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Analysis of the Impact of Double-Row Suture Bridge Technique under Shoulder Arthroscopy on Postoperative Recovery and Shoulder Joint Function in the Treatment of Rotator Cuff Injuries

Bing Yin

Hebei Medical University Third Hospital, Shijiazhuang 050051, Hebei, China

Abstract: *Objective:* To analyze the therapeutic effect of the double-row suture bridge technique under shoulder arthroscopy in treating rotator cuff injuries and its impact on postoperative shoulder joint functional rehabilitation. *Methods:* A retrospective analysis was conducted on the clinical treatment outcomes of 76 patients with traumatic rotator cuff injuries who underwent surgical treatment from 2024 to 2025. Patients who received single-row anchor suture fixation were designated as the control group (37 cases), while those who received the double-row suture bridge technique under shoulder arthroscopy during the same period were designated as the bridge group (39 cases). The ASES and Constant-Murley scores, as well as shoulder joint range of motion, were compared between the two groups before surgery and at 3 and 6 months postoperatively. *Results:* In the bridge group, the ASES score at 6 months postoperatively, as well as the shoulder joint forward flexion and abduction range of motion at 3 and 6 months postoperatively, were higher than those before surgery and in the control group during the same period, with statistically significant differences ($P < 0.05$). *Conclusion:* Compared to single-row anchor suture fixation, the double-row suture bridge technique under shoulder arthroscopy offers definite advantages in improving postoperative shoulder joint function and range of motion in patients with traumatic rotator cuff injuries, meeting the treatment needs of relevant patients.

Keywords: Traumatic rotator cuff injury; Shoulder arthroscopy; Double-row suture bridge technique; Functional rehabilitation

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1. Introduction

Rotator cuff injury is a common clinical condition involving soft tissue damage around the shoulder joint, typically resulting from varying degrees of tearing in the rotator cuff tissues. This condition manifests as symptoms such as weakness and pain in the affected shoulder joint during movement. Most patients have underlying pathologies such as rotator cuff degeneration and impingement syndrome, which can be exacerbated by trauma, leading to increased severity of rotator cuff injury [1]. Studies have indicated that traumatic rotator cuff injuries are the primary type observed in young and middle-aged adults. To maintain and ensure the integrity of shoulder joint function in patients, it is crucial to promptly initiate repair treatment following a rotator cuff injury [2]. Surgical treatment stands as the preferred option for patients with severe rotator cuff injuries, as it can restore the integrity of the rotator cuff structure and preserve shoulder joint function after repairing the damaged area as needed. However, a review of past treatment experiences has revealed that single-row anchor suture fixation can prolong the healing period of the rotator cuff and injured tendons, thereby affecting the timing and efficacy of subsequent rehabilitation interventions. In contrast, the double-row suture bridge technique, a novel surgical approach demonstrated in recent years to effectively facilitate shoulder joint function rehabilitation in patients with rotator cuff injuries, may optimize early postoperative shoulder joint function recovery in relevant patients [3,4]. Therefore, to analyze the therapeutic effects of the double-row suture bridge technique under shoulder arthroscopy in treating rotator cuff injuries and its impact on postoperative shoulder joint function rehabilitation, a clinical study was conducted, the details of which are as follows:

2. Materials and methods

2.1. Clinical data

Inclusion criteria: (1) A clear history of trauma to the affected shoulder, MRI imaging indicating unilateral supraspinatus tendon injury, and age ≥ 18 years; (2) Meeting the indications for minimally invasive arthroscopic surgery, with a duration of rotator cuff injury ≤ 3 months; (3) No history of old rotator cuff injury or previous shoulder surgery; (4) Having intact cognitive and verbal expression abilities and consenting to surgical treatment.

Exclusion criteria: (1) Clear surgical contraindications; (2) Clear presence of periarticular cystic changes or tendon calcification in the affected shoulder joint; (3) Clear primary or secondary osteoarthropathy of the shoulder joint; (4) Clear intolerance to surgery or presence of mental disorders.

A retrospective analysis was conducted on the clinical treatment outcomes of 76 patients with traumatic rotator cuff injuries who underwent surgical treatment upon admission between 2024 and 2025. Based on differences in surgical techniques, patients were divided into a control group (37 cases) and a bridge group (39 cases). There were no statistically significant differences in general data between the two groups ($P > 0.05$), indicating comparability, as shown in **Table 1**.

