Original Article

Arthritis Severity and Medical Comorbidities Are Prognostic of Worse Outcomes Following Arthroscopic Rotator Cuff Repair in Patients With Concomitant Glenohumeral Osteoarthritis

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Purpose: To assess demographic factors, comorbidities, radiographic variables, and injury patterns as potential prognostic indicators of poor functional and patient-reported outcomes following arthroscopic rotator cuff repair in patients with concomitant glenohumeral osteoarthritis. **Methods:** A retrospective review of consecutive patients with glenohumeral osteoarthritis who underwent arthroscopic supraspinatus repairs between 2013 and 2018 with a minimum of 1-year follow up was performed. Demographic variables included age, tobacco use, alcohol use, diabetes, sex, hypercholesterolemia, and body mass index while injury patterns included partial- versus full-thickness tear, bicep tendon involvement, and osteoarthritis severity. Multivariate linear regression was used to identify independent predictors of visual analog pain scale (VAS), subjective shoulder value (SSV), and American Shoulder and Elbow Surgeons (ASES) score as well as active range of motion (ROM) in forward flexion (FF) and external rotation (ER). Binary logistic regression was used to identify predictors of repair failure as well as postoperative strength in FF and ER. **Results:** In total, 91 patients (mean age 61.48 ± 9.4 years) were identified with an average follow up of 26.3 ± 5.7 months. Repair failures occurred in 9.9% (9/91 patients) of the total cohort. Postoperative outcomes were significantly improved with regards to visual analog pain scale, subjective shoulder value, ASES score, ROM in FF, FF strength, and external rotation strength compared with preoperative baseline. Obesity ($P = .023$) and diabetes ($P = .010$) were significant independent predictors of greater pain scores postoperatively. Obesity ($P = .029$) and tobacco use ($P = .007$) were significant predictors of lower ASES scores postoperatively. Finally, moderate-to-severe osteoarthritis was a significant risk factor for poor ROM and strength in FF postoperatively compared to mild osteoarthritis ($P = .029$). No variables were predictive of repair failure. **Conclusions:** Tobacco use, obesity, and diabetes are associated with worse pain and patient-reported outcomes following arthroscopic rotator cuff repair in the context of glenohumeral OA. In addition, moderate-to-severe OA is associated with worse strength and forward flexion compared to those with mild OA. **Level of Evidence:** Level III, retrospective cohort study.

Glenohumeral osteoarthritis (OA) is a common degenerative pathology,[1-4] affecting 16.1% to 20.1% of adults older than the age of 65 years.[3,5-7] As such, it is often seen clinically as a comorbidity in patients who present with rotator cuff pathology.[8] Studies have shown that anywhere between 23% and 76% of patients with rotator cuff tears also have glenohumeral OA.[9-11]

Management of rotator cuff tears in patients with concomitant glenohumeral OA varies and is still debated. Treatment may be dependent on the degree of shoulder OA and the size of the rotator cuff tear. For

those with mild OA and partial rotator cuff tears, treatment often is initiated with conservative management, including physical therapy and steroid injections.[12] For those with severe OA and larger rotator cuff tears, reverse or anatomic total shoulder arthroplasty has been shown to have favorable outcomes.[12-14] However, recent studies have demonstrated good-to-excellent outcomes following arthroscopic rotator cuff repair in the setting of glenohumeral OA.[12,15,16] Studies comparing rotator cuff repair (RCR) in patients with glenohumeral OA with those without have shown no difference in repair failure rates.[17−19] In addition, one study found no differences in range of motion (ROM), strength, or patient-reported outcomes between the 2 groups,[18] whereas others found slightly lower postoperative ROM among patients with glenohumeral OA.[17,19]

Few studies, however, have evaluated the subset of patients in this population who would benefit most from RCR. Risk factors for poor outcomes of RCR in patients presenting with concomitant glenohumeral OA have not been established. Identifying the risk factors for poor outcomes may promote optimal patient selection and would allow for more informative pre- and postoperative patient counseling.

The purpose of this study was to assess demographic factors, comorbidities, radiographic variables, and injury patterns as potential prognostic indicators of poor functional and patient-reported outcomes (PROs) following arthroscopic RCR in patients with concomitant glenohumeral OA. We hypothesized that tobacco use, obesity, diabetes, and increased severity of OA would be predictive of diminished patient-reported/functional outcomes and repair failure.

