

Midterm Clinical Outcomes After Arthroscopic Rotator Cuff Repair in Olympic Volleyball Players

Return to Sports and Return to Performance

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Background: The decision-making process and predicting the time to return to sport (RTS) and return to performance (RTP) after arthroscopic rotator cuff repair (ARCR) in elite volleyball players are difficult issues to address, even among experienced shoulder surgeons.

Purpose/Hypothesis: The purpose of the study was to evaluate the results in Olympic-level volleyball players treated with arthroscopic supraspinatus repair and to report the RTS and the RTP. It was hypothesized that these athletes had higher RTS and faster RTP.

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

Methods: This study included 17 elite volleyball athletes (11 male, 6 female; mean age, 26.2 years) who underwent ARCR for partial- and full-thickness supraspinatus tears that did not improve despite nonoperative treatment. The clinical results were evaluated at 12 months postoperatively. The authors compared the athletes' preoperative, 6-month, and 12-month Kerlan-Jobe Orthopaedic Clinic (KJOC) scores and the visual analog scale (VAS) for pain after competition and conducted 6- and 12-month isometric strength analyses. The athletes' RTS and RTP times were recorded.

Results: All tears were on the dominant side (15 right, 2 left), and 82% were partial tears (14 partial thickness, 3 full thickness). The mean time from the onset of symptoms to surgery was 11.3 ± 6.7 months. While the mean Kerlan-Jobe Orthopaedic Clinic score was 31 preoperatively, it was 89 after 6 months ($P < .001$ vs preoperative) and 96 after 12 months ($P = .003$ vs 6 months). The mean VAS for pain was 7.9 preoperatively, 0.4 at 6 months ($P < .001$ vs preoperative), and 0.1 at 12 months ($P = .02$ vs 6 months). All athletes were able to reach their preinjury level, with RTS at a mean of 6.9 months and RTP at a mean of 12.4 months.

Conclusion: ARCR appears to be an effective option for Olympic-level volleyball players who do not benefit from nonoperative treatment. All athletes returned to their preinjury level of sports. The surgeon and athlete can plan surgical decision-making and timing based on the mean RTS time of 6.9 months and mean RTP time of 12.4 months.

Keywords: sports injury; overuse; volleyball; beach volleyball; Olympic athletes; elite athletes; rotator cuff tear, partial rotator cuff repair; supraspinatus tear

Volleyball, one of the most popular sports in the world, has been in the Olympic Games since 1964.⁴² Although volleyball is considered a relatively safe sport compared to contact sports, such as football, handball, and rugby, where tackles are common, volleyball players are at risk of injury due to volleyball-specific tasks such as jumping, landing, blocking, and spiking.⁶ More than 180,000

volleyball-related injuries are treated each year, according to data from the American Academy of Orthopaedic Surgeons.³⁰ Due to their increasing frequency, volleyball-related injuries have gained importance.

Even though shoulder injuries can occur as a result of many sports activities, they can be difficult to manage, especially in overhead or throwing athletes. Overhead activities may cause pathologic conditions in shoulder structures such as the labrum, biceps, and rotator cuff, which are exposed to supraphysiologic stresses as a result of repetitive traumas.¹⁵ The most common cause of

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shoulder pain and dysfunction in volleyball players is the high number of consecutive microtraumas resulting from overuse of the rotator cuff.¹⁶

Treatment depends on several factors, including the athlete's type and onset of the symptoms, stage of pathology, age, athlete's expectation, timing according to season, nature of the cuff pathology, and concomitant diagnoses. Overhead athletes with partial-thickness rotator cuff tears (PTRCTs) or full-thickness rotator cuff tears (FTRCTs) for which nonsurgical treatment has failed are eligible for surgical intervention.^{10,12,38} When the patient is an Olympic athlete, many concerns come with surgical treatment of rotator cuff tears, such as the development of the athlete's career and their willingness to not miss prestigious competitions.

Our study aimed to evaluate the clinical results of Olympic volleyball players who underwent arthroscopic supraspinatus repair and determine the return time to the pitches of the athletes with full performance using objective measurement methods. To our knowledge, there is no study on rotator cuff tear surgery performed with Olympic-level overhead athletes in the literature. We also evaluated the return to sport (RTS) and return to performance (RTP) of Olympic volleyball players who underwent arthroscopic repair due to a supraspinatus tear, answering the first question asked by the athletes after a decision for surgery: "When will I return to sports and performance?" It was hypothesized that Olympic-level volleyball players would return to their sport 6 months after arthroscopic rotator cuff repair (ARCR) surgery and return to a similar level of performance 1 year after surgery.

