Original Article

Primary Rotator Cuff Bridging Reconstruction Shows Better Clinical and Radiographic Results Than Revision Bridging Reconstruction

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Purpose: To evaluate the outcome of revision rotator cuff bridging reconstruction (BR) as compared to primary BR in a large cohort of patients. **Methods:** A retrospective chart review was conducted for patients who underwent BR using dermal allograft for large/massive rotator cuff tears between 2010 and 2018. Patients who completed Western Ontario Rotator Cuff Index (WORC) and Disability of the Arm, Shoulder, and Hand (DASH) scores both pre- and postoperatively were included. Pre- and postoperative magnetic resonance imaging scans were compared to assess for differences in fatty infiltration, muscle atrophy, and graft status. **Results:** Eighty patients met the inclusion criteria, including 43 patients who underwent BR as a primary surgery and 37 patients who underwent revision BR. The mean follow-up duration was 5.7 ± 1.9 years in the primary group and 5.8 ± 2.0 years in the revision group. Both WORC and DASH scores significantly improved from pre- to postoperatively for both the primary and revision groups ($P < .05$). The primary group had significantly better postoperative WORC and DASH scores at 6 months, 1 year, and final follow-up ($P < .05$). Failure rate of the graft was higher in the revision group compared to primary group (14.3% vs 6.1%, respectively; $P = .337$), and the amount of fatty infiltration of supraspinatus and infraspinatus muscles significantly improved in patients who received primary BR compared to revision BR ($P < .05$). **Conclusions:** BR using dermal allograft for large/massive irreparable rotator cuff tears showed improvement of functional outcomes, with primary cases resulting in better improvement in patient-reported outcomes compared to revision cases. Primary BR was also associated with better postoperative fatty infiltration of supraspinatus and infraspinatus muscles. **Level of Evidence:** Level III, retrospective cohort study.

Massive rotator cuff tears make up approximately 10% to 40% of all rotator cuff tears, with up to 30% being irreparable.[1] Failure rates for repair of massive cuff tears range from 20% to 90%[2-4] and have been associated with persistent symptoms and reduced functional outcomes.[4-7] Several factors affect tendon healing and the retear rate, including the size of the rotator cuff tear, muscle atrophy, tendon quality, tendon retraction, and fatty infiltration.[8] Therefore, patients with massive, irreparable, retracted rotator cuff tears are less likely to achieve optimal outcomes, especially in revision cases, where the abovementioned factors are more prominent.[9]

Multiple options exist for the management of massive, irreparable rotator cuff tears, with no consensus on the optimal management. The use of biological tissue was described by Neviaser et al. in 1978.[10] Subsequently, multiple different types of grafts and techniques have been described in an attempt to improve the healing capacity of these tears or substitute the rotator cuff. Rotator cuff augmentation, bridging reconstruction (BR), and superior capsular reconstruction have all been described and have important differentiating characteristics. Rotator cuff augmentation involves integration of a graft over a reparable tear, which optimizes healing via increased biomechanical

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Received December 30, 2022; accepted December 13, 2023.

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2666-061X/221699

https://doi.org/10.1016/j.asmr.2023.100869

support.[11] BR or graft interposition involves lateral fixation of the graft to the footprint on the humerus and is sutured to the remnant rotator cuff tendon medially,[12] whereas in superior capsule reconstruction (SCR), the graft is also attached to the humeral footprint laterally but is instead anchored to the superior glenoid medially.[13,14]

Human dermal allograft has been used in BR for irreparable rotator cuff tears with promising results with improved functional scores and retear rates compared to maximal repair.[15-20] Although most of the studies investigating this technique show improvement in pain, strength, and range of motion (ROM), there is variability in the retear rates, and few differentiate between primary and revision rotator cuff tear.[12,16,17,21] Further, when evaluating rotator cuff repair, revision surgery is associated with worse mid- to long-term outcomes and a 2-fold higher risk of retear when compared to primary surgery.[22] The purpose of this study was to evaluate the outcome of revision rotator cuff BR as compared to primary BR in a large cohort of patients.

Methods

Design

Ethics approval for this study was obtained from the Nova Scotia Health Research Ethics Board. Patients who presented to our clinic with large/massive irreparable rotator cuff tears and who underwent arthroscopic BR using acellular human dermal allograft between 2010 and 2018 were retrospectively identified. The inclusion criteria were patients who were diagnosed with a large/massive irreparable rotator cuff tear and underwent BR with dermal allograft and who had completed Western Ontario Rotator Cuff Index (WORC) scores and Disabilities of Arm, Shoulder, and Hand (DASH) scores both preoperatively and at multiple postoperative time points. Patients without complete postoperative follow-up data (DASH or WORC scores) and patients with substantial glenohumeral arthritis, infection, and concurrent instability were excluded. Patients who received primary arthroscopic BR (primary group) were compared with those who received revision arthroscopic BR (revision group).

