

Postoperative Outcomes and Rehabilitation Period of Arthroscopic Rotator Cuff Repair in Patients with Diabetes

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ABSTRACT

AIM: Diabetic patients increase today, and postoperative joint contractures are often seen as well. In this study, we compared the postoperative outcomes of arthroscopic rotator cuff repair (ARCR) and duration of rehabilitation intervention between DM and non-DM patients.

MATERIAL AND METHODS: In total, 231 patients who underwent ARCR were included in this study (DM patients, 58; non-DM patients 173). The mean age of all subjects was 63.8 ± 11.0 (SD) years. We compared the two groups in terms of the pre and postoperative University of California Los Angeles (UCLA) and Japan Orthopaedic Association (JOA) scores, flexion angles at postoperative 3 months

and at the end of rehabilitation, and the duration of rehabilitation.

RESULTS: No significant differences were observed between the two groups in terms of UCLA and JOA scores determined 6 months and 1 year postoperatively and MRI-based ARCR levels 3 months, 6 months and 1 year postoperatively. The flexion angle at the end of rehabilitation did not differ significantly between the DM group 148.1 ± 16.6 (SD) $^{\circ}$ and the non DM group 153.3 ± 11.8 (SD) $^{\circ}$, and they were similar values. Rehabilitation required an average of 7.5 ± 3.3 (SD) months and 5.3 ± 1.5 (SD) months in the DM and non-DM groups, and a significant difference was observed between the 2 groups.

CONCLUSION: Preoperative and postoperative UCLA and JOA scores did not significantly differ between the two groups. The DM group required a rehabilitation period of about 2 months compared to the non DM group.

Level of evidence: Level III, Retrospective comparative study.

Key words: Arthroscopic rotator cuff repair (ARCR); Diabetes mellitus (DM); Patients with and without DM; Rehabilitation intervention period

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INTRODUCTION

Diabetes mellitus is one of the most common and chronic diseases affecting the health of millions of people worldwide, and its occurrence has been increasing. Over the past 10 years, one in four to five patients who underwent arthroscopic rotator cuff repair (ARCR) at our hospital had a history of DM. It is thought that peripheral microangiopathy due to diabetes not only causes complications, including neuropathy, nephropathy, and retinopathy, but also affects postoperative clinical outcomes following ARCR^[1]. This study aimed to compare the postoperative outcomes, range of motion, and

rehabilitation intervention period between patients with and without DM.

MATERIALS AND METHODS

In this study, we examined patients who were diagnosed as DM based on the guidelines^[2] at our department internal medicine at the time of surgery and were receiving treatment, such as diet therapy, oral therapy, and insulin injections. We excluded pre-diabetic patients from this study. We enrolled 231 patients (mean age \pm SD: 63.8 \pm 11.0 years) who underwent ARCR at our hospital from January 2012 to October 2015. This research has been approved by the IRB of the authors' affiliated institutions. The study cohort comprised 58 patients with DM (mean age \pm SD: 67.3 \pm 8.4 years) and 173 patients without DM (mean age \pm SD: 63.0 \pm 11.3 years). Based on the Cofield classification^[3] (small < 1 cm; medium 1-3 cm; large 3-5 cm), we defined tears < 3 cm in size as small-to-medium tears and those \geq 3 cm as large tears. We excluded incomplete tears due to difficulty in distinguishing it from shoulder joint peri-arthritis and extensive tears of >5 cm. The DM group comprised 24 patients with small-to-medium tears, and 34 with large tears, whereas the non-DM group included 74 patients with small-to-medium tears, and 99 with large tears, with no significant difference observed on the chi-square test ($p = 0.853$) (Table 1).

All the patients underwent surgery under general anesthesia and interscalene block in the lateral recumbent position with bidirectional traction. We mainly used the suture bridge.