Methods

Study Design and Patient Collection

This was a retrospective cohort study that reviewed electronic medical records of patients with glenohumeral OA who underwent a primary RCR performed by 2 fellowship-trained orthopaedic sports medicine surgeons from 2013 to 2018. Institutional review board approval was obtained at the University of Pittsburgh for this retrospective chart review, STUDY20030061. A waiver of consent was granted by the institutional review board at the University of Pittsburgh. Inclusion criteria were patients older than 30 years of age with concomitant glenohumeral OA and supraspinatus tear (both partial- and full-thickness tears as well as with concomitant infraspinatus/subscapularis tears), who underwent primary arthroscopic surgical repair and had a minimum of 1-year postoperative follow-up data. Exclusion criteria included previous RCR, open RCR, previous infection of symptomatic shoulder, and insufficient follow-up data. The patient outcomes

reported in this study are from the same cohort as one used in a previously published study by Reddy et al.[19]

Demographic Variables and Injury Patterns

Baseline demographic variables of age, body mass index (BMI), and sex were recorded, along with several comorbidities, including diabetes, hypercholesterolemia, alcohol use, and tobacco use. Age was analyzed as a continuous variable whereas obesity (BMI >30), sex, diabetes, alcohol/tobacco use, and hypercholesterolemia were analyzed as nominal bimodal variables.

Injury characteristics including partial- versus full-thickness tear, tear size, Goutallier classification, bicep tendon involvement, and severity of OA (mild vs moderate-to-severe) were also collected based on preoperative imaging and corroborated by intraoperative assessment. All high-grade partial-thickness tears (defined as >50% tearing of the footprint confirmed on intraoperative assessment) were completed to full tears and then repaired.

Severity of OA was classified by a musculoskeletal radiologist using radiographic parameters according to the Samilson-Prieto classification modified by Gerber,[20,21] which classifies arthrosis into 4 grades (normal, mild, moderate, and severe) based on size of humeral/glenoid exostosis and joint narrowing. Moderate and severe OA were combined into one category because those with moderate-to-severe OA could potentially be candidates for shoulder arthroplasty whereas patients with mild OA would be more likely to be managed with more conservative or joint-preserving options. Arthroscopic RCR was pursued in these patients because they were felt to have symptoms consistent with primary rotator cuff pathology but also had background OA noted on imaging, which was either asymptomatic or causing mild mechanical pain.

Outcomes

Primary outcomes included PROs of subjective shoulder value (SSV), visual analog pain scale (VAS), and American Shoulder and Elbow Surgeons (ASES) score; active (ROM) outcomes in forward flexion (FF) and external rotation (ER); as well as strength outcomes in FF and ER.

The secondary outcome was failure of repair, defined as a symptomatic retear confirmed on postoperative magnetic resonance imaging (MRI). Postoperative MRI, however, was not standard protocol for all patients in the study but rather for those with suspected symptomatic failure. These patients returned to clinic postoperatively complaining of recurring pain and were subsequently found to have imaging confirming retear.

All preoperative primary outcomes were determined at the last clinic visit before surgery and all postoperative primary outcomes were determined at the

12-month or final follow-up clinic visit postoperatively. Shoulder ROM and strength was assessed at 12 months' postoperatively.

FF and ER ROM were measured in their respective planes and strength testing was conducted with manual muscle grading from 0 to 5 based on previously validated methodology, with a 5 representing maintained muscle activation against examiner's full resistance, a 4 representing muscle activation against examiner's partial resistance, and a 3 representing muscle activation only against gravity or with no examiner resistance.[22] FF strength was tested with the patient in a standing position with the shoulder flexed to 90° in the scapular abduction plane. ER strength was tested with the elbow in 90° of flexion and the shoulder in a neutral position.

