Original Article

A High Rate of Return to Running Is Seen After Both Arthroscopic and Open Shoulder Surgery

Joseph W. Galvin, D.O., John M. Slevin, P.A.-C., Matthew J. Nowak, D.O., Henry H. Yu, M.D., Eric K. Turner, M.D., Brian R. Waterman, M.D., Jason A. Grassbaugh, M.D., and Edward D. Arrington, M.D.

Purpose: To determine the percentage of patients who report the ability to run 1 mile at various time points after arthroscopic and open shoulder surgery. **Methods:** We performed a retrospective review of prospectively collected data for all active-duty military patients aged 18 to 45 years who underwent shoulder surgery at a single institution over a 2-year period. The rehabilitation protocol discouraged running before 3 months, but all patients were able to return to unrestricted running at 3 months postoperatively. Patients were excluded if they lacked 1-year follow-up data. Parameters collected included demographic information and validated patient-reported outcome measures at the preoperative and short-term postoperative visits, as well as patients' ability to run at least 1 mile postoperatively. **Results:** A total of 126 patients were identified who underwent shoulder surgery with return-to-running data. Compared with baseline, significant improvements in patient-reported outcomes were shown at 1 and 2 years postoperatively ($P = .001$). The percentage of patients reporting the ability to run 1 mile postoperatively was 59% at 3 months, 74% at 4.5 months, 79% at 6 months, 83% at 12 months, and 91% at 24 months. There was no significant difference in patients undergoing shoulder surgery for instability versus non-instability diagnoses or in patients undergoing open versus arthroscopic anterior stabilization. All 11 patients unable to return to running at final follow-up had chronic lower-extremity diagnoses limiting their running ability. **Conclusions:** Young military athletes undergoing arthroscopic and open shoulder surgery have a high rate of early return to running. Approximately 60% of patients report the ability to run 1 mile at 3 months postoperatively, and three-quarters of patients do so at 4.5 months. Age, sex, military occupation, underlying diagnosis or type of surgery did not influence the rate of return to running after shoulder surgery. **Level of Evidence:** Level IV, therapeutic case series.

Running is a common leisure or recreational activity, but it is also required for many professions such as law enforcement and the military. Furthermore, running is a requisite activity for many team sports, including soccer, baseball, basketball, and football, and is a critical milestone for return-to-sport (RTS) progression pathways after musculoskeletal injury. Although the shoulder joint is not a direct load-bearing joint during running, running imparts loads on the shoulder that require coordinated contraction of the dynamic stabilizers of the glenohumeral joint to maintain concentric reduction of the glenohumeral joint. Although prior studies have reported on return to running after knee and hip surgery,[1,2] little is known regarding return to running after shoulder surgery. Numerous studies have reported on RTS after

From Madigan Army Medical Center, Joint Base Lewis-McChord, Washington, U.S.A. (J.W.G., J.M.S., M.J.N., H.H.Y.); Orthopedic Associates of Muskegon, Muskegon, Michigan, U.S.A. (E.K.T.); Atrium Health Wake Forest Baptist Medical Center, Winston-Salem, North Carolina, U.S.A. (B.R.W.); Franciscan Orthopedic Associates at St. Joseph, Tacoma, Washington, U.S.A. (J.A.G.); and University of Texas Southwestern Medical Center, Dallas, Texas, U.S.A. (E.D.A.).

The authors report the following potential conflicts of interest or sources of funding: B.R.W. receives speaker fees from Arthrex; receives fellowship support from Arthrex and Smith & Nephew; receives consulting fees from DePuy Mitek/Johnson & Johnson and FH Ortho; owns stock options in Vivorte, Kaliber AI, and Sparta Bioscience; is on the scientific advisory board of Vivorte, Kaliber AI, Sparta Bioscience, and Vericel; is Associate Editor of Arthroscopy*; and is on the design team of FH Ortho, outside the submitted work. Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

Received February 13, 2023; accepted June 3, 2023.

