Return to Sport After Arthroscopic Rotator Cuff Repair in Middle-Aged and Elderly Swimmers

Yohei Shimada,*† MD, Hiroyuki Sugaya,*‡ MD, Norimasa Takahashi,* MD, Keisuke Matsuki,* MD, Morihito Tokai,* MD, Takeshi Moriya,* MD, Yusuke Ueda,* MD, Shota Hoshika,* MD, Hiroshige Hamada,* MD, Satoshi Inoue,§ MD, Eiko Hashimoto,† MD, and Nobuyasu Ochiai,† MD

*Investigation performed at Funabashi Orthopaedic Hospital, Funabashi, Japan

Background: No reports have been published on the clinical outcomes, including return to sport, after rotator cuff repair in middle-aged and elderly swimmers with rotator cuff tears.

Purpose: To retrospectively investigate clinical outcomes and return to sport after arthroscopic rotator cuff repair in middle-aged and elderly swimmers.

Study Design: Case series; Level of evidence, 4.

Methods: Patients who underwent arthroscopic rotator cuff repair and met the following criteria were included: (1) age older than 45 years, (2) rotator cuff tears confirmed during surgery, (3) arthroscopic suture bridge rotator cuff repair, (4) primary surgery, and (5) swam more than once a week before surgery. The exclusion criteria were as follows: (1) irreparable large and massive tears, (2) shoulder instability, (3) arthritis or rheumatic disorders, or (4) less than 2-year follow-up. We investigated functional outcomes including range of motion; the University of California, Los Angeles (UCLA) score; the American Shoulder and Elbow Surgeons (ASES) score; return to swimming; and the return rates for each style of swimming. In addition, the functional outcomes and findings of magnetic resonance imaging were compared between the group with complete return and the group with incomplete or failed return.

Results: A total of 32 shoulders in 31 middle-aged and elderly swimmers (5 males, 26 females) were included. The mean age was 65 years (range, 47-78 years), and the mean follow-up was 47 months (range, 24-86 months). Return to swimming was achieved in 31 (97%) shoulders at a mean of 8 months (range, 3-24 months), and complete return was achieved in 18 (56%) shoulders at a mean of 12 months (range, 3-24 months). The return rate was 97% for freestyle, 83% for breaststroke, 74% for backstroke, and 44% for butterfly stroke. Postoperative UCLA and ASES scores were significantly higher in the group with complete return than in the group with incomplete or failed return ($P = .001$ and $.01$, respectively). Postoperative forward elevation was significantly better in the complete return group ($P = .01$).

Conclusion: This study demonstrated that 97% of elderly swimmers who underwent arthroscopic rotator cuff repair could return to swimming. The complete return rate was 56%; however, the group with incomplete or failed return showed poorer active forward elevation. Freestyle had the highest complete return rate, whereas the butterfly stroke had the lowest return rate. It may be important to achieve good active forward elevation postoperatively to return to swimming.

Keywords: rotator cuff tear; arthroscopic rotator cuff repair; swimming; return to sport; clinical outcomes

Swimming can cause shoulder pain due to repeated overhead motion, and shoulder disorders resulting from swimming have been widely referred to as swimmer’s shoulder since the report by Kennedy et al in 1978. The causes of shoulder disorders in swimmers have been reported to include subacromial impingement and tendinopathy of the supraspinatus tendon due to overuse. Brushøj et al reported that common arthroscopic findings in swimmers were labral abnormality (66%) and subacromial impingement (28%) and that the rate of return to competition was 56% after arthroscopic debridement of the labrum and subacromial decompression. Loel et al reported that 64% of athletes with partial rotator cuff tear, including swimmers, returned to preinjury sports after arthroscopic subacromial decompression and debridement.