A follow-up period of 1 year was used because multiple studies have shown that most RCR outcomes achieve the minimal clinically important difference (MCID) at 6 months postoperatively, with a much lower proportion achieving the MCID at 1 year.[23,24] The MCID for VAS ranges from 1.5 the 2.4, whereas the MCID for ASES ranges from 11.1 the 27.1.[25-27] Although the MCID for SSV following RCR is unknown, a value of 26.6 can be extrapolated from other pathologies.[28,29] Regarding functional outcomes, ER is also typically regained within 1 year and FF is often restored by 3 months for small tears and 6 months for medium to large tears.[30] Furthermore, a vast majority of repair failures occur within 6 months of surgery.[31]

Postoperative Rehabilitation Protocol

Postoperative rehabilitation was standardized for all patients. All patients were fitted with a sling for 4 weeks postoperatively. Physical therapy was initiated at 2 weeks postoperatively starting with passive ROM exercises, including passive FF, passive ER, and pendulums as tolerated. Active ROM exercises as well as active-assisted exercises were gradually initiated at 6 weeks postoperatively as tolerated. Finally, shoulder-strengthening exercises were introduced starting at 12 weeks.

Statistical Analysis

Univariate analyses were conducted using either independent samples t test, χ^2 analysis, Mann–Whitney U test, or Fisher exact test. Multivariate linear regression modeling was used to identify risk factors for poor outcomes regarding VAS, SSV, and ASES score as well as active ROM in FF, ER, and internal rotation. Binary logistic regression analysis was used to identify predictors of operative failure following RCR as well as postoperative strength in FF, ER, and internal rotation.

Independent variables included in the regression analyses were demographic characteristics of age, tobacco use, alcohol use, diabetes, sex, hypercholesterolemia, and obesity (BMI ≥30 vs BMI <30); and injury

Table 1. Demographic Data for Study Cohort

Demographic Variable	GH Arthritis (n = 91)
Age, y	61.48 ± 9.4
BMI	30.9 ± 4.6
Sex (male)	46 (50.5%)
Diabetes	14 (15.4%)
Tobacco use	14 (15.4%)
Alcohol use	43 (47.3%)
Hypercholesterolemia	28 (30.8%)
Average follow-up, mo	26.3 ± 5.7

NOTE. Data are reported as n (%) unless otherwise specified.
BMI, body mass index; GH, glenohumeral.

characteristics of tear size (partial vs full-thickness tear), bicep tendon involvement, and severity of OA (mild vs moderate-to-severe) characterized by the Samilson-Prieto classification. Significance level was set to $P < .05$.

A power analysis was performed. Given the cohort sample size, this study was able to achieve 89% power to detect an effect size of 0.5 with an alpha is 0.05 using a multiple linear regression analysis for VAS.

Results

Patient Demographics and Comorbidities

A total of 232 patients who underwent primary arthroscopic RCR of a supraspinatus tear were reviewed, of whom 112 had concomitant glenohumeral OA. Of these 112 patients, 19 were excluded due to insufficient follow-up and 2 were excluded as they were revision repairs. The remaining 91 patients had 1-year follow up and met the remaining inclusion criteria to be included in the analysis. The resulting cohort had an average age of 61.48 ± 9.4 years and an average follow-up of 26.3 ± 5.7 months from initial surgery date. Of the 91 patients, 46 were male (50.5%), 14 used tobacco products (15.4%), 43 consumed alcohol (47.3%), 14 were diabetic (15.4%), and 28 (30.8%) had hypercholesterolemia. Average BMI was 30.9 ± 4.6, with 40.7% classified as having obesity (BMI ≥30). The demographic variables are detailed in Table 1.

Injury Patterns

Of the 91 patients, 57 patients experienced a full-thickness tear of the supraspinatus (62.6%), whereas 34 patients had partial-thickness tears of the supraspinatus (37.4%) with an overall mean tear size of 15.5 mm. The Goutallier classification of the supraspinatus tendons was as follows: 45% grade 0, 13.2% grade 1, 19.8% grade 2, 5.5% grade 3, 5.5% grade 4, and 11% unspecified. Goutallier classification were similar between patients with and without obesity (grade 0: 49.0% vs 53.3%; grade 1: 17.6% vs 10.0%; grade 2: 19.6% vs 26.7%; grade 3: 5.9% vs 6.7%: and grade 4: 7.8% vs 3.3%; $P = .758$). Based on the Samilson–Prieto classification radiologically,

Table 2. Injury Patterns and Treatment Variables for Study Cohort

Clinical Variable	GH Arthritis (n = 91)
Single-row repair	17/79 (21.5%)
Double-row repair	62/79 (78.5%)
Partial thickness	34 (37.4%)
Full thickness	57 (62.6%)
Mild OA	70 (76.9%)
Moderate-to-severe OA	21 (23.1%)
Tear size, mm (range)	15.5 (6-45)
Nonpathologic biceps	33/88 (37.5%)
Goutallier classification	
Grade 0	41(45.0%)
Grade 1	12 (13.2%)
Grade 2	18 (19.8%)
Grade 3	5 (5.5%)
Grade 4	5 (5.5%)
Unspecified	10 (11.0%)
Biceps procedures	
None	47/91 (51.6%)
Arthroscopic tenodesis	17/91 (18.7%)
Open tenodesis	9/91 (9.9%)
Tenotomy	18/91 (19.8%)

GH, glenohumeral; OA, osteoarthritis.

