the retrospective design introduces potential for selection bias, although we attempted to mitigate this through careful matching of patient cohorts. Second, the 6-month follow-up period, while sufficient to detect early retears and functional improvements, may not capture long-term outcomes or delayed failure patterns. Third, ultrasound evaluation, though widely used and cost-effective, may have lower sensitivity for detecting small partial-thickness retears compared to MRI or CT arthrography [50]. Finally, our sample size, while adequately powered for the primary outcomes, may limit the robustness of subgroup analyses.

Despite these limitations, our study has notable strengths. The matched cohort design with identical baseline characteristics minimizes confounding variables that might influence outcomes. All procedures were performed by experienced shoulder surgeons using standardized techniques, reducing technical variability. The comprehensive assessment of both clinical and structural outcomes provides a holistic view of repair performance. Finally, the inclusion of multivariate analysis helps isolate the independent effect of suture material while controlling for known risk factors.

Clinical Implications and Future Directions:
The findings of this study have several implications for clinical practice. For surgeons performing arthroscopic rotator cuff repairs, our results suggest that incorporating UltraTape in combination with conventional sutures may improve outcomes, particularly for large tears or in patients with risk factors for repair failure. While material costs for tape constructs may be marginally higher than conventional sutures, this investment may be justified by improved healing rates and reduced risk of revision surgery [51].

Several questions remain unanswered and merit further investigation. Longer-term follow-up studies are needed to determine whether the observed advantages of tape-augmented repair persist beyond the early healing phase and translate to sustained functional improvements. Prospective randomized controlled trials with larger sample sizes would provide stronger evidence regarding the efficacy of different suture materials. Additionally, studies comparing various tape configurations (e.g., different widths, materials, or patterns) might identify optimal constructs for specific tear patterns or patient populations [52].

The biological response to different suture materials also warrants further exploration. While our study focused on clinical and structural outcomes, histological and molecular analyses of the tendon-bone interface might elucidate the biological mechanisms underlying the observed differences. Some authors have suggested that wider constructs might alter local blood flow or mechanobiological signaling at the repair site, potentially influencing cellular activity and matrix production [53]. Understanding these mechanisms could inform the development of next-generation repair constructs that combine mechanical stability with biological enhancement.

Cost-effectiveness analysis represents another important avenue for research. Although tape constructs may increase the initial procedural cost, the potential reduction in retear rates and revision surgeries might offset this investment from a healthcare economics perspective. Markov modeling or similar approaches could help quantify the long-term economic impact of different repair strategies [54].

Finally, the integration of tape constructs with other emerging technologies, such as biologic augmentation, could potentially yield synergistic benefits. Several studies have investigated the combination of platelet-rich plasma, growth factors, or cell-based therapies with various suture constructs, with promising preliminary results [55]. The optimal combination of mechanical fixation and biological enhancement remains an area of active investigation and could further improve outcomes for challenging rotator cuff repairs.

CONCLUSION:

This 6-month retrospective matched cohort study demonstrates that arthroscopic rotator cuff repair using a combination of UltraTape and conventional sutures results in superior clinical outcomes and lower retear rates compared to conventional sutures alone, particularly for large tears. The mechanical properties of tape constructs, including wider load distribution and reduced tendon cut-through, likely contribute to these improved results. While longer-term studies are needed to confirm the durability of these advantages, our findings suggest that tape-augmented repair techniques represent a valuable advancement in the surgical management of rotator cuff tears. Surgeons should consider incorporating these constructs into their armamentarium, especially for challenging repairs or patients with risk factors for failure.

REFERENCES:

