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Comparable clinical outcome with greater thickness and lesser re-tear rate following allogenous dermal scaffold augmentation for large to massive rotator cuff tears: a retrospective case-controlled study

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Abstract

Background Allogenous dermal scaffold augmentation enhances partial rotator cuff repairs by providing structural support and a biologic scaffold that promotes tissue regeneration, reduces mechanical strain, and compensates for poor tendon quality in large to massive rotator cuff tears. This approach helps lower the risk of retear and improves functional recovery.

Methods This study included 55 patients with large to massive rotator cuff tears, divided into two groups. Group A (28 patients) underwent arthroscopic partial repair, while Group B (27 patients) received allogenous dermal scaffold graft augmentation following partial repair to reinforce the repair and resurface the uncovered tendon footprint. Clinical assessments, including the University of California-Los Angeles score, Constant-Murley score, and visual analogue scale, were conducted preoperatively, at 3, 6, and 12 months postoperatively, and annually thereafter. Radiologic evaluations, including magnetic resonance imaging and ultrasonography, were performed preoperatively and postoperatively to assess tendon integrity.

Results The mean follow-up period was 40 months for Group A and 36 months for Group B. Clinical functional scores significantly improved in both groups at the final follow-up. Postoperative radiologic assessment showed 9 retears in Group A and 4 in Group B ($p < 0.05$), respectively, with significantly greater postoperative tendon thickness in Group B compared to Group A (p-value < 0.05). Additionally, acromiohumeral distance improved significantly in both groups, from 7 mm to 9 mm in Group A and from 7 mm to 11 mm in Group B, with Group B demonstrating superior improvement ($p < 0.01$).

Conclusion This study suggests that allogenous dermal scaffold graft augmentation, in addition to partial repair, enhances tendon thickness and acromiohumeral distance. Furthermore, it results in lower retear rates compared to partial repair alone.

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Keywords Rotator cuff, Allograft, Large to massive, Partial repair, Graft augmentation

Background

Advancements in surgical techniques and augmentation methods have significantly expanded treatment options for rotator cuff tears (RCTs). However, despite these technical improvements, failure rates remain as high as 40% due to factors such as patient age, tear chronicity and size, the number of involved tendons, and soft tissue quality, all of which influence postoperative tendon healing [1–9].

RCTs are classified based on tear size, which is a critical factor in tendon healing. A large rotator cuff tear is defined as a full-thickness tear measuring 3 to 5 cm at its greatest dimension, whereas a massive tear is classified as one exceeding 5 cm or involving the complete rupture of at least two of the four rotator cuff tendons [3–10]. Surgical management options for large to massive RCTs include partial repair, tendon transfer, graft augmentation, superior capsular reconstruction, and reverse total shoulder arthroplasty, though no single approach has been established as the gold standard [3–14].

Arthroscopic repair remains the primary surgical approach for RCTs. In recent years, various graft augmentation techniques have been introduced to supplement the remaining footprint and reduce excessive tensile forces at the repair site [14–25]. Among these, allografts—primarily acellular dermal matrix grafts—are favored due to their biological compatibility, absence of donor site morbidity, support for tendon healing and thickness, and favorable long-term outcomes, making them a superior choice compared to alternative graft options [3–10, 15, 22–26]. Some studies have indicated that the use of a dermal matrix can improve clinical outcomes and reduce retear rates in partial rotator cuff repairs [15].

Therefore, this study aimed to compare the clinical and radiologic outcomes of partial repair alone versus partial repair with allogenous dermal scaffold (ADS) augmentation in large to massive RCTs. We hypothesized that ADS augmentation, in addition to partial repair, would lead to improved clinical and mechanical outcomes, supported by radiologic evidence of superior tendon integrity and lower postoperative retear rates.

Methods

Study design

This retrospective case-controlled study was approved by the institutional review board at our institution (IRB File# J****** 2***-**-***-***). It was conducted in accordance with the principles of the Declaration of Helsinki; therefore, the requirement for informed consent was waived.

A total of 264 consecutive patients diagnosed with large to massive RCTs who underwent surgery between January 2014 and December 2019 were included in the initial assessment. Patients were considered candidates for arthroscopic repair if they had large to massive RCTs without irreparable tears or advanced cuff tear arthropathy. The diagnosis was confirmed by magnetic resonance imaging (MRI), which demonstrated detachment from the footprint of the humeral greater tuberosity and substantial retraction of the torn rotator cuff tendons, assessed by measuring the coronal and sagittal tear lengths. In addition to preoperative radiologic evaluation, the final determination of reparability was made intraoperatively through arthroscopic assessment of tear mobilization, ensuring sufficient capacity for repair.

Partial coverage repair was defined as cases where the tear could not be fully covered using standard repair techniques but could be completely covered with ADS augmentation. Eligible patients were between 18 and 80 years old, had persistent pain and shoulder dysfunction despite at least six months of conservative treatment, and had a rotator cuff tear that could not be fully reduced to cover the entire footprint, as confirmed by intraoperative arthroscopic assessment.

Patients were excluded if they had large to massive RCTs with irreparable subscapularis tears, were unwilling to comply with postoperative MRI assessments, or had undergone reverse total shoulder arthroplasty (RTSA), tendon transfer, or superior capsular reconstruction. Among 72 patients with reparable large to massive RCTs, additional exclusion criteria included preoperative adhesive capsulitis (also known as frozen shoulder, a condition of the shoulder characterized by functional loss of both passive and active shoulder motion), inability to comply with proper rehabilitation, history of shoulder infection, and loss to follow-up due to symptom resolution or transportation barriers. Ultimately, 55 patients with superoposterior-type massive rotator cuff tears, involving only the supraspinatus and infraspinatus tendons, were included in the study.