Address correspondence to Matthew J. Nowak, D.O., Madigan Army Medical Center, 9040A Jackson Ave, Joint Base Lewis-McChord, WA 98431, U.S.A. E-mail: matthewjnowak@gmail.com

2666-061X/23146

https://doi.org/10.1016/j.asmr.2023.100770

Table 1. Indications and Rehabilitation Protocols for Procedures Performed

Procedure	Indications	Rehabilitation Notes
Arthroscopic anterior and posterior stabilization	Recurrent unidirectional anterior or posterior shoulder instability with no prior surgery and <13.5% anterior-inferior glenoid bone loss and on-track Hill-Sachs lesion	Shoulder immobilizer for 6 wk with early initiation of passive ROM; no active use of shoulder; restricted internal rotation until 3 mo postoperatively for posterior repairs
Open Latarjet procedure	"Critical" (>20%) glenoid bone loss, >13.5% glenoid bone loss with off-track Hill-Sachs lesion, and history of failed arthroscopic Bankart repair with bipolar bone loss	Pendulum exercises immediately, passive ROM at 2 wk postoperatively, active ROM at 4 wk, and strengthening at 8 wk
Shoulder arthroscopy, rotator cuff repair, and open subpectoral biceps tenodesis with or without DCR	Symptomatic SLAP tear, rotator interval pulley lesion, or biceps tenosynovitis with 75%-100% resolution of symptoms with diagnostic injection; rotator cuff repair indicated for failure of nonoperative treatment for 6 wk with concordant examination and imaging	Biceps tenodesis and DCR only: passive ROM starting at 2 wk, active ROM at 6 wk, and strengthening starting at 8 wk; heavy lifting or resisted supination prohibited until 8 wk postoperatively Rotator cuff repair: use of shoulder immobilizer in abduction for 4-6 wk, followed by passive ROM at 6 wk, active ROM at 8 wk, and rotator cuff strengthening at 12 wk

DCR, distal clavicle resection; ROM, range of motion.

arthroscopic and open shoulder surgery with a common timeline of 5 to 6 months. This time to RTS varies based on the surgical procedure performed and is limited by retrospective study designs and the heterogeneity of cohorts with various sport types.[3-8] We focused on postoperative ability to return to running in this study given that running is one of the initial steps in the progression to returning to sports.

There is limited information on successful return to running after shoulder surgery, and this information would be helpful for patient counseling and understanding the speed of recovery after shoulder surgery. Additionally, many contact athletes would find this information valuable because they commonly request to return to running as the first activity in the recovery process to improve their aerobic fitness prior to resuming full sporting activity.

The purpose of this study was to determine the percentage of patients who report the ability to run 1 mile at various time points after arthroscopic and open shoulder surgery. We hypothesized that there would be a high rate of early return to running after arthroscopic and open shoulder surgery with greater than 50% of patients able to return to running by 6 months postoperatively.

Methods

After institutional review board approval was obtained, we performed a retrospective review of prospectively collected data from a single institution. The study included all active-duty military patients, aged 18 to 45 years, who underwent arthroscopic or open shoulder stabilization for symptomatic unidirectional shoulder instability, as well as patients who underwent arthroscopic or open surgery for rotator cuff tears, SLAP lesions, biceps tendinopathy, or acromioclavicular pathology, from October 2019 to August 2021. The surgical procedures were performed by 5 orthopaedic surgeons (J.G., H.Y., E.T., J.G., E.A.) at a single institution—a high-volume center where approximately 350 arthroscopic shoulder procedures are performed per year. All surgeons agreed to perform the same surgical techniques and to follow the same postoperative institutional rehabilitation protocols that allowed unrestricted running at 3 months postoperatively (Table 1). One hundred twenty-six patients were available with completed clinical outcome data and at least 1 year of clinical follow-up.

