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Original Article

Long-term prognoses of patients with and without re-rupture after arthroscopic rotator cuff repair

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Abstract. [Purpose] We followed-up patients who underwent arthroscopic rotator cuff repair (ARCR) for 2 years to assess the prognosis of rotator cuff tears and compared the outcomes of the patients with and without re-rupture. We also examined the usefulness of Shoulder36, a self-assessment tool, for assessing the long-term prognosis in patients undergoing ARCR. [Participants and Methods] We included 28 patients who received occupational therapy pre- and post-ARCR between April 2012 and August 2015 and categorized them based on the occurrence of re-rupture. We followed-up on their prognoses for 2 years using physical examination and Shoulder36 assessment. [Results] Re-rupture occurred in five patients within 3 months of treatment. During the 2 year follow-up, the control group showed a significant improvement in pain and bi-directional active range of motion during physical assessment and in five out of six domains during Shoulder36 assessment. In contrast, the re-rupture group showed significant differences for only three domains of the Shoulder36 assessment twelve months after surgery. [Conclusion] We confirmed the long-term functional improvement and maintenance in the re-rupture group, suggesting that continued rehabilitation, compensatory movements, and detailed guidance on daily life activities are required for patients after ARCR. Furthermore, Shoulder36 can be useful for assessing the prognosis of patients with and without re-rupture.

Key words: Soft tissue injury, Postoperative rotator cuff tear, Patient-based shoulder joint evaluation

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INTRODUCTION

Shoulder rotator cuff tear (a.k.a rotator cuff tear) is an injury that causes pain and leads to limited range of motion of the shoulder. This further affects daily life activities because of a significant reduction of upper limb function. The frequency of rotator cuff tear has been reported to be 20% in the general population and 50% or more among the elderly[1, 2)]. In Japan, rotator cuff tears occur in about 25% of people aged 50 years and older, and the frequency of rotator cuff tears has been observed to increase with age[3, 4)]. Many cases of rotator cuff tears improve with appropriate pain management and rehabilitation. However, surgery is performed in cases where the quality of life is reduced due to age and poor functional improvement with traditional treatment. In recent years, surgeries using the arthroscopic rotator cuff repair (ARCR) technique have been performed to treat rotator cuff tears with good long-term prognosis[5, 6)]. However, preoperative and postoperative rehabilitation are critical to its success[7)]. Despite good clinical results following ARCR, the re-rupture rate is reported to be 10–30%. This has been attributed to various risk factors, including age, fatty degeneration, diabetes, and compliance[8, 9)]. Conservative therapy is often the mode of treatment for re-rupture cases, but there are limited reports of the long-term prognosis of cases of re-rupture[6, 8, 10)]. The purpose of this study was to investigate the functional activities in patients with re-ruptures after ARCR

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and to compare the prognoses in the re-rupture and no rupture (control) group. We also examined the usefulness of Japanese Orthopedic Association Shoulder36 ver. 1.3 (hereafter referred to as Shoulder36)[10], a self-assessment tool, for the long-term prognosis of patients undergoing ARCR.

PARTICIPANTS AND METHODS

This study was performed with the approval of the Fuchinobe General Hospital Ethics Committee (Approval number: 15-002) and written consent was obtained from all participants. The study included 28 patients who received occupational therapy (OT) before and after undergoing ARCR for rotator cuff repair between April 2012 and August 2015. The patients were followed up for up to 24 months after surgery.

Patients who could not be followed up for 24 months were excluded. The average age was 65.2 ± 11.8 (36–75) years for males and 68.5 ± 13.8 (45–74) years for females. The average weight was 66.5 ± 10.2 (55–75) kg for males and 54.5 ± 8.8 (47–62) for females. The average height was 165.2 ± 6.6 (162–175) cm for males and 153.4 ± 5.0 (148–165) cm for females. There were 16 males and 12 females.

The right side of the shoulder was affected in 20 cases, while the left side was affected in 8 cases. For all cases, OT was initiated before surgery and was continued after surgery. The patients underwent OT daily during hospitalization and once or twice per week as outpatients. The average OT period was 6.7 ± 3.7 (3.8–15.5) months.

