Clinical and Radiological Outcomes of Arthroscopic Superior Capsular Reconstruction Versus Primary Rotator Cuff Repair in Massive Rotator Cuff Tears

A Propensity Score–Matched Study

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Background: Arthroscopic superior capsular reconstruction (aSCR) has emerged as a treatment option for managing massive rotator cuff tears (MRCTs) given the unpredictable results after an arthroscopic rotator cuff repair (aRCR). Yet, few comparative studies of aSCR and aRCR have been conducted.

Purpose: To compare the clinical and radiological outcomes between aRCR and aSCR in patients with MRCT.

Study Design: Cohort study; Level of evidence, 3.

Methods: A total of 163 cases of MRCT from 2010 to 2020 with follow-up ≥2 years were retrospectively reviewed. Among them, 102 had aRCR and 61 had aSCR using fascia lata autograft. Propensity score matching was used to select controls matched for age, sex, diabetes mellitus, osteoporosis, preoperative American Shoulder and Elbow Surgeons score, Single Assessment Numeric Evaluation score, Constant score, pain visual analog scale (pVAS) score, range of motion (ROM), tear size, global fatty degeneration index, and acromiohumeral distance (AHD). Last, 33 cases in each group were selected after propensity score matching. Radiological assessment was conducted using serial postoperative magnetic resonance imaging. Pre- and postoperative findings—including American Shoulder and Elbow Surgeons, pVAS, Single Assessment Numeric Evaluation, and Constant scores and ROM—were assessed to compare clinical outcomes. For radiological outcomes, global fatty degeneration index, AHD, and healing rate were evaluated. Healing failure was defined as Sugaya classification IV or V in the aRCR group, as compared with a full-thickness tear of the graft in the aSCR group, which corresponded to Sugaya classification IV or V.

Results: Postoperative clinical outcomes were significantly improved at the final follow-up in both groups. In the aSCR group, postoperative forward flexion, pVAS, and AHD were significantly improved as compared with the aRCR group (mean, 161° vs 148° [P = .02]; 1.03 vs 1.64 [P = .047]; 7.00 vs 5.23 mm [$P < .001$], respectively). The healing rate was 20 of 33 (60.6%) for aRCR and 29 of 33 (87.9%) for aSCR (P = .022).

Conclusion: aSCR and aRCR are effective and reliable treatment options for MRCT. However, when compared with aRCR, aSCR showed improved clinical outcomes, including pVAS score, postoperative ROM, and favorable radiological findings, including AHD and a higher healing rate.

Keywords: massive rotator cuff tear; arthroscopic rotator cuff repair; arthroscopic superior capsular reconstruction; propensity score matching

Severe shoulder pain and loss of function are associated with massive rotator cuff tears (MRCTs).[32] They are usually accompanied by tendon retraction, poor tendon quality, and muscle fatty infiltration, all leading to shoulder dysfunction.[14,25,30] The natural history of MRCT involves a predictable progression to arthritic changes of the glenohumeral joint.[40] Arthroscopic debridement,[55] partial or complete repair,[12,43] graft augmentation,[41] tendon transfer,[28] superior capsular reconstruction,[36] and

The American Journal of Sports Medicine
2023;51(8):1971–1978
DOI: 10.1177/03635465231171928

arthroplasty[44] have been reported as treatment options for MRCT.

Arthroscopic rotator cuff repair (aRCR) of MRCT has been traditionally performed.[2,31] aRCR has been shown to be beneficial in reducing pain and improving shoulder range of motion (ROM) and functional outcomes.[13] However, the unpredictable and inconsistent surgical outcome after MRCT treated with aRCR remains a great challenge for orthopaedic surgeons.[10] The characteristics of MRCT described as risk factors after surgical repair include a large tear size, a severely retracted tendon, a high grade of muscle atrophy, and fatty degeneration.[5,14,30] Rates of retear after aRCR surgery are reported to range from 30% to 94% and retear is often associated with poor clinical outcomes.[10,17]