A total of 28 patients who underwent arthroscopic partial repair of RCTs were assigned to Group (A) Partial repair was defined as a repair in which less than 50% of the footprint remained uncovered in the coronal plane after rotator cuff repair, with restoration of the rotator cable in the sagittal plane, without excessive tension on the supraspinatus and infraspinatus tendons. A total of 28 patients who underwent partial repair with ADS augmentation were assigned to Group (B) In this group, ADS grafts (CGDerm, CGBio Co., Daewoong Pharm, Seoul, Korea) were used to augment the uncovered footprint

following partial repair of large to massive RCTs. ADS grafts were chosen because (1) they are 4 mm thick for increased structural strength compared to xenografts, (2) eliminate donor site morbidity and patient unwillingness associated with autograft harvest, and (3) because synthetic grafts were unavailable for medical use in the domestic market at the time of the study (Fig. 1).

All patients underwent preoperative evaluation for shoulder and rotator cuff pathology using standard radiographs and MRI. Clinical outcomes were assessed using the visual analogue scale (VAS) for pain, the University of California – Los Angeles (UCLA) score, and the Constant-Murley score. These evaluations were performed preoperatively and postoperatively at 3, 6, and 12 months, and annually thereafter.

For anatomical assessment, fatty degeneration of the rotator cuff tendons was evaluated using the Goutallier classification [27], and tendon integrity was assessed by a single expert musculoskeletal radiologist at our institution. Tear size and retraction were measured on preoperative MRI for comparison. MRI was performed using a 3.0-T scanner (Gyroscan Intera Achieva; Philips Medical Systems, Best, Netherlands). T2-weighted MRI was used to measure the supraspinatus tendon's tear size in both coronal and sagittal oblique views. In the coronal oblique cut, the mediolateral tear size was defined as the straight-line distance between the tendon edge and the lateral cortex of the greater tuberosity. Tendon retraction was classified using the Patte classification [28].

To assess postoperative tendon integrity using the Sugaya classification, follow-up MRI was performed between 6 and 12 months postoperatively in all patients (Group A: 7.10 months ± 2.83; Group B: 7.32 months ± 2.83; $p > 0.05$). Sugaya grade IV or V was classified as a retear [29]. In addition, postoperative MRI was used to measure the thickness of the repaired supraspinatus tendon at its thickest point in the coronal plane to compare mechanical outcomes between the ADS augmentation group and the control group.

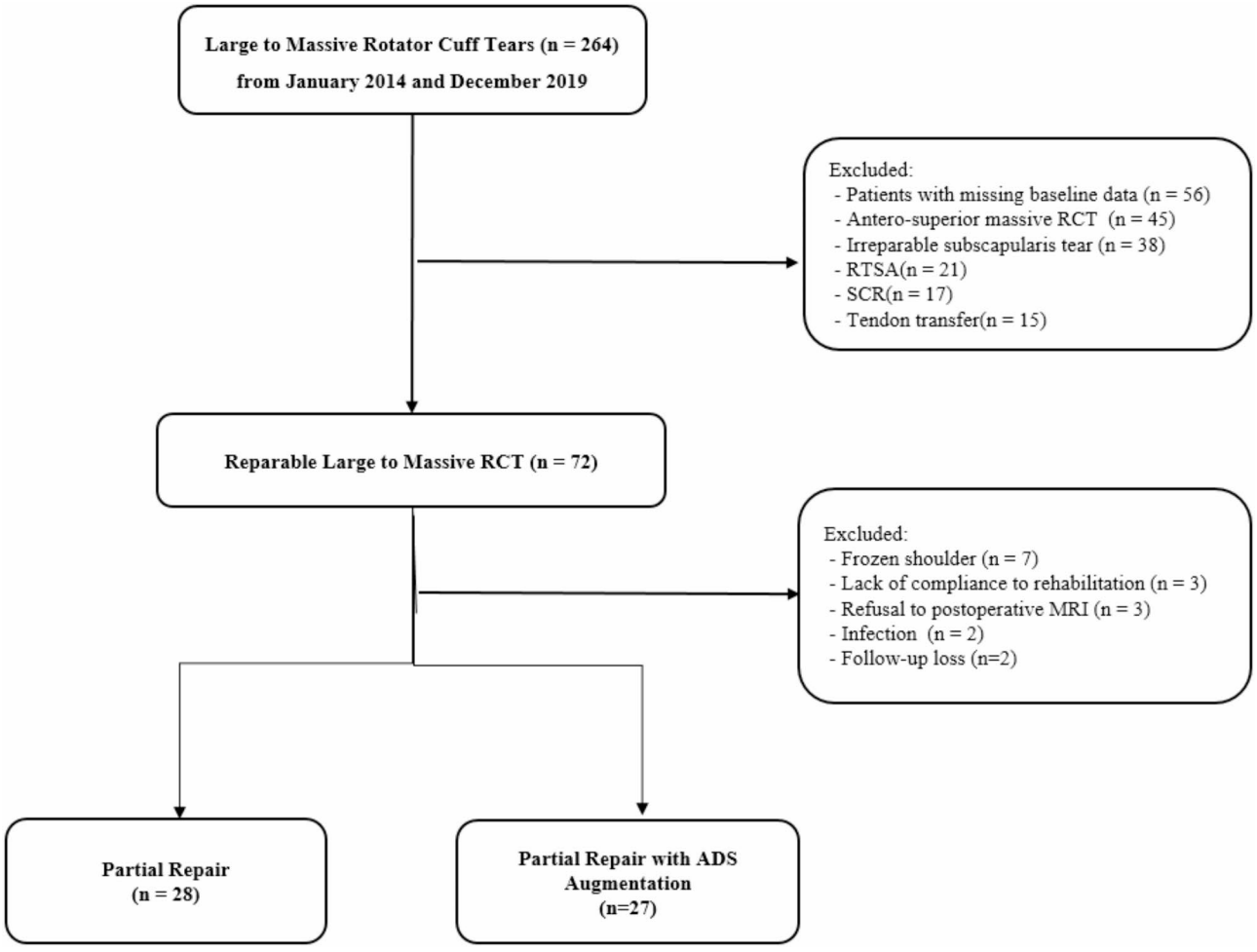

Fig. 1 Flowchart illustrating inclusion and exclusion criteria
RCTs: Rotator cuff tears, ADS: Allogenous dermal scaffold, RTSA: Reverse total shoulder arthroplasty, SCR: Superior capsular reconstruction

