

Postoperative Outcomes of Single-Stage Versus Staged Bilateral Rotator Cuff Repair in Patients with Bilateral Rotator Cuff Tear: A Retrospective Study

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Research article

Keywords: Rotator cuff repair, Arthroscopy, Clinical outcomes, Single-stage surgery, Staged surgery

Posted Date: February 17th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-241612/v1>

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Abstract

Background: In the present study, we aimed to compare the clinical outcomes of patients who underwent single-stage or staged bilateral arthroscopic rotator cuff repair.

Methods: From March 2013 to May 2018, a retrospective review on all patients who underwent bilateral arthroscopic rotator cuff repair at our department was performed. There were 24 patients in the single-stage group and 27 patients in the staged group. The minimum follow-up period was 2 years. The visual analog scale (VAS), American Shoulder and Elbow Surgeons (ASES) score, University of California, Los Angeles (UCLA) score, Constant-Murley (Constant) score, and the range of motion (ROM) of the shoulder were evaluated for comparison between the two groups before and after the operation. Moreover, the hospitalization costs in the two groups were also recorded.

Results: All 51 patients were available throughout follow-up. There was no significant difference in the VAS score ($P=0.424$), ASES score ($P=0.325$), UCLA score ($P=0.170$), and Constant score ($P=0.275$) between the single-stage group and the staged group before the operation. Postoperative clinical scores were significantly improved in both groups. The VAS score, ASES score, UCLA score, and Constant score were significantly different between the two groups at 6 months postoperatively ($P<0.05$). At 12, 18, and 24 months after the operation, the VAS score, UCLA score, Constant score, and ASES score were not significantly different between the two groups. At follow-up, the ROM of the shoulder was not significantly different between the two groups. Besides, there was a significant difference in hospitalization costs between the two groups ($P<0.05$). Furthermore, there was no significant difference in the VAS score, UCLA score, Constant score, ASES score, and ROM between the first surgery and second surgery in the single-stage group postoperatively.

Conclusion: Patients receiving single-stage or staged bilateral arthroscopic rotator cuff repair showed similarly good clinical outcomes at follow-up. Moreover, good outcomes were observed on both sides of the single-stage group.

Background

With the increasing life expectancy and a growing number of patients suffering from rotator cuff tear, the majority of patients need to accept both conservative and surgical treatments[1–4]. Furthermore, more and more patients with bilateral rotator cuff tears appear in sports medicine outpatient, and bilateral rotator cuff tear has been a common disease[2, 4, 5]. Previous studies have shown that patients with bilateral rotator cuff tears account for up to 25.9%-35.5% of all rotator cuff tears[1, 4]. Arthroscopic rotator cuff repair is one of the most common orthopedic surgeries, and this technology has been mature to a great extent. A large number of studies have shown that there are clinically foreseeable and beneficial results in restoring function and reducing pain after rotator cuff repair[6–8]. In clinic practice, patients with bilateral rotator cuff tears are prone to undergo unilateral shoulder surgery to gratify the demands of daily life and observe the effectiveness of surgery to decide whether the other shoulder

should receive the same surgery. However, the majority of patients have to accept the surgery to stop the deterioration of the contralateral shoulder[2, 9–11]. Aleem et al.[12] have pointed out that patients receiving the staged bilateral rotator cuff repair can expect to obtain similarly good clinical outcomes in both shoulders. Besides, Pak et al.[13] have inferred that single-stage bilateral rotator cuff repair is a good option in selected patients, providing a safe and effective procedure that does not compromise functional results. However, only very few studies have compared clinical outcomes of staged bilateral arthroscopic rotator cuff repair and single-stage arthroscopic repair. In the present study, we aimed to compare the postoperative outcomes of single-stage and staged surgeries. We hypothesized that the two surgical timing would have similar outcomes at the follow-up after the operation and assumed that patients would select appropriate surgical approaches to satisfy the demands of daily life.

Methods

From March 2013 to May 2018, a total of 65 patients were diagnosed to have bilateral rotator cuff tears with symptoms according to a rigorous preoperative physical examination and radiologic evaluation referring to magnetic resonance imaging (MRI). The physical examination including Jobe test, Hawkins test, Neer test and related shoulder test were performed by the same doctor. The surgical indications were shoulder pain with or without abduction weakness. Inclusion criteria included patients receiving single-stage or staged bilateral rotator cuff repair. Of all patients, seven patients were excluded because of glenoid labrum tears, fracture history and previous shoulder surgeries. Moreover, three patients were lost during the follow-up, and four patients were excluded due to incomplete preoperative data. Therefore, 51 patients were finally included in this retrospective study, and they attended a minimum clinical follow-up of 24 months.

