Five Years Follow-up After Arthroscopic Rotator Cuff Repair Using Suture Bridge Technique: Evaluation of the Retear Rate and the Impairment of the Shoulder Function

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Research article

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Abstract

Purpose: To evaluate the retear rate after arthroscopic rotator cuff repair using a suture bridge (SB) technique for patients with full thickness rotator cuff tears and whether the non-healing cuff impaired the shoulder function.

Methods: From January 2013 to January 2014, 92 patients in our institution underwent arthroscopic double-row suture bridge repair for the treatment of full-thickness rotator cuff tear 55 patients who have completed the 5 years follow-up were enrolled in this study. There were 36 female and 19 male patients, and the average age was 58.6 years (range, 41- 70 years). The tears were classified into small (<1 cm), medium (1-3 cm), large (3-5 cm), and massive (> 5 cm) according to the classification of DeOrio and Cofield. According to the intraoperative measurement, small tears were found in 5 shoulders (9%), medium tears in 19 shoulders (34.5%), large tears in 23 shoulders (41.8%), and massive tears in 8 shoulders (14.5%). The mean follow-up was 71.2 months (range, 66-78 months). Post-operative cuff integrity was evaluated with ultrasound (US) according to the published literature which was comparable to Sugaya MRI classification. Types I-III indicated cuff healing and types IV or V indicated retear. The retear patterns were divided into type 1 (failure at the original repair site) or 2 (failure around the medial row). At baseline and final follow-up, shoulder functional outcomes were measured using validated, shoulder-specific outcome scores, including the Constant-Murley score (CS) and the American Shoulder and Elbow Score (ASES). The difference in abduction muscle strength was also evaluated between the integrity and the retear group.

Results: At final follow-up, the rotator cuff was completely healed in 45 of the 55 shoulders. There were recurrent tears in 10 shoulders, and the retear rate was 18.2%. The type 1 re-tear pattern was found in 4 shoulders (40%), and type 2 in 6 shoulders (60%). The Constant and ASES scores improved from 41.00 to 92.00, and from 41.33 to 88.00, respectively. The mean differences in shoulder scaption strength between the healing and the retear group were $1.1 \pm 0.82\text{Kg}$ and $3.0 \pm 0.88\text{Kg}$ respectively. The difference in muscle strength between the retear and the healing group was statistically significant ($p < 0.001$).

Conclusion: Arthroscopic suture bridge repair of full-thickness rotator cuff tears led to excellent improvement in shoulder function, but maintained a high retear rate. Although the retear group had inferior muscle strength, the patients were still satisfied, and shoulder function was improved due to pain relief. Whether such changes in muscle strength impair patients' long-term quality of life and shoulder function remains to be discussed.

Level of evidence IV

Introduction

Tear of the rotator cuff (RC) is a common cause of shoulder pain and dysfunction. Previous studies have confirmed that arthroscopic rotator cuff repair can achieve good to excellent results. The goal of the surgery is to obtain healing of the RC to its footprint; however, reported retear rates after arthroscopic cuff

repair have varied from 11–94%[4, 9, 21, 24, 26]. The importance of RC healing has been shown by many studies, although other studies have shown functional improvement in the absence of RC healing. In general, rotator cuff repair techniques are divided into single-row and double-row repair techniques. It has been reported that there was no statistical difference in retear rate between the two techniques[14]; however, long-term follow-ups and systematic review studies have shown that the retear rate after single-row repair is significantly higher than that after double-row repair[8, 17]. The purposes of this study were: (1) to evaluate the retear rate and retear patterns after arthroscopic rotator cuff repair using double-row suture bridge technique at 5 years follow-up, and; (2) whether the non-healing cuff impaired the shoulder function.

Materials And Methods

Patient selection

From January 2013 to January 2014, 92 patients in our institution underwent arthroscopic double-row suture bridge repair for the treatment of full-thickness rotator cuff tear. 55 patients who completed the 5 years follow-up were enrolled in this study. There were 36 female and 19 male patients, the average age was 58.6 years (range, 41–70 years). The tears were classified into small (< 1 cm), medium (1–3 cm), large (3–5 cm), and massive (> 5 cm) according to the classification of DeOrio and Cofield. According to the intraoperative measurement, small tears were found in 5 shoulders (9%), medium tears in 19 (34.5%), large tears in 23 (41.8%), and massive tears in 8 (14.5%). The mean follow-up was 71.2 months (range, 66–78 months).