Arthroscopic superior capsular reconstruction (aSCR) was recently developed as an alternative treatment for MRCT.[36] As reported in biomechanical studies, aSCR provides superior stability and restores the stable fulcrum of the glenohumeral joint.[38,39] Early clinical findings from a number of studies revealed that aSCR could provide improvements in pain, ROM, function, and validated outcome measures.[23,35] However, reported success rates of aSCR vary from 0% to 55%.[8,27,29,33,47] Poor outcomes after aSCR were associated with old age, thickness of the graft, concomitant irreparable subscapularis tear, and severe fatty infiltration of the infraspinatus.[19,26,34,37,53] Consequently, there is still no consensus regarding nonprosthetic surgical reconstruction for the treatment of MRCT. The effectiveness of aRCR and aSCR as treatment for MRCT has not yet been fully investigated. Only a few comparative studies of aSCR and aRCR have been conducted.[6,49]

The purpose of this study was to evaluate and compare the clinical and radiological outcomes of aSCR using fascia lata autograft and aRCR in individuals with MRCT. The hypotheses of the study were as follows: (1) aSCR and aRCR would result in clinical and radiological outcome improvement for MRCT and (2) aSCR would result in better clinical and radiological outcomes as compared with aRCR.

METHODS

Patient Selection

This retrospective study was approved by the institutional review board (2022-1091). Given the study's retrospective nature, informed consent was waived. Consecutive patients who underwent aSCR using fascia lata autograft or aRCR for MCRTs between 2010 and 2020 were evaluated. The inclusion criteria were as follows: (1) patients with MRCT who underwent preoperative magnetic resonance imaging (MRI) for a diagnosis (MRCTs were diagnosed as rotator cuff tears that were >5 cm or affected >2 tendons) and (2) persistent symptoms after nonoperative treatment for ≥3 months. The exclusion criteria were glenohumeral joint arthritis, history of rotator cuff surgery, infectious arthritis, dysfunction of the deltoid muscle or axillary nerve, and <2 years of follow-up.

Preoperative Patient Characteristics

For propensity score (PS) matching, selected variables included sex, age, diabetes mellitus, osteoporosis, preoperative ROM, pain visual analog scale (pVAS) score, Single Assessment Numeric Evaluation (SANE), American Shoulder and Elbow Surgeons (ASES) score, Constant score, preoperative tear size, global fatty degeneration index (GFDI), and acromiohumeral distance (AHD). Most of the variables have been shown to have an effect on the surgical results of aRCR and aSCR.[21,24,46,48,51,54]

Clinical Assessment

Clinical data—including shoulder joint ROM, pVAS, ASES score, Constant score, and SANE—were evaluated pre- and postoperatively (6 and 12 months) and at the final visit. Measurements of ROM—namely, active forward elevation and external rotation—were performed using a manual goniometer. Postoperative complications (eg, infection and nerve damage) were reviewed via electronic medical records. In the aSCR group, graft donor-site morbidity was reviewed. Clinical data from pre- and postoperative assessment at the final visit were used for the analysis.

Radiological Assessment

The AHD was measured using plain radiographs pre- and postoperatively (at 6 and 12 months) and at the final visit, with the shoulder in a neutral position. Shoulder MRI was conducted with a 3-T machine (Ingenia; Philips Healthcare) before and after surgery. Preoperative MRI was used to assess the involved tendons, tear size, and GFDI. The tear size of the mediolateral direction was measured between the most medial margin of the tear stump of the involved tendon and the most lateral margin of the footprint of the greater tubercle on coronal oblique and axial images of shoulder MRI scans. The tear size of the

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Submitted November 10, 2022; accepted February 27, 2023.

