Simultaneous Arthroscopic Rotator Cuff Repair and Glenoid Microfracture in Active-Duty Military Patients Younger Than 50 Years

Outcomes at Midterm Follow-up

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Background: While concomitant full-thickness rotator cuff tears and glenoid osteochondral defects are relatively uncommon in younger patients, military patients represent a unique opportunity to study this challenging injury pattern.

Purpose/Hypothesis: To compare the outcomes of young, active-duty military patients who underwent isolated arthroscopic rotator cuff repair (ARCR) with those who underwent ARCR plus concurrent glenoid microfracture (ARCR + Mfx). It was hypothesized that ARCR + Mfx would produce significant improvements in patient-reported outcome measures.

Study Design: Cohort study; Level of evidence, 3.

Methods: This was a retrospective analysis of consecutive active-duty military patients from a single base who underwent ARCR for full-thickness rotator cuff tears between January 2012 and December 2020. All patients were <50 years and had minimum 2-year follow-up data. Patients who underwent ARCR + Mfx were compared with those who underwent isolated ARCR based on the visual analog scale (VAS) for pain, Single Assessment Numeric Evaluation (SANE), American Shoulder and Elbow Surgeons (ASES) shoulder score, and range of motion.

Results: A total of 88 patients met the inclusion criteria for this study: 28 underwent ARCR + Mfx and 60 underwent isolated ARCR. The mean final follow-up was 74.11 ± 33.57 months for the ARCR + Mfx group and 72.87 ± 11.46 months for the ARCR group (P = .80). There were no differences in baseline patient characteristics or preoperative outcome scores between groups. Postoperatively, both groups experienced statistically significant improvements in all outcome scores ($P < .0001$ for all). However, the ARCR + Mfx group had significantly worse VAS pain (1.89 ± 2.22 vs 1.03 ± 1.70; P = .05), SANE (85.46 ± 12.99 vs 91.93 ± 12.26; P = .03), and ASES (86.25 ± 14.14 vs 92.85 ± 12.57; P = .03) scores. At the final follow-up, 20 (71.43%) patients in the ARCR + Mfx group and 53 (88.33%) patients in the ARCR group were able to remain on unrestricted active-duty military service (P = .05).

Conclusion: Concomitant ARCR + Mfx led to statistically and clinically significant improvements in patient-reported outcome measures at the midterm follow-up. However, patients who underwent ARCR + Mfx had significantly worse outcomes and were less likely to return to active-duty military service than those who underwent isolated ARCR. The study findings suggest that ARCR + Mfx may be a reasonable option for young, active patients who are not candidates for arthroplasty.

Keywords: glenoid osteochondral defect; microfracture; military; rotator cuff repair

While concurrent rotator cuff tears and glenohumeral osteoarthritis commonly occur in elderly patients,[14,21] this injury pattern is less frequently observed in young patient populations. However, military patients represent a unique

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opportunity to study this challenging pathology. Members of the United States military are known to experience a disproportionately high incidence of shoulder injuries, likely attributable to the physical demands of many active-duty careers.[1,3,17,23,37] While the exact incidences of full-thickness rotator cuff tears and symptomatic glenoid chondral defects in military populations have not been described, several studies have suggested that these pathologies may occur more often in soldiers because of their close association with traumatic shoulder injuries.[11,30,31]

Management of concomitant rotator cuff and glenoid articular cartilage defects in young, active patients remains challenging, with little existing literature available to guide surgeons. A study by Hill et al[14] reported modest improvements in postoperative pain and functional scores at a short-term follow-up after combined arthroscopic rotator cuff repair (ARCR) and glenohumeral microfracture, albeit in a cohort with a mean age of 64 years. Several studies have reported on the repair of acute rotator cuff tears in young populations. Scanaliato et al[30] found statistically and clinically significant improvements in outcome scores and pain after ARCR at long-term follow-up in military patients <40 years. Similarly, favorable outcomes have been demonstrated after ARCR in young civilian cohorts.[2,6,18,20,24] Regarding symptomatic chondral lesions, shoulder arthroplasty remains the gold standard for the management of painful osteoarthritis in elderly populations. However, arthroplasty has been associated with high rates of persistent limitation and subsequent medical discharge from active-duty service in young military patients.[19] Microfracture is one of the most commonly used joint-preserving modalities for the operative management of isolated glenoid defects in young patients.[7,8,13,16,32] While other therapeutic options exist, such as autologous chondrocyte implantation, they require significant preoperative planning and currently lack adequate evidence to support their use for glenoid osteochondral lesions.