Previous studies have focused on young athletes, but swimming is a popular sport among middle-aged and elderly individuals, who are potentially at risk for rotator...
cuff tears. It has been reported that cuff tendon disruption increases with age,21 and subacromial impingement and tendinopathy due to overuse may enhance age-related changes in the rotator cuff. In fact, we have treated many middle-aged and elderly swimmers with rotator cuff tears. No research to date has reported on the clinical outcomes, including return to sport, after rotator cuff repair for middle-aged and elderly swimmers with rotator cuff tears. The purpose of this study was to retrospectively investigate clinical outcomes after arthroscopic rotator cuff repair in middle-aged and elderly swimmers as well as to elucidate factors associated with return to swimming. We hypothesized that arthroscopic rotator cuff repair in middle-aged and elderly swimmers would result in good clinical outcomes.

METHODS

Patients

Patients who underwent arthroscopic rotator cuff repair at our institute between January 2011 and April 2017 were retrospectively identified. The inclusion criteria for this study were as follows: (1) age older than 45 years, (2) partial- or full-thickness rotator cuff tears confirmed during surgery, (3) arthroscopic suture bridge rotator cuff repair, (4) primary surgery, and (5) swimming more than once a week before surgery. The exclusion criteria were as follows: (1) irreparable large and massive tears, (2) unidirectional or multidirectional shoulder instability, (3) arthritis or rheumatic disorders, or (4) less than 2 years of follow-up. All patients reported shoulder pain, and physical examination showed muscle weakness and/or positive impingement tests. Surgical treatment was indicated after failed nonoperative treatment for at least 3 months, including physiotherapy and subacromial steroid injections. Data were collected prospectively and were retrospectively reviewed. This study was approved by the institutional review board of our hospital.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) was performed pre- and postoperatively via a 1.5-T scanner (Intera; Philips) with a phased-array surface coil. Patients were positioned with the humerus in neutral rotation. Using an echo-train length of 10, we obtained T2-weighted MRI scans in axial, oblique coronal (parallel to the long axis of the supraspinatus tendon), and oblique sagittal (perpendicular to the long axis of the supraspinatus tendon) planes. A 3.5-mm slice thickness with a 1-mm gap between slices was used, and T1-weighted oblique sagittal images were routinely obtained to assess fatty degeneration of the rotator cuff muscle.7,18 The MRI parameters of the T2-weighted coronal scans were as follows: repetition time (TR)/echo time (TE), 5000/100 ms; field of view (FOV), 160 mm; matrix, 512 × 800. For the T2 sagittal scans, the parameters were: TR/TE, 4147/100 ms; FOV, 160 mm; matrix, 384 × 720. For the T2 axial scans, the parameters were: TR/TE, 4000/100 ms; FOV, 160 mm; matrix, 400 × 720. For the T1 scans, the parameters were: TR/TE, 400/10.5 ms; FOV, 160 mm; matrix, 400 × 720.

Pre- and postoperative fatty degeneration of the supraspinatus (SSP), infraspinatus (ISP), and subscapularis (SSC) muscles was graded through use of T1-weighted oblique sagittal images according to the Goutallier grading modified by Fuchs et al.4 The global fatty degeneration index (GFDI), which was the mean grade of the 3 muscles, was used for assessment.23 The repair integrity of the cuff tendon was evaluated using the Sugaya grading with postoperative T2-weighted oblique coronal, oblique sagittal, and transverse images: type 1, sufficient thickness with low intensity; type 2, sufficient thickness with a partial high-intensity area; type 3, insufficient thickness without discontinuity; type 4, minor discontinuity; and type 5, major discontinuity.18 Those classified as types 4 and 5 were regarded as a retear.18

Clinical Assessment

Athletic level was rated as “competition level” if the patient participated in athletic competitions and “recreational level” if otherwise. Each patient was examined pre- and postoperatively for active range of motion (forward elevation, external rotation at the side, external rotation at 90° of abduction, internal rotation at 90° of abduction, and hand behind the back) by 1 of the senior shoulder surgeons (H.S., N.T., K.M., M.T.) using a goniometer. Patients were also assessed using the University of California, Los Angeles (UCLA) score and the American Shoulder and Elbow Surgeons (ASES) score preoperatively and at the final follow-up.