The authors declared that they have no conflicts of interest in the authorship and publication of this contribution. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

anteroposterior direction was also measured; this is the longest diameter of the tear site from the edge of the anterior-to-posterior tendon on sagittal oblique images. To evaluate the fatty infiltration of the rotator cuff muscles, we measured the GFDI.[9] Follow-up MRI was performed at 3, 6, and 12 months and then annually after surgery. Oblique sagittal and coronal fat-suppressed T2-weighted images were obtained to evaluate the anatomic and qualitative status of tendon healing in the aRCR group or the graft integrity in the aSCR group. Tendon healing was assessed according to the Sugaya classification. Sugaya types IV and V were used to define the failure of tendon healing.[45] According to a previously published study, full-thickness graft tears, analogous to Sugaya types IV and V, were used to identify failure of graft healing.[29] Two orthopaedic surgeons (J.B.L. and H.B.) with fellowship training analyzed the entire radiological data in consensus (blinded). Radiological data used for the analysis included plain radiographs and MRI scans from pre- and postoperative assessments (ie, final visit).

Surgical Treatment

The indication for surgical treatment was symptomatic MRCT after nonoperative treatment, which was the same in both groups. Because there are no guidelines for optimal treatment of MRCT, the surgeon determined the surgical methods. However, aRCR was primarily done early in the study period before the introduction of aSCR.

Arthroscopic Superior Capsular Reconstruction. All procedures were performed with the patient under general anesthesia and were carried out while the patient was sitting in a beach-chair position after administration of an interscalene brachial plexus block. An arthroscopic examination was conducted to check the tear size and tear configuration. In all cases, the tear margin did not sufficiently cover the footprint during reduction trials. Acromioplasty was done in all cases to flatten the acromial undersurface. Biceps tenotomy was also performed in all cases. Biceps tenodesis after tenotomy was selectively carried out depending on the patient's age and activity level. The fascia lata autograft was harvested from the ipsilateral thigh and folded in half, with a continuous suture (Ethibond 2-0; Ethicon Inc) run at each margin. In 19 (57.58%) of 33 cases, a mesh was inserted between the grafts.[19,20] All patients had a mean graft thickness $\geq$6 mm after graft preparation. After debridement of the superior surface of the glenoid and the footprint of the humerus, 3 all-suture anchors (1.7-mm Suturefix Suture Anchor; Smith & Nephew) were inserted into the glenoid (or 2 anchors for a small glenoid), and 2 PEEK threaded anchors (4.5-mm Healicoil Suture Anchor; Smith & Nephew) were inserted into the medial row of the humeral footprint. A simple suture was performed for glenoid-side fixation on each anchor and mattress sutures for humeral-side fixation. The residual rotator cuff and subdeltoid bursal tissues were sutured with the remaining strings from the knots of the mattress sutures and fixed with 2 knotless anchors (4.5-mm Footprint Ultra; Smith & Nephew) in the lateral row of the footprint. All aSCR procedures were carried out with the shoulder joint abducted at a 30° angle. Subscapularis tendon tears were repaired with the single-row method in the case of small- to medium-sized tears. The tear was repaired using 1 simple suture and 1 mattress suture with 1 anchor screw. Large to massive subscapularis tears were not observed in this study.

For postoperative care, a shoulder immobilization brace with 30° of abduction was used for 8 weeks. After immobilization, passive ROM exercises were started. After full ROM was achieved, strengthening exercises and active ROM began. Experienced physical therapists provided the instructions and supervised the entire rehabilitation process.

Arthroscopic Rotator Cuff Repair. The surgical setting for aRCR was the same as for aSCR. An arthroscopic examination was conducted to check the tear size and configuration. In the reduction trials, the footprints could not be fully covered by the tear stump. To repair the tendon on the anatomic footprint, we performed aggressive soft tissue release, including the rotator interval, coracohumeral ligament, and scar tissues surrounding the cuffs. After full mobilization of the tendon, the anterior and posterior margins of the rotator cuff tear were sutured, and a side-to-side repair was carried out to achieve margin convergence. Single-row repairs were carried out using 2 or 3 suture anchors in the footprint. Complete primary repair was achieved in all cases. Medialization of the repair was implemented in 87.9% (29/33) to reduce the tension of the repaired site, and others were repaired without the need for medialization. Subscapularis tendon tear was repaired with a single-row method in cases of small- to medium-sized tears. The tear was repaired using 1 simple suture and 1 mattress suture with 1 anchor screw. There were no cases of large to massive subscapularis tears.