The purpose of this study was to evaluate outcomes after ARCR + Mfx in active-duty military patients <50 years. Additionally, we sought to compare outcomes with those after isolated ARCR. We hypothesized that combined ARCR + Mfx would produce significant improvements in patient-reported outcome measures; however, with inferior outcomes when compared with isolated ARCR in patients without concomitant chondral defects.

METHODS

This was a retrospective analysis of all military patients <50 years from a single base who underwent ARCR with or without microfracture between January 2012 and December 2020 with the senior surgeon (N.P.). Institutional review board approval was obtained before commencing the study, and written informed consent was obtained from all participants.

Patient Population

Active-duty military patients aged between 18 and 50 years who underwent ARCR for full-thickness tears with a minimum of 2-year follow-up met the inclusion criteria. Patients with a history of shoulder surgery, those who underwent concomitant capsulolabral repair, and those with osteochondral defects of the humeral head were excluded from this study. Patients with partial-thickness rotator cuff tears were not eligible for inclusion. All patients in the microfracture cohort were found to have Outerbridge grade 4 chondral lesions contained to the inferior glenoid during diagnostic arthroscopy. Patients with partial thickness chondral lesions (Outerbridge grades 1-3) were excluded from this study. All patients were referred to our clinic after having failed a minimum of 3 months of conservative treatment, including anti-inflammatory medications, physical therapy, and home exercise. All patients underwent 1.5-T magnetic resonance arthrogram evaluation before surgery.

From this cohort of eligible patients, we then identified all patients who had undergone simultaneous ARCR + Mfx (ARCR + Mfx group) versus isolated ARCR (ARCR group).

Surgical Procedure

The senior surgeon's technique did not change significantly during the study period. After the administration of general anesthesia and a presurgical interscalene block, all patients were positioned in a modified beach-chair position, and an examination under anesthesia was conducted. A Spider hydraulic arm holder (Smith & Nephew) was then used to stabilize the operative shoulder, and the patient was draped appropriately. A complete diagnostic

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Ethical approval for this study was obtained from Carson-Carthage (no. 2023-01).

arthroscopy was performed, and any concomitant intra-articular pathology was addressed at this stage.

For patients undergoing microfracture of isolated glenoid chondral lesions, slight traction was then applied to the humeral head to aid with access to the inferior aspect of the glenohumeral joint, and the loose cartilage margins surrounding the chondral defect were debrided with an arthroscopic shaver, arthroscopic biter, or ring curette. A ring curette was then utilized to create vertical walls around the defect, and the calcified cartilage was debrided, taking care to not penetrate the subchondral bone. A microfracture awl was then used to pierce the subchondral bone to a depth of approximately 3 to 4 mm, spacing the holes 3 to 4 mm apart. Arthroscope inflow was then stopped, and appropriate fill of the defect with bone marrow elements was confirmed.

A limited subacromial bursectomy was then performed to evaluate the bursal side of the rotator cuff and the greater tuberosity and edge of the rotator cuff tendon tear were prepared. A single-row repair technique was used for small tears (<1 cm), and a double-row repair was utilized for all medium or large tears (>1 cm).

Postoperative Rehabilitation

All patients attended physical therapy at the same military physical therapy group, and the rehabilitation protocol did not vary between study groups. Patients were instructed to begin pendulum shoulder exercises after the resolution of their interscalene block. Patients were immobilized in neutral rotation in a SmartSling (Ossur) for 4 weeks. At 4 weeks postoperatively, immobilization was discontinued, and passive forward flexion was begun. Active range of motion and a gradual strengthening program were started 6 weeks postoperatively, and patients were allowed to return to unrestricted activity at 6 months.