Data Collection

Demographic data were collected for all patients. The patient-reported outcomes (PROs) collected at the preoperative visit and short-term postoperative visits were the Subjective Shoulder Value (SSV), American Shoulder and Elbow Surgeons (ASES) score, visual analog scale (VAS) pain score, and Western Ontario Shoulder Instability (WOSI) index. Additionally, at clinical visits at 3 months, 4.5 months, 6 months, 1 year, and 2 years postoperatively, patients were asked whether they could run 1 mile on a track or pavement (even terrain).

Statistical Analysis

Descriptive statistics were determined for the study cohort's variables. Univariate analysis was performed for all variables. The Mann-Whitney nonparametric test for unpaired samples was used for continuous variables, whereas the 2-tailed Fisher exact test was used for categorical data. Multivariate logistic regression was used to determine independent variables significantly

Table 2. Procedures Performed in Study Participants

	Data (N = 126)
Surgical procedure performed, n (%)	
Arthroscopic Bankart repair	32 (25)
Arthroscopic posterior labral repair	24 (19)
Open Latarjet procedure	16 (13)
Biceps tenodesis	31 (24)
Biceps tenodesis and DCR	11 (9)
Open DCR	6 (5)
Arthroscopic RCR and BT	6 (5)
Open/arthroscopic, n	22/104
Instability surgery: yes/no, n	72/54

BT, biceps tenodesis; DCR, distal clavicle resection; RCR, rotator cuff repair.

associated with the ability to return to running at 6 months postoperatively. The level of statistical significance was set at a P value of .05. A post hoc power analysis was performed. We used prior literature as a reference on the rate of return to running after orthopaedic surgery and determined that 124 patients would be needed to achieve 80% power, with an α error set at .05. All statistics were performed using readily available online software (EasyMedStat).

Results

One hundred twenty-six patients were included in the final analysis. All 126 patients had 1-year outcome scores and return-to-running data, and 79 patients had 2-year outcome scores and return-to-running data (Table 2). The mean age was 30 years (range, 18-45 years), with a predominantly male cohort (Table 3). The median baseline preoperative PROs were as follows: SSV, 50; VAS pain score, 7; ASES score, 42; and WOSI index, 1,405. Compared with baseline, significant improvements in the SSV, VAS pain score, ASES score, and WOSI index were shown at 1 year postoperatively (SSV, 80; VAS pain score, 2; ASES score, 82; and WOSI index, 300) and 2 years postoperatively (SSV, 82.5; VAS pain score, 2; ASES score, 85; and WOSI index, 456; $P = .001$). The percentage of patients reporting the ability to run 1 mile postoperatively was 59% at 3 months, 74% at 4.5 months, 79% at 6 months, 83% at 12 months, and 91% at 24 months (Fig 1).

On subgroup analysis, there was no difference in the rate and time to return to running between patients who underwent arthroscopic Bankart repair for recurrent anterior shoulder instability (n = 32) and those who underwent the open Latarjet procedure (n = 16). Furthermore, there was no statistically significant difference in the rate and time to resume running at any time point between patients who underwent surgery for a diagnosis of shoulder instability (n = 72) and those who underwent surgery for non-instability diagnoses (n = 54) (Table 4). However, there were trends toward lower return-to-running rates in the group with non-instability diagnoses (63% for non-instability group vs 80% for instability group at 4.5 months, $P = .12$; 71% vs 86% at 6 months, $P = .08$; and 76% vs 89% at 1 year, $P = .09$). On multivariate logistic regression analysis, no variables were significantly associated with the ability to run 1 mile at 6 months postoperatively.

Complications and Reoperations

There were 5 complications in this patient cohort (5 of 126 patients, 4%). Four patients who underwent the open Latarjet procedure had transient sensory neurapraxia (axillary in 3 and musculocutaneous in 1), which completely resolved by 4 weeks postoperatively in all cases. Of the 4 patients who underwent the Latarjet procedure with temporary sensory neurapraxia, 2 returned to running at 3 months; the other 2 patients reported returning at 4.5 months postoperatively. In 1 additional patient who underwent the open Latarjet procedure for greater than 20% glenoid bone loss, coracoid graft lysis occurred without recurrent instability. He returned to running at 3 months postoperatively. He later sustained a traumatic rotator cuff tear after a motor vehicle collision and underwent arthroscopic rotator cuff repair.