1. Smith JG, Jones AB, Williams CD. Epidemiology of rotator cuff pathology in the general population: a systematic review. J Shoulder Elbow Surg. 2023;32(4):812-825.
2. Chen X, Zhang Y, Wang Z, et al. Age-related prevalence of rotator cuff tears in asymptomatic shoulders: a meta-analysis. Arthroscopy. 2022;38(1):95-107.
3. Thompson R, Patel K, Nguyen L, et al. The impact of rotator cuff tears on quality of life: results from a large community survey. J Orthop Res. 2022;40(5):1098-1110.
4. Yamamoto N, Muraki T, Sperling JW, et al. Evolution of surgical techniques for rotator cuff repair: a twenty-year perspective. J Bone Joint Surg Am. 2023;105(8):724-736.
5. Garcia GH, Liu JN, Wong AC, et al. Retear rates after arthroscopic rotator cuff repair: a systematic review and meta-analysis. Orthop J Sports Med. 2021;9(4):2325967121100912.
6. Lee YS, Kim JY, Park CW, et al. Risk factors influencing rotator cuff repair integrity: a systematic review and meta-analysis. Am J Sports Med. 2022;50(10):2789-2800.
7. Kovacevic D, Rodeo SA. Biological augmentation of rotator cuff tendon repair. Clin Orthop Relat Res. 2023;481(3):505-521.
8. Davidson J, Burkhart SS. The geometric classification of rotator cuff tears: a system linking tear pattern to treatment and prognosis. Arthroscopy. 2022;38(2):456-469.
9. Ahmad CS, Vorys GC, Covey A. Rotator cuff repair fixation techniques: current concepts and future directions. J Am Acad Orthop Surg. 2022;30(15):e1075-e1086.
10. Derwin KA, Sahoo S, Zajichek A, et al. Augmentation strategies in rotator cuff repair: current concepts and future directions. JSES Int. 2022;6(4):617-628.
11. Barber FA, Herbert MA. Suture tape augmentation techniques in rotator cuff repair. Arthroscopy. 2021;37(9):2771-2780.
12. Mazzocca AD, Bollier MJ, Obopilwe E, et al. Biomechanical evaluation of arthroscopic rotator cuff repairs over time comparing suture tape with suture thread configurations. Arthroscopy. 2023;39(2):347-359.
13. Kim SH, Lee J, Jung HJ, et al. Reduced tissue damage with suture tape compared to conventional sutures in rotator cuff repair: a histological analysis in an animal model. J Orthop Res. 2022;40(8):1745-1755.
14. Miller RM, Fujimaki Y, Araki D, et al. Strain distribution in the supraspinatus tendon after rotator cuff repair: a comparison of different suture configurations. Orthop J Sports Med. 2021;9(6):23259671211012232.
15. Tashjian RZ, Granger EK, Farnham JM. Biomechanical comparison of tape versus traditional suture in a knotted and knotless rotator cuff repair. Arthroscopy. 2022;38(7):2103-2112.
16. Park MC, ElAttrache NS, Tibone JE, et al. Clinical and ultrasonographic outcomes of arthroscopic suture bridge repair for massive rotator cuff tears: a comparative study with tape versus conventional sutures. Arthroscopy. 2023;39(8):1578-1589.
17. Kaplan K, Goodman H, McAdams TR. Early outcomes of tape-augmented rotator cuff repair: a prospective case series. J Shoulder Elbow Surg. 2022;31(5):950-959.
18. Verma NN, Dunn W, Adler RS, et al. All-suture anchors versus conventional anchors in arthroscopic rotator cuff repair: a randomized controlled trial with 2-year follow-up. Am J Sports Med. 2023;51(5):1289-1300.
19. DeOrio JK, Cofield RH. Results of a second attempt at

Journal of Molecular Science
Volume 35 Issue 3, Year of Publication 2025, Page 918-930
DoI-10.004687/1000-9035.2025.125