Data Collection

Patient characteristics, including age, laterality, sex, and military occupational specialty (MOS), were collected routinely during clinic visits. Preoperative imaging and operative reports were reviewed to determine procedures performed and concomitant pathology. Tear size was determined using the classification of the Southern California Orthopaedic Institute.[35] Preoperative and 2-year postoperative evaluations included the visual analog scale (VAS) for pain, the American Shoulder and Elbow Surgeons (ASES) shoulder score, the Single Assessment Numeric Evaluation (SANE), and range of motion. Return to active duty, complications, and revision procedures were collected as part of the postoperative follow-up.

Statistical Analysis

Statistical analysis was performed using SPSS Statistics, Version 25.0 (IBM). Continuous data were described by a combination of mean, standard deviation, range, and 95% CI. A paired t test was used to compare the differences between the pre- and postoperative results. Chi-square and Fisher exact tests were used to compare categorical variables between groups. The Pearson correlation coefficient was used to assess the linear relationship between variables. Statistical significance was set at $P < .05$.

Patients who met the minimal clinically important difference (MCID), substantial clinical benefit (SCB), and Patient Acceptable Symptom State (PASS) after ARCR were compared. Previously published values[5,36] for the VAS, SANE, and ASES were used ([MCID: VAS, 2.4 points; SANE, 16.9 points; ASES, 11.1 points]; [SCB: SANE, 29.8 points; ASES, 17.5 points]; [PASS: SANE, 82.5; ASES 86.7]).

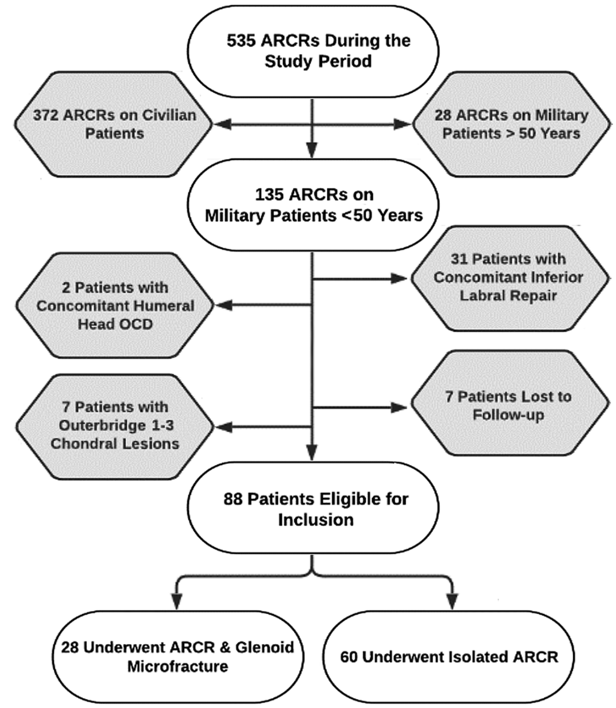

Figure 1. Flowchart for patient selection. ARCR, arthroscopic rotator cuff repair.

RESULTS

During the study period, the senior surgeon performed 535 ARCR. A total of 372 repairs were on nonmilitary patients and 28 were on military patients >50 years, leaving 135 ARCRs on military patients <50 years eligible for further inclusion. Also, 31 patients had concomitant anteroinferior labral repair, 2 patients had coexisting full-thickness humeral head osteochondral defects, 7 patients had partial thickness chondral lesions, and 7 patients were lost to follow-up. Of the 88 patients eligible for inclusion, 28 patients underwent concomitant Mfx, and 60 had isolated ARCR (Figure 1). The final follow-up for all patients was completed in December 2022 through either in-person clinic or telehealth appointments.