70 patients had mild OA (76.9%), whereas 21 had moderate-to-severe OA (23.1%). Finally, 63.5% of the patients had concomitant bicep tendon pathology as well. Injury and repair patterns are shown in Table 2.

Preoperative Baseline

Preoperative PROs were as follows: VAS of 7.2 ± 1.9, SSV of $54 \pm 22\%$, and ASES of 52 ± 25. Preoperatively, patients had a mean FF ROM of $146 \pm 35°$ and ER ROM of $47 \pm 13°$. In addition, only 22.5% and 44.9% of patients had 5/5 strength preoperatively in FF and ER, respectively. Preoperative baselines are outlined in Table 3.

Patient-Reported Outcomes

Postoperative VAS was 1.8 ± 2.8, significantly decreased compared with preoperative VAS by an average of 5.4 points ($P < .001$). MCID for VAS was achieved in 74.7% (68/91 patients) postoperatively. Postoperative ASES was 58 ± 23, significantly increased compared with preoperative ASES by an average of 6 points ($P = .048$). MCID for ASES was achieved in 60.6% (20/33 patients). Finally, postoperative SSV was $83 \pm 18\%$, a significant increase from preoperative baseline by 29% ($P < .001$) (Table 3). MCID for SSV was achieved in 69.2% (63/91 patients).

Obesity ($\beta = 1.59$, $P = .023$) and diabetes ($\beta = 1.46$, $P = .010$) were found to be predictive of increased postoperative VAS pain scores (Table 4). Obesity ($\beta = -24.48$, $P = .029$) and tobacco use ($\beta = -50.16$, $P = .007$) were predictive of lower ASES scores

Table 3. Comparison Between Outcomes Preoperatively Versus Postoperatively After Rotator Cuff Repair in Patients With Glenohumeral Osteoarthritis

Outcome	Preoperative (n = 91)	Postoperative (n = 91)	P Value
Repair failure, %	NA	9.9	NA
VAS	7.2 ± 1.9	1.8 ± 2.8	**<.001**
		74.7% achieving MCID	
SSV, %	54 ± 22	83 ± 18	**<.001**
		69.2% achieving MCID	
ASES	52 ± 25 (n = 33)	58 ± 23	**.048**
		60.6% achieving MCID (n = 33)	
ROM FF, °	146 ± 35	154 ± 21	**.012**
ROM ER, °	47 ± 13	47 ± 12	.737
ROM IR (level), %			
T1-T12	71.4	83.1	
L1-L5	22.6	14.3	**.000**
Sacrum	6.0	2.6	
Strength FF (MMT, %)			
≤3/5	2.2	0.0	**.000**
4/5	65.3	17.8	
5/5	22.5	82.2	
Strength ER (MMT, %)			
≤3/5	1.2	0.0	**.000**
4/5	53.9	14.4	
5/5	44.9	85.6	
Strength IR (MMT, %)			
≤3/5	0	0	**.003**
4/5	26.4	5.7	
5/5	73.6	94.3	

NOTE. Significance set at P value < .05 (bold).

ASES, American Shoulder and Elbow Surgeons score; ER, external rotation; FF, forward flexion; GH, glenohumeral; IR, internal rotation; L, lumbar; MMT, manual muscle test; NA, not available; ROM, range of motion; SSV, subjective shoulder value; T, thoracic; VAS, visual analog scale.