Method to repair complete tears. First, we inserted one anchor every 1 cm into the medial side of the greater tuberosity, followed by relaying sutures using Suture GrasperTM and SutureLassoTM. Depending on the bone quality and age, anchors used on the lateral side comprised the VERSALOK[®] anchor (Johnson & Johnson Ltd.), PopLok[®] anchor (Zimmer Ltd.), and HEALIX ADVANCE KNOTLESS BR[®] anchor (Johnson & Johnson Ltd.). In rehabilitation, after surgery, abduction shoulder brace (Ultra Sling II, DONJOY, US) for 3 weeks (period extended according to pain). From the day after surgery deltoid isometric exercise were gently performed. With small and medium size tears, passive ROM training on the surface of the shoulder blades started from 1 week after surgery and automatic exercise took place from 6 weeks. Also, with large tears, passive ROM training on the surface of the shoulder blades started 2 weeks after surgery and automatic exercise took place from 8 weeks. We excluded one patient who developed contracture due to complex regional pain syndrome (CRPS) of the hand, requiring prolonged rehabilitation for over 2 years. Furthermore, no patient developed an infection during the study period.

In this study, examination items included pre- and postoperative University of California at Los Angeles (UCLA) score and Japan Orthopaedic Association (JOA) scores to evaluate shoulder disorders and flexion angle before surgery, at 3 months postoperatively, and on completion of rehabilitation. Furthermore, we compared the rehabilitation intervention duration between the two groups. At our hospital, all patients are explained the criteria for the completion of rehabilitation when commencing rehabilitation after ARCR: rehabilitation will be completed when the elevation angle reaches 150°, and as a general rule, we aim to complete rehabilitation within 5 months to which health insurance is applied.

We evaluated the state of postoperative rotator cuff repair using magnetic resonance imaging (MRI) according to a five-point scale (Sugaya's classification^[4]: type I, indicating sufficient thickness with homogeneously low intensity; type II, sufficient thickness with partial high intensity; type III, insufficient thickness without discontinuity;

type IV, the presence of a minor discontinuity; and type V, the presence of a major discontinuity) at 3 months, 6 months, and 1 year postoperatively, with type 4 and 5 defined as a re-tear. Furthermore, the numeric rating scale (NRS, 0-10) pain scores preoperatively and on day 2, week 1, and week 2 postoperatively were compared with those at month 3 postoperatively.

We performed statistical analyses using the chi-square test, Mann-Whitney *U*-test, and Wilcoxon test. For all the tests, we considered $p < 0.05$ as statistically significant.

RESULTS

In the DM group, the UCLA scores increased from the preoperative mean of 15.2 \pm 2.5 (SD) to postoperative mean of 31.4 \pm 1.5 (SD) and the JOA scores increased from the preoperative mean of 63.6 \pm 10.4 (SD) to postoperative mean of 91.8 \pm 4.2 (SD); however, in the non-DM group, the UCLA scores increased from preoperative mean of 16.3 \pm 1.9 (SD) to postoperative mean of 32.9 \pm 5.9 (SD) and the JOA scores increased from the preoperative mean of 68.2 \pm 12.0

Table 1 Patient characteristics at baseline.

		DM group (n = 58)	nonDM group (n = 173)	P value
age at surgery	(range)	67.3(19-91)	63.0(50-81)	0.065
female/Male		35/23	96/77	0.519
tear size (small,medium/large)		24/34	74/99	0.853
Symptomatic period (months)	(range)	13.2(0.5-240)	14.2(0.1-360)	0.84
Preoperative UCLA score	(SD)	15.2(2.5)	16.3(1.9)	0.124
Preoperative JOA score	(SD)	63.6(10.4)	68.2(12.0)	0.234
Preoperative elevation angle	(SD)	111.2 (38.0)	113.8 (48.0)	0.812
Preoperative NRS	(0-10)	5.32	5.33	0.977
follow-up period (months)	(range)	38.3 (24-78)	34.4 (24-47)	0.184

DM: Diabetes mellitus, SD: Standard Deviation, UCLA: University of California Los Angeles, JOA: Japan Orthopaedic Association, NRS: numeric rating scale

Table 2 Evaluation and comparison of MRI in DM and non-DM groups.

Sugaya's MRI classification		DM	nonDM	P value
Post op. 3M	Type1-3	49	154	0.36
	Type4,5	9	19	
Post op. 6M	Type1-3	49	144	0.825
	Type4,5	9	29	
Post op. 12M	Type1-3	44	145	0.174
	Type4,5	14	28	

MRI: Magnetic Resonance Imaging, Op.:Operation, M: Months.