TABLE 1
Comparison of Patient and Injury Characteristics Between the Study Groups[a]

Characteristic	ARCR + Mfx (n = 28)	ARCR (n = 60)	*P*
Age, y	42.54 ± 5.71	42.28 ± 7	.8681
Follow-up, mo	74.11 ± 33.57	72.87 ± 11.46	.7976
Male sex	25 (89.29)	50 (83.34)	.4636
Tobacco use	8 (28.57)	16 (26.67)	.8518
Combat arms[b]	21 (75)	43 (71.66)	.7437
Dominant shoulder affected	16 (57.14)	39 (65)	.4782
Right shoulder	15 (53.57)	35 (58.33)	.6745
Preoperative evaluation			
VAS pain	8.21 ± 1.52	8.35 ± 1.57	.9897
SANE	43.75 ± 19.70	44.20 ± 19.52	.9202
ASES	42.93 ± 11.30	42.37 ± 15.63	.8656
Forward flexion	151.43 ± 14.52	154.25 ± 6.23	.2044
External rotation	59.89 ± 13.67	65.58 ± 8.03	**.0163**
Internal rotation	T 10.29 ± 2.40	T 10.17 ± 2.90	.8494
Tear size[c]			
C1 and C2	18 (64.29)	37 (61.67)	.8131
C3 and C4	10 (35.71)	23 (38.33)	.8131

[a]Data are reported as mean ± SD or n (%) unless otherwise indicated. The bold *P* value indicates a statistically significant difference between groups ($P < .05$). ASES, American Shoulder and Elbow Surgeons; SANE, Single Assessment Numeric Evaluation; T, t-spine level; VAS, visual analog scale.

[b]Defined as nonadministrative/nonsupport infantry, artillery, and/or military police.

[c]Based on Southern California Orthopaedic Institute classification: C1, small complete tear (pinhole sized); C2, moderate tear (<2 cm) of only 1 tendon without retraction; C3, large complete tear with an entire tendon with minimal retraction usually 3-4 cm; C4, massive rotator cuff tear involving ≥2 tendons with associated retraction and scarring of the remaining tendon.[35]

The mean patient age at the time of surgery was 42.54 ± 5.71 years in the ARCR + Mfx group and 42.28 ± 7 years in the ARCR group (*P* = .87). The mean final follow-up was 74.11 ± 33.57 months for the ARCR + Mfx group and 72.87 ± 11.46 months for the ARCR group (*P* = .80). The majority of patients in both groups were men (89.29% vs 83.34%; *P* = .46). There were no differences between groups in patient characteristics; injury characteristics; or preoperative VAS pain, SANE, or ASES scores (Table 1). The ARCR + Mfx group had significantly worse external rotation preoperatively (59.89 ± 13.67 vs 65.58 ± 8.03; *P* = .02). No difference in the distribution of tear size was observed between groups. In the ARCR + Mfx cohort, 2 (7.14%) patients had C1 tears, 16 (57.14%) had C2 tears, 5 (17.86%) had C3 tears, and 5 (17.86%) had C4 tears (Table 1). Similarly, 3 (5%) of ARCR patients had C1 tears, 34 (56.67%) had C2 tears, 9 (15%) had C3 tears, and 14 (23.33%) had C4 tears. The mean glenoid osteochondral defect size in the ARCR + Mfx group was 158 ± 140.60 mm^2 (10-400 mm^2) (Figure 2).

There were no group differences in concomitant procedures. Two (7.14%) patients in the ARCR + Mfx group and 6 (10%) patients in the ARCR group underwent arthroscopic distal clavicle resection (*P* = .66). Seventeen (60.17%) patients in the ARCR + Mfx group and 40 (66.67%) patients in the ARCR group had concomitant arthroscopic biceps tenotomy or tenodesis (*P* = .59).

Both the ARCR + Mfx and ARCR groups experienced statistically significant improvements in all outcome scores postoperatively ($P < .0001$ for all) (Table 2). The postoperative range of motion did not change significantly in either group. When comparing postoperative outcomes between groups, patients in the ARCR + Mfx group were found to have significantly worse VAS pain, SANE, and ASES scores compared with those in the ARCR group (*P* = .049, .026, and .03, respectively) (Table 3). Additionally, the ARCR + Mfx group had more limited postoperative external rotation versus the ARCR group (*P* = .0495).