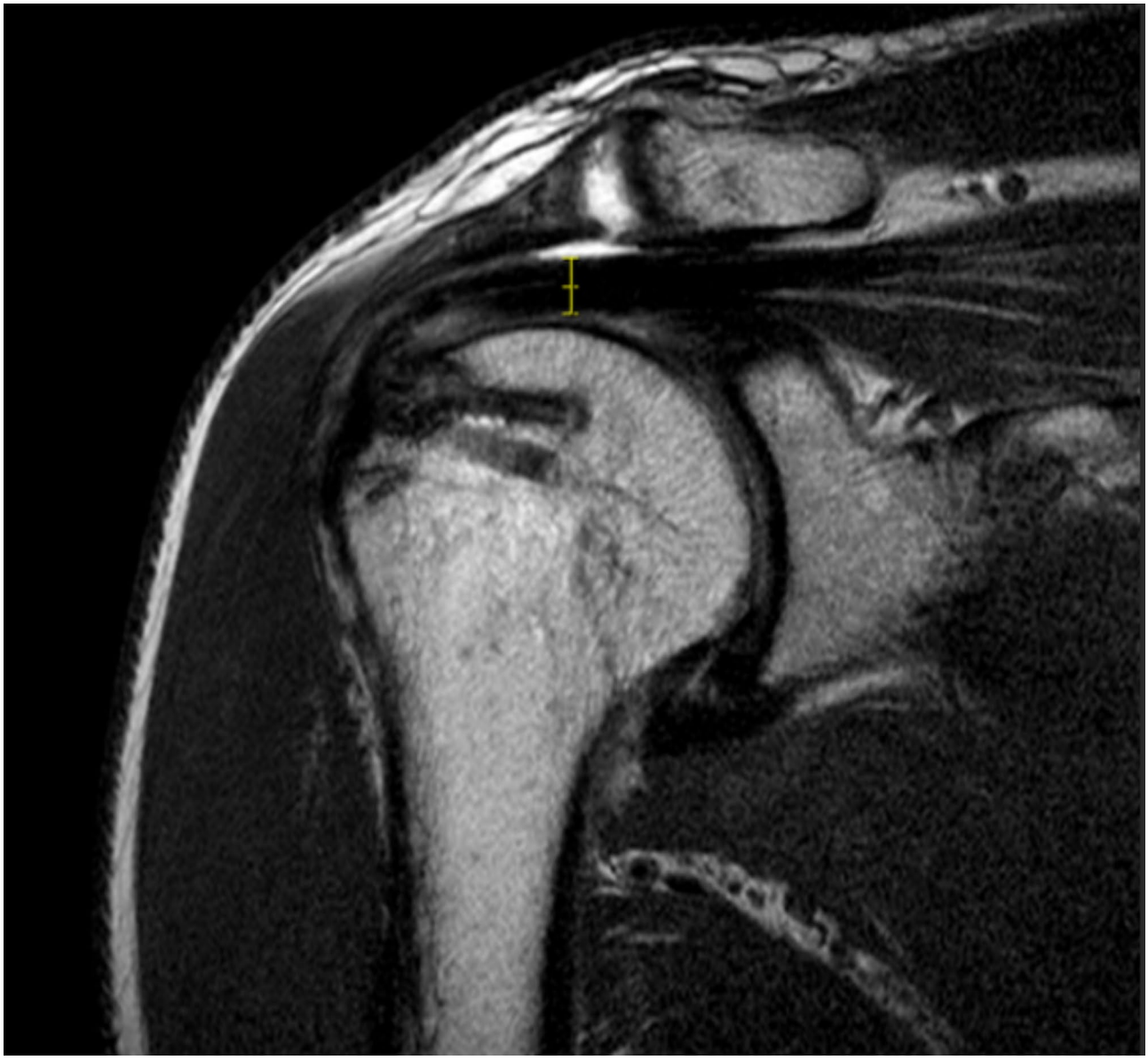

Fig. 2 Measurement of repaired supraspinatus tendon thickness at its thickest diameter in the coronal plane

In addition, acromiohumeral distance (AHD) was evaluated as an indirect assessment of the integrity of the repaired tendons under downward compression of the humeral head, both preoperatively and postoperatively. AHD, defined as the distance between the inferior edge of the acromion and the superior aspect of the humeral head, was measured on anteroposterior (AP) radiographs taken with the patient standing and the arm held in neutral rotation at shoulder level (Fig. 2). Radiologic assessment of the rotator cuff after the first postoperative year was performed using ultrasonography (USG) instead of MRI, and simple radiographs were taken annually to detect any developing arthritic changes. The interobserver correlation coefficient (ICC) was calculated by recording measurements twice at a two-week interval to evaluate the consistency of MRI interpretations between two authors (SJY and KRL), and the average of the two measurements was used for the final statistical tests between groups. ICC estimates and their 95% confidence intervals were calculated using SPSS software version 17.0 (SPSS, Inc., Chicago, IL) based on a mean rating ($k = 2$), absolute agreement, and a 2-way mixed-effects model. The interclass correlations for MRI interpretations were acceptable (> 0.8) (Table 1). An ICC value less than 0.50 indicated poor reliability, between 0.50 and 0.75 indicated moderate reliability, between 0.76 and 0.90 indicated good reliability, and over 0.90 indicated excellent reliability [30].