Recurrent Instability

Two patients who underwent arthroscopic Bankart repair reported reinjuries with recurrent traumatic subluxation events (2 of 32 patients, 6.3%); they declined to undergo further surgery and subsequently underwent medical separation. Both of these patients returned to running at 4.5 months postoperatively.

All 11 patients who reported the inability to return to running at final follow-up attributed this to chronic lower-extremity problems that limited their ability and desire to run. A total of 22 patients (17%) underwent medical separation from the military for their shoulder diagnoses, with a mean time to medical separation of 9.4 months (range, 4-24 months). Therefore, the return-to-duty (RTD) rate for this cohort was 83% (104 of 126 patients).

Table 3. Demographic Characteristics

Characteristic	Data (N = 126)
Mean age (SD), yr	30 (7.9)
Male/female sex, n	121/5
Laterality of surgery: R/L, n	64/62
Diagnosis, n (%)	
Anterior shoulder instability	48 (38)
Posterior shoulder instability	24 (19)
SLAP tear	12 (10)
Biceps tendinopathy	31 (25)
AC joint arthritis	7 (5)
Rotator cuff tear	4 (3)
Mean follow-up (range), mo	24 (12-34)

AC, acromioclavicular; L, left; R, right; SD, standard deviation.

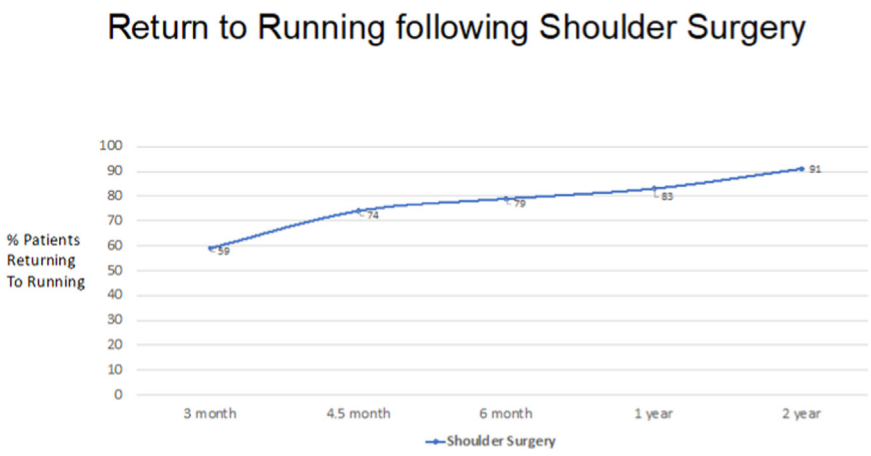

Fig 1. Return-to-running recovery curve.

Discussion

The primary finding of this study is that there is a high rate of return to running after arthroscopic and open shoulder surgery in young patients. Additionally, there are no significant differences in the rate and time to return to running between patients undergoing shoulder surgery for a diagnosis of instability and those undergoing shoulder surgery for non-instability diagnoses or between patients undergoing arthroscopic Bankart repair and those undergoing the open Latarjet procedure. Although we noted a faster return to running in younger patients after instability surgery, patient age did not meet the level of statistical significance. In the active military population, as in the general population, older patients commonly have other lower-extremity diagnoses such as meniscal pathology, hip labral tears, and mild to moderate osteoarthritis that limit their ability to run. Unfortunately, we did not collect data on the ability of all patients to run 1 mile preoperatively or the rate of antecedent lower-extremity symptoms.