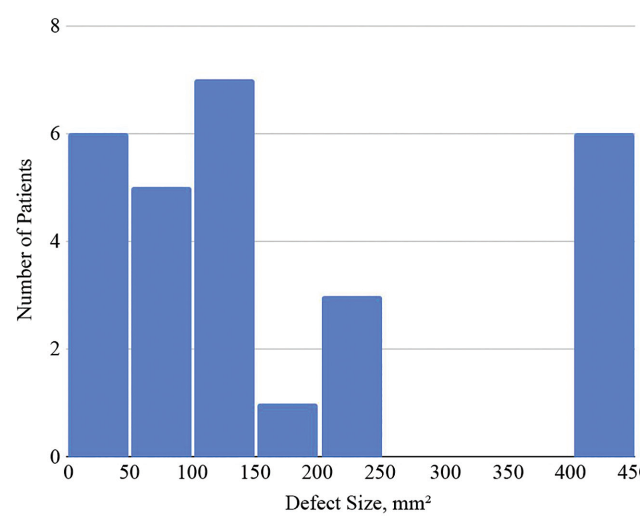

Figure 2. Distribution of osteochondral defect size.

TABLE 2
Comparison of Pre- Versus Postoperative Outcomes Within Study Groups[a]

	ARCR + Mfx (n = 28)			ARCR (n = 60)		
Outcome	Preoperative	Postoperative	*P*	Preoperative	Postoperative	*P*
VAS pain	8.21 ± 1.52	1.89 ± 2.22	**.0001**	8.35 ± 1.57	1.03 ± 1.70	**.0001**
SANE	43.75 ± 19.70	85.46 ± 12.99	**.0001**	44.20 ± 19.52	91.93 ± 12.26	**.0001**
ASES	42.93 ± 11.30	86.25 ± 14.14	**.0001**	42.37 ± 15.63	92.85 ± 12.57	**.0001**
Forward flexion	151.43 ± 14.52	154.64 ± 9.90	.3438	154.25 ± 6.23	155.42 ± 8.94	.3706
External rotation	59.89 ± 13.67	61.18 ± 8.19	.5494	65.58 ± 8.03	65.92 ± 11.26	.8575
Internal rotation	T 10.29 ± 2.40	T 10.82 ± 2	.2286	T 10.17 ± 2.90	T 9.87 ± 3.21	.4821

[a]Data are reported as mean ± SD or n (%). Bold *P* values indicate a statistically significant difference between pre- and postoperative values ($P < .05$). ASES, American Shoulder and Elbow Surgeons; SANE, Single Assessment Numeric Evaluation; T, t-spine level; VAS, visual analog scale.

TABLE 3
Comparison of Outcomes and Complications Between Groups[a]

	ARCR + Mfx (n = 28)	ARCR (n = 60)	*P*
Outcomes			
VAS pain	1.89 ± 2.22	1.03 ± 1.70	**.0487**
SANE	85.46 ± 12.99	91.93 ± 12.26	**.0262**
ASES	86.25 ± 14.14	92.85 ± 12.57	**.0302**
Forward flexion	154.64 ± 9.90	155.42 ± 8.94	.7135
External rotation	61.18 ± 8.19	65.92 ± 11.26	**.0495**
Internal rotation	T 10.82 ± 2	T 9.87 ± 3.21	.1539
Complications			
Retear/nonhealing	3 (10.71)	3 (5)	.3219
Stiffness	1 (3.57)	1 (1.67)	.5765
Total complications	4 (14.29)	4 (6.67)	.2487
Return to Active-Duty	20 (71.43)	53 (88.33)	**.0495**

[a]Data are reported as mean ± SD or n (%). Bold *P* values indicate statistically significant differences between groups ($P < .05$). ASES, American Shoulder and Elbow Surgeons; SANE, Single Assessment Numeric Evaluation; T, t-spine level; VAS, visual analog scale.