Shoulder immobilization with a 30° abduction brace was applied for postoperative care for 6 to 8 weeks. The rehabilitation protocol was similar to that of aSCR.

PS Matching

PS matching was done for the surgical option between aSCR and aRCR. Multiple logistic regression analysis was used to estimate the PS, with aSCR as the dependent variable. A model was created that included all the variables in Table 1. Model discrimination and calibration were assessed via the C statistic (C = 0.879) and Hosmer-Lemeshow goodness-of-fit test (χ^2 = 8.5705; P = .3798). Greedy matching was performed with a caliper of 0.2 SD. The absolute standardized differences were used to diagnose the balance. All absolute standardized differences after matching were <0.2. PS matching was conducted using R (Version 13.0; R Development Core Team).

Statistical Analysis

Sample size calculation had a power of 80%, a 2-sided significance level of .05, and a difference of a 30% failure rate

TABLE 1
Before and After Propensity Score Matching[a]

	Before Matching			After Matching			
	aRCR (n = 102)	aSCR (n = 61)	*P* Value	aRCR (n = 33)	aSCR (n = 33)	*P* Value	SMD
Sex	41:61	20:41	.34	11:22	10:23	≥.999	0.077
Age, yr	63.25 ± 7.20	64.38 ± 8.46	.37	62.85 ± 6.22	63.84 ± 8.62	.62	0.131
Diabetes mellitus	16	6	.29	4	5	≥.999	0.142
Osteoporosis	7	4	.99	1	1	≥.999	0.000
ROM, deg							
FF	152.21 ± 24.78	141.72 ± 38.13	.06	141.67 ± 34.20	146.81 ± 33.95	.47	0.150
ER	46.96 ± 18.15	37.79 ± 21.71	**.04**	41.21 ± 18.91	41.96 ± 21.43	.87	0.003
pVAS	4.80 ± 1.69	5.61 ± 1.85	**.05**	5.18 ± 1.63	5.51 ± 1.82	.38	0.191
SANE	49.12 ± 17.18	45.08 ± 17.95	.16	46.36 ± 15.77	46.36 ± 15.04	≥.999	0.000
ASES	55.66 ± 15.47	52.03 ± 17.00	.17	56.06 ± 15.04	53.54 ± 17.41	.49	0.154
Constant	56.67 ± 10.13	52.87 ± 14.19	.07	55.27 ± 11.80	54.42 ± 13.07	.79	0.068
Tear size, mm							
ML	35.14 ± 5.36	40.55 ± 5.26	**<.001**	38.56 ± 4.54	38.09 ± 4.08	.53	0.109
AP	26.06 ± 7.57	29.25 ± 7.29	**.01**	28.81 ± 6.70	28.76 ± 4.48	.42	0.160
GFDI	1.53 ± 0.46	1.66 ± 0.52	.12	1.45 ± 0.57	1.48 ± 0.41	.78	0.060
AHD, mm	5.31 ± 1.93	4.79 ± 2.30	.12	4.64 ± 1.94	4.86 ± 1.93	.76	0.085

[a]Data are presented as mean ± SD or No. Statistical significance is indicated in bold. AHD, acromiohumeral distance; AP, anteroposterior; aRCR, arthroscopic rotator cuff repair; aSCR, arthroscopic superior capsular reconstruction; ASES, American Shoulder and Elbow Surgeons; ER, external rotation; FF, forward flexion; GFDI, global fatty degeneration index; ML, mediolateral; pVAS, pain visual analog scale; ROM, range of motion; SANE, Single Assessment Numeric Evaluation; SMD, standardized mean difference.

(10% and 40%), which was referred to the failure rate of 39.8% in aRCR surgery for MRCT.[4] A minimum of 32 patients for each group was required. Before PS matching, the aRCR and aSCR groups were compared using the independent *t* test for continuous variables (age, ROM, pVAS, SANE, ASES, Constant, tear size, GFDI, and AHD) and the χ^2 test or Fisher exact test for categorical variables (sex, diabetes mellitus, and osteoporosis). After PS matching, the paired *t* test was used for continuous variables and the McNemar test for categorical variables. For subgroup analysis, the Mann-Whitney test was used for continuous variables and the Fisher exact test used for categorical variables. The significance level was set at $P < .05$. SPSS Version 21.0 (IBM) was used for all descriptive and analytic evaluations.