The prognosis was explored by surveying the following items at 3, 6, 12, and 24 months after operation: pain, visual analogue scale (VAS), and active range of motion (ROM)–shoulder joint flexion, abduction, external rotation (first position), and internal rotation. For measurement of the current pain using the VAS, a 100 mm-long line ("no pain" at the left end, "maximum pain imaginable" at the right end) was shown to the patients. In addition, the patient-based self-assessment tool, Shoulder36[11], for patients with shoulder joint injuries, was used. Self-assessment surveys were conducted at 12 and 24 months after surgery. The advantage of the self-assessment tool is that it evaluates the condition from the patient's point of view[12]. Shoulder36 comprises 36 questions categorized into six domains, each domain is scored with a value between 1 and 4, where 4 denotes a situation where the patient can perform the activity without difficulty and 1 denotes a situation where the patient cannot perform the activity. The six domains included pain, ROM, power (muscle strength), general health, activities of daily living (ADL), and the ability to participate in sports activities. The total score of the sub-items in each domain were investigated. Shoulder36 was classified into six regions, the average score was calculated, and comparative examination was recommended. The higher the score, the better the condition. Additionally, in diagnostic images captured by physicians, tendon rupture was evaluated using the DeOrio and Cofield classification[13], and fatty degeneration was evaluated using the Goutallier classification[14]. Statistical analyses were performed using the Friedman test, the multiple comparison test, and the Wilcoxon signed-rank sum test; the significance level was set at 5%. Statistical analyses were performed with EZR version 1.52 (Saitama Medical Center, Jichi Medical University, Saitama, Japan)[15], which is a graphical user interface for R version 4.02 (The R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Five cases (17%) of re-rupture were observed (re-rupture group). These cases were identified within 3 months of ARCR. According to the DeOrio and Cofield classification[13], the ruptures were large in three cases and widespread in two. Based on the Goutallier classification[14], fatty degeneration was classified as stage 3 in three cases and stage 4 in two.

Table 1 shows the progress of the re-ruptured group (five cases) and the symmetric group (23 cases) pre-surgery and 3 months, 6 months, 12 months, and 24 months post-surgery. The items compared were VAS, shoulder flexion, shoulder abduction, shoulder abduction, and shoulder external rotation as physical functions. A comparison of the physical assessment data between the re-rupture and control groups (23 cases) showed significant differences in VAS, shoulder flexion, abduction, and external rotation (VAS F=15.34, p=0.01; flexion, F=8.59, p=0.01; abduction, F=5.01, p=0.05, external rotation F=5.04, p=0.05, internal rotation F=1.69, p=1.20) (Table 1). There was a significant difference between preoperative and postoperative conditions in terms of the following factors: VAS, 3 M (p=0.05), 6 M (p=0.01), 12 M (p=0.01), and 24 M (p=0.01); shoulder flexion, 3 M (p=0.05), 6 M (p=0.01), 12 M (p=0.01), and 24 M (p=0.01); shoulder abduction, 3 M (p=0.05), 6 M (p=0.01), 12 M (p=0.01), and 24 M (p=0.01); external rotation, 12 M (p=0.05) and 24 M (p=0.01). Internal rotation showed significant improvement. In the physical assessment, VAS scores varied significantly in the re-rupture group between the preoperative and postoperative conditions (VAS F=12.66, p=0.05). No differences were observed in the other items; however, VAS, shoulder flexion, abduction, external rotation, and internal rotation showed significant improvement until 6 months post-surgery; shoulder flexion, abduction, and internal rotation showed significant improvement beyond 6 months post-surgery. Table 2 shows the progress of the re-ruptured group (five cases) and the symmetric group (23) before and 3 months, 6 months, 12 months, and 24 months after surgery. For the comparison items, we evaluated each item of Shoulder36 as a patient-based evaluation. Among Shoulder36 assessment domains, significant differences were found in all sub-items: pain F=24.9 (p=0.01), ROM F=17.1 (p=0.01), power F=7.4 (p=0.01), general health, F=16.2 (p=0.01), ADL F=8.5 (p=0.01), and ability to participate in sports F=7.9 (p=0.01) (Table 2). There was a significant difference between preoperative and postoperative conditions in terms of the following factors: pain, 12 M (p=0.01) and 24 M (p=0.05); ROM, 12 M (p=0.01) and 24 M (p=0.05); power, 12 M (p=0.01) and 24 M (p=0.05); general health, 12 M (p=0.05); ADL, 12 M (p=0.01) and 24 M (p=0.05); and ability to participate in sports, 12 M (p=0.05) and 24 M (p=0.05).

