Simultaneous or Staged Bilateral Arthroscopic Rotator Cuff Repair

An Observational Study of Intraoperative and Postoperative Outcomes

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Background: Bilateral arthroscopic rotator cuff repair (ARCR) is frequently performed in patients with symptomatic bilateral rotator cuff tears.

Purpose: To compare patient-reported outcomes and mobility between simultaneous and staged bilateral ARCR.

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

Methods: Included were 51 patients who underwent simultaneous (anesthetized once) and 42 patients who underwent staged (anesthetized twice) bilateral ARCR between January 2014 and January 2018; for the staged group, the interval between procedures was at least 12 months. All operations were performed by the same surgeon, and all patients had minimum 24-month follow up in both shoulders. Patient-reported outcomes and range of motion (ROM) were assessed preoperatively and postoperatively and compared between groups. Outcome measures included the Constant-Murley score (CMS) and American Shoulder and Elbow Surgeons (ASES) score as well as measures of psychological status, health-related quality of life, activities of daily living (ADL), and patient satisfaction with the state of one's shoulders.

Results: The mean follow-up times for the staged and simultaneous ARCR groups were 44.1 months (range, 36-60 months) and 37.5 months (range, 25-59 months), respectively. There were no significant differences in age, tear size, or fatty degeneration of rotator cuff muscles between the groups. The cumulative length of hospital stay in the staged group was significantly longer than in the simultaneous group ($P < .001$). At the final follow-up, both groups showed significant improvement in ROM, CMS, and ASES scores ($P < .05$). No significant differences between the groups were observed in terms of ROM, CMS, and ASES scores postoperatively. At 24 months postoperatively, psychological status and health-related quality of life in both groups improved significantly ($P < .05$), and there were no significant between-group differences. Patients were able to perform most essential ADL. Both groups had high patient satisfaction, but patient satisfaction for the second shoulder of the staged group was lower than that of the simultaneous group ($P = .039$).

Conclusion: Simultaneous bilateral ARCR was shown to be effective, resulting in similar improvements in clinical outcomes to staged bilateral ARCR at 2-year follow-up. In addition to higher patient satisfaction, simultaneous bilateral ARCR also had a shorter treatment cycle.

Keywords: bilateral; rotator cuff tear; arthroscopic rotator cuff repair; simultaneous or staged

With the aging of the global population and the increasing participation in sporting activities, a growing number of people sustain rotator cuff tears.[21] Patients with symptomatic, unilateral, full-thickness tears have a 35% chance of a contralateral full-thickness tear.[36] These contralateral rotator cuff tears may be asymptomatic at first; however, Yamaguchi et al[36] found that about 51% of these asymptomatic tears progress to symptomatic tears after a mean of 2.8 years.

Arthroscopic rotator cuff repair (ARCR) is a well-established technique for the treatment of rotator cuff tears.[35] Rhee et al[27] reported that 4% of the patients with rotator cuff repairs underwent bilateral ARCR. In patients with bilateral tears, treatment options include either a simultaneous (single-stage) bilateral ARCR or a staged

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bilateral ARCR. Typically, bilateral rotator cuff tears are treated with staged bilateral ARCR. Some studies[2,27] reported that good surgical outcomes could be obtained with staged bilateral ARCR. There are many theoretical advantages of using single-stage bilateral ARCR, including reduced hospitalization costs and shorter recovery times.[23,26] However, simultaneous surgery may lead to increased perioperative risk and poor shoulder functional recovery.[1,24] Pak et al[24] reported that the University of California, Los Angeles Shoulder Score of patients with unilateral repair was significantly higher than that of patients with single-stage bilateral repair.

The purpose of this study was to analyze inpatient and follow-up data from patients who underwent bilateral ARCR and compare postoperative shoulder function, psychological status, and quality of life between simultaneous and staged bilateral ARCR. We hypothesized that similar functional and psychological outcomes and better patient satisfaction would be found at final follow-up for simultaneous treatment.

METHODS

In this ethics committee–approved study, we retrospectively reviewed data from 1580 patients with primary rotator cuff tears who underwent primary ARCR according to our institution's patient database. All operations were performed by the same surgeon (J.J.G.). The criteria for performing ARCR included patients who had intractable shoulder pain and/or significant limitation of normal activities after 6 months of nonoperative treatment and who were younger than 70 years, with fatty degeneration grade <4, rotator cuff tears ≤ 5 cm, and no frozen shoulder. Only patients in whom both shoulders met the aforementioned criteria underwent bilateral ARCR.