Table 4. Summary of Multivariate Linear Regression for Patient-Reported Outcomes by Demographic and Injury Patterns

	Coefficient (β)	95% CI (β)	*P* Value
VAS (n = 91)			
Age	0.020	−0.058 to 0.097	.615
Obesity (BMI ≥30)	1.593	0.225 to 2.961	**.023**
Female sex	0.914	−0.415 to 2.244	.174
Tobacco use	1.455	−0.824 to 3.734	.206
Alcohol use	−0.133	−1.494 to 1.227	.845
Diabetes	2.967	0.751 to 5.183	**.010**
Hypercholesterolemia	0.215	−1.456 to 1.886	.797
Partial-thickness tear (as opposed to full-thickness tear)	0.095	−1.341 to 1.531	.895
Concomitant bicep tendon pathology	−0.376	−1.757 to 1.005	.588
Moderate-to-severe OA (as opposed to mild OA)	0.165	−1.340 to 1.669	.827
ASES (n = 33)			
Age	−0.032	−1.180 to 1.116	0.954
Obesity (BMI ≥30)	−24.478	−46.250 to −2.706	**.029**
Female sex	12.175	−10.107 to 34.457	.268
Tobacco use	−50.155	−84.757 to − 15.552	**.007**
Alcohol use	3.026	−17.048 to 23.099	.756
Diabetes	−23.973	−51.860 to 3.914	.088
Hypercholesterolemia	−5.425	−32.991 to 22.144	.686
Partial-thickness tear (as opposed to full-thickness tear)	−6.943	−31.220 to 17.334	.557
Concomitant bicep tendon pathology	−3.232	−15.914 to 22.377	.728
Moderate to severe OA (as opposed to mild OA)	−17.000	−38.417 to 4.417	.113
SSV (n = 91)			
Age	−0.109	−0.707 to 0.489	.716
Obesity (BMI ≥30)	−1.705	−12.147 to 8.737	.745
Female sex	−4.300	−14.576 to 5.977	.405
Tobacco use	−4.033	−21.116 to 13.051	.638
Alcohol use	4.292	−5.852 to 14.437	.400
Diabetes	6.702	−9.531 to 22.936	.411
Hypercholesterolemia	−5.246	−17.886 to 7.395	.409
Partial-thickness tear (as opposed to full-thickness tear)	−0.803	−11.303 to 9.698	.879
Concomitant bicep tendon pathology	−5.848	−16.525 to 4.829	.277
Moderate-to-severe OA (as opposed to mild OA)	−7.397	−18.945 to 4.188	.206

NOTE. Significance set at P value < .05 (bold).

ASES, American Shoulder and Elbow Surgeons score; BMI, body mass index; OA, osteoarthritis; SSV, subjective shoulder value; VAS, visual analog scale.

postoperatively (Table 4). No demographic variables or injury patterns were predictive of SSVs (Table 4).

ROM Outcomes

Average postoperative FF ROM was 154 ± 21°, whereas ER ROM was 47 ± 12°. Postoperative FF ROM was significantly improved from preoperative baseline by 8 degrees (*P* = .012), but postoperative ER ROM was not significantly improved (*P* = .737) (Table 3). Demographic variables were not predictive of decreased ROM in FF or ER (Table 5). Injury patterns were not prognostic indicators for ER ROM (Table 5). However, compared with mild OA, moderate-to-severe OA was predictive of lower ROM in FF (β = −12.4, *P* = .029) (Table 5).

Strength Outcomes

In postoperative strength testing, 82% of patients had 5/5 FF strength and 86% had 5/5 ER strength, both significantly improved from 22.5% and 44.9%, respectively (*P* < .001 for both) (Table 3). No

demographic variables or injury patterns were predictive of strength outcomes in ER (Table 6). However, compared with mild OA, patients with moderate-to-severe OA were less likely to have full strength in FF (odds ratio 0.226; 95% confidence interval 0.059-0.868; *P* = .03) (Table 6).

Repair Failure Outcomes

Symptomatic repair failure occurred in 9.9% (9/91 patients) of the total cohort at the minimum of 1-year follow up (Table 3). Failure occurred at similar rates in patients with partial-thickness and full-thickness tears, at 8.8% (3/34 patients) and 10.5% (6/57 patients), respectively. No demographic variables or injury patterns were prognostic indicators of repair failure (Table 7).