Table 3 compares the re-rupture group and the control group according to the evaluation time of each physical function evaluation item. The difference in ROM between the re-rupture and control groups was remarkable for shoulder flexion and abduction after 3 months and especially after 24 months (flexion, p=0.01; abduction, p<0.01) (Table 3).

Table 4 compares the re-rupture group and the control group according to the evaluation time of each Shoulder36 item. There was a remarkable difference in Shoulder36 parameters for the following factors: Pain at 12 months (p<0.01), ROM at 12 months or later (p=0.02, 0.05), and Power at 12 months or later (p<0.01, p=0.05) (Table 4).

DISCUSSION

We provided occupational therapy to 28 patients after ARCR surgery and followed their progress for 2 years. Five of the 28 patients (17%) experienced re-ruptures. We compared the re-rupture group with the control group and confirmed long-term functional improvement and maintenance in the re-rupture group.

The cause of re-rupture has been previously attributed to the size of the rupture and the degree of fat infiltration[8, 13)]. In line with previous studies, patients with re-rupture had large affected areas with high degrees of fat infiltration. In the postoperative rehabilitation of ARCR, about 6 to 8 weeks are required for tendon-bone repair. Therefore, it is recommended that only passive exercises should be performed, and active ROM exercises are prohibited in the first 6 weeks after surgery. Active ROM exercise can be performed 6 to 12 weeks post-surgery, and stress exercises and strength training can be started after 12 weeks[16, 17)]. Namdari et al.[18)] reported that patients with exercise restrictions at 3 months after rotator cuff repair experienced significantly more pain and lower outcome scores than patients without exercise restrictions. A randomized controlled trial by Arndt et al.[19)] showed that the early exercise therapy group performed significantly better than the late exercise therapy group. However, randomized controlled trials by Kim et al.[20)] and Lee et al.[21)] showed a decrease in the re-rupture rate in the

Table 1. Change over time between preoperative and postoperative pain and shoulder range of motion (ROM)

			Pre	Post 3M	Post 6M	Post 12M	Post 24M	F-value	p-value
VAS		Re-rupture group (N=5)	40.5 (33.7)	18.9 (13.3)	8.4 (7.5)	8.8 (7.7)	8.2 (6.8)	15.34	0.01
		Control group (N=23)	41.8 (37.4)	20.9 (14.7)	9.1 (8.2)	6.7 (5.2)	5.9 (5.4)		
ROM	Shoulder flexion	Re-rupture group (N=5)	118.8 (33.8)	100.8 (23.5)	110.3 (30.8)	126.8 (22.4)	125.5 (20.5)	8.59	0.01
		Control group (N=23)	120.1 (32.4)	130.5 (24.6)	145.2 (28.0)	156.6 (20.2)	161.4 (22.4)		
	Shoulder abduction	Re-rupture group (N=5)	115.4 (31.2)	100.8 (20.3)	108.5 (18.9)	126.8 (22.4)	125.5 (20.5)	5.01	0.05
		Control group (N=23)	118.8 (29.7)	125.4 (22.1)	133.2 (20.3)	156.6 (20.2)	161.4 (22.4)		
	Shoulder external rotation	Re-rupture group (N=5)	48.1 (18.4)	36.4 (20.4)	48.5 (13.5)	50.5 (18.2)	49.8 (17.6)	5.04	0.05
		Control group (N=23)	47.5 (19.2)	35.7 (15.6)	47.5 (19.5)	60.7 (16.8)	63.5 (15.4)		
	Shoulder internal rotation	Re-rupture group (N=5)	72.8 (9.7)	71.8 (13.1)	76.4 (10.2)	83.2 (7.9)	80.5 (8.8)	1.69	0.20
		Control group (N=23)	70.2 (8.8)	70.4 (9.7)	75.6 (9.4)	80.2 (7.8)	85.4 (9.7)		

Mean (standard deviation).
M: months; VAS: Visual analog scale; ROM: range of motion.