METHODS

All of the athletes were informed about the study, and their data were collected after obtaining their written informed consent. This is a retrospective review of the prospective surgical and rehabilitation process. The study protocol was approved by the local ethics committee.

Study Participants

All volleyball players who played in an Olympic game affected by a nontraumatic isolated supraspinatus lesion treated with arthroscopic repair in our institute were enrolled in the study. The diagnosis of an isolated supraspinatus tear was suspected based on clinical examination and confirmed with magnetic resonance imaging (MRI).¹ The main exclusion criterion was a clear traumatic event

that occurred before shoulder pain and diagnosis of supraspinatus tear. Furthermore, those who were diagnosed with concomitant lesions such as infraspinatus tear, superior labrum anteroposterior lesion, supraspinatus nerve injury, superior labrum anterior cuff lesion, partial articular supraspinatus tendon avulsion lesions, and labral injury during preoperative MRI evaluation and intraoperative diagnostic arthroscopy were excluded. Biceps tendinopathy was not considered an exclusion criterion, provided the tendon was intact. No exclusion criteria regarding age, sex, or other qualifying factor were applied.

All included athletes had been treated nonoperatively between 4 and 24 months (mean, 11.6 ± 5.0 months), thus avoiding surgical overtreatment if not strictly required.²⁵ Nonoperative treatments applied were therapeutic exercise, intra-articular injections of hyaluronic acid (2 athletes), platelet-rich plasma (5 athletes at external centers), and various nonsteroidal anti-inflammatory drugs. Arthroscopic supraspinatus repair was recommended for athletes whose complaints did not improve and progress.

Surgical Intervention

All patients were operated on by the same senior shoulder surgeon (G.P.). The patient lay on the contralateral side, with the operated side connected to the lateral decubitus shoulder traction tower. After standard sterilization and covering protocols, diagnostic arthroscopy was completed by entering the shoulder through the posterior and anterior portals. Moderate bursectomy to allow visualization was performed, but acromioplasty was not performed. The tear diameter measured in the preoperative MRI was reevaluated through the lateral portal opened regarding the intraoperative shaver size. Three athletes had FTRCT, and 14 had PTRCT involving more than two-thirds of the tendon that was converted to full thickness during the repair. After performing the microfracture to the greater tuberosity, the supraspinatus tendon was repaired in a single row with a ThRevo triple-loaded suture anchor (ConMed Utica) medially to the anatomic footprint to avoid excessive tension. The biceps tendon was preserved.

Postoperative Rehabilitation Protocol

An abduction (30°) sling was used by all patients for 4 weeks postoperatively. Our postoperative rehabilitation programs have a multistage approach for athletes, with specific goals in each phase. In the immediate postoperative period (0-6 weeks), pain and inflammation were controlled

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by applying ice covered with a cloth for 20 minutes in the first week. Passive mobilizations for full range of motion recovery, performed by a physical therapist, were begun at 3 weeks postoperatively. Athletes performed self-stretching exercises and active exercises in a warm swimming pool (33°C).

We emphasized the reestablishment of shoulder mobility during the intermediate postoperative period (6-10 weeks) by using active-assisted and passive range of motion exercise, stretching, joint mobilization techniques, and improving muscular strength and scapular control. Early exercises were prescribed at submaximal activation levels with the arm below 90° of abduction, to avoid impingement and upper trapezius activation. Examples of exercises included the “inferior glide,” “robbery” scapular retraction, and depression.^{11,21}

Elastic resistance bands were used during the advanced postoperative period (10-16 weeks) to rebuild strength in the shoulder girdle muscle groups. Resistance exercises were advanced during this phase, the goal of which was to restore strength and balance. There must be a balance between agonist and antagonist muscles, such as the rotator cuff, deltoid muscle, and retractor and protractor scapular muscles. The muscular ratio should be for the external rotation (ER)/internal rotation (IR) ratio of 62% to 70%.⁴⁴ Dynamic stabilization drills were also performed to enhance proprioception and neuromuscular control. Plyometric training may be used to enhance dynamic stability and gradually increase the functional stresses placed on the shoulder joint.^{26,43} In addition, we included muscular endurance and isotonic exercises with lower weights and higher repetitions to reduce the effects of fatigue, especially for overhead spikers.⁸

The RTS period rehabilitation program (after 16 weeks) and the return to volleyball involved the progression of the interval spike program. The athletes started to play volleyball without jumping for the first month; in addition, they were instructed to continue all exercises previously prescribed to improve upper extremity strength, power, and endurance. The athletes were also instructed to continue the stretching programs and core exercise training. Last, they were counseled in a year-round conditioning program to prevent the overstress of throwing and to protect the posterior rotator cuff muscles during the deceleration phase.