The size of the rotator cuff tear was determined during arthroscopic surgery. The size of full-thickness SSP/ISP tears was classified according to the Cofield classification: small, <1 cm in length; medium, 1-3 cm; large, 3-5 cm; and massive, >5 cm.5 SSC tear size was classified according to the LaFosse classification: type 1, partial tear; type 2, less than one-third superior tear; type 3, less than two-thirds superior tear; type 4, complete tear without eccentric humeral head; and type 5, complete tear with eccentric head.10

We investigated the following: return to swimming (same or higher/lower level compared with preinjury state

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1Address correspondence to Hiroyuki Sugaya, MD, Funabashi Orthopaedic Sports Medicine & Joint Center, 1-833 Hazama, Funabashi, Chiba 2740822, Japan (email: hsugaya@nifty.com).
2Funabashi Orthopaedic Sports Medicine & Joint Center, Funabashi, Japan.
3Department of Orthopedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Japan.
4Nakae Hospital, Wakayama, Japan.

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based on self-assessment), the time to return after surgery (start of swimming and complete return), and the return rates for each style of swimming (freestyle, breaststroke, backstroke, and butterfly stroke). Complete return was defined as return to the same or higher level compared with the preinjury state, whereas incomplete return was defined as return to a lower level. We compared the size of rotator cuff tears, pre- and postoperative range of motion, pre- and postoperative UCLA and ASES scores, pre- and postoperative fatty degeneration of the cuff muscles, and postoperative cuff integrity on MRI scans between patients with complete return and those with incomplete or failed return.

Surgical Procedures

All surgical procedures were performed by 1 of the senior surgeons. Patients received general anesthesia with an interscalene block and were placed in the beach-chair position. Standard posterior and anterior portals were established, and glenohumeral abnormality was investigated. The arthroscope was then removed from the glenohumeral joint and redirected into the subacromial space. An anterolateral portal and a posterolateral portal were also established, with the posterolateral portal being mainly used as the viewing portal, and subacromial decompression was performed, if necessary.

Tenodesis or tenotomy was performed when the long head of the biceps (LHB) showed pathological changes. Generally, we performed tenodesis for male patients younger than 70 years and female patients younger than 65 years of age.

For retracted tears, resection of the coracohumeral ligament and capsular release were performed to improve tendon mobility. Depending on tear size, 1 to 3 suture anchors loaded with three No. 2 high-strength sutures were inserted at the medial border of the footprint. We usually placed 2 sutures at a time into the tendon using a suture grasper. We performed suture bridging in every case before tying medial sutures. We retrieved 2 pairs of suture limbs and fixed them with a lateral-row anchor inserted into the greater tuberosity, and 1 suture was left untied for each anchor. We typically used 1 to 3 lateral-row anchors for suture bridging. After completion of the suture bridge, the remaining medial sutures were tied in a mattress fashion. These techniques were also applied for SSC tears.

Postoperative Rehabilitation

The shoulders were immobilized for 3 to 4 weeks in a sling immobilizer with an abduction pillow. Isometric rotator cuff exercises and relaxation of the shoulder girdle muscles were initiated the day after surgery. After the immobilization period, passive and active assisted exercises were initiated for forward flexion and external rotation, while avoiding the provocation of pain. After 6 weeks, patients began strengthening exercises of the rotator cuff and the scapular stabilizers. Patients normally visited the clinic for physiotherapy with therapists once or twice a week and performed home exercises on the other days. Light sport activities were permitted 3 months after surgery, and full unrestricted activities were permitted at 6 months depending on the patient’s functional recovery.

Statistical Analysis

The Student t test was used to compare age, follow-up period, postoperative range of motion, clinical scores, and GFDI between the 2 groups. The paired t test was used to compare pre- and postoperative clinical scores. The Mann-Whitney U test was used to compare cuff tear size and cuff integrity between the group with complete return and the group with incomplete or failed return. The chi-square test for independence was used to compare age and athletic level between the 2 groups. The significance level was set at \( P < .05 \).

RESULTS

Patients

A total of 37 shoulders (36 patients) met the inclusion criteria, and 5 shoulders were excluded (Figure 1). Consequently, this study included 32 shoulders in 31 patients (5 males, 26 females) with a mean age of 65 years (range, 47-78 years) at the time of surgery. The follow-up rate was 89% (32/36 shoulders), and the mean follow-up was 47 months (range, 24-86 months). In total, 24 tears were to the dominant side (75%). We noted that 7 swimmers (23%) were competition level, whereas 24 (77%) were recreational level. Further, 8 tears (25%) had traumatic onset.

