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Correlation between retear after arthroscopic rotator cuff repair and stiffness of the shoulder

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ABSTRACT

Background: The purpose of this study was to investigate the relationship between retear after arthroscopic rotator cuff repair and passive range of motion of the shoulder.
Methods: Passive range of motion before and after surgery was compared between the two groups.
Results: The healed and retear groups comprised 86.4% and 13.6% shoulders, respectively. Passive external rotation with the arm at the side at 3 months postoperatively was significantly smaller in the healed group than retear group.
Conclusions: This difference seemed to be associated with stiffness in external rotation of the shoulder and the process of cuff healing after surgery.
Level of evidence: Level III, Case-Control Study, Treatment Study.

1. Introduction

Various improvement patterns in the range of motion (ROM) of the shoulder are observed after arthroscopic rotator cuff repair (ARCR). In some cases, improvement of the ROM of the shoulder occurs in the early postoperative period. However, we have experienced cases in which improvement of the ROM of the shoulder was slow. Although rotator cuff healing after ARCR is a prognostic factor for achievement of a good clinical outcome and high patient satisfaction, the process of cuff healing after ARCR remains unclear. Stiffness of the shoulder was reported as a complication after ARCR and was regarded as a clinical factor associated with poor clinical outcomes.[1,2,4,8,11] Brislin[1] reported that limitation of ROM of the shoulder was one of the most common complications after ARCR. Namdari[8] also reported that limitation of passive ROM of the shoulder at 3 months after ARCR was correlated with limitation of ROM of the shoulder at 1 year after surgery.

Although the degree of postoperative stiffness of the shoulder has been defined in various ways, some reports have indicated that postoperative stiffness of the shoulder after ARCR was advantageous for cuff healing.[5–7,9] McNamara et al.[7] reported that rotator cuff repair was more likely to heal in patients who developed stiffness of the shoulder after ARCR. Keener et al.[5] and McGrath et al.[6] also reported that capsulitis was associated with postoperative stiffness of the shoulder and cuff healing after ARCR.

We hypothesized that stiffness of the shoulder in the early postoperative period is advantageous for cuff healing. The purpose of this study was to investigate the relationship between cuff healing after ARCR and passive ROM of the shoulder before and after surgery.

2. Materials and methods

This retrospective study was approved by our institutional review board. A total of 260 shoulders underwent ARCR during the study period (April 2012–February 2017). Patients who had undergone ARCR and were available for a minimum 1-year clinical follow-up were included in the study. The exclusion criteria were the inability to undergo clinical follow-up for more than 1 year after surgery (4 shoulders), rotator cuff tear (RCT) without primary complete repair (37 shoulders), a single subscapularis (SSC) tendon tear (2 shoulders), cuff tear arthropathy (2 shoulders), and a history of surgery on the affected shoulder (2 shoulders). The remaining 213 shoulders were included in the study. The indications for surgical treatment of RCT at our institute were typical symptoms of shoulder pain and the presence of shoulder joint dysfunction. All patients underwent nonsurgical treatments including a corticosteroid injection into the subacromial space or glenohumeral joint and physical therapy before surgery.

Repair integrity based on Sugaya's classification[10] was assessed by magnetic resonance imaging at 6 months after surgery. Types 1, 2, and 3 were classified as healed cuffs (healed group), and Types 4 and 5 were classified as retears (retear group).

According to a study by McNamara et al.[7], stiffness of the shoulder in external rotation with the arm at the side (ER1) at 3 months

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postoperatively was defined as ER1 ≤ 20°. ER1 ≤ 30° was also investigated in this study.

3. Study variables

3.1. Demographics

The demographic variables evaluated in both groups were the age at the time of surgery, sex, history of diabetes mellitus, and smoking status.

3.2. Evaluation items

For rotator cuff tendon evaluation, the size of the RCT according to Cofield's classification[3] and the repair rate of the SSC tendon were investigated. All patients underwent a standardized physical examination performed by the first author (T.T.) both preoperatively and postoperatively. Passive and active ROM of the shoulder were measured with a goniometer and included evaluation of the scapular plane anterior elevation (AE) and ER1 of the shoulder. For evaluation of passive ROM of the shoulder, we investigated AE and ER1 preoperatively and at 3 and 6 months and 1 year postoperatively. The relationship between retear and the degree of stiffness of postoperative ER1 was also investigated.