The indication for the procedure was magnetic resonance imaging (MRI) proven large/massive irreparable rotator cuff tear with or without previously failed repair. Large or massive irreparable rotator cuff tears were defined as tears larger than 3 cm in size or involvement of 2 or more tendons on preoperative MRI scan. The tears were deemed irreparable intraoperatively after appropriate release was performed and the tendon could not be brought back to the humeral footprint under reasonable tension.

Patient Evaluation

Primary outcome measures were the WORC and DASH score, and secondary outcome measures included MRI evaluation of graft healing, graft thickness, tear size and location, supraspinatus and infraspinatus fatty infiltration, and atrophy. Patients completed the WORC and DASH questionnaire preoperatively and postoperatively at 6 months, 1 year, and yearly thereafter. Both outcome scores have shown a high degree of validity, internal consistency, reliability, and responsiveness for assessing patients with rotator cuff disease.[23-25] The minimal clinically important difference (MCID) has been reported as 245.26 (11.7%)[26] for WORC and 10.2 for DASH.[27] The patient accepted symptom state (PASS) has been reported as 43 on the DASH score.[28,29] Patients who did not undergo a postoperative MRI were excluded from the secondary outcome measurements.

Surgical Procedure

All operative procedures were performed by a single surgeon (I.W.) using the following technique. The patient was placed in the standard lateral decubitus position, under general anesthesia, with the arm placed in a pneumatic arm holder in 45 degrees of abduction. A diagnostic shoulder arthroscopy was performed using the standard posterior and anterior portals. Addressing any labral pathology or subscapularis tear was done first if necessitated. Biceps tendon lesions were addressed with either tenotomy or an in situ tenodesis. Articular sided releases of the rotator cuff were performed as needed to create an adequate cuff margin for suturing. The subacromial space was then entered and a bursectomy was performed. The rotator cuff muscle edges were shaved down to stable tissue. The size of the tear and its repairability were then assessed by the operating surgeon. If the cuff tear edge could not be reduced to its footprint without tension, then BR with acellular human dermal allograft was performed. Two triple-loaded Heli-Coil suture anchors (Smith & Nephew) were placed through 2 separate percutaneous incisions into the prepared tuberosity surface, 1 posteriorly at the posterior edge of the rotator cuff tear and 1 anteriorly just behind the biceps tendon (Fig 1A). A partial rotator cuff repair was then performed by passing and tying down 1 suture from each anchor through the posterior edge of the remnant cuff tissue and 1 through the rotator interval or biceps tendon anteriorly to stabilize the edges of the tear. The cuff defect was then measured using a calibrated probe and used for determination of graft size. Four measurements were taken: (1) anterior to posterior adjacent to the medial stump of the residual cuff tissue, (2) anterior to posterior at the edge of the articular cartilage, (3) medial to lateral adjacent to the biceps tendon, and (4) medial to lateral adjacent to the posterior edge of the residual cuff.

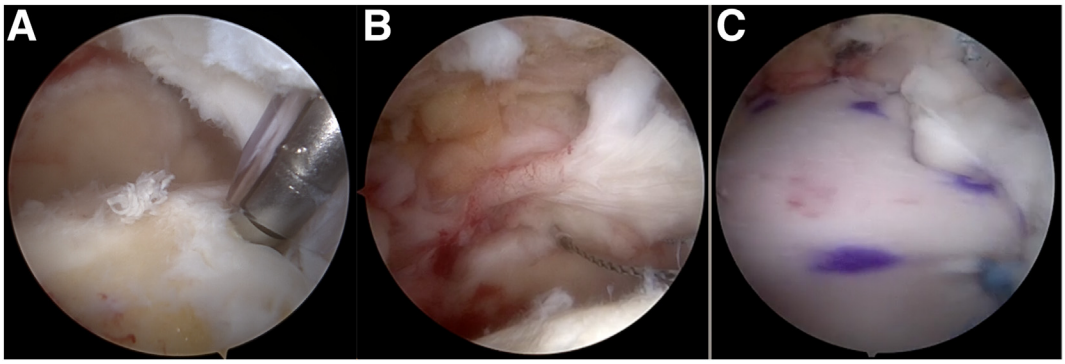

Fig 1. Intraoperative images of a left shoulder, viewing from the lateral portal. (A) A Heli-Coil suture anchor is inserted into the posterior aspect of the humeral footprint to perform a partial repair and stabilize the remaining rotator cuff tissue. (B) A spectrum suture passer is used to pass one of the sutures from the dermal allograft through the remnant medial cuff tissue using a naviaser portal. (C) Intraoperative picture following completion of the surgery. The dermal allograft is attached with multiple sutures to the posterior and medial remnant cuff tissue to span the defect.