Operative Findings

There were 31 shoulders involving SSP/ISP tears and 1 shoulder with an isolated SSC tear. SSP/ISP tears included 6 partial tears (5 bursal-side tears, 1 joint-side tear), 9 small tears, 9 medium tears, 5 large tears, and 2 massive tears. We noted that 5 shoulders had concomitant SSC tear. SSC tear was classified as type 1 in 3 shoulders, type 2 in 1 shoulder, and type 4 in 1 shoulder. The LHB was normal in 19 shoulders, hypertrophic or partially torn in 10 shoulders, and absent in 3 shoulders. LHB tenodesis was performed in 4 shoulders and tenotomy in 6 shoulders. No intra- or postoperative complications were seen during the follow-up period.

Clinical Evaluation

In total, 31 shoulders (97%) allowed for returned to swimming at a mean of 8 months (range, 3-24 months) after surgery. Complete return was achieved for 18 (56%) shoulders at a mean of 12 months (3-24 months).

In the comparison between the group with complete return and the group with incomplete or failed return, no significant differences in preoperative demographic data were found (Table 1). The complete return rate was 58% (14/24 shoulders) in partial and medium tears and 43%
Inclusion: 37 shoulder (36 patients)
• > 45 years old
• Partial- and full-thickness rotator cuff tear
• Arthroscopic suture bridge repair
• Primary surgery
• Swimming more than once a week

Exclusion: 1 shoulder
• Recurrent instability  n=1

Study candidates
• 36 shoulders (35 patients)

Lost follow-up
4 shoulders (4 patients)

Study subjects
• 32 shoulders (31 patients)

Figure 1. Patient selection.

TABLE 1
Demographic Data for Patients With Complete and Incomplete/Failed Return

| Demographic Data | Complete Return | Incomplete/Failed Return | P Value |
|------------------|-----------------|--------------------------|---------|
| No. of patients   | 18              | 14                       |         |
| Mean age, y (range) | 66 (54-76)   | 63 (47-78)               | .3      |
| Sex, male/female, n | 3/15         | 2/12                     | .5      |
| Mean follow-up, mo (range) | 46 (24-75)  | 48 (24-86)               | .9      |
| Athletic level, competition/ recreational, n | 4/14 | 3/11 | .9 |
| Cuff tear size, n |                 |                          | .2      |
| Partial           | 4               | 2                        |         |
| Small             | 6               | 3                        |         |
| Medium            | 4               | 5                        |         |
| Large             | 3               | 2                        |         |
| Massive           | 0               | 2                        |         |
| Isolated subscapularis | 1       | 0                        |         |

TABLE 2
Complete Return Rates for Each Swimming Style

| Style            | Complete Return, % (n/N) |
|------------------|--------------------------|
| Freestyle        | 97 (31/32)               |
| Breaststroke     | 83 (20/24)               |
| Backstroke       | 74 (20/27)               |
| Butterfly        | 44 (7/16)                |

that had complete return. Postoperative forward elevation was better in the group with complete return than in the group with incomplete or failed return (P = .02) (Table 3). UCLA and ASES scores significantly improved after surgery in both groups (P = .001 and P = .003, respectively) (Table 3). The complete return group showed significantly better postoperative UCLA and ASES scores than the group with incomplete or failed return (P = .001 and P = .01, respectively) (Table 3).

MRI Findings

MRI was conducted at a mean of 17 months (range, 12-36 months) after surgery (Figure 2). No significant differences were seen in pre- and postoperative GFDIs between the group with complete return and the group with incomplete or failed return (Table 3). GFDI showed no significant progress after surgery in both groups (Table 3).

No SSC retear was noted, but SSP/IP retear was found in 3 shoulders (8%): 1 in the complete return group and 2 in the group with incomplete or failed return (Table 4). No

(3/7 shoulders) in large and massive tears, and no significant difference was seen for complete return rates in terms of tear size (P = .2). No patient with a massive tear could completely return to swimming. Freestyle had the highest complete return rate, whereas butterfly stroke had the lowest rate (Table 2).