RESULTS

A total of 102 patients were treated with aRCR and 61 treated with aSCR for MRCT, for a total of 163 patients eligible for PS matching analysis. PS matching was conducted on a 1:1 basis, and the variables are listed in Table 1. The final matched cohort included 66 cases (33 per group). The mean ± SD follow-up period was 44.80 ± 14.90 months. Before PS matching, several preoperative characteristics between the aRCR group and the aSCR group revealed significant differences: external rotation (P = .04), pVAS (P = .05), mediolateral tear size ($P <$ .001), and anteroposterior tear size (P = .01). After PS matching, 33 patients in each group were matched for analysis. None of the variables in Table 1 were significantly different between the groups. There was no statistical difference in the rate of concomitant subscapularis tear and the healing rate of the subscapularis repair between the groups (Appendix Table A1, available in the online version of this article).

Postoperative Comparison of Clinical and Radiological Outcomes

Table 2 presents comparisons of pre- and postoperative clinical and radiological parameters between the aRCR and aSCR groups and within each group. All clinical and radiological parameters were significantly improved after surgery in both groups, except ROM, including forward flexion and external rotation in the aRCR group (P = .295 and P = .649, respectively) and external rotation in the aSCR group (P = .118). The postoperative clinical outcomes of forward flexion and pVAS after PS matching showed significant differences (P = .02 and P = .047). The aSCR group demonstrated higher postoperative AHD than did the aRCR group (7.00 ± 2.32 vs 5.23 ± 1.89 mm; $P <$ .001). The aSCR group had 29 (87.88%) healing cases out of 33, whereas the aRCR group had 20 (60.60%) (P = .022). There was no statistically significant difference between the groups in postoperative ASES, Constant, or SANE score ($P >$ .05). Postoperative active shoulder external rotation did not show a significant difference between the groups ($P >$ .05). Complications such as neurologic deficits and postoperative infections were not identified in either group. In addition, donor-site morbidity was not found in the aSCR group.

TABLE 2
Pre- and Postoperative Comparison Between aRCR and aSCR[a]

	aRCR (n = 33)	aSCR (n = 33)	*P* Value
Clinical outcomes			
ROM: FF, deg			
Preoperative	141.67 ± 34.20	146.81 ± 33.95	.47
Postoperative	147.88 ± 13.70	161.66 ± 9.57	**.02**
P value	.295	**.019**	
ROM: ER, deg			
Preoperative	41.21 ± 18.91	41.96 ± 21.43	.87
Postoperative	42.58 ± 15.92	48.18 ± 18.19	.14
P value	.649	.118	
pVAS			
Preoperative	5.18 ± 1.63	5.51 ± 1.82	.38
Postoperative	1.64 ± 0.90	1.03 ± 1.33	**.047**
P value	**<.001**	**<.001**	
SANE			
Preoperative	46.36 ± 15.77	46.36 ± 15.04	≥.99
Postoperative	77.58 ± 12.32	78.21 ± 11.71	.83
P value	**<.001**	**<.001**	
ASES			
Preoperative	56.06 ± 15.04	53.54 ± 17.41	.49
Postoperative	79.36 ± 10.94	82.61 ± 12.10	.30
P value	**<.001**	**<.001**	
Constant			
Preoperative	55.27 ± 11.80	54.42 ± 13.07	.79
Postoperative	64.20 ± 5.18	62.60 ± 4.39	.16
P value	**<.001**	**.002**	
Radiological outcomes			
AHD, mm			
Preoperative	4.64 ± 1.94	4.86 ± 1.93	.76
Postoperative	5.23 ± 1.89	7.00 ± 2.32	**<.001**
P value	**<.001**	**<.001**	
GFDI			
Preoperative	1.45 ± 0.57	1.48 ± 0.41	.78
Postoperative	1.80 ± 0.56	1.59 ± 0.49	.07
P value	**<.001**	**.033**	
Healing rate			
Postoperative	20 (60.60)	29 (87.88)	**.022**