No significant correlations were observed between chondral defect size and postoperative VAS pain ($r = 0.0056$; $P = .9775$), SANE ($r = -0.3499$; $P = .0680$), or ASES ($r = -0.0628$; $P = .7509$). Similarly, no significant differences were observed in postoperative outcome scores between patients assigned to a combat arms MOS and those who were not combat arms.

With regard to complications, 3 patients in each group had a nonhealing repair or retear ($P = .32$), and 1 patient in each cohort had postoperative stiffness requiring arthroscopic capsular release ($P = .58$). Twenty (71.43%) microfracture patients and 53 (88.33%) ARCR patients had returned to unrestricted active-duty military service at the final follow up ($P = .05$) (Table 3).

Most patients in both groups met the MCID for the VAS pain, SANE, and ASES and the SCB for the SANE and ASES. The proportion of ARCR + Mfx patients who met the PASS for the SANE and ASES was significantly lower compared with the ARCR group (SANE: 53.57% vs 90%; $P = .0001$; ASES: 57.14% vs 86.67%; $P = .0021$) (Table 4).

DISCUSSION

In our cohort of 28 active-duty military patients, concomitant ARCR + Mfx were found to produce clinically and statistically significant improvements in patient-reported outcome measures at the midterm follow-up. However, patients in the ARCR + Mfx cohort had significantly worse postoperative outcome scores when compared with patients who underwent isolated ARCR. At the end of the study period, 71% of patients in the ARCR + Mfx group had returned to active-duty military service compared with 88% in the ARCR cohort.

Although relatively uncommon in young civilian populations, the coincidence of glenoid cartilage defects in older patients found incidentally during routine ARCR has been reported to be as high as 28%.[14,21] Strenuous activities required as a part of routine military training (eg, pushups and bench press) place repetitive stress on the glenohumeral joint and are known to predispose soldiers to a variety of shoulder injuries.[1,9-11,17,23,25,28-30,37] Additionally, male

TABLE 4
Comparison of Patients Meeting the MCID, SCB, and PASS Between Groups[a]

	ARCR + Mfx (n = 28)	ARCR (n = 60)	*P*
VAS pain			
MCID	28 (100)	59 (98.33)	>.9999
SANE			
MCID	25 (89.29)	57 (95)	.3777
SCB	22 (78.57)	48 (80)	.8770
PASS	15 (53.57)	54 (90)	**.0001**
ASES			
MCID	28 (100)	59 (98.33)	>.9999
SCB	27 (96.43)	57 (95)	>.9999
PASS	16 (57.14)	52 (86.67)	**.0021**

[a]Data are presented as n (%). Bold *P* values indicate statistically significant differences between groups ($P < .05$). ASES, American Shoulder and Elbow Surgeons; MCID, minimal clinically important difference; PASS, patient acceptable symptomatic state; SANE, Single Assessment Numeric Evaluation; SCB, substantial clinical benefit; VAS, visual analog scale.

sex and acute chronic injuries are associated with rotator cuff tears in young patients.[33] While no studies have described the incidence of coexisting rotator cuff tears and glenoid chondral defects in military populations, it is reasonable to presume that the high physical demands of military training as well as the presence of multiple risk factors may increase the concurrent incidence of these pathologies among these patients. Furthermore, the cartilage overlying the glenoid fossa is known to be relatively thin.[38] It therefore follows that change in the native humeral station or loss of the force couple, as observed in rotator cuff lesions, may contribute to the rapid progression of glenoid chondral injuries.[12,26] Of the 128 military patients with full-thickness rotator cuff tears screened for inclusion in this study, 23.4% were found to have Outerbridge grade 4 lesions of the inferior glenoid, suggesting that isolated chondral defects may not be uncommon in young active patients with rotator cuff lesions.