We found no significant differences in preoperative range of motion between the 2 groups (Table 3). Forward elevation was significantly improved postoperatively in both groups (P = .001 for both), and internal rotation at 90° of abduction and hand behind the back improved in the group
statistical difference was seen in the Sugaya grades between the 2 groups. We found that 1 patient with a retear completely returned to swimming without any symptoms. The remaining 2 shoulders underwent revision surgery. One patient incompletely returned to swimming after revision surgery, and another failed to return after 2 revision surgeries.

DISCUSSION

This study revealed that 97% of patients were able to return to swimming at a mean 8 months after surgery and that complete return was achieved in 56% of patients at a mean 12 months after surgery. The return rate was higher with freestyle, backstroke, and breaststroke but was the lowest with butterfly stroke. With the numbers available for this study, we could identify no significant difference in the complete return rates with respect to tear size; however, no patient with a massive tear could completely return to swimming. The complete return group showed significantly better clinical scores and active forward elevation at follow-up evaluation than the group with incomplete or failed return.

No report has been published on return to sport after rotator cuff repair for middle-aged and elderly swimmers. Michel et al\textsuperscript{14} investigated the outcomes after open or arthroscopic rotator cuff repair in 29 golfers with a mean age of 60 years and reported a high complete return rate of 88%. In a study on tennis players with a mean age of 58 years, Bigliani et al\textsuperscript{15} reported that 19 of 23 patients (83%) could return to a satisfactory level of play after rotator cuff repair. The rate of return to swimming in the current study was comparable with other sports.

The group with incomplete or failed return showed poorer active forward elevation at follow-up. Tate et al\textsuperscript{19} found that symptomatic swimmers had limited shoulder flexion that resulted in reduced stroke length, incurring greater shoulder load. The repetitive load to the shoulder may lead to rotator cuff fatigue and subsequent secondary impingement.\textsuperscript{12,22} Insufficient forward elevation might be associated with incomplete return by causing improper stroke mechanics and secondary shoulder impingement.

Complete return rates were high in freestyle, backstroke, and breaststroke but low in butterfly stroke. During freestyle stroke, the impingement position, which is shoulder flexion with internal rotation and horizontal adduction, can be avoided by rolling the trunk.\textsuperscript{20} Limited shoulder range of motion during the freestyle stroke can be compensated by rolling and bending the trunk.\textsuperscript{6,22} The shoulder motions during backstroke can also be compensated by the movements of the trunk. The shoulder load during breaststroke

| TABLE 3 | Comparison of Pre- and Postoperative Clinical Evaluations\textsuperscript{a} |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Evaluated Factors | Complete Return | \textbf{P Value}\textsuperscript{b} | Incomplete/Failed Return | \textbf{P Value}\textsuperscript{b} | \textbf{P Value}\textsuperscript{c} |
| \textbf{Clinical score} | | | | | |
| UCLA (Pre) | 27 (21 to 32) | .001 | 24 (19 to 30) | .001 | .1 |
| (Post) | 34 (28 to 35) | 31 (29 to 35) | .001 | .001 |
| ASES (Pre) | 79 (61 to 95) | .001 | 75 (56 to 91) | .003 | .7 |
| (Post) | 98 (84 to 100) | 90 (65 to 100) | .01 | .01 |
| \textbf{Range of motion} | | | | | |
| Forward elevation (deg) (Pre) | 141 (60 to 180) | .001 | 136 (30 to 175) | .001 | .6 |
| (Post) | 173 (150 to 180) | 160 (80 to 180) | .02 | .02 |
| External rotation (deg) (Pre) | 52 (20 to 70) | .7 | 40 (0 to 70) | .1 | .06 |
| (Post) | 55 (25 to 70) | 50 (0 to 70) | .3 | .3 |
| \textbf{External rotation at 90° of abduction (deg)} (Pre) | 71 (50 to 90) | .2 | 72 (30 to 90) | .6 | .8 |
| (Post) | 74 (50 to 90) | 70 (50 to 90) | .3 | .3 |
| \textbf{Internal rotation at 90° of abduction (deg)} (Pre) | –10 (–30 to 0) | .001 | –7 (–20 to 0) | .3 | .3 |
| (Post) | –3 (–10 to 0) | –5 (–20 to 0) | .2 | .2 |
| \textbf{Hand behind the back} (Pre) | T12 (L5 to T8) | .001 | L1 (GT to T7) | .07 | .4 |
| (Post) | T10 (L4 to T7) | T11 (GT to T8) | .2 | .2 |
| \textbf{GFDI} (Pre) | 1.3 (1 to 2.3) | .2 | 1.6 (1 to 3.3) | .8 | .2 |
| (Post) | 1.3 (1 to 2.3) | 1.7 (1 to 3.3) | .4 | .4 |