According to patients inclination of surgery methods, 51 patients were divided into 2 groups. There were 24 patients aged from 39 to 62 (53.8 ± 5.3) years in group A, who underwent single-stage bilateral arthroscopic rotator cuff repair. There were 27 patients aged from 37 to 62 (52.2 ± 6.5) years in group B, who received staged bilateral arthroscopic rotator cuff repair. Pain in bilateral shoulders restrained patients from normal daily life, and they agreed to undergo single-stage or staged bilateral arthroscopic rotator cuff repair. As for patients receiving staged bilateral cuff repair, their more symptomatic shoulder would be firstly selected to repair. However, if symptoms of both sides were similar, the dominant shoulder would receive repair firstly. Basic demographic information of all patients, including age, gender, body mass index (BMI), and tear size, was collected. Before the operation, MRI was used to evaluate the tear size of shoulders in all patients. Oblique coronal and oblique sagittal images were obtained with a 3.0-T MRI unit (Siemens Medical Solutions, Erlangen, Germany). The tear size was measured along the anterior-posterior (AP) and medial-lateral (ML) length[14]. According to the classification criteria proposed by Cofield[15], there were 22 cases of a small tear (0–1 cm), 69 cases of a medium tear (1–3 cm), and 11 cases of a large tear (3–5 cm). At 6, 12, and 24 months postoperatively, routine postoperative MRI was performed. Muscle atrophy and fatty degeneration were evaluated with MRI performed before the operation and at 24 months postoperatively. Muscle atrophy was assessed on oblique sagittal images

using the occupation ratio as previously described[16]. Fatty degeneration in each muscle was assessed according to a 5-point grading system as described by Goutallier et al.[17].

Operative Technique

All patients underwent single-stage or staged rotator cuff repair, and operations were performed by the senior surgeons with 23 years of experience. Patients were placed in the lateral decubitus position when receiving single-stage or staged bilateral cuff repair under general anesthesia. To protect the first operated side in a single-stage procedure, it was well padded in abduction after the patient was turned for the contralateral rotator cuff repair. The posterior portal was established as the viewing portal, and an arthroscope was inserted through the posterior portal to assess intra-articular lesions. Subsequently, the arthroscope was inserted into the subacromial space to view the subacromial lesions and rotator cuff tear. If the patient had any evidence of impingement in subacromial or outlet position, subacromial decompression and acromioplasty would be performed to create a type-I flat acromion. Inflamed bursal tissues and adhesions were removed, and the edge of the torn cuff was debrided. The bleeding surface of bone was prepared to enhance bone-to-tendon healing. The single-row technique was conducted for rotator cuff repair with a suture anchor (Smith & Nephew, USA). Accordingly, the average time between 1st and 2nd operation was 6 month.

Rehabilitation

After the operation, shoulders were immobilized with an abduction brace for at least 6 weeks. All patients were provided a standard postoperative rotator cuff rehabilitation scheme, which should be strictly obeyed. The passive exercise was permitted on the second day after surgery, and the active exercise was permitted after 6 weeks to gradually increase the muscle strength and the active range of motion (ROM). After the operation, patients needed to take medicine referring to Celecoxib (200 mg once a day, each time) for 2 weeks.

Clinical Assessment

The visual analog scale (VAS) was used to determine preoperative and postoperative pain. To evaluate clinical outcomes of shoulders in all patients, the University of California, Los Angeles (UCLA) score, American Shoulder and Elbow Surgeons (ASES) score, and Constant-Murley score (Constant) were used before and after the operation. A goniometer was used to measure the active ROM, containing forward flexion, external rotation at the side, and internal rotation of the shoulder. Internal rotation was evaluated by the tip of the thumb reaching the vertebral level. The vertebral level was serially scored in this study: 1 point added for each level above the sacrum, with 0 for any level below the sacral region.

Statistical analysis

SPSS26.0 statistical software was used for analysis. Data were expressed as mean \pm standard deviation (SD). Categorical variables were analyzed using the Chi-square test. An independent sample t-test was adopted to compare quantitative data between groups. Repeated measures analysis of variance was employed to compare clinical scores between groups at different time points. The difference between preoperative and postoperative clinical scores of each group was detected using a paired t-test. $P < 0.05$ was considered statistically significant.

Results

All incisions healed by first intention without any complication after the operation. All the patients were followed up for 24 months. A total of 51 patients were included (Table I) in the final analysis, including 23 males and 28 females. The mean age was 52.9 years (SD, 5.9 years; range, 37–62 years). The mean BMI was 22.4 ± 2.7 kg/m². There were no significant differences in terms of the demographic characteristics between the single-stage group and the staged group.