Inclusion and Exclusion Criteria

Inclusion criteria of the study were as follows: (1) only one shoulder was involved; (2) patients were older than 20 but younger than 70; (3) there was full thickness tear of the rotator cuff; (4) AHI was greater than 7 mm and GH joint line was well-maintained; (5) the grade of Goutallier fatty infiltration was less than or equal to grade II, (6) the tendon length was greater or equal to 15 mm, (7) the patients had full PROM under anesthesia, (8) the patients experienced persistent symptoms for more than 6 months even after adequate conservative treatment.

Exclusion criteria of the study were as follows: (1) concomitant with shoulder instability, fracture, labrum pathology and shoulder stiffness, (2) past surgical history of ipsilateral shoulder, (3) impairment of the shoulder function due to neuropathy, (4) scar diathesis.

Surgical Technique

All of the operations were performed by a single senior surgeon (L.Z.) with the patient under general anesthesia combined with interscalene block in the lateral decubitus position. After diagnostic glenohumeral arthroscopy, acromioplasty was conducted when osteophytes were found under the

acromion, or when the type of acromial shape was III. Subsequently, the rotator cuff tendon was débrided, and the footprint was prepared.

Arthroscopic cuff repair was performed using the knot-tying double-row suture-bridge technique. One or two 4.5 mm Healix PEEK anchors (DePuy Mitek, Raynham, MA, USA), depending on the tear size (Figure1), loaded with 2 No. 2 Orthocord sutures, were inserted in the medial side of the cuff footprint of the humeral head. Sutures were passed through the cuff tendon tissue 2mm laterally from the muscle-tendon junction and tied in a horizontal mattress fashion. To establish the lateral row, the suture limbs of the medial-row anchor were crossed over the tendon and fixed laterally by 2 knotless anchors (Versalock; DePuy Mitek, Raynham, MA, USA). Lateral anchors were then inserted perpendicular to the cortical surface of the humerus 5 to 10 mm distal- lateral to the lateral edge of greater tuberosity.

Postoperative Rehabilitation

Patients were placed in a sling with an abduction pillow. The sling was worn continuously for 6 weeks. Cryotherapy was used for pain relief and for reducing the inflammatory reaction. Active elbow flexion and extension, active forearm supination and pronation, and active hand and wrist motions were encouraged on day 1 post operation. For large tears, the shoulder was immobilized for the first 3 weeks, and then the passive range of motion was initiated. For massive tears, the shoulder was immobilized for 6 weeks, and then the passive range of motion was initiated. After 6 weeks, the brace was removed, and active range of motion was initiated. For large to massive tears, the active range of motion was delayed. After 3 months, active resistance muscle- strengthening exercises begun. The patients could perform full activity 6 months after the operation, taking individual differences into consideration.

Clinical and radiologic evaluation

Clinical assessment: At baseline and final follow-up, shoulder functional outcomes were measured using validated, shoulder-specific outcome scores including the Constant-Murley score (CS), and the American Shoulder and Elbow Score (ASES).

Radiologic evaluation: The postoperative repair integrity was analyzed with use of US by two experienced musculoskeletal radiologists. The classification system developed by Barth[2], comparable to Sugaya[20] MRI integrity classification, was used: Type I indicated a repaired cuff that had sufficient thickness (> 2 mm) with normal echostructure as normal tendon hyperechoic and fibrillar on each image—Type II indicated a repaired cuff that had sufficient thickness (> 2 mm) associated with a partial hypo-echo-genicity or heterogeneity; Type III indicated a repaired cuff that had insufficient thickness (< 2 mm) without discontinuity; Type IV indicated the presence of a minor full-thickness discontinuity of which borders are visible, suggesting a small tear; and Type V indicated the presence of a major discontinuity of which the medial border is not visible under the acromial arch, suggesting a medium or large tear. Sugaya I-III indicated cuff healing, and Sugaya IV or V indicated retear.

Cho[5] et al. described two types of retear patterns after rotator cuff repair according to postoperative MRI: type 1, if the cuff tissue repaired at the insertion site of the rotator cuff was not observed to be remaining on the greater tuberosity; and type 2, if the remnant cuff tissue remained at the insertion site despite the retear. In our study, we evaluated the retear patterns via postoperative US.

Shoulder scaption strength assessment: Shoulder scaption strength was evaluated with the use of a weighing scale proposed by Collin[6] et al. Scaption strength of both shoulders were measured by one physician with the same weighting scale (accuracy: 0.5 Kg) (results expressed by Kg). The difference between the 2 shoulders was calculated as the basis for evaluation.

Statistical Analysis

SPSS 25.0 (SPSS Inc, Chicago, Illinois) was used for statistical analysis. Normal distribution data and non-normal distribution data were assessed by mean plus or minus the standard deviation ($\bar{x} \pm s$) and median(M).