Table 2. Change over time between preoperative and postoperative Shoulder36

			Pre	Post 12M	Post 24M	F-value	p-value
Shoulder36	Pain	Re-rupture group (N=5)	2.8 (0.5)	3.1 (0.4)	3.4 (0.6)	24.9	0.01
		Control group (N=23)	2.7 (0.8)	3.6 (0.3)	3.8 (0.7)		
	ROM	Re-rupture group (N=5)	2.8 (0.5)	2.9 (0.5)	3.0 (0.6)	17.1	0.01
		Control group (N=23)	2.7 (0.8)	3.4 (0.4)	3.8 (0.8)		
	Power	Re-rupture group (N=5)	2.1 (0.5)	2.7 (0.4)	3.1 (0.6)	7.4	0.01
		Control group (N=23)	2.3 (0.8)	3.5 (0.4)	3.8 (0.7)		
	General health	Re-rupture group (N=5)	2.7 (0.5)	3.5 (0.4)	3.4 (0.6)	16.2	0.01
		Control group (N=23)	2.8 (0.8)	3.7 (0.3)	3.8 (0.7)		
	ADL	Re-rupture group (N=5)	2.7 (0.5)	3.5 (0.4)	3.4 (0.6)	8.5	0.01
		Control group (N=23)	2.8 (0.8)	3.7 (0.5)	3.8 (0.7)		
	Ability to participate in sports	Re-rupture group (N=5)	1.4 (0.9)	2.5 (0.8)	2.5 (0.9)	7.9	0.01
		Control group (N=23)	1.5 (1.0)	2.9 (0.8)	3.1 (0.9)		

Mean (standard deviation).
M: months; ROM: range of motion; ADL: activities of daily living.

Table 3. Comparison of the surveyed items between the re-rupture and control groups

Surveyed item	Re-rupture group (N=5) Mean ± SD	Control group (N=23) Mean ± SD	p-value
Visual analog scale			
Pre-op	40.5 (33.7)	41.8 (37.4)	0.67
Post 3M	18.9 (13.3)	20.9 (14.7)	0.77
Post 6M	8.4 (7.5)	9.1 (8.2)	0.86
Post 12M	8.8 (7.7)	6.7 (5.2)	0.59
Post 24M	8.2 (6.8)	5.9 (5.4)	0.51
Shoulder flexion			
Pre-op	118.8 (33.8)	120.1 (32.4)	0.94
Post 3M	100.8 (23.5)	130.5 (24.6)	0.04*
Post 6M	110.3 (30.8)	145.2 (28.0)	0.02*
Post 12M	126.8 (22.4)	156.6 (20.2)	0.04*
Post 24M	125.5 (20.5)	161.4 (22.4)	0.01**
Shoulder abduction			
Pre-op	115.4 (31.2)	118.8 (29.7)	0.83
Post 3M	100.8 (20.3)	125.4 (22.1)	0.05*
Post 6M	108.5 (18.9)	133.2 (20.3)	0.02*
Post 12M	116.8 (19.2)	150.2 (18.2)	0.01**
Post 24M	114.2 (20.2)	153.9 (19.7)	<0.01**
Shoulder external rotation			
Pre-op	48.1 (18.4)	47.5 (19.2)	0.94
Post 3M	36.4 (20.4)	35.7 (15.6)	0.96
Post 6M	48.5 (13.5)	47.5 (19.5)	0.89
Post 12M	50.5 (18.2)	60.7 (16.8)	0.29
Post 24M	49.8 (17.6)	63.5 (15.4)	0.13
Shoulder internal rotation			
Pre-op	72.8 (9.7)	70.2 (8.8)	0.61
Post 3M	71.8 (13.1)	70.4 (9.7)	0.83
Post 6M	76.4 (10.2)	75.6 (9.4)	0.88
Post 12M	83.2 (7.9)	80.2 (7.8)	0.47
Post 24M	80.5 (8.8)	85.4 (9.7)	0.31