There was no significant difference in the VAS score ($P = 0.424$), ASES score ($P = 0.325$), UCLA score ($P = 0.170$), and Constant score ($P = 0.275$) between the single-stage group and the staged group before the operation. Compared with the preoperative values in the two groups, the VAS score, UCLA score, Constant score, and ASES score were significantly improved at follow-up after the operation. The VAS score, ASES score, UCLA score, and Constant score were significantly different between the two groups at 6 months postoperatively ($P < 0.05$). At 12, 18, and 24 months after the operation, there was no significant difference in the VAS score, UCLA score, Constant score, and ASES score between the two groups (Fig. 1). Besides, there was no significant difference in the VAS score ($P = 0.295$), ASES score ($P = 0.621$), UCLA score ($P = 0.248$) and Constant score ($P = 0.283$) between the first surgery and second surgery in the single-stage group before the operation. Moreover, there was no significant difference in the VAS score, UCLA score, Constant score, and ASES score between the first surgery and second surgery in the single-stage group postoperatively at follow-up (Fig. 2).

There was no significant difference in the forward flexion ($P = 0.478$), external rotation ($P = 0.464$) at the side, and internal rotation ($P = 0.438$) of the shoulder between the single-stage group and the staged group before the operation. Compared with the preoperative values in the two groups, the ROM of the shoulder was significantly improved at follow-up. At follow-up, the ROM of the shoulder was not significantly different between the two groups (Fig. 3). Besides, there was no significant difference in the forward flexion ($P = 0.105$), external rotation ($P = 0.247$) at the side, and internal rotation ($P = 0.137$) of the shoulder between the first surgery and second surgery in the single-stage group before the operation. There was no significant difference in the ROM between the first surgery and second surgery in the single-stage group postoperatively at follow-up (Fig. 4).

Postoperative integrity and healing status of the repaired tendon showed good results in MRI. Table 2 shows the MRI findings of muscle atrophy and fatty degeneration in the single-stage group and the staged group. There was no significant difference in distributions of muscle atrophy or fatty degeneration

between the two groups. Besides, Table 3 summarizes the MRI findings of muscle atrophy and fatty degeneration in the first surgery and second surgery in the single-stage group. There was no significant difference in distributions of muscle atrophy or fatty degeneration between the two groups.

Table 1
Demographic data

	Single-stage	Staged	P value
Male/female	11/13	12/15	0.842
Age (year)	53.8 (39–62; ±5.3)	52.2 (37–62: ±6.5)	0.353
BMI (kg/m ²)	22.1 (18.7–25.4; ±2.8)	22.6 (18.2–26.1: ±2.6)	0.501
Diabetes	3	5	0.838
Smoking history	4	7	0.422
Tear size: small/medium/large	12/31/5	10/38/6	0.729
Symptom duration at presentation (month)	6.8 (3–18; ±3.5)	7.6 (5–18; ±3.1)	0.441
Night pain	19	21	0.574

Table 2
Muscle atrophy and fatty degeneration in patients between single-stage repair and staged repair

	Single-stage	Staged	P value
Atrophy			
Preoperative	1.60 ± 0.32	1.54 ± 0.31	0.486
Postoperative		1.53 ± 0.33	0.948
Fatty degeneration	1.54 ± 0.30		
SSC			
Preoperative		0.87 ± 0.55	0.923
Postoperative	0.85 ± 0.65	0.83 ± 0.54	0.812
SSP	0.80 ± 0.56		
Preoperative			
Postoperative		0.87 ± 0.53	0.822
ISP		0.76 ± 0.56	0.944
Preoperative	0.83 ± 0.64		
Postoperative	0.77 ± 0.61	0.80 ± 0.50	0.719
		0.83 ± 0.54	0.711
	0.85 ± 0.63		
	0.77 ± 0.66		

Table 3
Muscle atrophy and fatty degeneration in patients between first surgery and second surgery in the single-stage group

	1st surgery in single-stage group	2nd surgery in single-stage group	P value
Atrophy			0.364
Preoperative	1.61 ± 0.33	1.59 ± 0.32	0.817
Postoperative	1.53 ± 0.34	1.54 ± 0.31	
Fatty degeneration			0.426
SSC	0.92 ± 0.72	0.83 ± 0.64	0.664
Preoperative	0.88 ± 0.68	0.79 ± 0.78	
Postoperative			0.627
SSP	0.88 ± 0.61	0.79 ± 0.88	0.714
Preoperative	0.79 ± 0.59	0.75 ± 0.74	
Postoperative			0.802
ISP	0.88 ± 0.61	0.83 ± 0.87	0.747
Preoperative	0.75 ± 0.61	0.79 ± 0.83	
Postoperative			

The average hospitalization costs of patients in the single-stage group and staged group were 28,725.00 ± 844.41 and 32,766.67 ± 1647.84 Yuan, respectively, and there was a significant difference between the two groups ($P < 0.05$). Box analysis showed that the hospitalization costs of patients in the single-stage group were relatively lower. Besides, the distribution of hospitalization costs in the staged group was relatively scattered. In contrast, the distribution of hospitalization costs in the single-stage group was relatively concentrated. Moreover, there was no obvious discrete value in the two groups (Fig. 5).