A 4-mm-thick acellular dermal allograft was cut on the back table according to the tear dimensions previously measured (GraftJacket Max Force Extreme [Wright Medical] or Allopatch [MTF Biologics]). Eleven No. 2 Orthocord sutures were then used to prepare short-tailed interference knots (STIKs) and were passed through the graft in an alternating pattern. Three sutures were passed anteriorly, 3 medially, 3 posteriorly, and 2 laterally. Once graft preparation was finished on the back table, the graft was placed on a moistened towel, clamped around the arm. A suture tail from the posterior and anterior humeral anchor was retrieved from the lateral portal and passed through the graft in the posterolateral and anterolateral corner of the graft, respectively, and a STIK was tied on each. The 9 sutures on the anterior, medial, and posterior graft were then sequentially passed through the remnant cuff, starting anterior and working posteriorly (Fig 1B). Next, the graft was shuttled through the lateral portal with a pull-and-push technique. Once the graft was flat within the shoulder, the STIKs and corresponding suture tails were retrieved from the shoulder and sequentially tied, starting from anterior and working posteriorly. Finally, a lateral row repair was performed with 2 knotless Heli-Coil anchors (Smith & Nephew). The 2 sutures from the tied-down anterior anchor and 1 suture from each lateral STIK were passed through the anchor for the anterior lateral row anchor and similarly done with the posterior anchor sutures for the posterior lateral row anchor (Fig 1C).

Rehabilitation Protocol

The postoperative rehabilitation was identical for both groups. The patient's arm was supported in an abduction sling for 8 weeks, and daily active ROM exercises for elbow, wrist, and hand were started immediately. Pendular shoulder exercises were started 2 days postoperatively. Formal physical therapy with pool therapy and passive shoulder ROM exercises were started at 2 to 8 weeks postoperatively. Active ROM exercises began 12 to 16 weeks and gradual strengthening exercises were allowed at 16 weeks postoperatively.

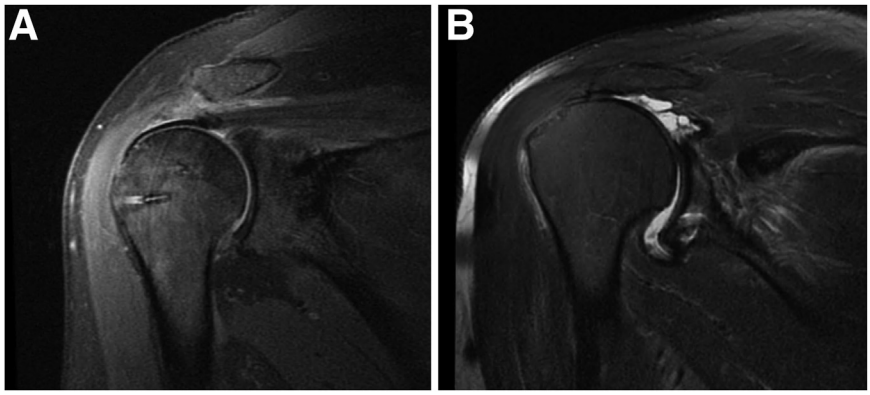

Fig 2. Postoperative T2-weighted coronal magnetic resonance images of 2 patients with bridging reconstruction. (A) Coronal imaging of a right shoulder showing an intact graft. (B) Coronal image of a right shoulder showing a patient with a complete rupture of their graft. There is associated superior humeral migration.

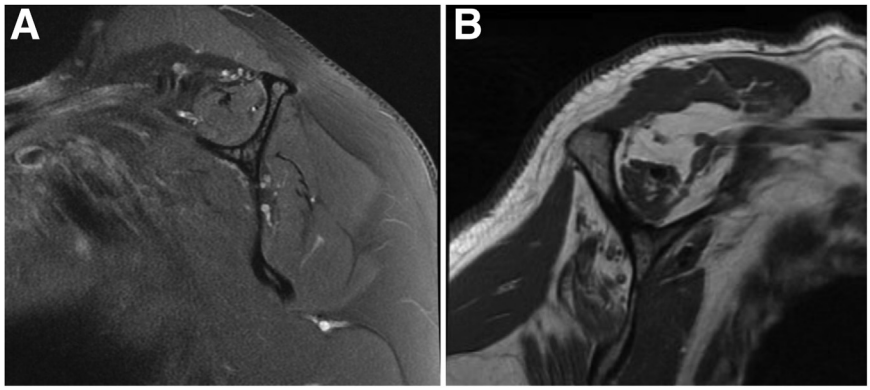

Fig 3. Postoperative sagittal fat saturated magnetic resonance imaging (MRI) in 2 patients. (A) Left sagittal image in a patient who received primary bridging reconstruction. Minimal muscle atrophy and fatty infiltration of the supraspinatus and infraspinatus are seen. (B) Right sagittal MRI of a patient who received revision bridging reconstruction. Severe muscle atrophy and fatty infiltration of the supraspinatus and infraspinatus are seen.