Table 1. Comparison of general data between the two groups

Clinical data	Control group (*n* = 37)	bridge group (*n* = 39)	Statistical value	*P* value
Gender (*n*, %)			$\chi^2 = 0.187$	0.665
Male	20 (54.05)	23 (58.97)		
Female	17 (45.95)	16 (41.03)		
Age (mean ± SD, years)	57.68 ± 6.25	57.74 ± 6.31	$t = 0.042$	0.967
BMI (mean ± SD, kg/m²)	24.25 ± 1.07	24.32 ± 1.14	$t = 0.276$	0.784
Duration of rotator cuff injury (mean ± SD, months)	2.27 ± 0.32	2.31 ± 0.28	$t = 0.581$	0.563
Severity of rotator cuff tear (*n*, %)			Z = 0.071	0.943
Moderate tear	22 (59.46)	23 (58.97)		

Table 1 (Continued)

Clinical data	Control group (n = 37)	bridge group (n = 39)	Statistical value	P value
Large tear	10 (27.03)	12 (30.77)		
Massive tear	5 (13.51)	4 (10.26)		
Comorbidities (n, %)				
Type 2 diabetes	7 (18.92)	5 (12.82)	$\chi^2 = 0.531$	0.466
Hypertension	13 (35.14)	14 (35.90)	$\chi^2 = 0.005$	0.945

2.2. Methods

All surgeries were performed by the same medical team, with patients undergoing surgery in a healthy-side lateral position under general anesthesia. Control group: After anesthesia and positioning, the affected upper limb was abducted 30° and flexed 20° for traction. Posterior, anterior, anterolateral, and lateral approaches were established to explore the site of rotator cuff injury. Debridement was performed on the tear and surrounding tissues. Subsequently, based on the results of intraoperative imaging evaluation, anchor implantation was carried out at the site of rotator cuff injury as needed, and the rotator cuff was sutured using non-absorbable sutures. Bridge group: After anesthesia and positioning, the affected upper limb was abducted 30° and flexed 20° for traction. After establishing a surgical incision and inserting a shoulder arthroscope, the damaged tissues at the site of rotator cuff injury and the inflammatory bursa beneath the acromion were explored and treated. After the aforementioned treatments, under arthroscopic visualization, the torn rotator cuff was reduced and tractioned, and tension was adjusted. After confirming the reduction effect, the footprint area of the greater tuberosity of the humerus was trimmed. As needed, two suture anchors with threads were placed at the cartilage edge of the healing area. The sutures were passed through the proximal end of the torn rotator cuff using a suture passer, fixed to the medial side of the bone bed, and the rotator cuff was sutured. Subsequently, two external row anchors were placed at the outer edge of the greater tuberosity of the humerus, and the torn rotator cuff was compressed and the anchors were tightened using sutures. After surgery, all patients received immobilization of the affected shoulder joint with a brace for 6 weeks. Starting from the 6th week postoperatively, the brace was removed as needed based on the healing status of the rotator cuff tear, and staged rehabilitation therapy for shoulder joint function was initiated.

2.3. Observation indicators

All patients underwent evaluation using the American Shoulder and Elbow Surgeons (ASES) [5] and Constant-Murley shoulder function scores [6] on the day of preoperative and postoperative follow-up visits at 3 and 6 months to assess the rehabilitation effect of shoulder joint function. The assessment of shoulder joint range of motion was conducted at the same time points, with the affected shoulder joint's forward flexion and abduction range of motion evaluated in a seated position.

2.4. Statistical methods

Data statistics were performed using SPSS 29.0 statistical software. Normally distributed measurement data were expressed as mean ± standard deviation (SD), with independent sample *t*-tests for intergroup comparisons and paired *t*-tests for intragroup comparisons. Categorical data were expressed as [n (%)], with chi-square tests for constituent ratio data and rank-sum tests for ordinal data. A P-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of shoulder joint function scores between the two groups

Preoperatively, there was no statistically significant difference in shoulder joint function scores between the two groups ($P > 0.05$). At 3 and 6 months postoperatively, both the ASES and Constant-Murley scores increased compared to preoperative values, and the ASES score at 6 months postoperatively in the bridge group was higher than that in the control group ($P < 0.05$). See **Table 2**.

Table 2. Comparison of shoulder joint function scores between the two groups (mean ± SD)

Group	ASES (score)			Constant-Murley (score)		
	Preoperative	3 months postoperatively	6 months postoperatively	Preoperative	3 months postoperatively	6 months postoperatively
Control group (*n* = 37)	57.45 ± 15.63	79.36 ± 6.87*	87.72 ± 6.15*	68.54 ± 15.32	79.54 ± 7.63*	86.34 ± 9.21*
Bridge group (*n* = 39)	57.52 ± 15.71	79.84 ± 6.85*	92.04 ± 4.36*	68.57 ± 14.97	82.84 ± 7.21*	87.58 ± 8.79*
t value	0.019	0.305	3.547	0.009	1.939	0.601
P value	0.985	0.761	0.001	0.993	0.056	0.550

Note: $P < 0.05$ indicates a statistically significant difference compared to the preoperative values within the same group.