Discussion

Patients with unilateral rotator cuff tears usually choose to have surgical treatment, and rotator cuff repair is a routine surgery[18–21]. Bilateral rotator cuff tears have become more and more common, and most of the patients receive staged surgery in clinical practice[2, 10]. However, single-stage surgery is now gradually being implemented, and the effect of single-stage surgery requires further exploration. Postoperative outcomes are evaluated to compare single-stage bilateral rotator cuff repair and staged bilateral rotator cuff repair.

Liem et al.[22] have pointed out that the prevalence of contralateral supraspinatus tears is significantly higher in the surgery group (67.3%). These findings suggest that patients with rotator cuff tears undergoing surgery have a higher risk of developing a rotator cuff tear on the contralateral side. Yoo et al. [14] have performed a comparison between the patients with surgical and non-surgical treatments after the suggestion of operative treatment for symptomatic rotator cuff tear. Out of the 137 patients, 104 patients (75.9%) ultimately undergo operative treatment. Deterioration of function and symptom with non-surgical treatment is a primary reason for surgery. The primary reasons for not undergoing surgery in the remaining 33 (24.1%) patients include improvement of function and symptom in 18 patients (55%), economic pressure in four patients (12%), and worry for long-term rehabilitation in three patients (9%). There are many reasons that prompt patients to decide to undergo surgery or not. The probability of bilateral rotator cuff tears is likely to happen while one side tear occurs. Patients with rotator cuff tears are prone to require surgical treatment, and the opposite side has to undergo surgery after receiving surgery on one side. Nowadays, patients are prone to accept staged surgery, and single-stage surgery remains uncommon. Therefore, we focused on the outcomes of the two surgical methods.

For patients with bilateral rotator cuff tears undergoing staged surgery, a large number of studies have shown that the final result of the second operation is equivalent to the first operation. Rhee et al.[2] have reported that patients with bilateral rotator cuff tears undergoing staged surgery prefer to repair the more severely symptomatic side. Compared with the first operation, the VAS pain score in the second operation was significantly worse at 6 months postoperatively. However, there was no significant difference in the VAS score between the two groups at the final follow-up. When all these clinical outcomes from the final follow-up were combined, both sides of shoulders undergoing staged bilateral arthroscopic rotator cuff repairs would get a similarly good result. Because a large number of studies have investigated the impact of staged surgery on both shoulders, our study did not compare these values. However, we compared single-stage surgery and staged surgery, and observed the results of postoperative functional scores to study whether single-stage surgery could be a good substitute.

Gerber et al.[23] have demonstrated that single-stage bilateral total joint arthroplasty is considered an alternative to staged bilateral surgery. The authors have compared six patients receiving single-stage bilateral total shoulder arthroplasty with eight patients receiving staged bilateral total shoulder arthroplasty. Compared with the staged group, the postoperative outcomes of the single-stage group are significantly improved, and there are no extra complications in the single-stage group. Similarly, Pak et al. [13] have focused on the results of a single-stage bilateral rotator cuff repair, including 10 patients receiving single-stage bilateral surgery and 17 patients receiving unilateral surgery. The operation time of the single-stage group is longer, while there is no difference in the postoperative rehabilitation time. The single-stage bilateral repair offers similar results with no additional complications. Compared with unilateral repair, this process does not require more hospitalization and rehabilitation work. They suggest that for patients who can tolerate both shoulder fixation, single-stage bilateral arthroscopic rotator cuff repair is a viable option. Patients with unilateral rotator cuff tears have to accept surgical treatment after inefficient conservative treatment, while patients with bilateral rotator cuff tears can choose single-stage

or staged bilateral arthroscopic rotator cuff repair. Our results provided important clinical guidance for patients with bilateral rotator cuff tears when choosing the appropriate surgical method.

The VAS and functional scores are effective methods to assess postoperative clinical outcomes[24–28]. In our study, at 6 months postoperatively, VAS pain and functional scores after the single-staged operation were worse compared with the staged operation. However, there was no significant difference in VAS pain and functional scores between the two groups at the 12-month follow-up. Because the bilateral rotator cuff tears were repaired at the same time during the single-stage operation with bilateral trauma, the patients needed time to overcome early pain and underwent difficult functional recovery. It demonstrated that patients who accepted single-stage bilateral rotator cuff repair would undergo a more painful experience and more difficult functional rehabilitation, while the difference at 6 months would disappear at subsequent follow-up without special treatment. Both surgical methods could achieve good functional rehabilitation postoperatively, and there was no difference at the final follow-up. After the two operations, the ROM was significantly improved during the follow-up, and the two surgical methods achieved similarly good results. MRI has comparable accuracy in measuring the tear size of rotator cuff tears. Similarly, it has high accuracy for the detection of rotator cuff healing[29–33]. The repaired tendons were intact, and no obvious postoperative symptoms were observed in our study.