Numerous studies have reported on the rate and time to RTS after shoulder surgery, but there is notably limited evidence specifically evaluating the timeline for returning to running. Abdul-Rassoul et al.[4] conducted a meta-analysis of 16 studies to determine the rate and time to RTS after surgery for anterior shoulder instability. They found that there was a consistently high rate of RTS. The time to RTS was 5.9 months after arthroscopic Bankart repair, 8.2 months after open Bankart repair, 5.1 months after the open Latarjet procedure, 5.9 months after the arthroscopic Latarjet procedure, and 7 months after arthroscopic Bankart repair with remplissage. Similarly, Hurley et al.[8] conducted a systematic review of 36 studies including 2,134 patients to determine the rate and time to return to play after the Latarjet procedure. They found that the overall rate of return to play was 88.8%, with 72.6% of patients returning to the same level of play. Additionally, they reported the mean time to return to play was 5.8 months (range, 3.2-8 months). In a military cohort, Cruz et al.[6] reported on 50 active-duty military personnel who had undergone the open Latarjet procedure. They reported a mean time to RTD of 5.3 months. However, in this study, the authors retrospectively asked patients at final follow-up how long after surgery were they able to return to "full-duty status." Limited data are also available on RTS and physical activity after shoulder arthroplasty. In a study of 76 patients undergoing reverse total shoulder arthroplasty, the authors found that the overall time to RTS was 5.3 months, with patients younger than 70 years showing significantly higher RTS rates.[9] Küffer

Table 4. Return to Running After Surgery for Instability Versus Non-instability Diagnoses

	Surgery for Instability (n = 72)	Surgery for Non-instability Diagnoses (n = 54)	*P* Value
Mean age (SD), yr	26 (5)	36 (8)	.001*
Male/female sex, n	70/2	51/3	.65
Able to run 1 mile postoperatively, %			
3 mo	58	61	.95
4.5 mo	80	63	.12
6 mo	86	71	.08
1 yr	89	76	.09
2 yr	95	87	.4

SD, standard deviation.
*Statistically significant.

et al.[10] performed a retrospective review to evaluate RTS after shoulder arthroplasty and found a return rate of 75.5% at 7 months, with no difference between reverse arthroplasty, anatomic arthroplasty, and hemiarthroplasty. Although these studies are valuable, they lack granularity and specific information for patients and coaches on the true process of recovery and time to return to sport-specific tasks such as running.

A number of studies have reported on the rate and time to RTS and RTD after surgical treatment of SLAP tears. Abdul-Rassoul et al.[3] conducted a systematic review of RTS after SLAP tear treatment. They included 15 studies with 195 patients and found that the overall RTS rates were high for SLAP repair (79.5%), SLAP repair with rotator cuff debridement (76.6%), and biceps tenodesis (84.5%). Provencher et al.[11] conducted a well-designed retrospective review of prospectively collected data from 101 active-duty military patients who underwent biceps tenodesis and were available for follow-up. They reported that 82% of patients returned to "full activity" at a mean of 4.1 months. These data are similar to findings reported by Cassidy et al.,[5] who performed a systematic review of 17 studies with 374 cases and identified a mean time to RTS of 5.4 months after biceps tenodesis. The challenge with the use of RTS as an outcome measure is that the data are limited by heterogeneity in the study population with varying sports and competitive levels. Additionally, in the military, the time to RTD is limited by numerous psychosocial factors and limitations inherent to the physical standards required of military personnel.

Although our current physical therapy protocol does not allow patients to return to running until 3 months after surgery, 22% of patients reported that they were able to run 1 mile at 6 weeks postoperatively. The patients consisted of 7 who underwent open biceps tenodesis, 2 who underwent open biceps tenodesis and open distal clavicle resection, 4 who underwent open distal clavicle resection, 4 who underwent the open Latarjet procedure, 5 who underwent arthroscopic Bankart repair, and 6 who underwent arthroscopic posterior labral repair. None of these patients had any complications, and at 2-year follow-up, their median outcome scores were as follows: SSV, 95; ASES score, 93; VAS pain score, 2; and WOSI index, 152. This provides valuable information on the speed of recovery and questions the necessity of institutional rehabilitative protocols that do not allow running until 3 months. Furthermore, the potential for even earlier time points for returning to running may warrant further investigation while balancing the risk of damage to the surgical repair.