Outcome Measurements

Preoperatively, all patients had their pain measured using a visual analog scale (VAS), completed the Kerlan-Jobe Orthopaedic Clinic (KJOC) questionnaire, and underwent isometric strength testing.^{18,28,31,33}

VAS Pain

Patients were asked to express the most severe pain they felt after exercise on a 10-cm VAS (0 = no pain, 10 = worst pain imaginable), and it was recorded. VAS was measured preoperatively and at 6- and 12-month follow-ups, asking to express pain after intense exercise.

KJOC Questionnaire

The questions are aimed at investigating the current performance level and function of the relevant extremity. Athletes are asked to respond by placing a mark on a 10-cm VAS. The scores of the 10 items are added together to form the total score between 0 and 100, with 100 being the highest level of perceived physical ability.³¹ The KJOC minimal detectable change (95%) is assessed at 6.7 points.³¹

Questions 5 to 9, which make up half of the scoring, are about function and athletic performance; questions 1 to 4 measure upper extremity symptoms; and question 10 expresses the athlete's opinion on how the condition of their arm affects their level of competition.^{18,28}

Isometric Strength

The isometric strength of the rotator cuff muscles was assessed with the Total Shoulder (Technogym) machine, which is provided with a strain gauge and dedicated software to calculate the maximum isometric peak torque strength and IR/ER ratio of the affected and healthy arms. The device was placed on the floor in the gym, verbal encouragement was not provided, and the testing procedure was performed with the athlete seated, arm adducted, and elbow flexed to 90°. Angles were verified with a goniometer. Each maximal isometric test lasted 5 seconds and consisted of ER and IR measurements at 3 different angles (-20°, 0°, and +20°), for a total of 6 tests, with 10 seconds of rest between each measurement.

Athletes underwent isometric strength testing at 6 months postoperatively, on both the affected and healthy sides. Before athletes returned to training, 2 items needed to have been reached: (1) adequate ER strength and (2) enough balance between IR and ER. The mean ER value for each side was considered to compare strength: if the ratio of the affected/healthy sides was >50%, the first item was considered achieved. To evaluate the balance between IR and ER, a mean value of both was taken, and if the ER reached 66% of the IR, the second item was considered achieved. To evaluate improvement in balance, strength testing was also undertaken at 12 months postoperatively.⁹

RTS and RTP

The concepts of returning to training, RTS, and RTP are used in different ways in the literature. To avoid confusion, we used the terms *return to training* when athletes started training, *RTS* when they resumed professional competition,¹⁷ and *RTP* to express when the athlete felt they had returned to their preinjury performance level. To evaluate RTP, question 10 on the KJOC (“How much do you feel your arm affects your current level of competition in your sport [ie, is your arm holding you back from being at your full potential]?”) was asked of the patients each month after surgery for 12 months.^{4,14}

TABLE 1
Athlete and Injury Characteristics (N = 17)

Athlete	Age, y	Sex	Height, cm	Weight, kg	Dominant Side ^a	Position	Time From Symptoms to Surgery, mo
1	25	Male	206	112	Right	Outside hitter	4
2	26	Female	193	76	Right	Outside hitter	6
3	29	Female	175	63	Right	Outside hitter	16
4	23	Male	215	120	Right	Outside hitter	6
5	28	Male	208	105	Right	Outside hitter	18
6	27	Male	204	97	Right	Outside hitter	12
7	25	Female	185	80	Right	Outside hitter	12
8	29	Male	206	97	Left	Middle blocker	18
9	30	Male	203	90	Left	Outside hitter	24
10	23	Female	168	54	Right	Libero	6
11	25	Male	193	100	Right	Outside hitter	12
12	23	Male	207	100	Right	Middle blocker	6
13	25	Female	186	70	Right	Outside hitter	4
14	31	Male	197	92	Right	Outside hitter	24
15	25	Male	183	76	Right	Outside hitter	6
16	28	Female	182	67	Right	Outside hitter	12
17	24	Male	196	93	Right	Outside hitter	6

^aAll surgeries were on the dominant side.