Table 1 The inter-observer correlation coefficient (ICC) values of magnetic resonance imaging (MRI) interpretations of the rotator cuff muscles

	Preoperative-tear size	Goutallier classification	Sugaya classification	Repaired-tendon thickness
Observer 1	0.91	0.89	0.90	0.92
Observer 2	0.91	0.89	0.88	0.90
Interobserver	0.90	0.90	0.88	0.88

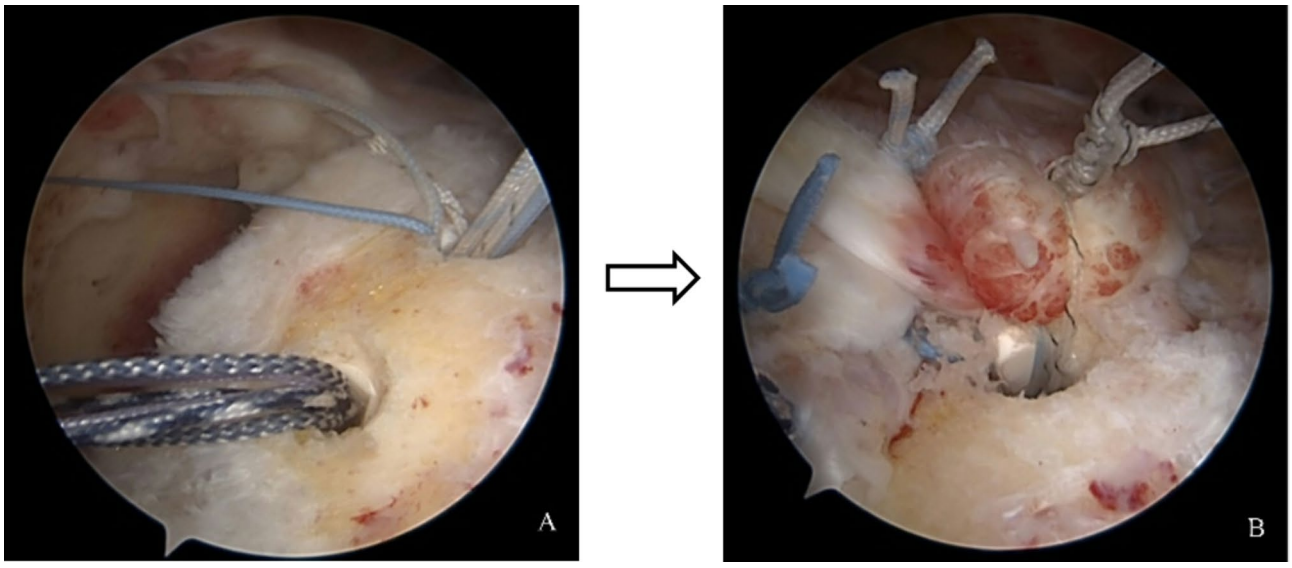

Fig. 3 Partial rotator cuff repair without graft augmentation
(**A**) Medialized anchor positions for partial repair are noted to avoid excessive tension on the repaired tendons
(**B**) Partial rotator cuff repair using the single-row suture technique in massive rotator cuff tears

Ultrasonography was performed by the surgeon (SWC) with the patient seated, using a high-frequency linear probe (12 MHz, iU-22, Philips Healthcare, Bothell, WA, USA). All tendons were assessed along their long and short axes to evaluate postoperative tendon integrity according to the Sugaya classification.

Surgical procedure

All surgical procedures were performed by the corresponding author. The patients were positioned in the lateral decubitus position under general anesthesia with traction applied to the involved extremity using a limb positioner (Spider, Smith and Nephew, Watford, England, UK). Following an interscalene nerve block, a complete inspection of the glenohumeral joint was performed arthroscopically through standard posterior viewing and anterior working portals to assess intraoperative tendon quality and delamination. The tear size was measured using a graduated ruler to determine the medial-to-lateral length and anterior-to-posterior width. Acromioplasty was performed in all patients, and a thorough subacromial bursectomy was carried out to ensure proper visualization. In Group A, after releasing adhesions for adequate mobilization of the torn and retracted tendons, cuff mobility was assessed on both the bursal and articular sides to ensure that the lateral margins of the torn tendons could be reduced to the debrided footprint of the greater tuberosity as much as possible without excessive tension. After assessing the reparability of the torn tendons and preparing the footprint surfaces until a bleeding surface was observed, the torn tendons were reattached to the medial edge of the footprint using a single-row suture technique with a medial row anchor (Bio-Corkscrew suture anchor; Arthrex, Naples, FL, USA). Either a scorpion (Arthrex, Naples, FL, USA) or a suture hook (Linvatec, Largo, FL, USA) was used to pass the sutures through the supraspinatus and infraspinatus near the musculotendinous junction. The number of anchors used depended on the size of the tear (Fig. 3). In Group B, arthroscopic partial repair was performed on large to massive RCTs in a manner equivalent to that in Group A, and an ADS graft was applied to the uncovered footprint without placing excessive tension on the reduced tendons after repair. For augmentation with ADS, the graft was cut to be 1 cm larger than the measured defect of the footprint on each border. Two or three double-loaded anchors were passed through the retracted tendon, and the graft was inserted into the joint space after being passed through with each anchor. When necessary, an additional double-loaded anchor was

inserted on the uncovered footprint for extra stability. Then, one suture from the cuff tendon and another from the dermal patch were tied using the double-row suture bridge technique (Fig. 4).