4. Surgical procedure

All operations were performed by the first author (T.T.) with the patient under general anesthesia and in the beach chair position. Depending on the size of the RCT, single-row repair was performed for partial tears of the supraspinatus (SSP), infraspinatus (ISP), and SSC tendons, while conventional suture bridge repair was performed for complete tears of the SSP, ISP, and SSC tendons. Subacromial decompression and anterior acromioplasty were performed in all patients. Long head of the biceps (LHB) tendon tenotomy or tenodesis was performed in patients with a positive hourglass test result and in patients with dislocation or subluxation of the LHB as detected from the bicipital groove. Pathological conditions of the LHB were divided into four groups according to the condition of the LHB[12] absent group (absence of the LHB within the joint), hourglass group (positive hourglass test result), dislocation group (dislocation or subluxation from the bicipital groove), and fraying group (fraying of the LHB).

5. Postoperative rehabilitation

Sling fixation was performed for 5 weeks after surgery, passive AE ROM exercise was started from 3 weeks postoperatively, and passive ER1 ROM exercise was started from 4 weeks postoperatively. Active assisted ROM exercise was started from 6 weeks postoperatively, and active ROM exercise was permitted from 7 weeks postoperatively. Therapy was delayed 1 week for shoulders with larger than medium RCTs.

6. Statistical analysis

The Mann–Whitney test was used to compare differences in outcomes between the two groups. A paired *t*-test was used to compare differences in preoperative and postoperative outcomes within each group. Multivariate analyses were carried out with the chi-square test. SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA) was used for all statistical analyses. The level of statistical significance was set at $P < 0.05$. The results are given as mean values.

Table 1
Patient demographics.

	Healed group	Retear group
Number (%)	184 (86.4)	29 (13.6)*
Age at surgery, year (range)	64.8 ± 8.85 (33–87)	66.7 ± 7.60 (46–80)
Males: females, number (%)	104 (56.5): 80 (43.5)	18 (62.1): 11 (37.9)
Co-morbidities, number (%)		
Diabetes millitus	17 (9.2)	1 (3.5)
Smoker, number (%)	36 (19.6)	4 (13.8)

* Significant P value ($P < 0.05$).

7. Results

7.1. Patient demographics

The patient demographics are shown in Table 1. The healed group comprised 184 (86.4%) shoulders, 104 (56.5%) men, and 80 (43.5%) women, and the average age at the time of surgery was 64.8 years. The retear group comprised 29 (13.6%) shoulders, 18 (62.1%) men, and 11 (37.9%) women, and the average age at the time of surgery was 66.7 years. There were no significant differences in the average age or sex distribution between the two groups. There were also no significant differences in the history of diabetes mellitus or the smoking status between the two groups.

7.2. RCT

The RCT characteristics are shown in Table 2. The retear group contained significantly fewer small RCTs and significantly more larger than medium RCTs than the healed group. SSC tendon repair was performed in 112 (60.9%) shoulders in the healed group and 21 (72.4%) shoulders in the retear group, with no significant difference between the two groups.

7.3. Retear and passive ROM

Data regarding passive ROM of the shoulder, including AE and ER1 before and after surgery, are shown in Table 3. Passive ER1 at 3 months postoperatively was significantly smaller in the healed group than retear group. Passive AE before and after surgery and ER1 at other time points were not significantly different between the two groups.

In total, 43 (20.2%) shoulders showed ER1 ≤ 30° at 3 months after surgery and 170 (79.8%) shoulders showed ER1 > 30° at 3 months after surgery. There were no significant differences in the patients' demographics, size of the RCT, or repair rate of the SSC tendon between the two groups. The average ER1 at 1 year postoperatively was 39° in shoulders with ER1 ≤ 30° at 3 months after surgery and 53° in those with ER1 > 30° at 3 months after surgery, and the difference between the average ER1 of 39° and 53° was statistically significant. Among shoulders with ER1 ≤ 30° at 3 months postoperatively, retear of the SSP and ISP tendons occurred in 1 (2.4%) shoulder and retear of the SSC tendon occurred in 0 (0.0%) shoulders. Among shoulders with

Table 2
Size of rotator cuff tear and rate of subscapularis tendon repair in both groups.

	Healed group (n = 184)	Retear group (n = 29)
Not complete tear, number (%)	51 (27.7)	4 (13.8)
Complete tear, number (%)		
Small	35 (19)	2 (6.9)*
Medium	61 (33.2)	10 (34.5)
Larger than medium	37 (20.1)	13 (44.8)*
Subscapularis repair (%)	112 (60.9)	21 (72.4)

* Significant P value ($P < 0.05$).