At our institution, the decision to perform simultaneous or staged bilateral ARCR is based on patient preference after the patient is provided a detailed description of the advantages and disadvantages of both procedures. However, only patients with ASA 1 or 2 could choose simultaneous bilateral ARCR.[5,25]

Study Patients

Of the 1580 patients, 132 (8.3%) underwent bilateral ARCR and were considered for the study. We excluded 35 patients for the following reasons: partial rotator cuff tear (n = 10), history of shoulder surgery for any reason (n = 2), revision surgery because of retear (n = 2), irreparable tears (n = 3), and <2-year follow-up in both shoulders (n = 4). Of the patients who underwent staged bilateral ARCR, we only included those who were diagnosed with bilateral tears before their first surgery. Ultimately, 93 patients were included: 42 patients who underwent staged bilateral ARCR and 51 patients who underwent simultaneous bilateral ARCR. The patient selection process is shown in Figure 1.

Surgical Procedures

All procedures were carried out by the same experienced surgeon (J.J.G.) under general anesthesia. The patients were placed in the beach-chair position. Inflamed bursal tissue and adhesion in the subacromial space were debrided to facilitate visualization of tear size and retraction. If there were osteophytes on the acromion or the acromion was Bigliani type 3 (hook), subacromial decompression and acromioplasty were performed. The footprint of the greater tuberosity was prepared to enhance tendon-to-bone healing. Finally, reconstruction was performed using a typical double-row suture-bridge technique. Two 4.5- or 5.5-mm suture anchors (HEALIX; DePuy Mitek) were inserted at the edge of the articular cartilage. According to the tear size, 1 or more 5.5-mm suture anchors were placed at the lateral edge of the footprint on the greater tuberosity.

In the simultaneous group, the right shoulder was repaired first. Moreover, in the staged group, the more symptomatic tear was repaired first. For the staged group, the time between procedures was at least 12 months to allow the initially repaired shoulder sufficient time to heal.

Rehabilitation

Postoperative management was the same for both groups. The shoulders were immobilized using a sling with an abduction pillow for 6 weeks. All patients followed the same standard postoperative rehabilitation protocol, including passive forward flexion exercises and passive external rotation exercises on the first day after surgery. Patients in both groups were allowed to perform essential daily activities that require active motion, such as toilet needs and meal taking. Nonetheless, patients were instructed to perform these activities with care and within a limited range.

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Ethical approval for this study was obtained from The First Affiliated Hospital of Soochow University (study No. 2018-312).

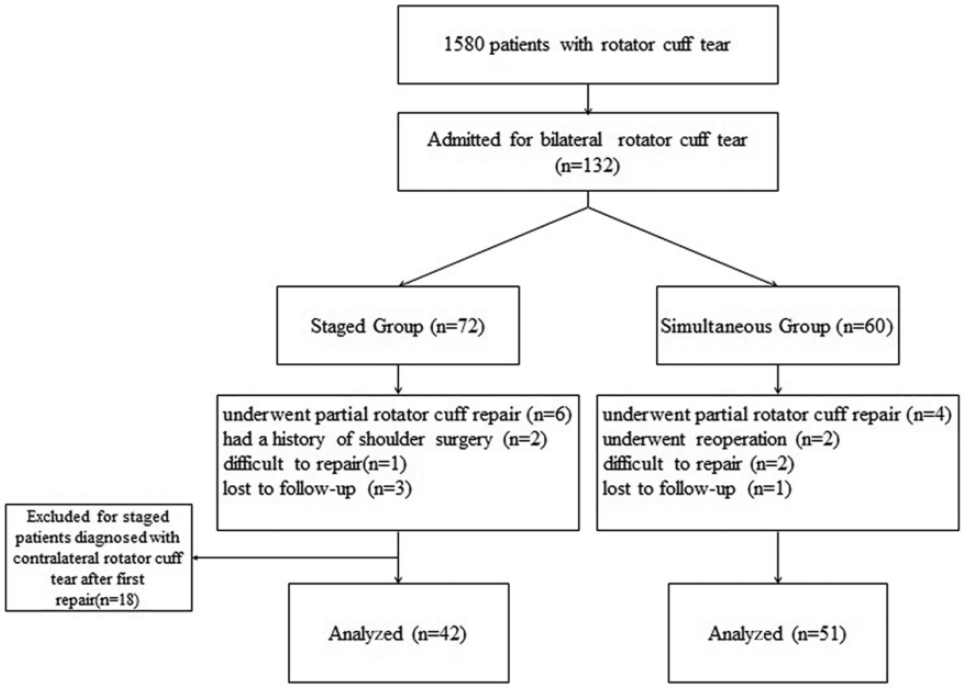

Figure 1. Flowchart of study enrollment.