For postoperative care, a shoulder abduction brace was provided, pendulum exercises were initiated immediately after surgery, and continuous passive motion exercises began between 4 and 6 weeks postoperatively. Muscle strengthening exercises were initiated after full forward flexion of the shoulder was achieved. All patients were educated and encouraged to follow a daily home exercise program at each postoperative outpatient clinic follow-up.

Statistical analysis

All statistical analyses were performed using SPSS software version 17.0 (SPSS, Inc., Chicago, IL). Independent *t*-tests and paired *t*-tests were used for continuous variables, and a chi-squared test with continuity correction was used for categorical variables. A p-value < 0.05 was considered statistically significant. Post-hoc power analysis was conducted to assess the validity of the sample size, and a two-tailed α of 0.05 with a power of 0.8 indicated that the minimum detectable effect size was 0.43.

Table 2 Baseline demographics

Variables	Group A ($n=28$)	Group B ($n=27$)	p-value
Number of patients	28	27	-
Age (years)	64 ± 7	64 ± 7	0.63
Gender (male: female)	12:16	11:16	0.54
Dominant hand (right: left)	28:0	27:0	0.48
Surgical side (right: left)	19:9	23:5	0.55
Diabetes Mellitus	4	6	0.26
Smoking	0	0	-
Mean follow-up (months)	40 ± 4	36 ± 4	0.34

Results

Clinical outcomes

Baseline demographic data for both Groups A and B are described in Table 2. The average follow-up periods for Groups A and B were 40 months (37–41 months) and 36 months (35–40 months), respectively. All patients in both groups underwent follow-up MRI and USG assessments. None of the variables described in Table 2 showed any statistical differences between the two groups (p-value > 0.05).

In terms of functional assessment, both groups were evaluated for pain using the VAS score and for clinical

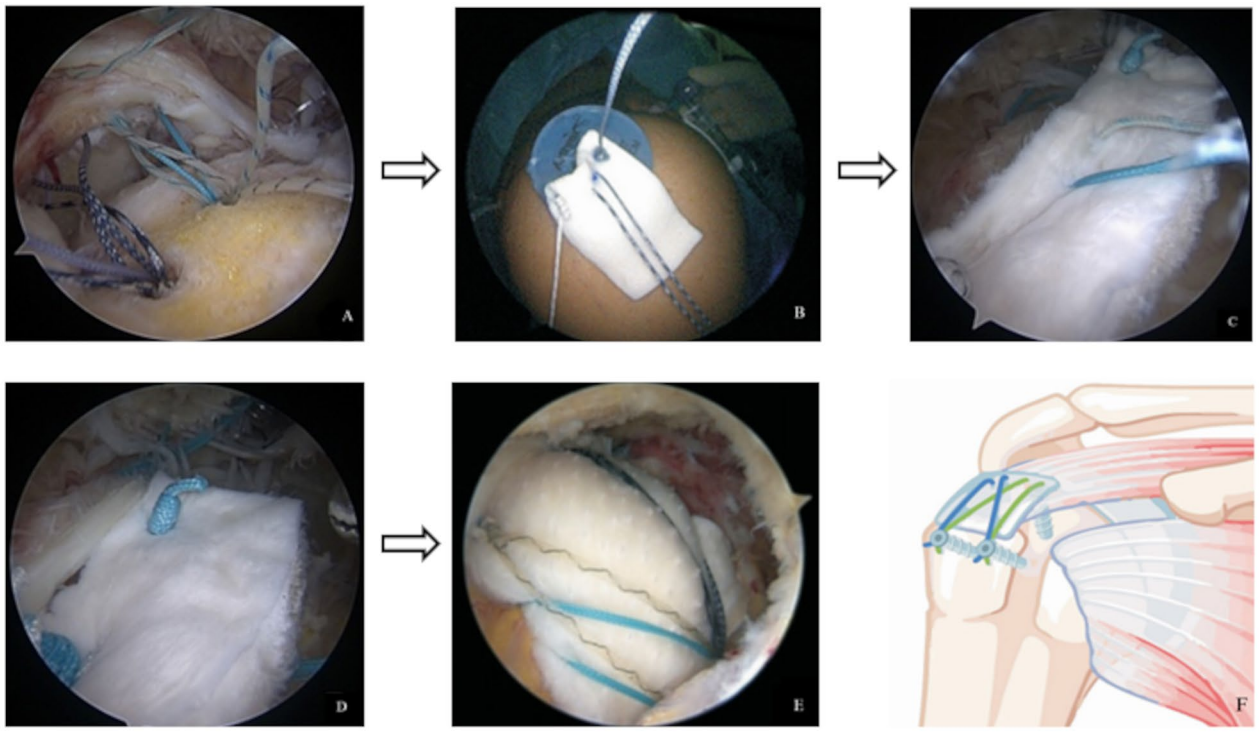

Fig. 4 Partial rotator cuff repair with allogenous dermal scaffold graft augmentation
A. Medialized anchor positions for partial repair with preparation for allogenous dermal scaffold graft augmentation
B. Tailored allogenous dermal scaffold graft before its insertion
C, **D**. An additional anchor thread was passed through the allogenous dermal scaffold graft for firm attachment
E. Allogenous dermal scaffold graft firmly fixed with the double-row suture bridge technique
F. Schematic illustration of allogenous dermal scaffold graft augmentation after partial repair

function using the UCLA score and the Constant-Murley score at preoperative, postoperative 3rd, 6th, and 12th months, and annually thereafter for up to 3 years (Table 3). Both groups demonstrated equivalent improvements in all three measured scoring systems from preoperative assessment to the final follow-up.