[a]Data are presented as mean ± SD or No. (%). Statistical significance is indicated in bold. AHD, acromiohumeral distance; aRCR, arthroscopic rotator cuff repair; aSCR, arthroscopic superior capsular reconstruction; ASES, American Shoulder and Elbow Surgeons; ER, external rotation; FF, forward flexion; GFDI, global fatty degeneration index; pVAS, pain visual analog scale; ROM, range of motion; SANE, Single Assessment Numeric Evaluation.

Subgroup Analysis of Healed and Failed Groups per Procedure

The aRCR group had 13 cases (39.40%) of failure (Sugaya types IV and V). There were significant differences in SANE and ASES scores for healed versus failed groups (P = .009 and P = .004, respectively). Postoperative AHD was significantly higher in the success group of aRCR than in the failed group (P = .001). Pre- and postoperative GFDI was significantly higher in the failed group (P = .011 and P = .004). Four cases failed (12.12%) in the aSCR group. Postoperative forward flexion was significantly better in the success group (P = .014), which also showed a significantly higher postoperative ASES score (P = .002). In comparison between the success groups of the aSCR and aRCR groups, aSCR had better postoperative pVAS scores (0.93 ± 1.30 vs 1.50 ± 0.76 vs P = .021) and AHD (7.18 ± 2.16 vs 6.11 ± 1.56mm; P = .025) (Table 3). The aSCR group demonstrated no statistically significant differences between the mesh and nonmesh groups in terms of clinical and radiological outcomes. It also revealed no significant difference in graft failure rate (10.53% vs 14.29%; P = .464) (Appendix Table A2, available online).

DISCUSSION

This was a comparative study between the aRCR and aSCR groups using PS matching. Both surgical methods could serve as reliable treatments for MRCT because clinical outcomes were improved after surgery. In this study, the healing rate after the surgical procedure was higher in the aSCR group than the aRCR group (87.88% vs 60.60%; P = .022). Moreover, the aSCR group showed better results in pVAS score than the aRCR group (1.03 ± 1.33 vs 1.64 ± 0.90; P = .047). In postoperative forward flexion, the aSCR group had better outcomes than the aRCR group (161.66° ± 9.57° vs 147.88° ± 13.70°; P = .02). However, the postoperative clinical scores (ASES, Constant, and SANE) were not significantly different between the groups.

For MRCT, the reported success rate of the primary repair ranges from 30% to 94%.[10,16,17] The high rate of failure after surgery is burdensome for surgeons. Tendon and muscle release is required during surgery to repair an MRCT. However, current research suggests that excessive release adversely affects tendon healing owing to tissue devascularization.[18,23] In addition, poor tendon quality and muscle fatty degeneration that accompany massive rotator cuff tears are known as negative prognostic factors for tendon healing after rotator cuff repair.[11,14,30] A surgical method such as partial repair has been developed to reduce the tension of the torn tendon after repair, although it has been noted that the outcomes are poor in cases of severe fatty degeneration.[1] Thus, the concept of functional irreparable rotator cuff tear (FIRCT) is emerging.[3] The original definition of irreparability was a rotator cuff tear characterized by the inability to achieve a direct repair of native tendon to the proximal humerus despite mobilization of the remaining tissue using conventional techniques of soft tissue release.[52] However, FIRCT is a concept that considers the possibility of tendon-bone healing failure before surgery, and the corresponding risk factors include the tear size of the rotator cuff tendon and fatty degeneration of rotator cuff muscles.[3,22] With this perspective, we sought to compare the 2 surgical methods for MRCT using PS matching to reduce the selection bias. In this study, most cases were accompanied by tendon retraction and muscle fatty degeneration. In addition, during the process of repairing the tendon, excessive soft tissue release and medialization (if needed) were performed to reduce the soft tissue tension. In this study, the failure rate of aRCR after PS matching was 39.40%.