MRI Evaluation

Preoperative MRI scans were done within 1 year of the surgery date and postoperative MRI scans were done between the 1- and 2-year time points, but timing was resource dependent. The MRI was performed with a 1.5-T scanner. All MRI scans were reviewed by an independent musculoskeletal radiologist who was blinded to the clinical results (J.P.K.). Graft healing status, presence and size of a tear, tendon thickness, and muscle atrophy and fatty infiltration were assessed.

Determination of graft status was performed as described by Awad et al.[30] A continuous T1 and T2 hypointense linear band extending from the native tendon to the greater tuberosity with a flat/linear subacromial course and down-sloping convexity at the humeral insertion was defined as an intact graft. A complete tear was identified under 2 circumstances: (1) a complete gap in the anteroposterior and craniocaudal dimensions located between the native tendon and greater tuberosity or (2) presence of a serpentine/curvilinear retracted configuration of the graft. Finally, a partial tear was defined when there was a portion of the graft identified as continuous from the tendon to the greater tuberosity, with another portion showing a gap, incomplete fibers, or a serpentine/curvilinear configuration. Anteroposterior and mediolateral size and location of graft tears were documented (Fig 2 A and B).

Graft thickness was measured on coronal images on the slice that most fully viewed the anterior medial row anchor. The graft was divided into 3 segments between the level of the glenoid and the greater tuberosity, and graft thickness measurements were taken in each segment to report a medial, middle, and lateral graft thickness measurement. Muscle atrophy was evaluated and graded according to the classification system described by Warner et al.[31] on an oblique sagittal plane image, medial to the coracoid. Fatty infiltration was graded based on the Goutallier classification,[32] using the most lateral parasagittal image where the scapular spine was in contact with the scapular body (Fig 3 A and B).

Statistical Analysis

Data were analyzed using SPSS software (IBM, Version 26). All analyses were performed at a 95% significance level ($\alpha = 0.05$). Descriptive statistics were performed for both groups. Continuous data, including demographic data and outcome scores, were compared between both groups using a 2-tailed independent *t* test or Mann-Whitney *U* test depending on the results of Levene's test and normality test. Outcome scores were compared within both groups using a paired sample *t* test or Wilcoxon signed-rank test depending on the results of Levene's test and normality test. Categorical data, including graft healing, muscle atrophy, and fatty infiltration, were compared between the 2 groups using the χ^2 test or Monte Carlo simulation with 99% confidence interval if the assumptions of the χ^2 test were not met. Cohen's *d* effect sizes were used to supplement the significant *P* values computed based on *t* tests, and the effect size *r* calculated based on the equation $r = Z/\sqrt{N}$ was used to supplement the significant *P* values computed based on the Mann-Whitney *U* test. Cohen's *d* indicates effects that are interpreted weak if less than 0.2, between 0.2 and 0.8 is interpreted moderate, and larger than 0.8 is interpreted strong.[33] Mann-Whitney *U* test effect size *r* is considered weak if less than 0.3, between 0.3 and 0.5 is considered moderate, and larger than 0.5 is considered strong. The correlations between graft status and clinical and radiographic variables in each group were tested using Pearson and Spearman correlations depending on the data categories of the variables.

Results

A total of 130 patients had arthroscopic BR using dermal allograft for massive, irreparable rotator cuff tear between 2010 and 2018. Fifty of the 130 patients