The differences between pre- and postoperative mean Constant scores and ASES scores were analysed using the Wilcoxon rank sum test. A P-value less than 0.05 was considered to be a significant difference.

Patients were categorized into two separate groups, using Sugaya classification and corresponding percentages of preoperative rotator cuff tear size. Patients with Sugaya I-III indicated cuff healing and were classified into the healing group. Conversely, patients with recurrent tear were classified into the retear group. Postoperative Constant scores and ASES scores were determined significant by Student's test between the two groups. The Mann–Whitney U test compared muscle strength differences between the two groups. If the test results were $P < 0.05$, the difference in data between the groups was considered statistically significant.

Results

In 55 patients, Sugaya type I was found in 16 cases (29.09%), type II in 23 cases (41.82%), type III in 6 cases (10.91%), type IV in 7 cases (12.73%) and type V in 3 cases (5.45%). The rotator cuff was completely healed in 45 of the 55 shoulders (Sugaya type I-III); the healing rate was 81.82%. 10 patients had recurrent tear (Sugaya IV or V type); the retear rate was 18.18%. The type 1 re-tear pattern was found in 4 shoulders (40%), and type 2 in 6 shoulders (60%).

Two cases (40%) of retear occurred in patients with small-sized rotator cuff tears; 1 case (5.2%) of retear occurred in patients with medium-sized rotator cuff tears; 4 cases (17.3%) of retear occurred in patients with large-sized rotator cuff tears; and 3 cases (37.5%) of retear occurred in patients with massive-sized rotator cuff tears. The retear rate of patients with small tears was as high as 40%, which was considered as sample size bias. Sugaya classification for patients with different rotator cuff tear size was mainly concentrated on Sugaya type II (Figure 2). Moreover, the retear rate of rotator cuff tear has a positive correlation with the tear size of rotator cuff preoperatively.

The Constant and ASES scores improved from 41.00 to 92.00, and from 41.33 to 88.00, respectively. Results of pre- and postoperative Constant and ASES scores were statistically different ($p < 0.001$) (Table 1). In the healing group, the Constant and ASES scores improved from 40.00 to 92.00, and from 38.33 to 91.67, respectively. In the retear group, the Constant and ASES scores improved from 40.00 to 92.00, and from 38.33 to 91.67, respectively. The postoperative Constant score and ASES score between the healing and retear group were not statistically significant ($p > 0.05$), according to the Mann-Whitney U test.

The mean differences of shoulder scaption strength between the healing and retear group were $1.1 \pm 0.82\text{Kg}$ and $3.0 \pm 0.88\text{Kg}$ respectively. The differences of abductor muscle strength between the two groups was statistically significant ($p < 0.001$) (Table 2) by t test of two independent samples.

Discussion

Arthroscopic rotator cuff repair using suture- bridge technique can achieve good to excellent clinical results. The shoulder functional outcomes were significantly improved even in the absence of RC healing[1, 18]. The patient satisfaction rate was above 80% after the surgery. In some studies, the satisfaction rate was as high as 92%[13]. In general, rotator cuff repair techniques are divided into single-row and double-row repair techniques. It has been reported that there was no statistical difference in retear rate between the two techniques[14]; however, long-term follow- ups and systematic review studies have shown that the retear rate after single-row repair was significantly higher than that after double-row repair [8, 17].

Cho[5] et al. described two types of retear patterns after rotator cuff repair: type 1, if the cuff tissue repaired at the insertion site of the rotator cuff was not observed to be remaining on the greater tuberosity; and type 2, if the remnant cuff tissue remained at the insertion site despite the retear. In our study, the type 2 retear pattern was found in 6 shoulders (60%). The result was similar to Cho's study. Multiple studies[3, 5, 12] have reported that the type 2 retear pattern was found in most of the cases after double-row suture bridge repair. Surgeons should pay attention to tendon quality, suture tension, needles' insertion site and tightness when knot tying during the surgery, as these factors may increase the risk of Type 2 retear when using double-row suture bridge technique[5]. Several technical factors should be considered to prevent medial cuff failure in arthroscopic suture bridge repair. First, to avoid tension overload of the suture-tendon interface at the medial row, surgeons should not intend to achieve too much medial suture tendon passage for greater footprint coverage. They should also try to avoid the tendon passage obtained at the musculotendinous junction instead of the tendon portion. Even in cases when a large portion of the rotator cuff has to be captured, it may be helpful to capture it to achieve the tendon passage to the lateral rather than at the musculotendinous junction. This may be the reason why many authors still prefer single-row fixation. Recently, some authors have proposed that double-row repair without medial tying may reduce the retear rate after the surgery. However, in a perspective comparative study conducted by Kim[16] et al, the knotless group had a higher retear rate compared to the conventional knot tying group.