Radiologic assessment

Preoperative and postoperative MRI assessments were performed in all study participants to evaluate RCTs and postoperative tendon integrity. The sizes of cuff tears and retraction in RCTs showed no statistically significant differences between Groups A and B (Table 4).

Preoperative MRI indicated mean tear sizes of 4 cm in both groups, as well as mean retraction sizes of 3 cm in Group A and 4 cm in Group B. In the preoperative assessment of fatty infiltration, no statistical differences were found between Groups A and B in the supraspinatus, infraspinatus, subscapularis, and teres minor tendons, based on the Goutallier classification (p-value > 0.05). The mean time to postoperative MRI assessment was 9 months in Group A and 10 months in Group B (Fig. 5).

The majority of patients in both Groups A and B exhibited sufficient tendon thickness after repair, indicating Sugaya grade I or II. However, Group B showed significantly superior postoperative supraspinatus tendon thickness of 8 mm compared to 6 mm in Group A (p-value < 0.01) (Tables 3 and 4). In addition, postoperative MRI assessments of tendon healing and integrity, based on the Sugaya classification, identified 5 retears in Group A and 3 in Group B, without statistical significance. However, postoperative USG assessments at the three-year follow-up revealed an additional 4 retears in Group A and 1 in Group B. Consequently, a total of 9 and 4 retears in Groups A and B, respectively, resulted in a significant difference in retear rates in the longer-term follow-up (p-value = 0.03) (Table 5).

Furthermore, AHD improved postoperatively in both groups with statistical significance. In Group A, preoperative AHD was 7 mm, which increased to 9 mm postoperatively. In Group B, AHD improved from 7 mm preoperatively to 11 mm at the final postoperative follow-up (p-value < 0.05) (Table 4).

Discussion

In the present study, both partial repair and partial repair with ADS augmentation in large to massive RCTs demonstrated satisfactory clinical and radiologic outcomes concerning retear rates, postoperative tendon integrity, and AHD. Furthermore, ADS augmentation in addition to partial repair may have provided superior mechanical durability and structural stability in the treatment of large to massive RCTs.

Table 3 Comparison of preoperative and postoperative clinical variables associated with shoulder function between groups A and B

Variables	Group A (n = 28)	Group B (n = 27)	p-value
Visual Analogue Scale			
Preoperative	6 ± 3	6 ± 2	0.96
Postoperative 3 month	3 ± 2	3 ± 2	0.83
Postoperative 6 month	2 ± 2	2 ± 2	0.56
Postoperative 1 year	2 ± 3	1 ± 1	0.46
Postoperative 2 year	2 ± 2	2 ± 2	0.67
Postoperative 3 year	2 ± 2	2 ± 2	0.33
UCLA score *			
Preoperative	18 ± 5	18 ± 5	0.70
Postoperative 3 month	15 ± 5	24 ± 6	0.64
Postoperative 6 month	18 ± 5	29 ± 5	0.71
Postoperative 12 month	31 ± 6	31 ± 4	0.71
Postoperative 2 year	30 ± 5	30 ± 5	0.28
Postoperative 3 year	30 ± 5	31 ± 5	0.43
Constant-Murley Score			
Preoperative	59 ± 17	56 ± 16	0.60
Postoperative 3 month	75 ± 19	68 ± 19	0.48
Postoperative 6 month	80 ± 18	70 ± 16	0.68
Postoperative 12 month	81 ± 20	72 ± 14	0.07
Postoperative 2 year	77 ± 18	68 ± 19	0.72
Postoperative 3 year	66 ± 16	66 ± 17	0.61

* UCLA score: University of California score

Table 4 Comparison of preoperative and postoperative radiologic variables between groups A and B

Variables	Group A (n = 28)	Group B (n = 27)	p-value
Preoperative MRI (cm)			
Tear size	4 ± 1	4 ± 2	0.35
Retraction size	3 ± 1	4 ± 1	0.99
Humeral head size	45 ± 8	46 ± 8	0.14
Intraoperative tear sizes (cm)			
Anterior to Posterior	3 ± 1	4 ± 1	0.29
Retraction	3 ± 1	3 ± 1	0.82
Goutallier grades (I/II/III/IV) [a]			
Supraspinatus	13/10/3/2	8/13/4/2	0.64
Infrasupinatus	1/10/10/7	0/9/14/4	0.47
Teres minor	8/14/4/2	5/17/3/2	0.78
Subscapularis	0/21/7/0	1/20/4/1	0.43
Acromiohumeral distance (mm)			
Preoperative	7 ± 2	7 ± 3	0.83
Postoperative	9 ± 2	11 ± 3	< 0.05
Pre-postoperative difference[b]	< 0.01	< 0.01	
Postoperative MRI (mm)			
Repaired tendon thickness	6 ± 2	8 ± 1	< 0.05

[a] Goutallier grades (I/II/III/IV) represent the number of patients in each grade

[b] P-values of pre-postoperative differences were provided in the comparison of each group

(MRI: Magnetic resonance imaging, cm: centimeter, mm: millimeter)