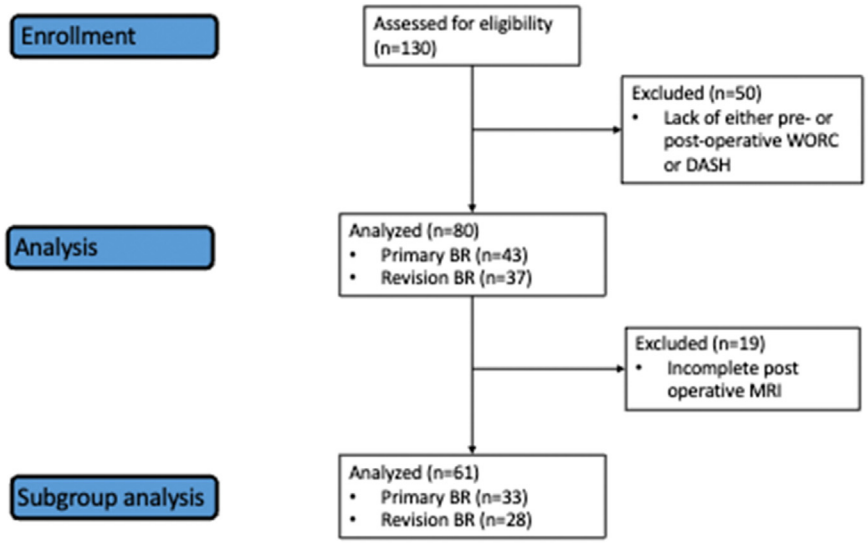

Fig 4. Flowchart outlining patient selection. Fifty of the 130 patients did not have complete postoperative data (i.e., missing Western Ontario Rotator Cuff Index or Disability of the Arm, Shoulder, and Hand scores) and were excluded from this study. As a result, a total of 80 patients were included in the analysis. Among the included patients, 43 patients underwent bridging reconstruction (BR) as their primary procedure and 37 patients had BR as a revision procedure with a previously failed rotator cuff surgery. A total of 61 of the included patients had a postoperative magnetic resonance imaging scan and were included in the radiographic subset analysis.

did not have complete postoperative data (i.e., missing WORC or DASH scores) and were excluded from this study. As a result, a total of 80 patients were included in the analysis. Among the included patients, 43 patients underwent BR as their primary procedure, and 37 patients had BR as a revision procedure with a previously failed rotator cuff surgery. A total of 61 of the included patients had a postoperative MRI scan and were included in the radiographic subset analysis as depicted in Figure 4.

The mean age of the study population was 60.1 years with a mean duration of follow-up in the primary group of 5.7 ± 1.9 years and 5.8 ± 2.0 years in the revision group. No statistical differences were found between the groups in terms of demographics, except for time to postoperative MRI (Table 1).

Clinical Assessment

Both WORC and DASH outcome scores significantly improved from the pre- to postoperative time points in both groups (Figs 5 and 6, respectively). The primary group had significantly better postoperative WORC and DASH scores compared to the revision group at 6 months and at 1 year ($P < .05$), with no significant difference observed after 2 years of follow-up. However, at final follow-up, the primary group had significantly better WORC scores than the revision group. The primary group had a higher percentage of the patients who reached the MCID of WORC than the revision group but did not reach significance (97.3% and 83.3%, respectively; $P = .080$). The percentage of patients who reached the MCID of the DASH score (88.9% in primary and 78.6% in revision) and exceeded the PASS score (90% in primary and 72.4% in revision) of DASH was higher in the primary group than that of the revision group but did not reach clinical significance ($P = .425$ and $P = .057$, respectively).

Radiologic Assessment

Postoperative MRI was performed in 61 cases (76.3%; 33 in the primary group and 28 in the revision group). MRI scans were resource dependent, which caused a wide

Table 1. Demographic Data

Characteristic	Primary (n = 43)	Revision (n = 37)	*P* Values, α = 0.05	Effect Size
Sex			.129	—
Male	27	29		
Female	16	8		
Side			.094	—
Left	8	13		
Right	35	24		
Age at surgery, mean ± SD, y	62.6 ± 8.9	57.7 ± 10.1	.066	—
Time after surgery, mean ± SD, y	5.7 ± 1.9	5.8 ± 2.0	.873	—
MRI follow-up, mean ± SD, y	2.1 ± 1.2	1.4 ± 0.9	.016	0.630*

MRI, magnetic resonance imaging.
*Effect size was Cohen's *d*.