Due to strict restrictions on both shoulders after the single-stage surgery, it was generally considered that they could not perform daily life or early rehabilitation activities. Patients who underwent single-stage operation tended to protect their repaired shoulders rather than performing high-intensity exercises. Although patients undergoing single-stage repair needed help with shoulder pad replacement and passive exercise, and some patients slept uncomfortably throughout the night in the early postoperative period, they could adapt and overcome difficulties gradually. Compared with the staged operation, patients receiving single-stage operation saved hospitalization costs and avoided the second operation. If patients could adapt to the early difficult rehabilitation period and did not require much daily work, we would advise that patients with bilateral rotator cuff tears could consider single-stage bilateral rotator cuff repair. Compared with the staged bilateral rotator cuff repair, good results would also be achieved.

Besides, our operation used a lateral position for a single-stage operation. It is generally believed that although the first operation side is protected by thick gauze and shoulder pad, it would be compressed to some extent when patients receiving surgery on the contralateral side[14]. Currently, no research has reported whether the compression of the first operation side in single-stage rotator cuff repair has an impact on postoperative pain, functional scores, and ROM. Our study compared the postoperative outcomes of bilateral shoulders in the single-stage operation. During the follow-up, there was no significant difference in pain scores, functional scores, and ROM. It showed that a short period of intraoperative compression would not affect postoperative functional rehabilitation. Under good protection and short-time operation, short-term compression might not have adverse effects on the first operation side. However, we should try to shorten the operation time under the premise of ensuring the quality of operation. A longer operation time would increase the operation risk.

This study has several limitations. Because of the strict inclusion criteria, the sample size was relatively small, and the follow-up duration was short. The results of this study need to be validated by large clinical samples and prospective randomized controlled studies.

Conclusions

All 51 patients with bilateral rotator cuff tears were assessed for 2 years after rotator cuff repair. The comparison of clinical scores and MRI showed that both single-staged and staged repair achieved good clinical scores during 2 years of follow-up, although the staged group achieved better results at 6 months postoperatively with less pain. Additionally, both the first operation side and the second operation side had good clinical outcomes in the single-staged group. Therefore, it was a good selection for patients to choose single-stage operation without more hospitalization and rehabilitation.

Abbreviations

VAS: Visual analog scale; ASES: American Shoulder and Elbow Surgeons score; UCLA: University of California, Los Angeles score; ROM: Range of motion; SD: Standard Deviation; MRI: Magnetic resonance imaging ; BMI: Body mass index; AP: Anterior-posterior; ML: Medial-lateral

Declarations

Acknowledgements We express heartfelt gratitude to all those including the colleagues in our institution, professional peers and supervisors, who provided significant help to our research.

Authors' contributions CW wrote the manuscript. All surgeries were performed by CQ. PY and DZ analyzed the data. CW, DZ and PY contributed to data collection and outcomes evaluation. TY, YZ and IJ revised the manuscript. CQ planned and supervised the study. All authors read and approved the final manuscript.

Funding No funding was received.

Availability of data and materials The datasets analyzed during the current study are available as a supporting file or from the corresponding author on reasonable request.

Ethics approval and consent to participate The Ethical Committee of Affiliated Hospital of Qingdao University approved the protocol for this investigation and all investigations were conducted in conformity with ethical principles of research. The Ethical NO. is QYFY WZLL 25928.

Consent for publication Written informed consent to publish this information was obtained from study participants. All the data are available for the consultation.

Competing interests The authors declare that they have no competing interests.