\textsuperscript{a}Values are expressed as mean (range). ASES, American Shoulder and Elbow Surgeons; GFDI, global fatty degeneration index; post, postoperative; pre, preoperative; UCLA, University of California, Los Angeles.

\textsuperscript{b}Pre- vs postoperative.

\textsuperscript{c}Complete return vs incomplete/failed return.
should be less than that of the other styles because the hands never move below the hips. Butterfly stroke requires a similar shoulder motion to freestyle, but the motion of the trunk cannot be used because the arms require symmetrical motions. This may be the cause of the lower return rate for butterfly stroke. In addition, the decreased flexibility of the trunk with age might put more stress on shoulders during butterfly stroke.

Several authors have reported no correlation between tear size and surgical outcomes, whereas others reported a correlation. The controversy might be associated with inadequate study power. Kang and Gupta reported that massive rotator cuff tears were associated with the progression of fatty degeneration and poor functional outcomes. Michel et al reported that all shoulders with a massive rotator cuff tear could not completely return to golf. Similarly, in the current study, no patient with a massive rotator cuff tear could return to swimming, despite the fact that the study was unable to detect any significant differences in return to swimming with regard to tear size or the degree of fatty degeneration, probably due to the inadequate study power. Thus, further studies with larger cohorts are required to elucidate these relationships.

This study had several limitations. First, this was a retrospective case series study. Second, the number of patients was relatively small, which weakened the statistical power. Consequently, we could not find statistical differences in several variables such as the size of the rotator cuff tear or postoperative cuff integrity. In addition, because of the small sample size, it may be difficult to evaluate interactions between variables, such as the interaction between age and tear size. Third, we used only shoulder range of motion to evaluate the relationship between physical findings and return to swimming. The impediment in swimming can be affected by the stability of the scapula and poor posture as well as range of motion. Fourth, the range of age was relatively large, and sport ability and shoulder function may differ between younger and older patients. Fifth, the level of swimming varied among the patients, which might affect the return to sport. Therefore, future studies with a greater number of patients are warranted to validate our results. Despite these limitations, this study may still provide useful information on outcomes after arthroscopic rotator cuff repair in middle-aged and elderly swimmers.

**CONCLUSION**

This study demonstrated that 97% of middle-aged and elderly swimmers who underwent arthroscopic rotator cuff repair could return to swimming. The complete return rate

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**TABLE 4**

| Type of Return                  | Sugaya Grade |
|--------------------------------|--------------|
|                                | 1 | 2 | 3 | 4 | 5 |
| Complete                       | 11| 5 | 1 | 1 | 0 |
| Incomplete/failed              | 7 | 2 | 3 | 1 | 1 |
| P value                        | .2 |

**Figure 2.** Pre- and postoperative magnetic resonance imaging (MRI) scans of a 69-year-old female with successful repair (right shoulder). (A) Preoperative MRI shows a small complete tear. (B) Postoperative MRI at 2 years after surgery shows successful repair.

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**Shimada et al The Orthopaedic Journal of Sports Medicine**
was 56%. Conversely, the group with incomplete or failed return showed poorer active forward elevation. With regard to stroke, freestyle had the highest complete return rate, whereas butterfly stroke had the lowest return rate. It may be important to achieve good postoperative forward elevation for return to swimming.

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