At 6 weeks postoperatively, the sling was removed, and active exercises to improve muscle strength and range of motion (ROM) were gradually initiated. After 3 months, light sport activities were permitted. Full, unrestricted activities and manual work were permitted at 6 months, depending on the patient's functional recovery.

Clinical Assessment

Basic characteristic information was collected preoperatively for all patients. The size of the tear in the anteroposterior dimension was used to categorize tears into 2 groups: (1) small (<1 cm) or medium (1-3 cm) and (2) large (3-5 cm). Early periprocedural complications within 30 days after surgery were collected, including infection, deep vein thrombosis, and medical complications.

Every operated shoulder was evaluated preoperatively; postoperatively at 3, 6, 12, and 24 months; and annually thereafter. In the staged group, final follow-up was calculated from the date of the patients' first surgery. Patients completed the Constant-Murley score (CMS),[10] American Shoulder and Elbow Surgeons (ASES) score,[20] ROM, and modified Oxford Shoulder Score (OSS)[11] preoperatively and at 24 months postoperatively. Further, they completed the Hospital Anxiety and Depression Scale (HADS)[16], Pittsburgh Sleep Quality Index (PSQI),[6] and World Health Organization Quality of Life Scale–Abbreviated Version (WHOQOL-BREF)[12] preoperatively and at 3, 6, 12, and 24 months postoperatively. Patient satisfaction was self-evaluated preoperatively and at final follow-up and was categorized as very satisfied, satisfied, dissatisfied, or very dissatisfied.

The CMS and ASES score were used to assess shoulder function. ROM was determined with a goniometer and included forward flexion, abduction, external rotation, and internal rotation. Internal rotation was determined by the level that the dorsum of the hand could reach: thoracic vertebra 7, thoracic vertebra 12, lumbar vertebra 3, lumbosacral junction, buttocks, or lateral thigh.

We modified the OSS slightly so that the patients could intuitively assess their activities of daily living (ADL). The modified OSS included 12 items. The response options for the questions about ADL performance were no difficulty, little difficulty, moderate difficulty, extreme difficulty, and unable. The HADS and PSQI were used to assess psychological status. The HADS is composed of two 7-item subscales measuring anxiety (HADS-A) and depression (HADS-D). The WHOQOL-BREF was used to evaluate health-related quality of life (HRQoL).

Statistical Analysis

Descriptive statistics were reported as means, standard deviations, and percentages. Internal rotation was expressed as median values. For shoulder function scores and ROM (except internal rotation), preoperative and postoperative means were compared using the Student *t* test. Internal rotation was compared using the analysis of variance (ANOVA). The magnitude of improvement was evaluated for significant differences in the shoulder function scores and ROM (except internal rotation) between each group using a Student *t* test. The McNemar test was used to compare patient satisfaction between groups and changes from preoperative to final follow-up.

TABLE 1
Characteristic Data[a]

Variable	Staged Surgery (n = 42)		Simultaneous Surgery (n = 51)		P
	First Shoulder	Second Shoulder	First Shoulder	Second Shoulder	
Sex, male/female	17/25		23/28		.658
Side, right/left	28/14	14/28	51/0	0/51	
Age, y	57.3 ± 8.6		52.8 ± 7.2		.720
Interval between surgeries, mo, mean (range)	13.7 (12-18)		0		
Length of follow-up, mo, mean (range)	44.1 (36-60)		37.5 (25-59)		**.041**
Length of hospital stay, d	6.8 ± 0.6		3.5 ± 0.4		**<.001**
Duration of anesthesia, min	135.6 ± 8.8		120.5 ± 9.3		**.027**
Trauma history	5	3	7	3	NS
Tear size, <3/3 to 5 cm	25/17	26/16	31/20	29/22	NS
Fatty degeneration grade					NS
Supraspinatus	1.6 ± 0.8	1.8 ± 0.7	1.9 ± 0.8	1.8 ± 0.9	
Infraspinatus	1.0 ± 0.5	0.8 ± 0.4	0.8 ± 0.6	0.9 ± 0.5	
Subscapularis	0.7 ± 0.5	0.9 ± 0.6	0.8 ± 0.5	0.7 ± 0.6	
Combined lesions					NS
Subscapularis tear	7	4	8	6	
AC arthritis	5	5	3	4	
SLAP lesion	9	8	13	8	
Biceps tear	7	6	10	7	
2 of the above	6	4	8	6	
Concomitant procedures					NS
Biceps tenotomy	29	29	31	31	
Acromioplasty	7	5	10	8	

[a]Data are reported as absolute values or mean ± SD unless stated otherwise. Bolded *P* values indicate statistically significant between-group difference ($P < .05$). AC, acromioclavicular; NS, not significant; SLAP, superior labrum anterior-posterior.