Statistical Analysis

Statistical analyses were performed using the statistical package STATA Version 13.0 (StataCorp). Shapiro-Wilk test was performed to assess the normality ($P > .05$) of KJOC and VAS distribution. A parametric longitudinal analysis was performed using a t test score (2-tailed, 95% confidence interval) to compare KJOC and VAS scores pre- and postoperatively. Results were reported as P values (statistically significant difference if $P < .05$). Evaluation of KJOC score, VAS score, and isometric strength was treated with a simple statistic method considering the mean value and standard deviation.

RESULTS

Demographic and Physical Characteristics

Of the elite athletes with at least 1 Olympic Games experience in indoor volleyball (15 athletes) and beach volleyball (2 athletes) included in the study, 6 athletes were female and 11 were male. Isolated supraspinatus tendon rupture was diagnosed in all patients on preoperative MRI, including FTRCT in 3 patients and PTRCT in 14 patients. The mean time between the onset of symptoms and surgery was 11.3 ± 6.7 months. All surgeries were on the dominant side (15 on the right shoulder and 2 on the left shoulder). Athlete and injury characteristics are shown in Table 1.

Outcome Data

All patients were able to RTS at the previous level. The mean KJOC was 31 ± 12 preoperatively; this score improved significantly to 89 ± 11 at 6 months postoperatively ($P < .001$ vs preoperatively) and again improved to 96 ± 0.6 at 12 months postoperatively ($P = .003$ vs 6 months).

Preoperatively, the mean VAS was 7.9 ± 1.0 ; this improved to 0.4 ± 0.6 at 6 months postoperatively ($P < .001$ vs preoperatively) and again 0.1 ± 0.5 at 12 months postoperatively ($P = .02$ vs 6 months) (Table 2).

Mean isometric strength values are shown in Table 3. At 6-month follow-up, the IR/ER ratio of the affected/healthy sides was larger than 60% in all patients. At 6 months, 66% of the IR/ER balance was reached in 9 patients, and at 12 months, 66% of the IR/ER balance was reached in 14 patients.

RTS and RTP

All patients were able to RTS at the previous level. The mean time to RTS was 6.9 ± 0.8 months, and the mean training time was 20.5 ± 2.5 h/wk. The mean time to RTP was 12.4 ± 1.9 months (Table 2).

DISCUSSION

The most important finding of the study, if degenerative supraspinatus tendon tears diagnosed in competitive volleyball players do not improve despite appropriate nonoperative treatment, was that surgical treatment can yield excellent clinical results with a high rate of return to play at the same level. All 17 study patients were able to return to their previous level of Olympic-level volleyball despite having tears on their dominant shoulder. In addition, we determined the mean time to RTS as 6.9 months and the mean time to RTP as 12.4 months. Although the durations vary depending on the age of the athlete, degenerative origin, the degree of injury, the timing of the surgery, and the rehabilitation process, the mean RTS and RTP values are important for the athlete's healthy decision-making and future career plan.²⁴ The possible reasons for the successful results of our study are that the tears were mostly partial,

TABLE 2
Clinical Outcome Scores, Return to Sport, and Return to Performance^a

Athlete	VAS Pain			KJOC			RTS, mo	RTP, mo
	Preoperative	6 mo Postoperative	12 mo Postoperative	Preoperative	6 mo Postoperative	12 mo Postoperative		
1	8	1	0	20	85	100	7	12
2	8	1	0	45	80	100	7	11
3	9	2	0	20	70	90	8	14
4	7	0	0	40	80	100	7	15
5	7	0	0	40	90	100	6	10
6	7	1	2	20	70	90	7	10
7	8	0	0	20	80	90	8	12
8	8	0	0	20	90	100	7	12
9	7	0	0	40	100	100	7	12
10	7	0	0	40	100	100	5	14
11	8	0	0	20	100	100	7	13
12	8	0	0	50	100	100	7	13
13	10	0	0	20	100	100	7	10
14	10	0	0	20	80	90	8	16
15	8	0	0	50	100	100	6	11
16	8	1	0	20	90	80	7	15
17	7	0	0	40	100	100	6	11
Mean ± SD	7.9 ± 1.0	0.4 ± 0.6	0.1 ± 0.5	31 ± 12	89 ± 11	96 ± 0.6	6.9 ± 0.8	12.4 ± 1.9

^aKJOC, Kerlan-Jobe Orthopaedic Clinic; RTP, return to performance; RTS, return to sport; VAS, visual analog scale.