Table 3
Comparisons of preoperative and postoperative passive range of motion between the groups.

	Pre op	Post op 3 months	Post op 6 months	Post op 1 year
Anterior elevation				
Healed group	133.8 ± 36.8 (40–170)	152.1 ± 18.4 (95–170)*	157.3 ± 18.4 (130–175)*	160.0 ± 18.4 (130–175)*
Retear group	134.7 ± 39.6 (20–175)	147.4 ± 19.1 (85–175)*	157.8 ± 13.7(155–175)*	164.1 ± 18.4 (120–175)*
External rotation arm at the side				
Healed group	47.7 ± 20.0 (-10-85)	43.9 ± 15.4 (0–65)*§	46.8 ± 12.4 (10–65)	49.8 ± 12.8 (5–65)
Retear group	51.0 ± 20.3 (0–85)	50.9 ± 12.4 (20–70)	50.4 ± 12.4 (35–70)	50.6 ± 11.3 (35–70)

Values are expressed as mean.
* Statistically significant difference between preoperative and postoperative ($P < 0.05$).
§ Statistically significant difference between groups ($P < 0.05$).

Table 4
Comparisons between the cases with ER1 ≤ 30°and ER1 > 30° at 3 months after surgery.

	ER1 ≤ 30°	ER1 > 30°
Number (%)	43 (20.2)	170 (79.8)*
Age at surgery, year (range)	63.0 ± 8.37 (40–77)	65.6 ± 8.72 (46–80)
Males: females, number (%)	19 (44.2): 24 (55.8)	103 (60.6): 67 (39.4)
Co-morbidities, number (%)		
Diabetes millitus	9 (20.9)	18 (10.6)
Not complete tear, number (%)	10 (23.2)	45 (26.5)
Complete tear, number (%)		
Small	8 (18.6)	28 (16.5)
Medium	14 (32.6)	58 (34.1)
Larger than medium	11 (25.6)	39 (22.9)
Subscapularis repair (%)	29 (67.4)	100 (58.8)
Retear (%)	SSP & ISP 1 (2.4)	SSP & ISP 28 (16.5)*
	SSC 0 (0)	SSC 3 (1.8)
Average passive ROM at 1 year after surgery		
AE	161° ± 8.05	164° ± 14.09
ER1	39° ± 1308	53° ± 11.27*

* Significant P value ($P < 0.05$).

Table 5
Comparisons between the cases with ER1 ≤ 20°and ER1 > 20° at 3 months after surgery.

	ER1 ≤ 20°	ER1 > 20°
Number (%)	17 (8.0)	196 (92.0)*
Age at surgery, year (range)	61.2 ± 9.22 (40–76)	65.4 ± 8.61 (33–87)
Males: females, number (%)	8 (47.1): 9 (52.9)	114 (58.2): 82 (41.8)
Co-morbidities, number (%)		
Diabetes millitus	9 (20.9)	18 (10.6)
Not complete tear, number (%)	5 (29.4)	50 (25.5)
Complete tear, number (%)		
Small	3 (17.6)	33 (16.8)
Medium	6 (35.3)	66 (33.7)
Larger than medium	3 (17.7)	47 (24.0)
Subscapularis repair (%)	11 (64.7)	118 (60.2)
Retear (%)	SSP & ISP 0 (0)	SSP & ISP 29 (14.8)*
	SSC 0 (0)	SSC 3 (1.5)
Average passive ROM at 1 year after surgery		
AE	164° ± 7.42	163° ± 13.54
ER1	31° ± 11.76	52° ± 11.51*

* Significant P value ($P < 0.05$).

ER1 > 30° at 3 months after surgery, retear of the SSP and ISP tendons occurred in 28 (16.5%) shoulders and retear of the SSC tendon occurred in 3 (1.8%) shoulders. The retear rate of the SSP and ISP tendons was significantly lower in shoulders with ER1 ≤ 30° than ER1 > 30° at 3 months after surgery (Table 4).