The described cutoff values were used to categorize anxiety and depression based on the HADS-A and HADS-D as normal, mild, moderate, and severe. The repeated-measures ANOVA was used to compare psychological status scores and HRQoL between groups and changes from preoperative to final follow-up. Preoperative and postoperative prevalence of insomnia, depression, and anxiety was compared using the chi-square test. The threshold for statistical significance was set at $P = .05$. SPSS Version 19.0 (IBM) was used for statistical analysis.

RESULTS

Complete preoperative and postoperative clinical data were available for 42 patients who underwent staged ARCR (staged group) with a mean final follow-up of 44.1 months (range, 36-60 months) and 51 patients who underwent simultaneous ARCR (simultaneous group) with a mean final follow-up of 37.5 months (range, 25-59 months). Characteristic data of the groups are shown in Table 1. The mean interval between the 2 procedures in the staged group was 13.7 months (range, 12-18 months). Total anesthesia time in the simultaneous group was significantly shorter than that of staged group ($P = .027$). The cumulative length of hospital stay in the staged group was significantly longer than the simultaneous group ($P < .001$). There were no significant differences in tear size, fatty degeneration grade, trauma history, combined lesions, and concomitant procedure between the 2 groups (Table 1). No early periprocedural complications were experienced in either group.

There were significant improvements in shoulder function scores (CMS and ASES) and ROM from preoperative to the final follow-up in both groups (all $P < .05$) (Table 2). No significant differences were noted between the 2 groups. The second shoulder of the simultaneous group showed significantly greater improvement than the second shoulder of the staged group for ASES ($P = .043$), forward flexion ($P = .039$), and abduction ($P = .025$) (Table 3). The magnitude of improvement in shoulder function scores and ROM did not differ significantly between the first shoulder of the simultaneous group and the first shoulder of the staged group.

All patients in both groups were dissatisfied or very dissatisfied with their shoulders before surgery (Table 4). In the simultaneous group, 47 of 51 patients (92.2%) were satisfied or very satisfied postoperatively. In the staged group, 37 of 42 patients (88.1%) were satisfied or very satisfied after their first surgery and 30 of 42 patients (71.4%) were satisfied or very satisfied after their second surgery. The changes in patient satisfaction were statistically significant for both groups (all $P < .001$). At the final follow-up, patient satisfaction in the second shoulder of the staged group was substantially lower than that in the simultaneous group ($P = .039$).

After surgery, insomnia, anxiety, and depression decreased, whereas HRQoL increased significantly (Table 5). Both the simultaneous group and the second shoulder of the staged

TABLE 2
Shoulder Function Scores and Mobility[a]

	Staged Surgery (n = 42)				Simultaneous Surgery (n = 51)			
	First Shoulder		Second Shoulder		First Shoulder		Second Shoulder	
Variable	Preop	Final	Preop	Final	Preop	Final	Preop	Final
CMS pain	4.0 ± 2.6	13.4 ± 5.2	5.2 ± 2.6	11.9 ± 4.0	4.9 ± 4.8	13.1 ± 5.1	5.5 ± 3.5	13.5 ± 4.7
CMS activity	6.8 ± 5.1	17.3 ± 5.5	7.3 ± 2.9	16.5 ± 5.9	6.4 ± 4.5	17.2 ± 5.7	6.6 ± 5.1	17.8 ± 4.9
CMS mobility	12.3 ± 6.8	33.4 ± 10.6	16.2 ± 7.5	32.5 ± 11.2	14.9 ± 8.4	34.9 ± 9.9	15.9 ± 9.1	34.1 ± 10.6
CMS strength	6.3 ± 4.2	19.7 ± 6.7	8.4 ± 3.0	20.1 ± 5.6	7.0 ± 3.8	21.2 ± 7.3	7.4 ± 3.0	20.6 ± 7.7
CMS total	29.3 ± 12.4	83.7 ± 17.5	37.4 ± 9.3	81.1 ± 16.7	33.2 ± 13.1	86.4 ± 17.7	35.4 ± 12.6	86.0 ± 16.8
ASES	30.0 ± 11.0	85.5 ± 15.2	40.8 ± 7.8	80.8 ± 13.3	30.7 ± 12.2	87.0 ± 14.2	33.5 ± 10.6	91.6 ± 11.3
Forward flexion	61.2 ± 23.4	140.9 ± 20.3	85.5 ± 22.2	137.6 ± 18.8	78.7 ± 28.1	147.1 ± 21.2	84.9 ± 26.0	153.7 ± 22.3
Abduction	48.6 ± 21.5	122.4 ± 15.9	59.3 ± 18.6	110.2 ± 16.5	56.7 ± 21.7	131.3 ± 20.8	60.9 ± 23.5	129.1 ± 23.2
External rotation	32.1 ± 11.5	74.8 ± 13.7	42.1 ± 14.3	62.8 ± 10.0	41.0 ± 15.2	73.1 ± 10.9	45.6 ± 17.5	77.5 ± 12.3
Internal rotation, n (%)[b]								
Lateral thigh	4 (9.5)	0 (0)	5 (11.9)	0 (0)	4 (7.8)	0 (0)	3 (5.9)	0 (0)
Buttocks	21 (50.0)	1 (2.4)	18 (42.9)	2 (3.7)	15 (29.4)	0 (0)	12 (23.5)	0 (0)
LS junction	15 (35.7)	6 (14.3)	15 (35.7)	4 (9.5)	22 (43.1)	5 (9.8)	24 (47.5)	4 (7.8)
L3	2 (4.8)	13 (31.0)	3 (7.1)	17 (36.5)	7 (13.7)	20 (39.2)	10 (19.6)	18 (35.3)
T12	0 (0)	17 (40.5)	1 (2.4)	12 (33.6)	2 (3.9)	16 (31.4)	1 (2.0)	18 (35.3)
T7	0 (0)	5 (11.9)	0 (0)	7 (16.7)	1 (2.0)	10 (19.6)	1 (2.0)	11 (21.5)
Median	Buttocks	T12	Buttocks	T12	LS junction	T12	LS junction	T12