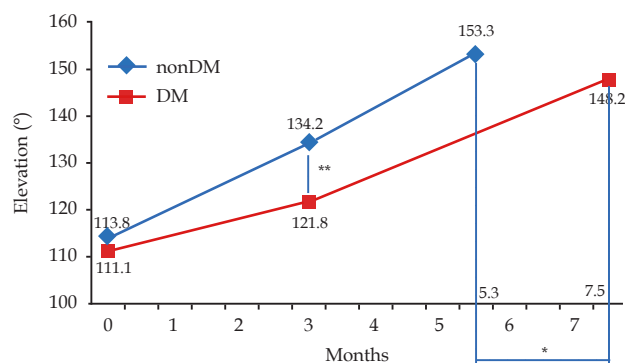


Figure 1 Relationship between elevation angle and rehabilitation intervention period in each group. * denotes statistical significance in the rehabilitation intervention period in the 2 groups < 0.05 . ** denotes statistical significance in elevation angle between 2 groups at 3 months postoperative, $p < 0.01$.

(SD) to postoperative mean of 90.8 ± 6.9 (SD). Thus, both the groups exhibited an improvement with a significant difference between preoperative and postoperative scores ($p < 0.0001$), but the difference between the groups was not statistically significant. We double-checked the MR images from a radiologist to determine the state of rotator cuff repair. In the DM group, at 3 months postoperatively, we observed types 1-3 in 84.4% of patients and type 4 and 5 in 15.6%. At 1 year postoperatively, we observed types 1-3 in 75.8% of patients and type 4 and 5 in 24.2%. In the non-DM group, at 3 months postoperatively, types 1-3 were observed in 89.0% of patients and type 4 and 5 in 11.0%, and at 1 year postoperatively, types 1-3 were observed in 83.8% and type 4 and 5 in 16.2%. There were no significant differences between the two groups in the re-tear rate for 3 months, 6 months and 1 year postoperatively (Table 2).

In the DM and non-DM groups, we examined the changes in the shoulder elevation angle and the number of days until the completion of rehabilitation. In the non-DM group, the angle of elevation changed from the preoperative mean of $113.8^\circ \pm 48.0^\circ$ (SD) to $134.2^\circ \pm 13.1^\circ$ (SD) at 3 months postoperatively and to $153.3^\circ \pm 11.8^\circ$ (SD) at the final examination, with a mean time to rehabilitation completion of 5.3 ± 1.5 (SD) months. In the DM group, the angle of elevation changed from the preoperative mean of $111.1^\circ \pm 38.0^\circ$ (SD) to $121.8^\circ \pm 17.7^\circ$ (SD) at 3 months postoperatively and to $148.2^\circ \pm 16.6^\circ$ (SD) at the final examination, with a mean time to rehabilitation completion of 7.5 ± 3.3 (SD) months (Figure 1).

At 3 months postoperatively, the flexion angle was 12.4° greater in the non-DM group than that in the DM group. Significant difference was found in the Mann-Whitney test ($p < 0.01$) between the two groups. Although the flexion angle at the end of rehabilitation did not differ significantly between the two groups, but we observed a significant difference in the time until completion of rehabilitation between the groups ($p < 0.01$).

In this study, we evaluated the improvement in NRS scores preoperatively and at 2 days, 1 week, and 2 weeks postoperatively; both the groups showed similar improvement. A comparison of the pain scores of JOA obtained at 6 months postoperatively revealed that the scores increased from the preoperative mean of 15.2 ± 3.3 (SD) to postoperative mean of 25.9 ± 3.5 (SD) in the DM group and from 14.6 ± 4.5 (SD) to 25.9 ± 3.5 (SD) in the non-DM group. Both the groups exhibited a significant improvement in scores ($p < 0.0001$), and the difference between the groups was not statistically significant.