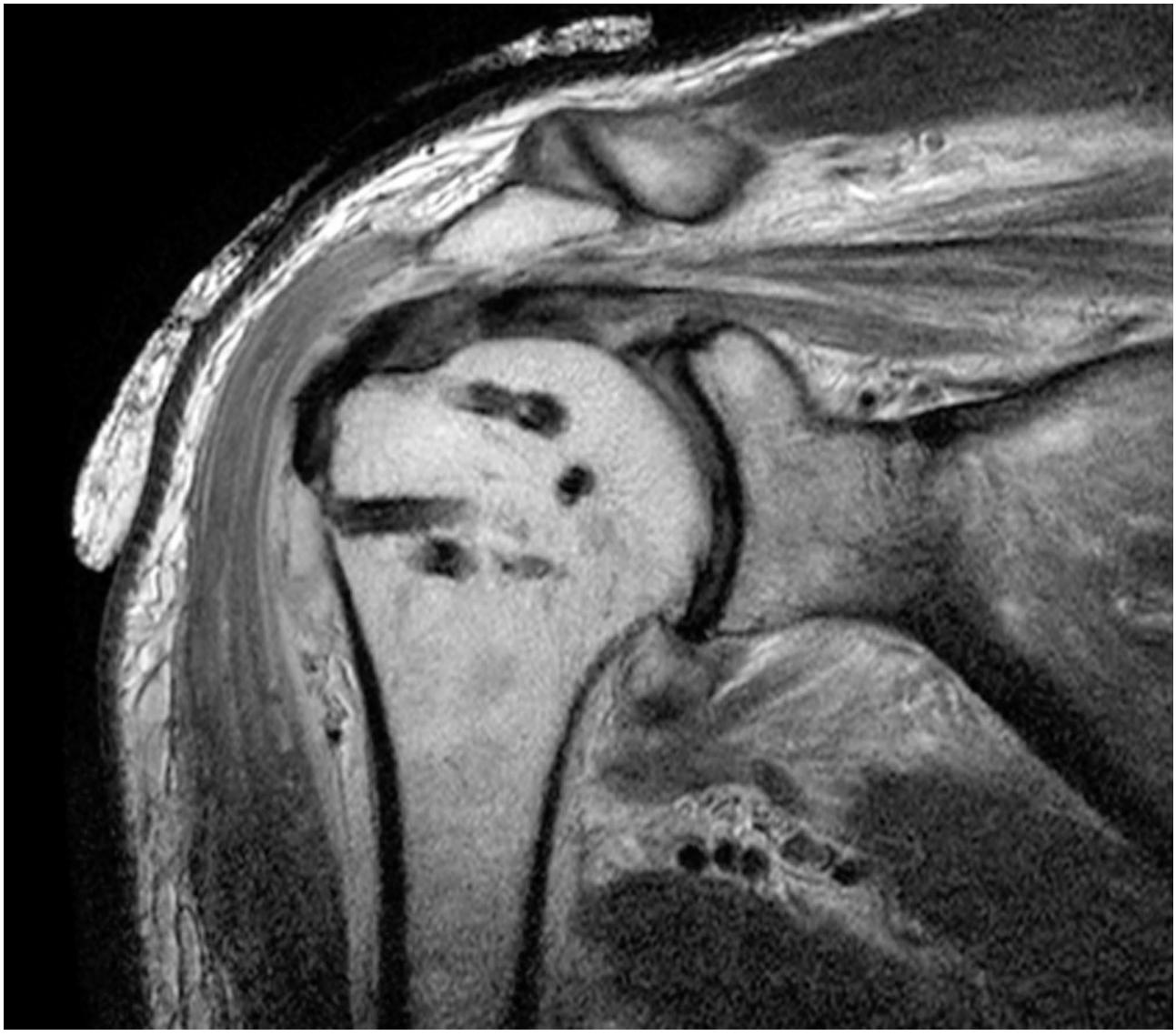

Fig. 5 Postoperative 9th-month magnetic resonance coronal image showing intact repaired tendons and allogenous dermal graft after partial repair with graft augmentation

Table 5 Comparison of retear rates between the two groups using postoperative MRI and USG

Variables	Group A	Group B	*p*-value
Postoperative MRI			
Sugaya classification			
I	3	3	
II	20	21	
III	0	0	
IV (Retear)	1	1	-
V (Retear)	4	2	-
Postoperative USG			
Retear	4	1	-
Total Retear Cases	9	4	-

(MRI: Magnetic resonance imaging)

Surgical treatment of large to massive RCTs presents immense challenges due to the limited mobility of retracted rotator cuff tendons, poor tendon quality, fatty degeneration, and difficulty in covering the footprint of the greater tuberosity without excessive tension on the retracted tendons. Severe retraction and immobility of the involved tendons in large to massive RCTs were intraoperatively evident in the present study, and severe fatty degeneration (Goutallier grades III and IV) was also observed in the preoperative MRI assessment. Given these characteristics of large to massive RCTs, the additional use of ADS augmentation proved to be an effective method for covering the remaining uncovered humeral footprint after partial repair. ADS augmentation provides

greater mechanical strength in terms of graft thickness on the repaired tendons compared to other graft options.

The primary purpose of ADS augmentation is to provide structural stability by supplementing the soft tissue defect over the footprint of the greater tuberosity while enhancing biological and cellular recovery to promote tendon regeneration in large to massive RCTs. A previous animal study comparing primary repair and ADS augmentation in large RCTs revealed that ADS augmentation resulted in superior histological characteristics, including fibroblastic ingrowth at the tendon-to-bone interface, neovascularization, and improved collagenous extracellular matrix formation compared to the control group [26, 31]. Additionally, a previous prospective, randomized controlled study comparing ADS augmentation with single-row repair in large RCTs, with a mean follow-up of two years, reported better clinical outcomes and significantly lower retear rates in the ADS augmentation group than in the control group [32]. Furthermore, a previous meta-analysis comparing ADS augmentation to xenograft and synthetic graft augmentation demonstrated a significantly lower retear rate of 15% with ADS augmentation compared to other graft types [13]. Although previous human studies on allografts in partial rotator cuff repair have lacked large study populations to date, ADS augmentation has shown promising results in large to massive RCTs without serious complications such as immunologic reactions or tendon degeneration associated with residual DNA, as reported in xenografts [33, 34]. In the operative management of large to massive RCTs, it is important to recognize that the characteristics of severe retraction and poor tendon quality lead to inevitable limitations in achieving complete anatomical repair. However, the goal in repairing large to massive RCTs should be to establish a functional rotator cuff—one that is biomechanically intact despite anatomical deficiency. ADS augmentation provides an adequate biological and cellular environment for regeneration supporting this objective [35].