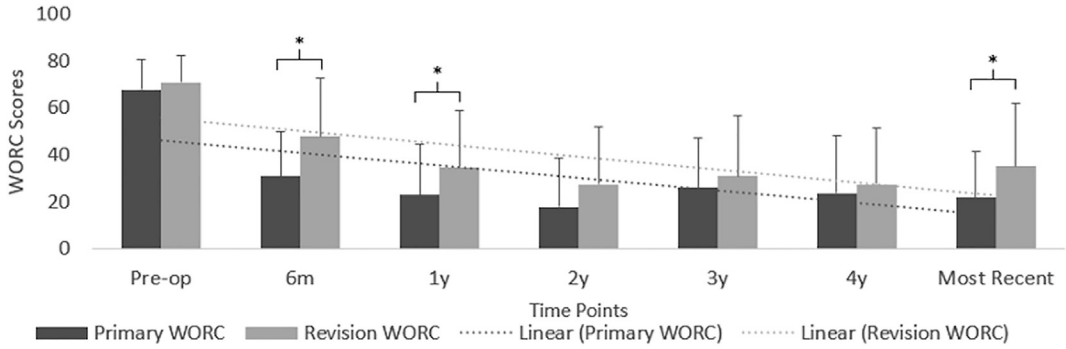

Fig 5. Comparison of Western Ontario Rotator Cuff Index (WORC) scores between the 2 groups at different time points. The primary group had significantly better WORC scores compared to the revision group at 6-month and 1-year postoperative time points ($P = .007$ with effect size Cohen's $d = 0.768$ and $P = .026$ with effect size $r = 0.294$, respectively). The most recent WORC scores of the primary group were also significantly better than those of the revision group ($P = .044$, effect size $r = 0.235$). Most recent is the collection of the latest outcome scores for each patient. (m, month; pre-op, preoperative; y, year.)

variability in the time point of the postoperative imaging. The mean time to postoperative MRI was 1.8 ± 1.1 years. The primary group had 2 of 33 (6.1%) patients with complete tears, whereas the revision group had 4 of 28 (14.3%) with complete tears. The difference between the 2 groups was not statistically significant ($P = .337$). Graft status for the primary and revision group is shown in Table 2. The location of the graft tears is summarized in Table 3, with the majority of complete tears occurring either at the humeral head anchor site or within the midsubstance of the graft. No complete tears occurred at the tendon graft anastomosis site, but 2 of 6 partial tears in the primary group and 4 of 7 partial tears in the revision group occurred at the anastomosis site. The postoperative medial graft thickness in the primary group was significantly larger than that in the revision group (3.0 ± 1.1 mm and 2.3 ± 1.3 mm, respectively; $P = .031$). No significant differences between the 2 groups were found in the middle and lateral graft thicknesses. The postoperative graft tear sizes between the 2 groups were also compared and no significant differences was found in both anteroposterior and mediolateral directions ($P > .05$).

Higher levels of muscle atrophy and fatty infiltration were found in the revision group compared to the primary group preoperatively and postoperatively, with significantly more improvement in the primary group compared to the revision group. There was no significant difference in fatty infiltration between the groups preoperatively, but significantly higher Goutallier scores were found in the revision group for both supraspinatus and infraspinatus postoperatively ($P = .017$ and .014, respectively). Although there was a significant difference in preoperative supraspinatus muscle atrophy, there was no difference in muscle atrophy of the supraspinatus or infraspinatus between the 2 groups postoperatively.

We found a significant correlation between the postoperative supraspinatus muscle atrophy grading

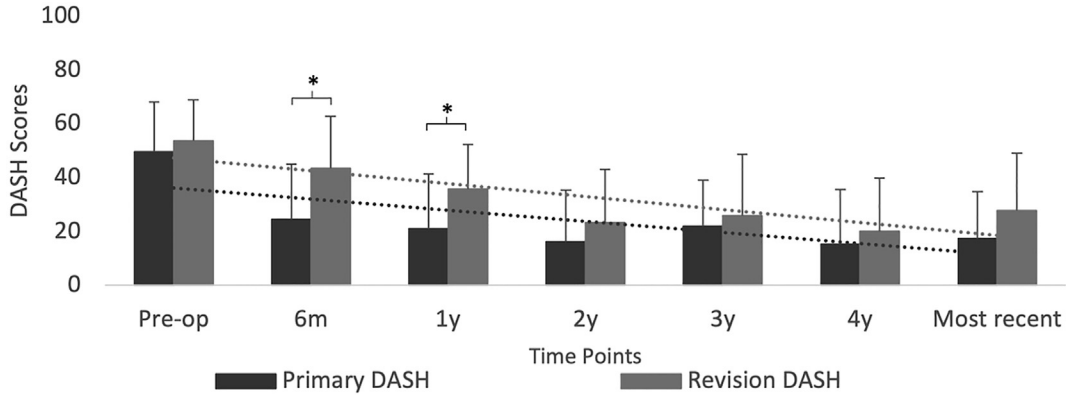

Fig 6. Comparison of Disability of the Arm, Shoulder, and Hand (DASH) scores between primary and revision bridging reconstruction at different time points. The primary group had significantly better DASH scores compared to the revision group at 6-month and 1-year postoperative time points ($P = .014$ with effect size Cohen's $d = 0.919$ and $P = .017$ with effect size $r = 0.379$, respectively). Most recent is the collection of the latest outcome scores for each patient. (pre-op, preoperative.)