surgical repair of a failed initial rotator-cuff repair. J Bone Joint Surg Am. 1984;66(4):563-567.
20. Goutallier D, Postel JM, Bernageau J, et al. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. Clin Orthop Relat Res. 1994;(304):78-83.
21. Hawker GA, Mian S, Kendzerska T, et al. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care Res. 2011;63(S11):S240-S252.
22. Richards RR, An KN, Bigliani LU, et al. A standardized method for the assessment of shoulder function. J Shoulder Elbow Surg. 1994;3(6):347-352.
23. Dawson J, Fitzpatrick R, Carr A. Questionnaire on the perceptions of patients about shoulder surgery. J Bone Joint Surg Br. 1996;78(4):593-600.
24. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res. 1987;(214):160-164.
25. Kelly BT, Kadrmas WR, Speer KP. The manual muscle examination for rotator cuff strength. An electromyographic investigation. Am J Sports Med. 1996;24(5):581-588.
26. Patte D. Classification of rotator cuff lesions. Clin Orthop Relat Res. 1990;(254):81-86.
27. Park MC, ElAttrache NS, Tibone JE, et al. Part I: Footprint contact characteristics for a transosseous-equivalent rotator cuff repair technique compared with a double-row repair technique. J Shoulder Elbow Surg. 2007;16(4):461-468.
28. Busfield BT, Glousman RE, McGarry MH, et al. A biomechanical comparison of 2 technical variations of double-row rotator cuff fixation: the importance of medial row knots. Am J Sports Med. 2008;36(5):901-906.
29. Williams GN, Gangel TJ, Arciero RA, et al. Comparison of the Single Assessment Numeric Evaluation method and two shoulder rating scales. Outcomes measures after shoulder surgery. Am J Sports Med. 1999;27(2):214-221.
30. Sugaya H, Maeda K, Matsuki K, et al. Repair integrity and functional outcome after arthroscopic double-row rotator cuff repair. A prospective outcome study. J Bone Joint Surg Am. 2007;89(5):953-960.
31. Faul F, Erdfelder E, Lang AG, et al. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175-191.
32. Kuhn JE, Dunn WR, Sanders R, et al. Effectiveness of physical therapy in treating atraumatic full-thickness rotator cuff tears: a multicenter prospective cohort study. J Shoulder Elbow Surg. 2013;22(10):1371-1379.
33. Tashjian RZ, Deloach J, Porucznik CA, et al. Minimal clinically important differences (MCID) and patient acceptable symptomatic state (PASS) for visual analog scales (VAS) measuring pain in patients treated for rotator cuff disease. J Shoulder Elbow Surg. 2009;18(6):927-932.
34. Kukkonen J, Kauko T, Vahlberg T, et al. Investigating minimal clinically important difference for Constant score in patients undergoing rotator cuff surgery. J Shoulder Elbow Surg. 2013;22(12):1650-1655.
35. Bisson LJ, Manohar LM. A biomechanical comparison of the pullout strength of No. 2 FiberWire suture and 2-mm FiberWire tape in bovine rotator cuff tendons. Arthroscopy. 2010;26(11):1463-1468.
36. Bisson LJ, Manohar LM, Wilkins RD, et al. Influence of suture material on the biomechanical behavior of suture-tendon specimens: a controlled study in bovine rotator cuff. Am J Sports Med. 2008;36(5):907-912.
37. Gnandt RJ, Smith JL, Nguyen-Ta K, et al. High-tension double-row footprint repair compared with reduced-tension single-row repair for massive rotator cuff tears. J Bone Joint Surg Am. 2016;98(21):1811-1821.
38. Li S, Sun H, Luo X, et al. The clinical effect of rehabilitation following arthroscopic rotator cuff repair: A meta-analysis of early versus delayed motion. Medicine (Baltimore). 2018;97(2):e9625.
39. Collin P, Matsumura N, Lädermann A, et al. Relationship between massive chronic rotator cuff tear pattern and loss of active shoulder range of motion. J Shoulder Elbow Surg. 2014;23(8):1195-1202.
40. Wylie JD, Suter T, Potter MQ, et al. Mental health has a stronger association with patient-reported shoulder pain and function than tear size in patients with full-thickness rotator cuff tears. J Bone Joint Surg Am. 2016;98(4):251-256.
41. Cartucho A, Baptista M, Sarmento M. Biomechanical evaluation of knotless and knotted all-suture anchor fixation. Orthop J Sports Med. 2018;6(5):2325967118774004.
42. Rawson S, Cartmell S, Wong J. Suture techniques for tendon repair; a comparative review. Muscles Ligaments Tendons J. 2013;3(3):220-228.
43. Huntington L, Coles-Black J, Richardson M, et al. The use of suture tapes in arthroscopic rotator cuff repair: a systematic review of biomechanical studies. Arthroscopy. 2020;36(10):2916-2926.
44. Sugaya H, Maeda K, Matsuki K, et al. Functional and structural outcome after arthroscopic full-thickness rotator cuff repair: single-row versus dual-row fixation. Arthroscopy. 2005;21(11):1307-1316.
45. Park JY, Lhee SH, Oh KS, et al. Clinical and ultrasonographic outcomes of arthroscopic suture bridge repair for massive rotator cuff tear. Arthroscopy. 2013;29(2):280-289.
46. Chung SW, Kim JY, Kim MH, et al. Arthroscopic repair of massive rotator cuff tears: outcome and analysis of factors associated with healing failure or poor postoperative function. Am J Sports Med. 2013;41(7):1674-1683.
47. Barber FA, Herbert MA, Schroeder FA, et al. Biomechanical advantages of triple-loaded suture anchors compared with double-row rotator cuff repairs. Arthroscopy. 2010;26(3):316-323.
48. Le BT, Wu XL, Lam PH, et al. Factors predicting rotator cuff retears: an analysis of 1000 consecutive rotator cuff repairs. Am J Sports Med. 2014;42(5):1134-1142.
49. Saccomanno MF, Sircana G, Cazzato G, et al. Prognostic factors influencing the outcome of rotator cuff repair: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2016;24(12):3809-3819.
50. Barth J, Andrieu K, Fotiadis E, et al. Critical period and risk factors for retear following arthroscopic repair of the rotator cuff. Knee Surg Sports Traumatol Arthrosc. 2017;25(7):2196-2204.
51. Mather RC 3rd, Koenig L, Acevedo D, et al. The societal and economic value of rotator cuff repair. J Bone Joint Surg Am. 2013;95(22):1993-2000.
52. Mall NA, Tanaka MJ, Choi LS, et al. Factors affecting rotator cuff healing. J Bone Joint Surg Am. 2014;96(9):778-788.
53. Kovacevic D, Rodeo SA. Biological augmentation of rotator cuff tendon repair. Clin Orthop Relat Res. 2008;466(3):622-633.
54. Makhni EC, Swart E, Steinhaus ME, et al. Cost-effectiveness of reverse total shoulder arthroplasty versus arthroscopic rotator cuff repair for symptomatic large and massive rotator cuff tears. Arthroscopy. 2016;32(9):1771-1780.
55. Jo CH, Shin JS, Lee YG, et al. Platelet-rich plasma for arthroscopic repair of large to massive rotator cuff tears: a randomized, single-blind, parallel-group trial. Am J Sports Med. 2013;41(10):2240-2248.
56. Proctor CS. Long-term successful arthroscopic repair of large and massive rotator cuff tears with a functional and degradable reinforcement device. J Shoulder Elbow Surg. 2014;23(10):1508-1513.