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Figures

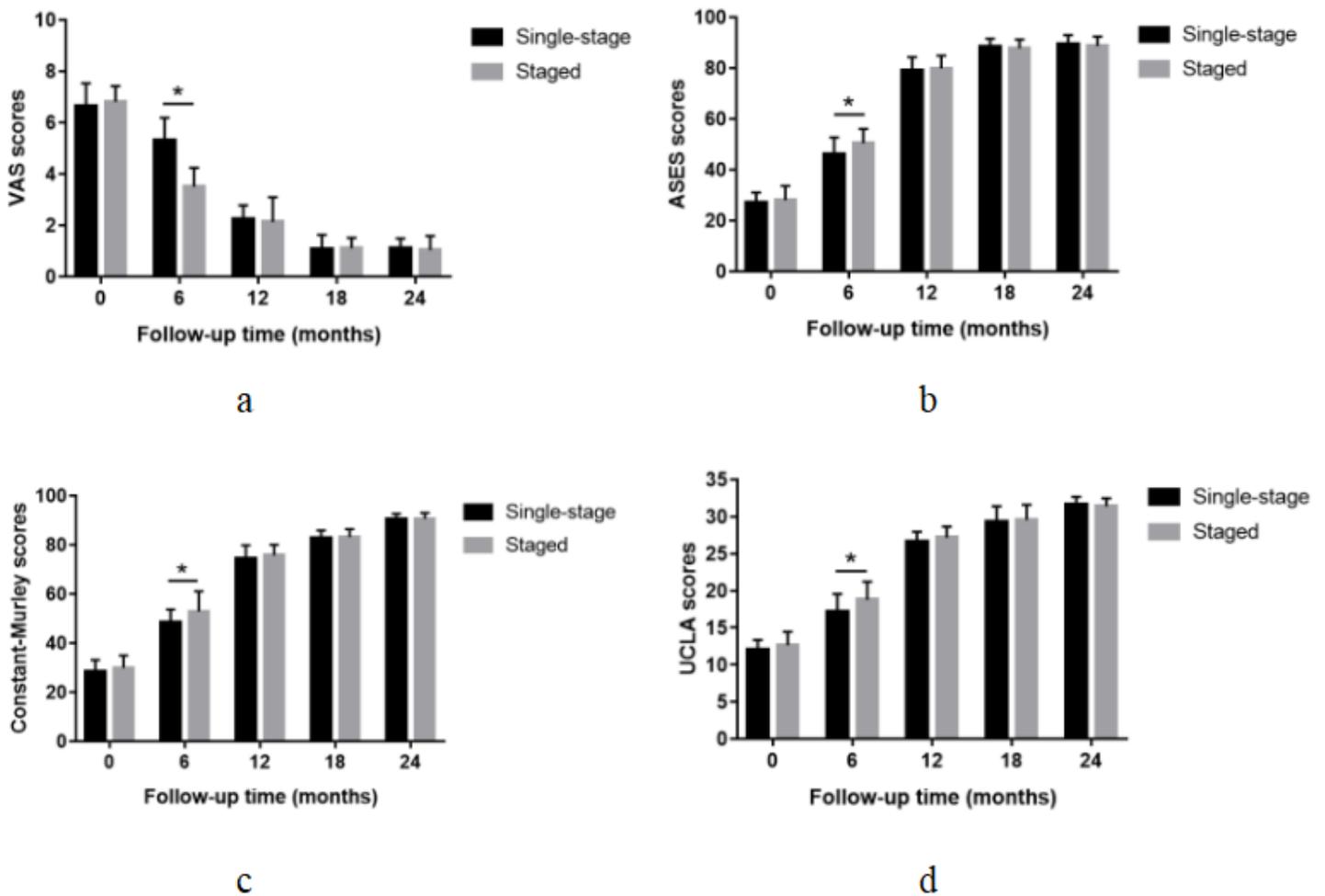


Figure 1

VAS (a), ASES (b), Constant (c), and UCLA (d) scores preoperatively and at 6, 12, 18, and 24 months after single-stage vs. staged bilateral rotator cuff repair. *Significant difference ($P < 0.05$).