Table 2. Graft-Healing Summaries With No Significant Difference Between the 2 Groups ($P = .343$)

Group	Graft Intact, n (%)	Partial Tear, n (%)	Complete Tear, n (%)
Primary (n = 33)	25 (75.8)	6 (18.2)	2 (6.1)
Revision (n = 27)	16 (59.3)	7 (25.9)	4 (14.8)

NOTE. This analysis was conducted using a χ^2 test at the significance level of .05.

and the graft status in the revision group ($P = .046$). In the primary group, the graft healing was significantly correlated with postoperative middle and lateral graft thickness ($P = .012$ and $P = .021$, respectively). In the revision group, the graft healing was significantly correlated with medial graft thickness ($P = .037$), middle graft thickness ($P < .001$), and most recent WORC scores ($P = .012$). No other significant correlations were found between muscle atrophy, fatty infiltration, and radiographic and clinical variables.

Discussion

The results of this retrospective comparative study show that arthroscopic BR using dermal allograft is associated with improved functional outcomes, with a 6.1% failure rate in the primary group and 14.8% in the revision group. Primary cases resulted in better improvement in patient-reported outcomes (PROs), especially within the first year, with sustained functional outcomes over the course of follow-up for both primary and revision groups. The patients from the primary group had larger medial graft thickness measurements on MRI and better improvement in fatty infiltration of the supraspinatus and infraspinatus. The findings in this study confirm the hypothesis of inferior outcomes after revision BR in terms of functional and structural outcomes compared to primary BR.

There was a significant improvement in PRO scores in both primary and revision BR procedures with sustained improvement over time. The primary group, however, showed significantly better WORC and DASH scores during the first year postoperatively and at their final follow-up. This is similar to findings by Gupta et al.[16] and Bond et al.,[17] which showed significant improvement in American Shoulder and Elbow Surgeons (ASES) and UCLA scores at 26 and 36 months, respectively. These finding are also in keeping with multiple other studies that have reported on outcomes following BR using dermal allograft,[15,18-21,30,34,35] but very few have used WORC as their primary outcome, which makes comparison of our data difficult. A prospective randomized controlled trial by Wong et al.[15] evaluated BR compared to maximal repair and showed improved WORC and DASH scores in BR compared to maximal repair at the 2-year follow-up with a higher incidence of progression of rotator cuff tear arthropathy in the maximal repair group ($P < .001$). Thus, although there is variability in the outcome measure used, the available literature indicates that BR improves pain and function in patients with large/massive rotator cuff tears.

The current literature available on BR using dermal allograft is predominantly case series and very few report the incidence of revision surgery. A wide range of techniques, including open, mini-open, and arthroscopic, have been used, making it difficult to directly compare our results to that of others. Kokkalis et al.[20] reported on 21 patients with mini-open BR, of which 10 were revision cases. They found no difference in pain, ROM, and ASES scores between revision and primary surgery. These results are similar to other reports of revision BR, showing improvement in outcome scores in revision surgery,[17,35,36] but low sample sizes make it difficult to make any correlations about differences between revision and primary surgery. Thus, further research with larger sample sizes is warranted to confirm the findings of this study.

Most patients in our study had sustained improvement in functional outcomes over the course of their follow-up. This is an important outcome to note, as many have shown that primary surgeries tend to have better longevity of positive outcomes. Shamsudin et al.[22] conducted a retrospective cohort study comparing the outcomes of primary and revision arthroscopic rotator cuff repair. The authors concluded that the improvement in functional outcomes in the revision group was not maintained over time; in fact, it started to deteriorate after 2 years of follow-up.[18] Our findings with respect to using BR in a revision setting demonstrated not only improved functional outcomes but also sustained improvement over time. It is possible that the maintenance of good outcomes is a result of decreased tension on the repair site. The decreased tension and the use of a dermal allograft may provide a scaffold for revascularization and tissue healing.[12,17] Others have suggested that a tuberoplasty effect may be the mechanism of action that decreases shoulder pain.[37] It is important to note, however, that the sustained improvement in both groups lasted until the 4-year mark. The sustained outcomes continued to be

Table 3. Location of Graft Tears in the Primary and Revision Groups

Group	Graft Status	Humeral Head	Midgraft	Anastomosis
Primary	Partial tears (n = 6)	1	3	2
	Complete tears (n = 2)	2		
Revision	Partial tears (n = 7)	3		4
	Complete tears (n = 4)	2	2	

seen in the primary BR procedures, but in some cases, deterioration was seen in the revision group after 4 years.