Regarding our study results, partial tendon repair in large to massive RCTs without full footprint coverage showed comparable functional outcomes but higher retear rates compared to partial repair with ADS augmentation. This finding highlights the importance of restoring shoulder biomechanics with a functional rotator cuff and repairing retracted tendons with severe fatty degeneration while avoiding excessive tension, rather than prioritizing anatomical restoration with full humeral footprint coverage in RCTs involving large defects [34]. However, despite successful clinical and radiologic improvements in both groups, postoperative MRI indicated superior results with partial repair and ADS augmentation in terms of postoperative repaired tendon thickness, with statistical significance compared to partial repair alone. This finding supports the mechanical advantages of ADS augmentation in large to massive RCT repair. Additionally, postoperative AHD showed a significantly greater increase in Group B (p-value < 0.05), suggesting that ADS augmentation contributed to improved tendon healing by enhancing structural stability and mechanical durability.

Postoperative retear is a significant complication in partial rotator cuff repair and is particularly concerning in large to massive rotator cuff tears, which may necessitate revision surgery or RTSA. Previous studies on repair with mechanical augmentation have demonstrated that exogenous extracellular matrix scaffolds provide sustained mechanical protection at the repaired tendon site for up to six months—a critical period during which most retears occur [16, 32]. In the current study, retear rates showed an interesting trend over longer follow-up periods. Postoperative MRI, performed at an average of 10 months postoperatively, identified 5 and 3 retears in Groups A and B, respectively. However, postoperative USG, performed at the three-year follow-up, identified an additional 4 and 1 retears in Groups A and B, respectively. Although early postoperative MRI showed no statistically significant differences in retear rates, the cumulative retear rates over three years were statistically significant.

Additionally, among the 9 retears in Group A, 4 patients underwent RTSA conversion, and 1 patient underwent revision repair with ADS augmentation. In contrast, among the 4 retears in Group B, only 1 patient required RTSA conversion. Group B demonstrated lower retear rates and a lower rate of revision surgery compared to Group A. Moreover, ADS augmentation is a cost-effective and widely available option for partial rotator cuff repair. However, careful patient selection and surgical expertise remain crucial to maximizing its benefits.

There are several limitations in the present study. First, this study was conducted retrospectively with a small number of patients and involved two different surgical techniques. As a result, the outcome variables between the groups were underpowered to detect a small effect size, which may have limited clinical significance. To minimize bias in study enrollment, all surgical procedures were performed by a single surgeon, the corresponding author of this study, and similar demographics and postoperative follow-up periods were maintained. More importantly, postoperative MRI assessment was performed for all study participants to compare the efficacy of the two different surgical procedures in postoperative tendon integrity.

Second, in large to massive rotator cuff tears, comparisons with other surgical techniques or graft materials, such as autograft, xenograft, or synthetic graft, would have provided a broader spectrum of information for determining the most ideal surgical treatment options.

Third, the timing of postoperative MRI assessment ranged from 6 to 12 months rather than a single time point, which may have resulted in variability in tendon appearance. However, postoperative MRI was conducted at a minimum of 6 months, as most retears after partial rotator cuff repair occur within this timeframe. Comparative MRI imaging at both preoperative and postoperative time points provided more power in analyzing the efficacy of partial repair versus repair with ADS augmentation.

Fourth, postoperative radiologic assessment of the repaired tendon beyond the first postoperative year was performed using USG due to financial considerations, reduced waiting time, and the ability to perform dynamic assessment. Although USG may be less sensitive and specific than MRI in detecting partial tears, its use in this study was justified by financial constraints, its proven reliability in detecting clinically significant retears, and its practical advantages. The imaging protocol plays a critical role in determining the accuracy of late retear detection and the interpretation of final outcomes. Therefore, the conclusions of this study should be considered in light of these limitations related to imaging timing and modality.

Lastly, without postoperative tendon biopsy, this study was unable to evaluate histological evidence of biological healing in the repaired tendon with ADS.

Although the use of ADS is a promising approach in partial rotator cuff repair, further long-term prospective studies or comparisons with alternative graft types are necessary to fully understand its effectiveness and safety in clinical practice.

Conclusion

Both partial repair and partial repair with ADS augmentation demonstrated equivalently satisfactory clinical improvements throughout the average three-year follow-up. This study suggests that ADS augmentation in addition to partial repair resulted in increased tendon thickness and AHD, as well as reducing retear rates compared to partial repair alone.

In large to massive rotator cuff tears, although anatomical restoration is important, the emphasis should be placed on functional restoration of rotator cuff function. Surgeons evaluating patients with large to massive rotator cuff tears should consider the potential benefits of ADS augmentation.

Abbreviations

RCTs	Rotator cuff tears
ADS	Allogenous dermal scaffold
MRI	Magnetic resonance imaging
RTSA	Reverse total shoulder arthroplasty
VAS	Visual analogue scale
UCLA	University of California
AHD	Aacromiohumeral distance
USG	Ultrasonography

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Author contributions

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Data availability

The dataset used and/or analyzed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the local Institutional Review Board of Jeju National University Hospital in Jeju, South Korea (IRB File No. 2021-10-003) and was conducted in accordance with the Declaration of Helsinki. The informed consents were obtained from all participants.

Consent for publication

Written informed consent for publication of their clinical details and clinical images was obtained from the patient.

Competing interests

The authors declare no competing interests.

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