Case

The subject was a 66-year-old male with a history of type 2 diabetes since the age of 40 years and was receiving insulin therapy. He presented with an injury to the left shoulder because of a fall. Physical examination revealed the following findings: left shoulder elevation, 90° ; external rotation with arms hanging down, 20° ; passive internal rotation at the buttock level; right shoulder flexion, 150° ; external rotation with arms hanging down, 30° , and passive internal rotation, 5 lumbar level. Both his left shoulder impingement signs and supraspinatus tendon test results were positive, the left shoulder UCLA score was 12, JOA score was 67 (pain score, 20; function score, 14; and range of motion score, 13). In addition, HbA1c level was 6.2% (reference range: 4.6%-6.2%) The HbA1c level was 6.2% and the control was good. Furthermore, MRI findings suspected large tear of the supraspinatus tendon (Figure 2A). Accordingly, the subject underwent rehabilitation on an outpatient basis; however, he experienced persistent limited range of motion, night pain, and sleeplessness. Thus, we performed ARCR. His intraoperative findings included synovial proliferation with congestion in the rotator interval

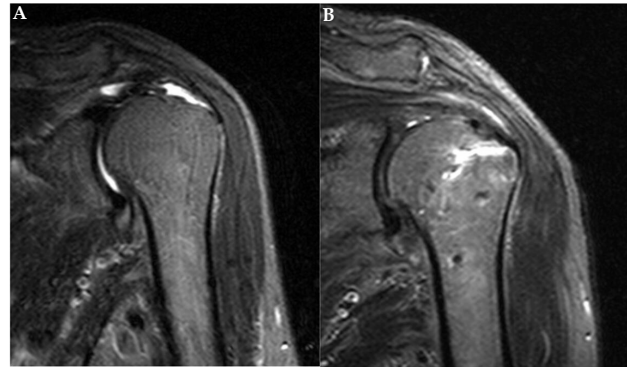


Figure 2 T2-weighted oblique coronary MRI images. (A): Before surgery. (B): 1 year after operation.

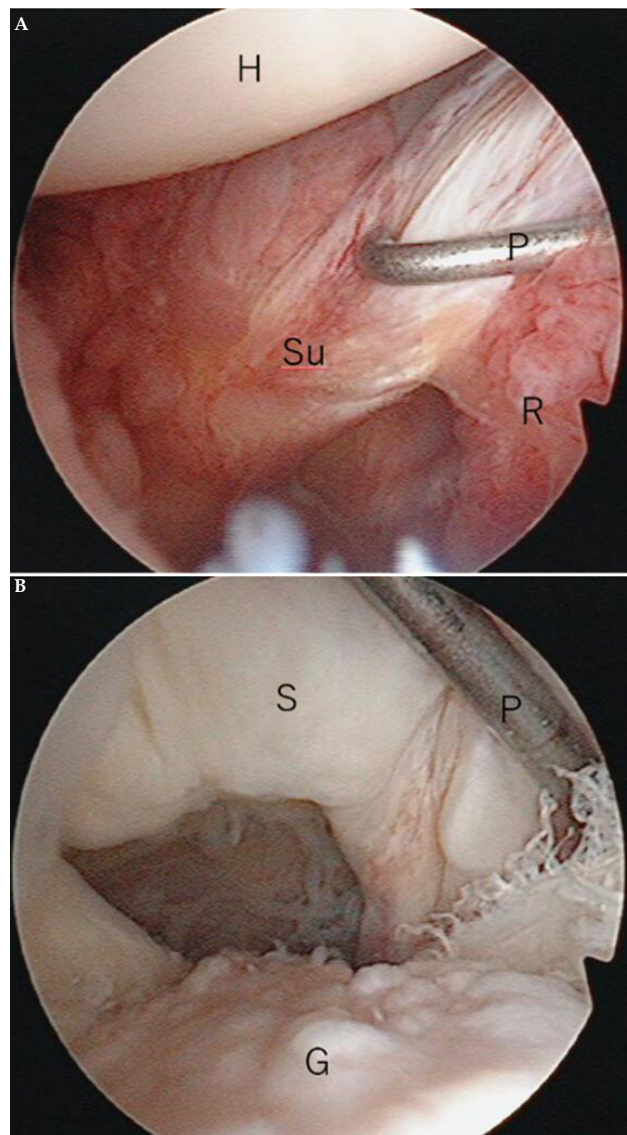


Figure 3 Arthroscopic view. (A): H: humeral head, R: rotator interval, Su: subscapularis tendon, P: probe. (B): S: torn supraspinatus tendon G: greater tuberosity.