Discussion

Overall, we found that certain risk factors in the OA population may predict greater pain scores, worse ASES

Table 5. Summary of Multivariate Linear Regression for Range of Motion by demographic and Injury Patterns

	Coefficient (β)	95% CI (β)	P Value
Forward flexion (n = 91)			
Age	−0.091	−0.647 to 0.464	.744
Obesity (BMI ≥30)	3.125	−6.767 to 13.017	.531
Female sex	0.293	−9.075 to 9.660	.951
Tobacco use	−8.541	−22.500 to 5.417	.227
Alcohol use	0.896	−8.773 to 10.565	.854
Diabetes	−6.632	−22.170 to 8.906	.398
Hypercholesterolemia	3.173	−9.590 to 15.936	.622
Partial-thickness tear (as opposed to full-thickness tear)	0.532	−9.464 to 10.529	.916
Concomitant bicep tendon pathology	0.495	−9.335 to 10.325	.920
Moderate-to-severe OA (as opposed to mild OA)	−12.423	−23.483 to −1.363	**.028**
External rotation (n = 91)			
Age	57.336	−0.461 to 0.186	.401
Obesity (BMI ≥30)	0.431	−5.163 to 6.025	.878
Female sex	−0.251	−5.556 to 5.055	.925
Tobacco use	−3.449	−11.412 to 4.515	.391
Alcohol use	3.604	−1.883 to 9.090	.195
Diabetes	2.880	−5.900 to 11.661	.515
Hypercholesterolemia	−6.054	−13.272 to 1.164	.099
Partial-thickness tear (as opposed to full-thickness tear)	0.130	−5.567 to 5.827	.964
Concomitant bicep tendon pathology	−1.106	−6.699 to 4.487	.695
Moderate-to-severe OA (as opposed to mild OA)	−1.449	−7.796 to 4.899	.878

NOTE. Significance set at P value < .05 (bold).

BMI, body mass index; OA, osteoarthritis.

scores, and diminished ROM/strength outcomes postoperatively. Obesity and diabetes were significant predictors of greater pain scores postoperatively. In addition, obesity and tobacco use were significant predictors of lower ASES scores postoperatively. Finally, moderate-to-severe OA was a significant risk factor for decreased ROM and strength in FF postoperatively compared with mild OA. No risk factors were predictive of SSV, ROM/strength in ER, and symptomatic repair failure.

It is important to note that the suboptimal outcomes in patients with severe OA as opposed to mild OA were

Table 6. Odds of Full (5/5) Postoperative Strength in Forward Flexion and External Rotation by Demographic and Injury Patterns

Forward Flexion (n = 91)	Odds of 5/5 Strength in **Forward Flexion**	95% CI	P Value
Age	0.990	0.916 -1.070	.806
Obesity (BMI ≥30)	2.682	0.609-11.808	.192
Female sex	0.785	0.205-3.003	.055
Tobacco use	0.342	0.065-1.810	.207
Alcohol use	1.466	0.409-5.253	.557
Diabetes	0.939	0.127-6.721	.939
Hypercholesterolemia	1.215	0.208-7.087	.829
Partial-thickness tear (as opposed to full-thickness tear)	4.235	0.815-22.000	.086
Concomitant bicep tendon pathology	1.354	0.349-5.253	.661
Moderate-to-severe OA (as opposed to mild OA)	0.226	0.059-0.868	**.030**
External Rotation (n = 91)	Odds of 5/5 Strength in External Rotation	95% CI	P Value
Age	1.011	0.935-1.093	.784
Obesity (BMI ≥30)	1.120	0.265-4.731	.877
Female sex	0.678	0.174-2.635	.574
Tobacco use	0.217	0.043-1.105	.066
Alcohol use	0.842	0.225-3.155	.799
Diabetes	1.055	0.148-7.523	.957
Hypercholesterolemia	0.564	0.095-3.347	.528
Partial-thickness tear (as opposed to full-thickness tear)	2.733	0.567-13.159	.210
Concomitant bicep tendon pathology	0.842	0.207-3.431	.810
Moderate-to-severe OA (as opposed to mild OA)	0.325	0.082-1.282	.109

NOTE. Significance set at P value < .05 (bold).

BMI, body mass index; CI, confidence interval; OA, osteoarthritis.