[a]Data are reported as mean ± SD unless stated otherwise. There were no statistically significant differences between shoulder groups for preoperative or final follow-up scores for any of the measures. Preoperative to final follow-up changes showed statistically significant improvement for all measures (all $P < .05$). ASES, American Shoulder and Elbow Surgeons score; CMS, Constant-Murley score; Preop, preoperative; LS, lumbosacral.

[b]Determined by the level at the back that the dorsum of the hand could reach.

TABLE 3
Improvement at Final Follow-up by Shoulder Group for Select Measures[a]

	Staged Surgery (n = 42)[b]		Simultaneous Surgery (n = 51)[b]		*P*	
	First Shoulder	Second Shoulder	First Shoulder	Second Shoulder	Staged First vs Simultaneous First	Staged Second vs Simultaneous Second
CMS pain	9.4	6.7	8.2	8.0	.610	.598
CMS total	54.4	43.7	53.2	50.6	.918	.375
ASES	55.5	40	56.3	58.1	.872	**.043**
Forward flexion, deg	79.7	52.1	68.4	68.8	.213	**.039**
Abduction, deg	73.8	50.9	74.6	68.2	.898	**.025**
External rotation, deg	42.7	20.7	32.1	31.9	.116	.091

[a]Bolded *P* values indicate statistically significant difference ($P < .05$). ASES, American Shoulder and Elbow Surgeons score; CMS, Constant-Murley score.

[b]Data are reported as change from pre- to postoperative.

group showed critical improvement in the mean HADS-A, HADS-D, PSQI, and WHOQOL-BREF scores at 24 months postoperatively (all $P < .05$) (Figure 2), with no significant differences between the 2 groups on any of these measurements. However, the course of recovery in the 2 groups was different. In the simultaneous group, all measurements continued to improve with time. In the second side of the staged group, all measurements deteriorated at 3 months and recovered to improve at 6 months, reaching the final results at 24 months.

The results of the modified OSS are shown in Table 6. Although some challenges were found with specific ADLs, the majority of patients in both groups were able to perform most activities. Especially for the activities of using public transport, carrying a plate of food, resting, and washing under arms, more than 90% of the patients in both groups had "no difficulty" or "little difficulty" in performing these activities. Playing sport was the most difficult activity for patients, but 66.7% of the patients in the staged group and 62.7% of the patients in the

TABLE 4
Patient Satisfaction[a]

	Staged Surgery (n = 42)					
	First Shoulder		Second Shoulder		Simultaneous Surgery (n = 51)	
Satisfaction	Preoperative	Final	Preoperative	Final	Preoperative	Final
Very satisfied	0 (0)	28 (66.7)	0 (0)	20 (47.6)	0 (0)	34 (66.7)
Satisfied	0 (0)	9 (21.4)	0 (0)	10 (23.8)	0 (0)	13 (25.5)
Dissatisfied	8 (19.0)	4 (9.5)	15 (35.7)	11 (26.2)	7 (13.7)	4 (7.8)
Very dissatisfied	34 (81.0)	1 (2.4)	27 (64.3)	1 (2.4)	44 (86.3)	0 (0)
P^b	**<.001**		**<.001**		**<.001**	

[a]Data are reported as n (%). Bolded *P* values indicate statistically significant between-group difference ($P < .05$).
[b]McNemar test for change from preoperative to final follow-up in satisfied (very satisfied or satisfied) vs dissatisfied (very dissatisfied or dissatisfied) scores.