In addition to surgical technique and preoperative tear size, the risk factors of retear were also related to patient age, preoperative grade of fatty infiltration, and postoperative rehabilitation. In elderly patients, the retear rate is positively correlated with age. According to the literature, the postoperative retear rate increases significantly when the age is over 70 years old[7], which may be related to rotator cuff degeneration and poor tendon quality in the elderly population. Goutallier[11] developed the 5-stage grading system. Many studies have confirmed that the retear rate was significantly increased when the degree of fatty infiltration was higher than that of grade II, which indicated that preoperative fatty infiltration was a risk factor affecting rotator cuff healing[5, 10, 15, 22]. A meta-analysis comparing "early mobilization" with "delayed mobilization" after arthroscopic rotator cuff repair has shown that patients with early mobilization have a better range of motion 1 year after the surgery, but that the retear rate was higher when the preoperative tear size was greater than 3cm[19].

Previous studies have shown that there was significant shoulder functional improvement and high patient satisfaction after arthroscopic rotator cuff repair regardless of the structural integrity of the repair. We have the same results in our study. In addition, we compared the difference in shoulder scaption strength between the integrity group and the retear group and found that the scaption strength of the retear group was significantly inferior to the cuff healing group. The results of our study showed that higher grades of Sugaya classification correlated with abduction muscle strength. These results were consistent with studies conducted by Collin[25] and Cho[5]; however, they did not describe the relationship between the inferior abduction muscle strength and the patient's quality of life and satisfaction. There was 1 case in our study who had recurrent rotator cuff tear after the surgery, demonstrated significant weakness of the shoulder, and was incapable of doing physical work postoperatively, but he was still satisfied with the surgery due to pain relief after the surgery. A questionnaire survey conducted by Romeo[23] et al showed that for manual workers, retaining muscle strength was more important than relieving pain. Therefore, we considered that muscle strength recovery is equally important for patients who need to do physical work. However, there is still a lack of relevant studies on the effect of muscle strength on patients' function and satisfaction; whether such changes in muscle strength would impair patients' long-term quality of life and satisfaction remains to be discussed.

Summary

Arthroscopic suture bridge repair of full-thickness rotator cuff tears led to excellent improvement in shoulder function, but maintained a high retear rate. Although the retear group had inferior muscle strength, the patients were still satisfied, and shoulder function was improved due to pain relief. Whether such changes in muscle strength impair patients' long-term quality of life and satisfaction remains to be discussed.

Abbreviations

RC
Rotator cuff

SB
Suture bridge
CS
Constant-Murley score
ASES
American Shoulder and Elbow Score

Declarations

Ethical approval and consent to participate

Methods to retrospective analyzed the clinical data of patients, thus no ethical approval and patient consent are required.

Availability of data and materials

The datasets analyzed in the study are available from the corresponding

Consent for publication

It is necessary that all patients have signed informed consent prior to surgery.

Competing interests

The authors declare that they have no competing interests.

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Authors' contribution

Lei Zhang contributed to the conception of the study. Sheng Zhang, first author, wrote the manuscript. Huisheng Shi and Xiaohua Liu, co-first author, selected the appropriate patients and included them in this study, collected the data and performed the statistical analysis. Zheng Wang, Yan Li, Nanling Deng, Jin Sun, Jia Ma, Bo Jiang helped perform the analysis with constructive discussions.

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Tables

Score	Constant <i>M</i>	ASES <i>M</i>
Preoperative	41.00	41.33
Postoperative	92.00	88.00
<i>P</i> value	<0.001	<0.001

Table 1 Preoperative and postoperative Constant scores and ASES scores of the patients were compared.

	Healing group	Retear group	Statistics	<i>p</i>
Age (years)	58.78±6.11	57.90±9.10	<i>t</i> =0.375	0.709
Follow-up (months)	31.33±18.06	27.10±12.10	<i>t</i> =0.704	0.694
Constant (<i>M</i>)	92.00	90.00	–	0.291
ASES (<i>M</i>)	91.67	83.50	–	0.104
DAMS ($\bar{x} \pm s$)	1.1±0.82	3.0±0.88	<i>t</i> =−6.522	<0.001

Table 2 The Constant and ASES were not significant differences between healing group and re-tear group. However, the abductor muscle strength (DAMS) was significant difference between the 2 groups

Figures

Figure 1

The arthroscopic view from the lateral portal shows the completed repair of a rotator cuff tear with suture bridge technique (Arthrex). Asterisks indicate the medial row.

Figure 2

Post-operative Sugaya classification for patients with different rotator cuff tear sizes was mainly concentrated on Sugaya type II.