TABLE 3
Isometric Strength Values and Ratios

Athlete	Strength at 6 mo Postoperative ^a				Strength at 12 mo Postoperative ^a		Strength Ratio, %		
	IR, Affected	ER, Affected	IR Healthy	ER, Healthy	IR, Affected	ER, Affected	Affected/Healthy, ER, 6 mo	ER/IR, 6 mo	ER/IR, 12 mo
1	258.6	153	270.75	155.00	255	175	100	59	68
2	163.2	133.6	172.80	98.67	175	149	135	82	85
3	150.4	96	133.43	106.83	156	106	91	64	68
4	186.8	140	183.17	147.03	275.8	206	95	75	75
5	300	227.8	237.93	164.83	315	220.9	138	76	70
6	171.9	96.3	186.93	96.90	167.5	121	100	56	72
7	93.2	55	100.97	67.33	95	65	80	59	68
8	200	100	186.73	127.20	205	128	78	50	62
9	212	150	212.47	132.83	240	160	113	71	66
10	74	64	100.17	60.93	126.7	107.9	110	86	86
11	150	110	218.33	120.00	203	152	103	73	75
12	190	150	226.53	147.43	242	176	91	79	72
13	115.6	80	141.97	88.97	140	109	89	70	78
14	228	116	232.00	93.90	219	137.8	123	51	63
15	128	70	125.60	88.57	136	100	79	55	73
16	100.8	55.9	131.27	80.30	116	89	70	56	76
17	150.9	86.9	125.73	115.00	159	102	75	57	64

^aMaximum isometric strength was measured as the mean value in newtons of 3 different angles (−20°, 0°, +20°) for internal rotation (IR) and for external rotation (ER).

most of the athletes were younger than 30 years of age, and professional athletes tend to have a high level of compliance to tailored rehabilitation programs.

Contrary to acute injuries, nonoperative treatment options can be recommended for degenerative rotator cuff

tears.³² The duration of nonoperative treatment in our study athletes, which was approximately 1 year (11.6 months; range, 4-24 months), varied according to time to the Olympic Games, the age, the pain level, and the expectations of the athlete and the club. We observed that

athletes could sacrifice their current season in order not to miss the Olympics.⁴⁰ Conversely, when the Olympics are imminent, athletes may delay a possible surgical treatment decision.³ Our 2 participants who waited the longest from symptom onset to surgery (24 months) were the oldest athletes, ages 30 and 31 years. The athlete with the longest RTP (16 months) was also the only athlete older than 30 years. However, 1 study reported that the return rate of athletes older than 30 years was higher than those younger than 30 years.¹³

The current literature associates arthroscopic repair of PTRCTs with >50% thickness with high-functional outcomes and pain relief, regardless of repair technique.²⁰ Surgery is indicated in patients with PTRCT who have failed nonoperative treatment and have persistent symptoms.⁴¹ The timing of surgical treatment in PTRCTs is debated. Although Kim et al²³ found similar functional results and recurrence rates in their study comparing acute and delayed ARCR in PTRCT, they reported superior functional results in the group deferred to 6 months after nonoperative treatment, which they defined as delayed surgery.

When comparing the results of high-grade PTRCT and FTRCT repair, it has been shown that although clinical and functional results are similar, the retear rates of PTRCT repairs are lower.¹⁹ We consider this heterogeneity as a weakness of our study.

RTP is more complicated after mini-open rotator cuff repair (RCR) in baseball players with FTRCT.²⁷ Although RTP is possible for all position players with nondominant shoulder injuries, it was possible for half of those injured on the dominant side, especially for only 1 of 12 pitchers who all had dominant-side injuries. The results vary not only for the size and repair technique of the tear but also depending on the type of sport, the athlete's position, and the dominant side injury.²⁷ A study of lateral footprint repair noted that although 5 of 6 pitchers returned to the sport, only a few players returned to performance based on the number of hits. In that study, RTS was defined as a return to the preinjury competition level for at least 1 full season, while RTP was evaluated by comparing the number of shots in the past period.