TABLE 5
Prevalence of Depression, Anxiety, and Insomnia[a]

	Staged Surgery (n = 42)			Simultaneous Surgery (n = 51)		
Psychological Parameter	Preoperative	Final	*P*	Preoperative	Final	*P*
Depression			**.024**			**.005**
Normal	33 (78.6)	39 (92.9)		38 (74.5)	47 (92.2)	
Abnormal	9 (21.4)	3 (7.1)		13 (25.5)	4 (7.8)	
Mild	6 (14.3)	3 (7.1)		5 (9.8)	2 (3.9)	
Moderate	2 (4.8)	0 (0)		5 (9.8)	1 (2.0)	
Severe	1 (2.4)	0 (0)		3 (5.9)	1 (2.0)	
Anxiety			**.003**			**<.001**
Normal	26 (61.9)	39 (92.9)		31 (60.8)	47 (92.2)	
Abnormal	16 (38.1)	3 (7.1)		20 (39.2)	4 (7.8)	
Mild	7 (16.7)	3 (7.1)		9 (21.4)	2 (3.9)	
Moderate	6 (14.3)	0 (0)		6 (14.3)	2 (3.9)	
Severe	3 (7.1)	0 (0)		5 (9.8)	0 (0)	
Insomnia			**<.001**			**<.001**
Yes	32 (76.2)	16 (38.1)		40 (78.4)	18 (35.3)	
No	10 (23.8)	26 (61.9)		11 (21.6)	33 (64.7)	

[a]Data are reported as No. of patients (%). Bolded *P* values indicate statistically significant difference.

simultaneous group had "no difficulty" or "little difficulty" in playing sport.

DISCUSSION

These results suggest that simultaneous bilateral ARCR is an effective treatment with few complications, producing similarly good clinical outcomes in shoulder function, mobility, psychological status scores, and HRQoL when compared with staged bilateral ARCR.

Our study found some postoperative outcome measures (ASES, abduction, and forward elevation) were slightly better in the simultaneous group relative to the second shoulder of the staged group, although the outcomes for the first shoulder were comparable between groups. We speculate that the reason for this difference was the varying amount of early active motion. Although the postoperative rehabilitation plan was the same for both groups and that we suggested early mobilization for all patients, some patients in the staged group were inclined to use the recovered first shoulder to do daily activities and did not follow the rehabilitation plan. It has been reported that delayed motion may increase the risk of postoperative muscle atrophy, tendon degradation, and joint adhesions, which adversely affect the recovery of shoulder.[22,33] On the other hand, patients in the simultaneous group had to use both shoulders as early as possible, and it has been found that early active motion can decrease the incidence of postoperative shoulder stiffness and accelerate the healing process without increased risk of retears.[7,19,29]

One important finding in our study was that bilateral ARCR could significantly improve psychological status and HRQoL regardless of the timing of operation. Sleep disturbance is a common symptom in patients with rotator cuff tear.[4] Sleep disturbance secondary to shoulder discomfort is likely to have a negative effect on patients' quality of life and increase their anxiety and depression.[8] The rate of