The failure rate in the present study was 6.1% in the primary group and 14.3% in the revision group, if we consider a complete tear of the graft as a failure. Although the failure rate between groups was not statistically significant, it may be considered clinically significant. Higher failure rates in the revision group could be explained by the fact that the reconstruction was done in a degenerated and already weakened tendon from a previous repair. The area of a degenerative rotator cuff tendon has been shown to have lower microcirculation and less capillary density and diameter compared to an unaffected rotator cuff tendon.[38] Therefore, a higher retear rate may be due to the resulting fibrosis from a lower capacity for neovascularization and dysfunction in tendon-healing capability. However, it is interesting to note that in our study, no complete tears occurred at the graft-tendon interface, and only partial tears were located in this region. It is important to note that in our study, 44% of the patients had partial cuff tears. While this percentage is high, partial cuff tears are not necessarily indicative of a poor surgical outcome, with literature indicating that in patients in whom the graft is still partially connected, continued improvement in function at postoperative time points is often seen.[13,37]

Other studies that report graft integrity based on MRI or ultrasound report variable results with a wide range of failure rates of 5% to 30%.[12,17,20,21,35,36,39,40] Modi et al.[40] performed open allograft BR and reported an incidence of partial tears of 14.3% with no complete tears in their cohort at 1-year follow-up, while a mini-open technique as reported by Gupta et al.[16] resulted in a 5% complete retear rate and 19% partial retear rate. Arthroscopic BR has been reported less commonly than open techniques but has shown good results. The largest case series published on arthroscopic BR included 109 shoulders and found a 26% failure rate, but they did not differentiate between partial and complete tears.[39]

Many factors may explain the wide range of failure rates between studies. Overall, there is a lack of consistency in the definition of graft integrity and the modality with which retears were identified between studies. Many studies did not distinguish between partial and complete graft tears postoperatively, which makes the results difficult to interpret. Other potential causes for the variability in retear rates may be related to the number of revision cases in each study group, different operative techniques, and varying rehabilitation protocols. To our knowledge, no study has compared the retear rates in primary vs revision settings; thus, our study stands as a unique contribution, shedding light on the comparative retear rates between primary and revision BR, bridging a gap in the existing literature.

In a case series of 8 patients who underwent open BR, Gouk et al.[36] reported an 84% retear rate at 6 months. The tears were partial in nature and interestingly occurred at the graft-tendon junction. While this case series only included a small number of patients that may not be representative of a larger population, this finding contrasts with our results presented herein. In our study, 68% (13/19) of tears occurred at either the humeral insertion or midsubstance of the graft. One reason for the difference in tear location may be the postoperative protocol that was used. The patients included in the Gouk et al.[36] study started strengthening exercises at 6 weeks, while our patients did not begin strengthening until 3 months postoperatively. Thus, failure of complete graft healing at this location may be due to early strengthening prior to graft incorporation into the native tendon.

Improvement in fatty infiltration and muscle atrophy after rotator cuff repair surgery is a subject of debate in the literature. Goutallier et al.[41] showed improvement in fatty degeneration in successful rotator cuff repairs. Yamaguchi et al.[42] similarly observed that successful repair led to improvement of fatty infiltration in 50% of their patients and improvement in muscle atrophy in 25% of patients. Conversely, others have reported that repair of a massive rotator cuff tear does not lead to a reversal of fatty degeneration or muscle atrophy and can progress even with a successful result.[43,44] Supraspinatus atrophy on MRI is a strong predictor of postoperative retearing,[45] and therefore, preservation of rotator cuff musculature is crucial. In our study, there was worse preoperative and postoperative muscle atrophy and fatty infiltration, with improvement seen only in the primary group. This may explain the larger improvement in functional outcomes in the primary group, especially at the most recent follow-up, and further supports the use of BR in primary rotator cuff tears to prevent worsening muscle quality following failure of a primary repair.

Limitations

The limitations of this study are that it is a retrospective review of prospectively collected data, with all procedures being done at a single center by a single surgeon. Another limitation was the number of patients excluded from the analysis due to loss to follow-up or missing postoperative imaging in this retrospective review. Additionally, there was a large range in timing of postoperative MRIs due to availability, which could have affected the results.

Conclusions

BR using dermal allograft for large/massive irreparable rotator cuff tears showed improvement of functional outcomes, with primary cases resulting in better improvement in PROs compared to revision cases.

Primary BR was also associated with better postoperative fatty infiltration of supraspinatus and infraspinatus muscles.

Disclosures

The authors report the following potential conflicts of interest or sources of funding: I.W. reports consulting fees from DePuy Mitek, consulting fees from Smith and Nephew, consulting fees from CONMED Corp, and consulting fees from Bioventus LLC, outside the submitted work; is an editorial board member for the *American Journal of Sports Medicine* and *Arthroscopy: The Journal of Arthroscopic and Related Surgery*; and is a board or committee member for AANA, ISAKOS, and AAC. All other authors (J.K., S.S., J.M., J.-P.K.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

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