(Figure 3A). Degenerative tear tendon and irregular greater tuberosity image was observed from glenohumeral view Figure 3B). Thus, we performed ARCR using the suture bridge method. A 1-year follow-up MRI revealed good recovery (Sugaya's classification type 1; Figure 2B). However, it took about 7 months to improve the range of motion of the shoulder joint.

DISCUSSION

The increasing prevalence of DM is marked by a growing rate of three major DM-related complications, including retinopathy, nephropathy, and neuropathy, and disturbances of the musculoskeletal system^[5]. Of these, adhesive capsulitis and frozen shoulder are reported in approximately 20% of patients with DM; in addition, several patients with DM complain of a limited range of motion and pain in the shoulder twice as much as that in non-DM patients^[6]. At our hospital, one in four to five patients who undergo ARCR have diabetes. This study included patients with rotator cuff injury and tear; however, this rate is anticipated to increase further with the addition of patients who undergo shoulder mobilization alone for joint contracture. Thus, this study presents intraoperative articular findings for 58 patients with DM who underwent ARCR at our hospital. In the glenohumeral joint, we determined that many patients exhibit inflammatory synovial hyperplasia with congestion in the rotator interval, around the biceps brachii tendon, and in the joint capsule. Furthermore, in the subacromial bursa, compared with non-DM patients, patients with DM exhibited more severe inflammatory bursitis and ischemic synovial hyperplasia. Among patients with poor diabetes control or with long-term diabetes and untreated severe contracture, some experience fibrosis progression and develop adhesion of the deltoid muscles and bursa. In future, we intend to examine arthroscopic and pathological findings in synovial tissue based on the blood glucose control and disease duration. The three-month postoperative MRI in this study revealed a reduction in tenosynovitis of the biceps brachii tendon and articular swelling compared with those in preoperative MRI; however, symptoms persisted in many patients. Abate *et al.*^[7] ultrasonographically examined elderly patients without shoulder pain or dysfunction and with asymptomatic diabetes and observed higher incidences of swelling of the subacromial bursa and tenosynovitis of the biceps brachii tendon than those in the control group. Their findings were consistent with our arthroscopic and MRI findings at 3 months postoperatively.

Perhaps, the presence or absence of as well as the control of diabetes affect postoperative outcomes and duration of rehabilitation due to joint contracture. Chen *et al.*^[8] performed open surgery in 30 patients with type 1 diabetes who sustained complete rotator cuff tears and reported that the active and passive range of motion was smaller, with an ultimate range of motion 90%, than that of the control group, and that three patients had deep infection, all of whom developed re-tear. Furthermore, Tsuruta *et al.*^[9] performed arthroscopic surgery in 10 patients without large tears and with good control of diabetes. They reported no postoperative re-tears and no significant difference between the DM and non-DM groups for the range of motion, JOA score, and muscle strength. Thus, we can assert that if the tear is small and diabetes control is good, postoperative outcomes will be good. Further, arthroscopic surgery is considered to provide better results with fewer complications. This study examined 58 patients with DM and 173 without DM and observed no significant difference in the postoperative UCLA, JOA scores and evaluation of rotator cuff repair on MRI, which were consistent with previous studies. Furthermore, we examined the target range of motion (elevation angle) and rehabilitation duration. At 3 months postoperatively, the elevation angle was 12.4° smaller in the DM group than in the non-DM group. The non-DM group completed rehabilitation with the elevation angle of 153.3° in rehabilitation intervention period of 5.3 months. This is almost consistent with the rehabilitable 150-day rule using health insurance in Japan since April 2006^[10], and this time it is set as the goal in the rehabilitation period.