3.2. Comparison of shoulder joint range of motion between the two groups

Before surgery, there was no statistically significant difference in shoulder joint range of motion between the two groups ($P > 0.05$). At 3 and 6 months postoperatively, the range of motion for forward flexion and abduction of the shoulder joint increased compared to preoperative values in both groups, with the bridge group showing higher values than the control group ($P < 0.05$). See **Table 3**.

Table 3. Comparison of shoulder joint range of motion between the two groups (mean ± SD)

Group	Forward flexion (°)			Abduction (°)		
	Preoperative	3 months postoperatively	6 months postoperatively	Preoperative	3 months postoperatively	6 months postoperatively
Control group (*n* = 37)	45.32 ± 8.45	115.35 ± 11.95*	133.28 ± 15.97*	7.68 ± 1.36	34.29 ± 3.58*	42.04 ± 4.85*
Bridge group (*n* = 39)	45.48 ± 8.41	132.25 ± 13.64*	146.25 ± 16.74*	7.71 ± 1.45	40.04 ± 4.65*	47.32 ± 5.31*
t value	0.083	5.733	3.452	0.093	6.017	4.519
P value	0.934	<0.001	<0.001	0.926	<0.001	<0.001

Note: $P < 0.05$ indicates a statistically significant difference compared to preoperative values within the same group.

4. Discussion

Due to the unique structural characteristics of the rotator cuff, it is prone to tears under the cumulative effects of long-term exercise, labor-related injuries, trauma, and other factors, leading to rotator cuff injuries. The occurrence of rotator cuff injuries can directly affect the muscle strength of the tendon tissues surrounding the shoulder joint and impair shoulder joint mobility, necessitating early and active treatment after injury to promote healing and maintain shoulder joint function [7].

Arthroscopic repair of rotator cuff injuries, as the primary treatment technique at this stage, demonstrates clear effects in repairing injuries and maintaining shoulder joint function. However, based on past experiences with single-row anchor suture fixation, although this surgical approach can effectively restore the physiological anatomy of the rotator cuff, release adhesions, restore shoulder joint mechanical balance, and reduce the risk of tendon atrophy, it has limitations. These include limited coverage of the injured rotator cuff area, concentrated stress on the anchors, a relatively long healing period postoperatively, and a risk of secondary tears during rehabilitation due to stress issues. Therefore, there is a definite clinical limitation, and optimizing the actual treatment effects and improving patient prognosis may be achieved by adjusting the coverage of the rotator cuff and the stress on the anchors during repair treatment [8].

The arthroscopic double-row suture bridge technique is a newly developed minimally invasive surgical approach for rotator cuff injuries that has been widely applied in recent years. During this procedure, double-row anchors are implanted and bridged with sutures to adjust the uniformity of anchor stress and provide extensive coverage of the injured rotator cuff area. This has a positive impact on the effective fixation of the torn rotator cuff and enhances the biomechanical stability of the fixation, effectively avoiding the risk of secondary tears during rehabilitation caused by stress on the anchors and rotator cuff. It provides a foundation for the active improvement of shoulder joint function after surgery [9]. The above conclusions are consistent with the findings of this study, where the ASES score at 6 months postoperatively and the shoulder joint forward flexion and abduction range of motion at 3 and 6 months postoperatively in the bridge group were higher than preoperative values and higher than those in the control group during the same period, with statistically significant differences ($P < 0.05$). Furthermore, after analyzing the results of this study, it is believed that the arthroscopic double-row suture bridge technique significantly simplifies the operational steps, avoiding the risk of iatrogenic injury to the local rotator cuff and tendon tissues caused by tightening knots. Additionally, treating the surrounding cartilage tissue of the rotator cuff with inner and outer double-row anchors can actively increase the fixation range of the rotator cuff, reasonably control the risk of anchor dislodgement, and balance the pressure between the humeral bone surface and the tendon through a mesh-like suture structure, thereby promoting the healing of the torn rotator cuff [10].

5. Conclusion

In summary, compared to single-row anchor suture fixation, the arthroscopic double-row suture bridge technique offers definite advantages in improving postoperative shoulder joint function and range of motion in patients with traumatic rotator cuff injuries, meeting the treatment needs of relevant patients.

Disclosure statement

The author declares no conflict of interest.

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