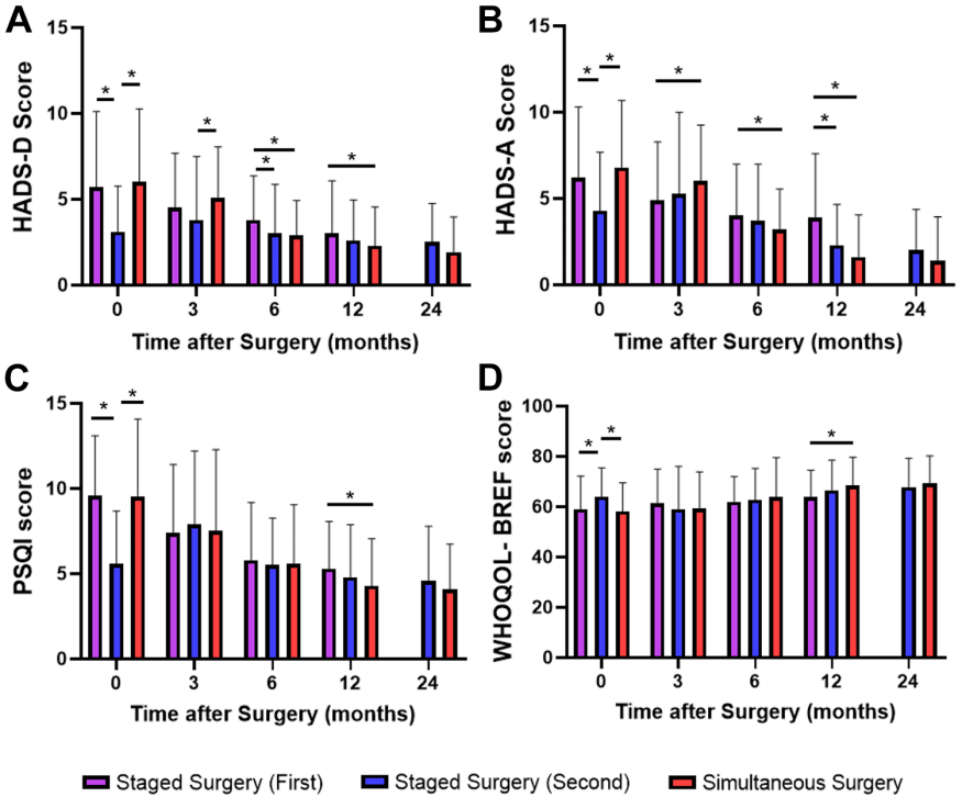

Figure 2. Comparison of pre- and postoperative (A) HADS-D, (B) HADS-A, (C) PSQI, and (D) WHOQOL-BREF scores between the staged and simultaneous surgery groups. *Statistically significant difference ($P < .05$). HADS-A, Hospital Anxiety and Depression Scale–Anxiety subscale; HADS-D, Hospital Anxiety and Depression Scale–Depression subscale; PSQI, Pittsburgh Sleep Quality Index; WHOQOL-BREF, World Health Organization Quality of Life Scale–Abbreviated Version; 0 months = preoperative.

TABLE 6
Modified Oxford Shoulder Score ADL Values[a]

	Staged Surgery (n = 42)					Simultaneous Surgery (n = 51)				
Functional Domain	No Difficulty	Little Difficulty	Moderate Difficulty	Extreme Difficulty	Unable	No Difficulty	Little Difficulty	Moderate Difficulty	Extreme Difficulty	Unable
Ability to play sport (worst pain)	10 (23.8)	18 (42.9)	8 (19.0)	5 (11.9)	1 (2.4)	15 (29.4)	17 (33.3)	13 (25.5)	6 (11.8)	0 (0)
Ability to dress independently	22 (52.4)	13 (31.0)	5 (11.9)	2 (4.8)	0 (0)	26 (51.0)	16 (31.4)	7 (13.7)	2 (3.9)	0 (0)
Ability to use public transport	25 (59.5)	11 (26.2)	6 (14.3)	0 (0)	0 (0)	27 (52.9)	19 (37.3)	5 (9.8)	0 (0)	0 (0)
Ability to eat independently	27 (64.3)	13 (31.0)	1 (2.4)	1 (2.4)	0 (0)	26 (51.0)	18 (35.3)	6 (11.8)	1 (2.0)	0 (0)
Ability to shop independently	15 (35.7)	20 (47.6)	5 (11.9)	2 (4.8)	0 (0)	16 (31.4)	21 (41.2)	11 (21.6)	2 (3.9)	1 (1.9)
Ability to carry a plate of food	31 (73.8)	10 (23.8)	1 (2.4)	0 (0)	0 (0)	35 (68.6)	13 (25.5)	3 (5.9)	0 (0)	0 (0)
Ability to comb own hair	17 (40.5)	15 (35.7)	6 (14.3)	3 (7.1)	1 (2.4)	24 (47.0)	18 (35.3)	7 (13.7)	1 (2.0)	1 (2.0)
Ability to rest (usual pain)	32 (76.2)	8 (19.0)	2 (4.8)	0 (0)	0 (0)	43 (84.3)	6 (11.7)	1 (2.0)	1 (2.0)	0 (0)
Ability to hang clothes up	23 (54.8)	11 (26.2)	5 (11.9)	2 (4.8)	1 (2.4)	27 (52.9)	12 (23.5)	8 (15.7)	2 (3.9)	2 (3.9)
Ability to wash under arms	35 (83.3)	6 (14.3)	1 (2.4)	0 (0)	0 (0)	42 (82.4)	7 (13.7)	1 (2.0)	1 (2.0)	0 (0)
Ability to perform usual work	27 (64.3)	10 (23.8)	3 (7.1)	2 (4.8)	0 (0)	32 (62.7)	14 (27.5)	3 (5.9)	1 (2.0)	1 (2.0)
Ability to sleep comfortably	26 (61.9)	8 (19.0)	7 (16.7)	1 (2.4)	0 (0)	33 (64.7)	10 (19.6)	5 (9.8)	3 (5.9)	0 (0)

[a]Data are reported as number of patient responses (%). ADL, activities of daily living.

sleep disturbance in the general public is 25%[8]; however, the prevalence of preoperative sleep disturbance in both groups in the current study was 76.2% and 78.4%, almost thrice that of the general public.