After PS matching, the aSCR group had a higher surgical healing rate than aRCR (87.88% vs 60.60%; P = .022). Mihata et al[36] reported a success rate of 83.3% in the initial study. In a recent report, the graft tear rate after SCR using autograft ranged from 8% to 29%.[50]

TABLE 3
Subgroup Analysis of Healed vs Failed Groups per Procedure[a]

	aRCR (n = 33)			aSCR (n = 33)		
	Success (n = 20)	Failed (n = 13)	*P* Value	Success (n = 29)	Failed (n = 4)	*P* Value
Clinical outcomes						
Preoperative						
ROM: FF, deg	149.00 ± 28.63	128.85 ± 10.65	.080	147.07 ± 35.44	145.00 ± 23.80	.911
ROM: ER, deg	41.50 ± 18.74	42.69 ± 18.58	.187	41.72 ± 20.88	43.75 ± 28.68	.863
pVAS	4.95 ± 1.61	5.54 ± 1.66	.318	5.38 ± 1.70	6.50 ± 2.65	.255
SANE	49.50 ± 18.49	41.54 ± 17.25	.224	44.83 ± 15.50	57.50 ± 15.00	.134
ASES	56.95 ± 14.18	54.69 ± 16.79	.680	52.10 ± 17.99	64.00 ± 6.73	.224
Constant	57.85 ± 9.64	51.31 ± 14.00	.121	53.44 ± 13.62	61.50 ± 3.87	.254
Postoperative						
ROM: FF, deg	155.75 ± 8.79	143.46 ± 13.29	**.010**	163.27 ± 8.69	150.00 ± 8.17	**.014**
ROM: ER, deg	41.75 ± 15.66	43.85 ± 16.85	.718	46.72 ± 18.48	58.75 ± 13.14	.221
pVAS	1.50 ± 0.76[b]	2.00 ± 0.91	.285	0.93 ± 1.30[b]	2.25 ± 0.96	**.025**
SANE	82.25 ± 10.06	70.38 ± 12.33	**.009**	80.86 ± 9.74	70.50 ± 7.50	**.041**
ASES	83.70 ± 8.42	72.69 ± 11.29	**.004**	84.76 ± 10.23	60.00 ± 11.34	**.002**
Constant	65.28 ± 5.23	62.77 ± 4.69	.18	63.54 ± 5.15	60.75 ± 2.22	.299
Radiological outcomes						
Preoperative						
AHD, mm	4.77 ± 2.04	3.67 ± 1.63	.114	4.77 ± 2.03	5.47 ± 0.91	.509
GFDI	1.22 ± 0.48	1.79 ± 0.55	**.011**	1.47 ± 0.41	1.63 ± 0.43	.474
Postoperative						
AHD, mm	6.11 ± 1.56[b]	3.88 ± 1.56	**.001**	7.18 ± 2.16[b]	4.22 ± 1.62	**.008**
GFDI	1.56 ± 0.41	2.17 ± 0.57	**.004**	1.55 ± 0.46	1.88 ± 0.63	.35

[a]Data are presented as mean ± SD. Statistical significance is indicated in bold. AHD, acromiohumeral distance; aRCR, arthroscopic rotator cuff repair; aSCR, arthroscopic superior capsular reconstruction; ASES, American Shoulder and Elbow Surgeons; ER, external rotation; FF, forward flexion; GFDI, global fatty degeneration index; pVAS, pain visual analog scale; ROM, range of motion; SANE, Single Assessment Numeric Evaluation.

[b]Significant difference in Mann-Whitney test ($P < .05$).

Additionally, during aSCR, vigorous soft tissue release is not required for the procedure, which respects the vascularity of the remaining tissue to support biological healing.

There was a significant difference in postoperative pVAS score between the aRCR and aSCR groups (1.64 ± 0.90 vs 1.03 ± 1.33; P = .047). Moreover, the success group of the aSCR group had a significantly lower pVAS score than the aRCR group. The aRCR group revealed no statistically significant difference in pVAS score between the healing group and the failed group. It was speculated that the graft might not be pain-sensitive tissue so that patients in the aSCR group were more tolerant of pain than those in the repair group. Thus, aSCR might be more effective in reducing postoperative shoulder pain compared with aRCR. However, further investigation is needed into this issue.