In a systematic review of the results of RCR, approximately 50% RTP was reported in professional overhead athletes.³⁴ As can be seen in the literature, the rates of RTP in ARCR treatment range from 8% to 100%.²⁷ In 1 of the few studies with a similar concept, it took 14 months for patients to regain their daily movements after surgery,²² compared with RTP at a mean of 12.4 months after ARCR in the current study. Kim et al²² defined RTP as reaching 80% of the University of California, Los Angeles Shoulder Rating Scale, whereas we evaluated RTP based on athletes' responses to question 10 on the KJOC questionnaire. Although small, medium, and massive rotator cuff tears were compared in the Kim et al²² study, the results of a more homogeneous group are presented in our study. The fact that our participants were professional athletes who had high compliance with the structured rehabilitation program may have led to a shorter RTP period. In a 2016 meta-analysis, it was reported that almost all recreational athletes returned to sports at the same level after rotator cuff surgery, but this

rate was halved in professional athletes.²⁴ All the athletes in our series were able to return to their preinjury sports level. The fact that instability and superior labrum anterior and posterior lesions were not excluded, acute and chronic lesions were not differentiated, open and mini-open procedures were included, and athletes from all sports branches of all levels were included in the meta-analysis explains the difference. Another meta-analysis² reported that the rate of RTS at the same level in recreational athletes was 71% and 79% in professionals, but that study included patients with labral damage and superior labrum anterior and posterior lesions, unlike the present study.

There is no consensus in the literature for RTS defined by different criteria. However, in most of the relevant studies, "time since surgery" was reported as the only and most valid criterion.⁷ While the concept of RTS is used more homogeneously as "starting competitions," the criteria for RTP, which refers to an RTP at preinjury levels, are also unclear.^{2,7,12,17,24,28} For example, in a study in which ARCR was applied to middle- to advanced-aged swimmers, RTP was expressed as complete and incomplete RTS.³⁹ In a review reporting the results of superior labrum repair performed on overhead athletes, RTP was reported as full and limited RTS.³⁷ Doege et al¹⁴ advocate the necessity of additional definitions such as return to recovery/participation/performance, as we claim in our article, instead of the dual approach of returning to sports or not doing sports for RTS, as in many articles. In addition, the biopsychosocial parameters of RTS are emphasized in the First World Congress in Sports Physical Therapy Consensus statement.⁴

High rates of RTS have been reported in athletes. Unlike recreational athletes, however, the rate of returning to sports at the preinjury level (RTP) is not satisfactory in professional athletes.^{24,36} Some studies have reported that the athlete cannot RTS, cannot return to the same level, and sometimes changes positions.^{2,5,7,17,29,35,37,39} There are wide differences between RTP rates in the literature: Milllett et al²⁹ report 60%, Davey et al¹² 50%, and Young et al⁴⁵ 25%. These differences arise according to the age of the participants, the type of sport, the factors accompanying the injury and the time elapsed since the injury, and whether the sport is played professionally versus recreationally. For this reason, making a direct comparison is impossible even though studies on similar concepts exist.

Even though it has been stated in previous publications that athletes generally do not return to the same activity level after rotator cuff surgery, today it is possible to RTS with total and near-complete activity due to developments in surgical techniques and structured rehabilitation.³⁸ Davey et al¹² reported 85% RTS and 50% RTP after ARCR was applied to athletes who developed acute RCR. Although the sample size and age range were similar, the participants were from collision and noncollision sports injured by heterogeneous mechanisms. All of our participants were competitive volleyball players who were operated on after degenerative processes. The reason for the higher RTS and RTP rates in our study may be that our study group consisted of Olympic-level overhead athletes. In the Davey et al¹² study, where only professional and competitive

athletes were evaluated, the RTS rate approached 90% and showed higher consistency with our study.

Strengths and Limitations

Our study has several limitations and strengths. The main limitation of the study is the small sample size. Unlike acute injuries, the mechanisms of overuse injuries due to repetitive trauma may be different. The coexistence of high-grade PTRCT and FTRCT can be considered heterogeneity. Minor changes in rehabilitation protocols can also potentially change the outcome. Lack of postoperative imaging and interventions by a single surgeon are other limitations.

Some aspects make our study unique. Although the study group seems relatively small, there is no example of our sample of Olympic-level athletes in the literature. The fact that all athletes were diagnosed with an isolated supraspinatus tear without accompanying pathologies formed a homogeneous study group. The follow-up period is adequate, considering the period of nonoperative treatment of the athletes and that it was at least 12 months after surgery. In addition to the VAS and KJOC scales, isometric strength measurements increased the objectivity of the evaluation. A limited number of studies have been published on RTS and RTP in elite athletes.

CONCLUSION

ARCR appears to be an effective option for elite volleyball players who do not benefit from nonoperative treatment. In our study, all participants returned to preinjury level sports with excellent clinical results. When planning the timing of surgery, the mean RTS of 6.9 months and the mean RTP time of 12.4 months can act as useful guides for the surgeon and athlete.

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