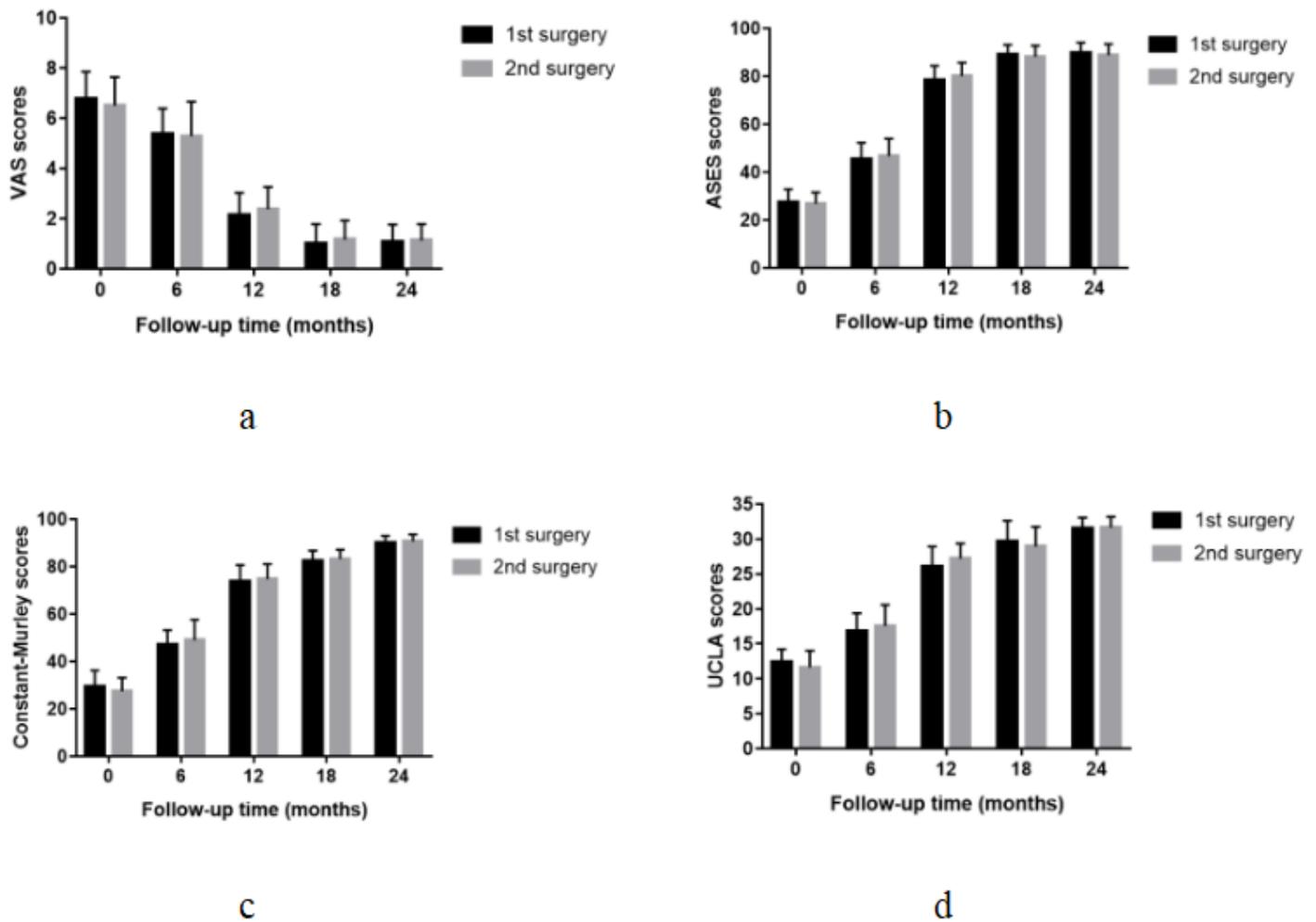
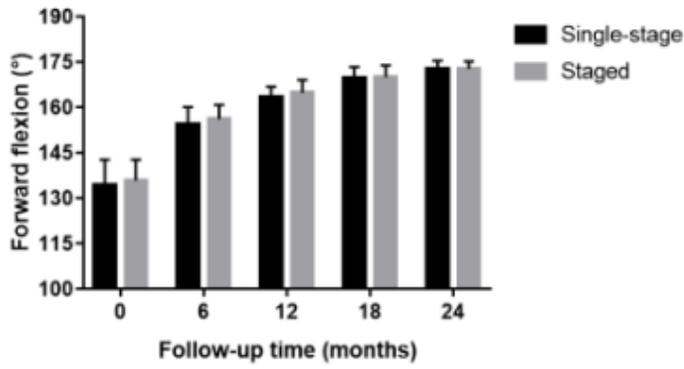
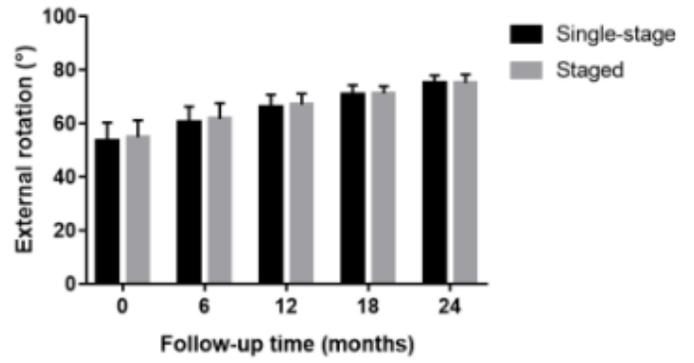


Figure 2

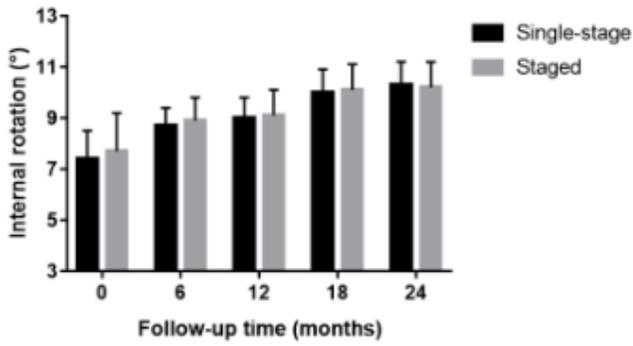
VAS (a), ASES (b), Constant (c), and UCLA (d) scores preoperatively and at 6, 12, 18, and 24 months after the first surgery vs. second surgery in the single-stage group. No statistically significant differences were found.