SD: standard deviation; Pre-op: pre-operation; M: months; N: number of cases.
*p<0.05; **p<0.01.

limited rehabilitation group. They recommended gradual rehabilitation in the early stage after ARCR for good tendon healing. According to Tonotsuka et al.[22], if the ROM at 3 months after surgery reaches 120° for flexion and 20° for external rotation, sufficient ROM can be obtained within 2 years. Even when the angle is below the above values, the authors recommend the avoidance of forced rehabilitation. In the current study, the target ROM was achieved in 82% of the patients in the first 3 months after the operation, and the prognosis was good. However, it is advisable to proceed with rehabilitation carefully in cases with large-sized ruptures and high fat infiltration. Some patients showed improvement 6 months after the operation; therefore, a long-term perspective for ROM training is necessary. In the Shoulder36 assessment, significant differences were observed beyond 12 months after surgery for all sub-items, indicating the effectiveness of the treatment. Furthermore, even in cases of re-ruptures, significant differences were observed between postoperative and preoperative values of power, general health, and sports ability, suggesting the possibility of long-term improvement. Between the two groups, significant differences were found in pain, ROM, and power in the control group 12 months after surgery, but no significant differences were observed in general health, activities of daily life, or sports ability. Improvement was also observed in the re-rupture group indicating the possibility of improving activities of daily life by performing exercise. Shoulder36 was considered not only a useful tool for improving the physical function but also a subjective index for assessing the long-term course.

One major limitation of this study is the small number of cases (total number and re-rupture cases). I would like to consider this issue using likelihood-based Bayesian analysis in the future. Our study suggests that lifestyle guidance immediately after surgery is crucial in mitigating postoperative pain.

In this study, we investigated the long-term prognosis of the re-rupture and control groups after ARCR. Two years after the

Table 4. Comparison of Shoulder36 domains between the re-rupture and control groups

Shoulder36 domain	Re-rupture group (N=5) Mean ± SD	Control group (N=23) Mean ± SD	p-value
Pain			
Pre-op	2.8 (0.5)	2.7 (0.8)	0.79
Post 12M	3.1 (0.4)	3.6 (0.3)	<0.01**
Post 24M	3.4 (0.6)	3.8 (0.7)	0.15
Range of motion			
Pre-op	2.8 (0.5)	2.7 (0.8)	0.68
Post 12M	2.9 (0.5)	3.4 (0.4)	0.02*
Post 24M	3.0 (0.6)	3.8 (0.8)	0.05*
Power			
Pre-op	2.1 (0.5)	2.3 (0.8)	0.59
Post 12M	2.7 (0.4)	3.5 (0.4)	<0.01**
Post 24M	3.1 (0.6)	3.8 (0.7)	0.05*
General health			
Pre-op	2.7 (0.5)	2.8 (0.8)	0.80
Post 12M	3.5 (0.4)	3.7 (0.3)	0.21
Post 24M	3.4 (0.6)	3.8 (0.7)	0.24
Activities of daily living			
Pre-op	2.7 (0.5)	2.8 (0.8)	0.79
Post 12M	3.5 (0.4)	3.7 (0.5)	0.41
Post 24M	3.4 (0.6)	3.8 (0.7)	0.24
Ability for sports			
Pre-op	1.4 (0.9)	1.5 (1.0)	0.83
Post 12M	2.5 (0.8)	2.9 (0.8)	0.32
Post 24M	2.5 (0.9)	3.1 (0.9)	0.19

SD: standard deviation; Pre-op: pre-operation; M: months; N: number of cases
$^{*}p<0.05$; $^{**}p<0.01$.

surgery, the ROM and power of the re-rupture group were significantly lower than those of the control group, as shown by physical examination findings and self-assessment-based evaluation. However, there were no significant differences between the two groups in daily life-related domains, such as pain and general health. Shoulder36 was considered to be useful in the diagnosis of the prognosis of patients with and without re-rupture. In future, prospective studies to determine optimal exercise start time and its effectiveness should be conducted. Further investigations on exercise intensity and frequency should also be conducted.

Conference presentation

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Conflicts of interest

None.

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