In total, 17 (8.0%) shoulders showed ER1 ≤ 20° at 3 months after surgery and 196 (92.0%) shoulders showed ER1 > 20° at 3 months after surgery. There were no significant differences in the patients' demographics, size of the RCT, or repair rate of the SSC tendon between the two groups. The average ER1 at 1 year postoperatively was 31° in shoulders with ER1 ≤ 20° at 3 months after surgery and 52° in those with ER1 > 20° at 3 months after surgery, and the difference between the average ER1 of 31° and 52° was statistically significant. In no shoulders with ER1 ≤ 20° at 3 months after surgery did retear of the SSP, ISP, or SSC tendons occur. Among shoulders with ER1 > 20° at 3 months after surgery, retear of the SSP and ISP tendons occurred in 29 (14.8%) shoulders and retear of the SSC tendon occurred in 3 (1.5%) shoulders. The retear rate of the SSP and ISP tendons was significantly lower in shoulders with ER1 ≤ 20° than ER1 > 20° at 3 months after surgery (Table 5).

8. Discussion

In this study, we investigated the relationship between retear after ARCR and passive ROM of the shoulder before and after surgery. Stiffness of the shoulder is one of the postoperative complications that may occur after ARCR and increases the risk of a poor clinical outcome.[1,2,4,8,11] Namdari[8] reported that limitation of passive ROM of the shoulder at 3 months after ARCR was correlated with limitation of ROM of the shoulder at 1 year after surgery. In addition, Brislin[1] reported that limitation of ROM of the shoulder was the one of the most common complications after ARCR; moreover, 23 (8.7%) of 263 shoulders had a limited ROM of AE < 100° and ER1 < 10° of after ARCR. Huberty[4] also reported that limitation of ROM of the shoulder was found in 24 (4.9%) of 489 shoulders after ARCR and that these shoulders required secondary arthroscopic surgery. In the present study, 43 shoulders had ER1 ≤ 30° and 17 shoulders had ER1 ≤ 20° at 3 months after surgery, and the average ER1 at 1 year after surgery was 39° and 31°, respectively; as a result, limitation of ER1 in these cases remained.

In contrast, Parsons et al.[9] defined AE < 100° and ER1 < 30° as stiffness of the shoulder at 6–8 weeks after ARCR. Evaluation by magnetic resonance imaging at 1 year after surgery showed that the cuff healing rate was 70% in the stiff group and 36% in the non-stiff group. McNamara et al.[7] also defined stiffness as ER1 ≤ 20° at 6 weeks after ARCR in their study of 1533 shoulders. The cuff healing rate was 93% in the stiff group and 85% in the non-stiff group according to ultrasound evaluation at 6 months postoperatively. Additionally, they reported a correlation between stiffness of the shoulder and repair integrity. In the present study, the degree of ER1 at 3 months after surgery was significantly smaller in the healed group than retear group, which is similar to previous reports. Keener et al.[5] and McGrath et al.[6] reported that capsulitis was associated with postoperative stiffness of the shoulder after ARCR and was advantageous for the cuff healing process. Our findings support these previous studies. Although postoperative limitation of ER1 throughout the long-term period may be a poor clinical outcome factor, the cuff healing rate was significantly high in the shoulders with ER1 ≤ 30° or ER1 ≤ 20° at 3 months after surgery in this study. From this result, we cannot conclude that limiting ER1 in the early postoperative period by delaying the start of ER1 ROM exercise during postoperative rehabilitation is necessarily advantageous for cuff healing. However, despite the similar postoperative rehabilitation conducted in the two groups of the present study, the cuff healing rate

was significantly high among the shoulders with limitation of ER1 in the early postoperative period. This outcome seemed to be associated with the postoperative shoulder stiffness of ER1 and cuff healing process.

This study has two main limitations. First, the data were collected retrospectively. However, our patients were monitored closely in the postoperative period, and standardized examination techniques were performed by a single examiner. Second, the minimum follow-up duration may be considered a potential limitation; nevertheless, Charousset[2] reported that functional recovery occurred from 3 months after surgery and almost plateaued at 1 year after surgery. Our 1-year follow-up of functional recovery after ARCR was therefore considered appropriate.

9. Conclusions

We investigated the relationship between retear after ARCR and passive ROM before and after surgery. We found that ER1 at 3 months after surgery was significantly smaller in the healed group than retear group. This finding seemed to be associated with shoulder stiffness in ER1 and the cuff healing process after surgery.

Disclaimer

The authors, their immediate family, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

Nakatsushima Hospital Institutional Review Board (IRB) approved this study on April 1, 2012 (IRB No.: 2012-04-003).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jor.2019.05.002.

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