The reason why patients with rotator cuff tear experience increased nocturnal pain remains unclear. Ha et al[14] reported that melatonin levels that fluctuate according to circadian rhythms may lead to increased inflammatory

reaction in the subacromial bursa at night. Therefore, the therapeutic effect of ARCR combined with the excision of the pathologic subacromial bursa may result in the improvement of nocturnal pain. Our results indicated that both surgical interventions were beneficial to patients with bilateral rotator cuff tear experiencing sleep disturbance. Depression, anxiety, and HRQoL in both groups improved significantly as well.

After the second shoulder was repaired, the outcome of psychological status and HRQoL in the staged group significantly deteriorated at 3 months postoperatively. One reason for this phenomenon may be that postoperative pain was greater in the second operated shoulder than in the first. Studies[18,32] have shown that patients who experienced repeated surgical injury can induce hyperalgesia through central sensitization.

In our study, patient satisfaction for the second shoulder of the staged group was lower than that in the simultaneous group. Several previous studies[28,31,34] have reported that patients had lower satisfaction scores after the second surgery compared with the first. Sundaram et al[31] found in their study of staged total knee arthroplasty that patients were more than twice as likely to state that their first operation was better than the second. Complex modeling and multivariate analysis have indicated that patient satisfaction is most influenced by preoperative expectations of surgery, hospital experience, and clinical outcomes.[15] Thus, lower patient satisfaction is likely because of higher expectations for the second operation. At our institution, if staged surgery is involved, the more symptomatic shoulder is repaired first. After their first shoulder achieved good postoperative results, the patients in the staged group may have had higher preoperative expectations for their second side. However, the second side had less room for improvement, and it was therefore more difficult to meet patients' expectations. On the other hand, the preoperative expectation of the patients in the simultaneous group might have been pain relief and function recovery for both shoulders.

In our study, simultaneous bilateral ARCR reduced the length of hospital stay by almost 50% compared with staged bilateral ARCR. Although many centers around the world perform ARCR on an outpatient basis because it is a safe and cost-effective option, it is an inpatient surgery in our country. In addition, patients have to wait 1 or 2 days after being admitted before they undergo surgery, which contributes to their length of stay. The treatment cycle of patients in the simultaneous group was also significantly shorter than that of patients in the staged group. If the time between procedures in the staged group is decreased, patients in the staged group can shorten the overall duration of symptoms and reduce recovery time.

Kim et al[17] found in their study of staged bilateral ARCR that patients with an interval of $\leq$9 months between stages had a higher retear rate and significantly inferior clinical outcomes compared with patients with an interval of $>$9 months. Considering these issues, we did not perform surgery on the second side until the postoperative time of the first repaired side reached 12 months. Although the interval between the 2 operations was long, many patients still chose the staged surgery. One reason was to avoid possible difficulties with daily routines, such as personal hygiene, that may occur with a simultaneous bilateral procedure. Another reason was that they could not tolerate using bilateral slings for 6 weeks. Moreover, some patients chose staged surgery because they could independently undergo the postoperative rehabilitation.

To our knowledge, this is the first study comparing the clinical outcomes between simultaneous and staged bilateral ARCR. Our study has several limitations. First, there was no routine postoperative imaging to evaluate the integrity of rotator cuff repairs. Second, there were differences in tear characteristics and sizes. We chose to include these patients because previous literature showed generally equivalent functional results after rotator cuff repair regardless of different tears.[3] Third, the use of individual responses on the CMS or ASES may not have validity, though the overall outcome measure has validity. The CMS and ASES were used in this study because they evaluated shoulder function with high accuracy, reproducibility, and test-retest reliability, and they had had shown a good correlation with shoulder function.[9,13,30]

CONCLUSION

Simultaneous bilateral ARCR was shown to be effective, resulting in similar improvements in clinical outcomes during a 2-year follow-up, compared with staged bilateral ARCR. In addition to an overall higher patient satisfaction, simultaneous bilateral ARCR also had a shorter treatment cycle. Simultaneous bilateral ARCR is a promising option for patients with bilateral rotator cuff tears.

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