There were significant differences between the groups in postoperative AHD (aRCR vs aSCR, 5.23 ± 1.89 vs 7.00 ± 2.32 mm; $P < .001$). Effective head suppression may result from the aSCR graft. One of these results was caused by graft tension. We fixed the graft in 30° to 40° of shoulder abduction, so in the neutral position of the shoulder, the graft was under tension, and the humeral head was suppressed by the graft. The thickness of the graft may also affect the AHD.

The aSCR group demonstrated significantly better postoperative forward flexion than the aRCR group (161.66° ± 9.57° vs 147.88° ± 13.70°; P = .02). Thus, patients will have wider options for their activities of daily living or even recreational activities. In this study, the differences were thought to be due to those in surgical success rates. Between the successful groups of the aRCR and aSCR groups, the difference in postoperative results was not significant. In addition, in the failed group of each surgical method, forward flexion had a significant difference from that in the successful group. Thus, the success of surgery to restore the stable fulcrum of the glenohumeral joint is a key factor for postoperative forward flexion rather than the surgical option, whether aRCR or aSCR.

There were significant differences in clinical outcomes according to the surgical results. In the aRCR group, the success group showed significantly higher postoperative forward flexion, ASES score, and SANE score versus the failed group. The success group of the aSCR group showed significantly higher postoperative forward flexion, ASES score, and SANE score versus the failed group. pVAS was also significantly lower in the success group than the failed group. Thus, surgical success is an important factor for good clinical outcomes. This suggests that ultimate surgical healing was important in terms of clinical improvement regardless of the selection of surgical modalities.

This is the first study based on PS matching to compare the clinical and radiological outcomes between aRCR and aSCR for patients who experience MRCT. The matching technique included sex, age, diabetes mellitus, osteoporosis, preoperative ROM, pVAS, SANE, ASES, Constant, preoperative tear size, GFDI, and AHD. Second, 3-T MRI was used to evaluate pre- and postoperative radiological status. However, the study has several limitations. First, selection bias may have occurred in the collection of data from patients who underwent aSCR for irreparable rotator cuff tears and those who underwent aRCR for reparable rotator cuff tears. Yet, the definition of "irreparability" remains somewhat controversial and is largely dependent on the interpretation of the surgeon, who decides if a direct repair of the native tendon to the proximal humerus is achievable.[22] Although an MRCT can be initially repaired with aRCR, symptomatic retear can occur during follow-up, which raises questions about the tear's true reparability.[3,22] Even severely retracted MRCTs can be physically repaired depending on the degree of soft tissue dissection.[15] Therefore, it is difficult to predict reparability before surgery, and the choice of surgical methods is challenging. Although rotator cuff tears can be clinically classified as irreparable (aSCR) and reparable (aRCR), the classification should be reevaluated. Accordingly, the concept of FIRCT is emerging,[3] and various factors are being used to predict irreparability before surgery (eg, preoperative tear size and fatty degeneration of the affected muscle).[7,42] With this perspective, we compared aRCR and aSCR in similar reparability conditions by using PS matching. Second, the aSCR group demonstrated heterogeneity in that mesh was used for some cases but not all. Still, there was no significant difference between the mesh and nonmesh groups in subgroup analysis. Third, the short follow-up of the study may limit the extrapolation of its results. Further comparison studies of the middle- to long-term effects of each surgical method may be of value. In terms of the prevalence of cuff tear arthropathy, a middle- to long-term study is especially needed. Last, this study had a retrospective design, but we used PS matching analysis to minimize the selection bias between the groups.

CONCLUSION

aRCR and aSCR provide surgical outcome improvement for the treatment of MRCT. However, in this study based on PS matching analysis, aSCR showed superiority in terms of clinical outcomes, including pain relief, increased forward flexion, radiological healing rate, and AHD.

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