The strengths of this study include the meticulous preoperative and postoperative collection of PROs and return-to-running data. Another strength is that our study provides information that may be of assistance to athletes, coaches, employers, and military commanders in better understanding the speed of recovery after arthroscopic and open shoulder surgery.

Limitations

As with any retrospective study, we acknowledge certain limitations of this study. This study may be exposed to recall bias and the inherent weaknesses in RTD self-reporting.[12] Additionally, we did not collect data on patients' preoperative ability to run 1 mile or the reasons patients were not able to run at each postoperative time point. Furthermore, we did not collect the speed at which patients were able to run postoperatively. Moreover, these results are from a specific military patient cohort and may not be generalizable to a civilian cohort. However, this limitation is mitigated by the ubiquity of running in both military and civilian occupations. Finally, the influence of our 3-month institutional rehabilitative restriction on running, as well as the possible impact on patients' responses to questions, is unclear.

Conclusions

Young military athletes undergoing arthroscopic and open shoulder surgery have a high rate of early return to running. Approximately 60% of patients report the ability to run 1 mile at 3 months postoperatively, and three-quarters of patients do so at 4.5 months. Age, sex, military occupation, underlying diagnosis, or type of surgery did not influence the rate of return to running after shoulder surgery.

References

1. Grondin J, Crenn V, Gernigon M, et al. Relevant strength parameters to allow return to running after primary anterior cruciate ligament reconstruction with hamstring tendon autograft. *Int J Environ Res Public Health* 2022;19:8245.
2. Reynolds AW, McGovern RP, Nickel B, Christoforetti JJ. Pre-operative comparisons for a return to running protocol in recreational athletes following hip arthroscopy. *J Hip Preserv Surg* 2020;7:262-271.
3. Abdul-Rassoul H, Defazio M, Curry EJ, Galvin JW, Li X. Return to sport after the surgical treatment of superior labrum anterior to posterior tears: A systematic review. *Orthop J Sports Med* 2019;7:2325967119841892.
4. Abdul-Rassoul H, Galvin JW, Curry EJ, Simon J, Li X. Return to sport after surgical treatment for anterior shoulder instability: A systematic review. *Am J Sports Med* 2019;47:1507-1515.
5. Cassidy JT, Hurley ET, Moore D, Pauzenberger L, Mullett H. The majority of patients return to athletic activity following biceps tenodesis. *Knee Surg Sports Traumatol Arthrosc* 2021;29:216-222.
6. Cruz CA, Sy J, Miles R, Bottoni CR, Min KS. Surgical treatment of anterior shoulder instability with glenoid bone loss with the Latarjet procedure in active-duty military service members. *J Shoulder Elbow Surg* 2022;31:629-633.

7. Dickens JF, Owens BD, Cameron KL, et al. Return to play and recurrent instability after in-season anterior shoulder instability: A prospective multicenter study. *Am J Sports Med* 2014;42:2842-2850.
8. Hurley ET, Montgomery C, Jamal MS, et al. Return to play after the Latarjet procedure for anterior shoulder instability: A systematic review. *Am J Sports Med* 2019;47:3002-3008.
9. Garcia G, Taylor SA, Mahony GT, et al. Patient activity levels after reverse total shoulder arthroplasty: What are patients doing? *Orthop J Sports Med* 2015;3(suppl 2).
10. Küffer J, Taha ME, Hoffmeyer P, Cunningham G. Return to sport after shoulder arthroplasty: A systematic review. *EFORT Open Rev* 2021;6:771-778.
11. Provencher MT, McCormick F, Peebles LA, et al. Outcomes of primary biceps subpectoral tenodesis in an active population: A prospective evaluation of 101 patients. *Arthroscopy* 2019;35:3205-3210.
12. Zalneraitis BH, Drayer NJ, Nowak MJ, et al. Is self-reported return to duty an adequate indicator of return to sport and/or return to function in military patients? *Clin Orthop Relat Res* 2021;479:2411-2418.