In the DM group, however, rehabilitation was completed in 7.5 months, with an elevation angle of 148.2°. It was an approximated value with the non-DM group and there was no significant difference. Furthermore, prolonging the rehabilitation period by approximately 2 months resulted in the achievement of roughly the same elevation angle as that in the non-DM group. Moreover, this study suggested that the short target elevation angle should be approximately 150°, which is approximately the range of motion needed to brush one's hair. In the rehabilitation following ARCR for patients with DM, we believe that these should be established as the target range of motion and duration. Continued observation in the medium to long term is necessary. Of note, we did not evaluate pre- and postoperative HbA1c levels in this study, and the control of diabetes would have varied among cases. In future, we intend to compare the clinical outcomes according to pre- and postoperative control of diabetes.

CONCLUSIONS

1. We examined the postoperative outcomes of 231 patients who underwent ARCR by segregating them into the DM and non-DM groups.
2. No significant difference was observed in the UCLA, JOA scores, postoperative pain, and rotator cuff repair on MRI.
3. Even when the end of rehabilitation for non-diabetic group was set to 5 months, in the DM group, prolonging the rehabilitation duration by approximately 2 months facilitated the achievement of an elevation angle (approximately 150°) that was approximately comparable to that in the non-DM group.

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REFERENCES

- 1 Cho NS, Moon SC, Jeon JW, Rhee YG. The influence of diabetes mellitus on clinical and structural outcomes after arthroscopic rotator cuff repair. *Am J Sports Med.* 2015 Jan; **43**(4): 991-997. [DOI: 10.1177/0363546514565097]
- 2 Seino Y, Nanjo K, Tajima N, Kadowaki T, Kashiwagi A, Araki E, Ito C, Inagaki N, Iwamoto Y, Kasuga M, Hanafusa T, Haneda M, K Ueki Report of the committee on the classification and diagnostic criteria of diabetes mellitus. *J Diabetes Investig.* 2010 Oct 19; **1**(5): 212-28. [PMID; 24843435]; [PMCID; PMC4020724]; [DOI: 10.1111/j.2040-1124.2010.00074.x.]
- 3 Cofield RH, Parvizi J, Hoffmeyer PJ, Lanzer WL, Ilstrup DM, Rowland CM. Surgical repair of chronic rotator cuff tears. A prospective long-term study. *J Bone Joint Surg Am.* 2001 Jan; **83-A**(1):71-7. [PMID; 11205861]
- 4 Sugaya H, Maeda, K, Matsuki K, Moriishi J. Repair integrity and functional outcome after arthroscopic double-row rotator cuff repair. A prospective outcome study. *J Bone Joint Surg Am.* 2007 May; **89**(5): 953-960. [PMID;17473131]; [DOI:10.2106/JBJS.F.00512]
- 5 Arkkila PE, Gautier JF. Musculoskeletal disorders in diabetes mellitus: an update. *Best Pract Res Clin Rheumatol.* 2003 Dec; **17**(6):945-70. [PMID; 15123045]; [DOI: 10.1016/j.berh.2003.11.001]
- 6 Ingelfinger JR, Jarcho JA. Increase in the incidence of diabetes and its implications. *N Engl J Med.* 2017 Apr 13; **376**(15): 1473-74. [DOI: 10.1056/NEJMe1616575]
- 7 Michele A, Cosima S, Vincenzo S. Sonographic evaluation of the shoulder in asymptomatic elderly subjects with diabetes. *BMC Musculoskelet Disord.* 2010 Dec 7; **11**: 278-284. [PMID;

21138564]; [DOI: 10.1186/1471-2474-11-278]

- 8 Chen AL, Shapiro JA, Ahn AK, Zuckerman JD, Cuomo F. Rotator cuff repair in patients with type1 diabetes mellitus. *J Shoulder Elbow Surg.* 2003 Sep-Oct; **12(5)**: 416-21. [PMID; 14564259]; [DOI: 10.1016/S1058274603001721]
- 9 Tsuruta D, Takagi M, Mura N. Postoperative outcome of arthroscopic rotator cuff repair in diabetic Patients (in Japanese).

Katakansetsu. 2013; **37(2)**: 641-644. [DOI: 10.11296/katakansetsu.38.896]

- 10 Okamoto T, Ando S, Sonoda S, Miyai I, Makoto . “Kaifukuki Rehabilitation Ward” in Japan. *Jpn J Rehabil Med.* 2014; **51(10)**: 629-633. [DOI:10.2490/jjrmc.51.629]

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