We are not aware of any previously published studies reporting on combined ARCR + Mfx in young populations. A single study by Hill et al[14] reported on a cohort of patients >50 years who underwent ARCR with concomitant microfracture and found modest improvements in pain and functional scores at a short-term follow-up. Regarding outcomes after isolated ARCR, multiple studies have reported on the repair of traumatic rotator cuff tears in young patient populations. Scanaliato et al[30] noted statistically and clinically significant improvements in outcome scores and pain after ARCR at a long-term follow-up in a cohort of military patients <40 years. Similarly, Burns and Snyder[2] found that ARCR in patients <50 years consistently produced good to excellent results regardless of tear size. Published outcome data after operative management of isolated glenoid defects, however, is less encouraging. While Frank et al[8] demonstrated a return to preoperative activity level of 88% in a cohort of 16 patients at a midterm follow-up, longer-term studies have reported high clinical failure rates and suggested that over 20% of patients will convert to arthroplasty after glenoid microfracture.[22,27,34] However, isolated glenoid microfracture was shown to improve shoulder pain and function in a group of military patients with 75% survivorship at 5 years, although 35% of patients were unable to remain on active-duty service.[31] Furthermore, Green et al[11] found that combined microfracture and glenoid stabilization in a military cohort produced modest, albeit statistically significant, improvements in patient-reported outcome measures with no patients progressing to further surgery at midterm.

These findings align with the results of the present study and suggest that while symptomatic glenoid chondral defects are a challenging pathology to manage, concomitant microfracture during ARCR may be an appropriate treatment option for young, highly active patients. Although our isolated ARCR cohort demonstrated better outcomes, 71% of patients in the ARCR + Mfx group had maintained active-duty military service at a mean of 6-year follow-up. Additionally, the proportion of patients in each group who met clinical significance thresholds did not vary significantly, except for significantly more patients in the isolated ARCR group meeting the PASS for the SANE and ASES.

The results of this study are of particular interest given the theoretical risk of rotator cuff repair to increase compressive forces across the glenohumeral joint. It has been postulated that ARCR in patients with degenerative changes may lead to increased pain and progression of osteoarthritis.[14] However, there also exists evidence to suggest that rotator cuff pathology may contribute to the progression of glenohumeral osteoarthritis, leaving surgeons without a clear consensus regarding the best management of patients with coexisting pathology.[4,15] While our sample size was limited, all patients in our ARCR + Mfx cohort met the MCID for VAS pain, indicating that ARCR in the setting of focal chondral damage led to clinically meaningful improvements in pain at the short-term follow-up. Additionally, no patients in the ARCR + Mfx group had progressed to further surgery at the conclusion of the study period, and only 14% experienced a postoperative complication. These results contrast with findings after shoulder arthroplasty in military patients. In their cohort of young military patients, Kusnezov et al[19] found that 46.2% of patients reported short-term complications and 23.1% required reoperation after shoulder arthroplasty. While further studies are needed to fully elucidate the ideal treatment of coexisting rotator cuff and glenoid chondral lesions in young, active patients, our findings indicate that combined ARCR + Mfx may offer statistically and clinically significant improvements in pain and function with lower rates of complications and reoperation when compared with shoulder arthroplasty in this population.

Limitations

Our study was not without its limitations. The observational design and limited sample size both represent potential sources of bias in our investigation. Additionally, our study population was comprised of primarily male active-duty patients, potentially limiting the generalizability of our results to within military populations. Additionally, the high demands required of our cohort may have resulted in lower outcome scores than might be observed in patients with less physically demanding lines of work. With regard to microfracture outcomes, follow-up imaging was not performed, and therefore, our ability to evaluate the extent of fibrocartilage formation at the site of the osteochondral defect was limited. Furthermore, we did not include patients with full-thickness chondral lesions who underwent only ARCR, or treatment of the defect with another technique, and therefore, we are unable to fully determine the extent to which concomitant microfracture contributed to functional outcomes. Last, the MCID, PASS, and SCB values used in this study have not been previously defined for combined ARCR and microfracture; therefore, values previously established for ARCR were used.[5,36]

CONCLUSION

Concomitant ARCR + Mfx lead to statistically and clinically significant improvements in patient-reported outcome measures at midterm follow-up. However, microfracture patients had significantly worse outcomes and were less likely to return to active-duty military service than those who underwent isolated ARCR. The findings of this study suggest that combined ARCR + Mfx may be a reasonable option for young, active patients who are not candidates for arthroplasty.

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