a



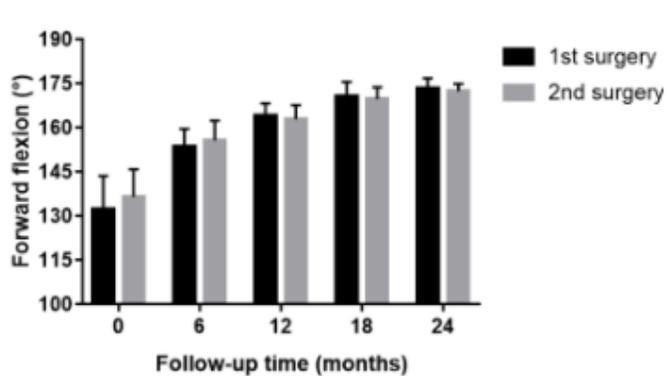
b



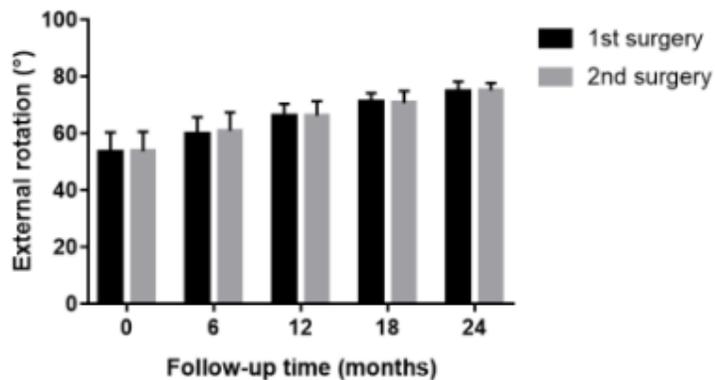
c

Figure 3

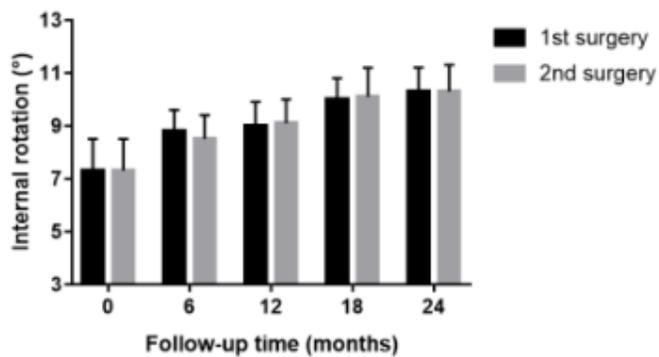
Forward flexion (a), external rotation (b), internal rotation (c) preoperatively and at 6, 12, 18, and 24 months after single-stage vs. staged bilateral rotator cuff repair. No statistically significant differences were found.



a



b



c

Figure 4

Forward flexion (a), external rotation (b), internal rotation (c) preoperatively and at 6, 12, 18, and 24 months after the first surgery vs. second surgery in the single-stage group. No statistically significant differences were found.

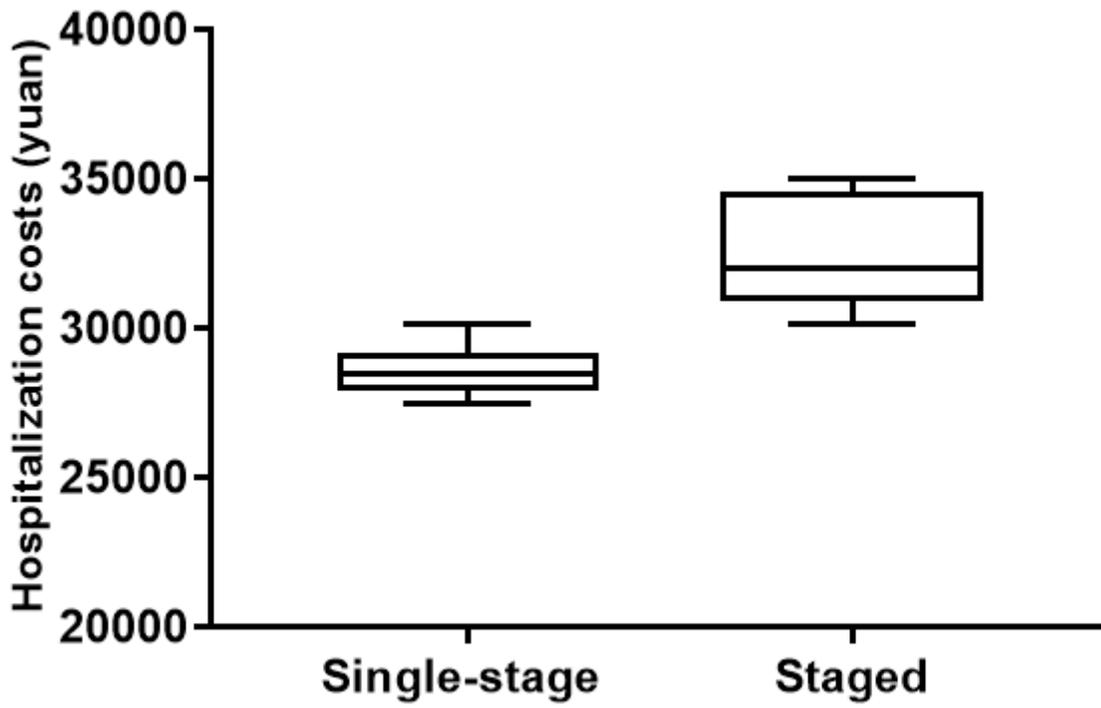


Figure 5

Hospitalization costs in single-stage vs. staged bilateral rotator cuff repair