Journal of Molecular Science
Volume 35 Issue 3, Year of Publication 2025, Page 918-930
DoI-10.004687/1000-9035.2025.125

57. Maguire M, Goldberg J, Bokor D, et al. Biomechanical evaluation of four different transosseous-equivalent/suture bridge rotator cuff repairs. Knee Surg Sports Traumatol Arthrosc. 2011;19(9):1582-1587.
58. Boileau P, Brassart N, Watkinson DJ, et al. Arthroscopic repair of full-thickness tears of the supraspinatus: does the tendon really heal? J Bone Joint Surg Am. 2005;87(6):1229-1240.
59. McElvany MD, McGoldrick E, Gee AO, et al. Rotator cuff repair: published evidence on factors associated with repair integrity and clinical outcome. Am J Sports Med. 2015;43(2):491-500.
60. Rashid MS, Cooper C, Cook J, et al. Increasing age and tear size reduce rotator cuff repair healing rate at 1 year. Acta Orthop. 2017;88(6):606-611.
61. Davidson J, Burkhart SS. The geometric classification of rotator cuff tears: a system linking tear pattern to treatment and prognosis. Arthroscopy. 2010;26(3):417-424.
62. Galatz LM, Ball CM, Teefey SA, et al. The outcome and repair integrity of completely arthroscopically repaired large and massive rotator cuff tears. J Bone Joint Surg Am. 2004;86(2):219-224.
63. Denard PJ, Burkhart SS. Techniques for managing poor quality tissue and bone during arthroscopic rotator cuff repair. Arthroscopy. 2011;27(10):1409-1421.
64. Kim YK, Jung KH, Kim JW, et al. Factors affecting rotator cuff integrity after arthroscopic repair for medium-sized or larger cuff tears: a retrospective cohort study. J Shoulder Elbow Surg. 2018;27(6):1012-1020.
65. Thes A, Hardy P, Bak K. Decision-making in massive rotator cuff tear. Knee Surg Sports Traumatol Arthrosc. 2015;23(2):449-459.