Table 7. Odds of Repair Failure by Demographic and Injury Patterns

Variable (n = 91)	Odds Ratio of Repair Failure	95% CI	*P* Value
Age	1.020	0.921-1.130	.702
Obesity (BMI ≥30)	0.867	0.714-1.052	.148
Female sex	5.749	0.962-34.376	.055
Tobacco use	2.559	0.290-22.580	.398
Alcohol use	2.028	0.390-10.550	.400
Diabetes	2.920	0.388-21.961	.298
Hypercholesterolemia	1.244	0.233-11.884	.445
Partial-thickness tear (as opposed to full-thickness tear)	0.403	0.059-2.762	.355
Concomitant bicep tendon pathology	0.214	0.039-1.161	.074
Moderate-to-severe OA (as opposed to mild OA)	0.191	0.018-1.993	.166

BMI, body mass index; CI, confidence interval; OA, osteoarthritis.

related to objective functional outcomes (FF strength and ROM) rather than subjective PROs. This may indicate that patients with severe OA may expect similar satisfaction and subjective results, regardless of their relative functional deficits postoperatively. Worse pain and ASES scores, however, were associated with other lifestyle factors and comorbidities including obesity, tobacco use, and diabetes. Furthermore, other injury characteristics besides OA severity, including tear thickness and concomitant bicep pathology, did not seem to affect outcomes. Regardless of risk factors, however, the results of this study indicate that RCR remains an excellent treatment option in patients with concomitant glenohumeral OA. All postoperative PROs, ROMs, and strength outcomes improved significantly from their preoperative baselines except for ER ROM.

The risk factors for poor RCR outcomes in patients with glenohumeral OA are not well understood. Previous studies, however, have assessed prognostic factors for RCR in the general population.[32] This study found that obesity (defined as BMI ≥30) was a predictor of greater pain scores and decreased ASES scores postoperatively in patients with glenohumeral OA. Obesity has been associated with fatty degeneration of the rotator cuff and has been proposed as an explanation for worse outcomes in this population.[33] However, in this study, there was no significant difference in the supraspinatus Goutallier classifications between obese and non-obese patients. While comparative studies, including Warrender et al.[34] and Kessler et al.[35] have shown worse repair outcomes in patients with obesity, retrospective review studies with multivariate analyses have failed to identify obesity as an independent risk factor for poor outcomes.[36,37]

We found that tobacco use was an independent predictor of decreased ASES scores postoperatively in patients with glenohumeral OA. Although the evidence in the general population remains conflicting,[38] a study by Naimark et al.[39] of 126 RCRs using regression analysis also revealed worse improvement in ASES scores among smokers. This may be due to nicotine's potent vasoconstrictive effects which may decrease oxygen delivery to soft tissues and negatively affect healing.[40]

We found diabetes to be associated with increased VAS pain scores postoperatively in patients with glenohumeral OA. This is consistent with the literature in the general population, as Sayegh et al.[41] and Berglund et al.[42] both demonstrated that patients with diabetes mellitus undergoing arthroscopic RCR experienced more pain and had poorer ASES scores at 6 and 12 months. These findings have been attributed to significantly reduced collagen fiber cross-linking and fibrocartilage formation in the setting of hyperglycemia.[43]

Finally, we found severity of OA to be a negative prognostic factor for postoperative strength and ROM during FF in patients with glenohumeral OA. Patients with severe glenohumeral OA, when treated surgically, are often treated with shoulder arthroplasty. As such, most of the literature regarding RCR in patients with glenohumeral OA involves cases with mild OA.[17,18] However, a previous comparative study with this same patient cohort found that RCR may be a successful treatment with outcomes comparable with those without OA, and may still be a viable treatment option in patients with moderate-to-severe glenohumeral OA but with decreased strength and ROM outcomes compared with mild OA.[19]

Limitations

This study is not without limitations. First, as a retrospective cohort study, the sample size is limited by the inclusion criteria. The limited sample size may be a reason that this study found no significant predictors of repair failure, as there were only 9 repair failures. Second, retear outcomes were measured based on symptomatic failure confirmed on MRI. As MRI was not standard for all patients, asymptomatic retears may have been missed. Third, this study included supraspinatus tears with concomitant infraspinatus/subscapularis tears, which may serve as a confounder for functional ROM and strength outcomes. Finally, this study may contain selection bias, as some patients in

the initial cohort were excluded due to lack of 1-year follow up. Those lost to follow-up may have had better outcomes than those who continued to follow up at 1 year.

Conclusions

Tobacco use, obesity, and diabetes are associated with worse pain and PROs following arthroscopic RCR in the context of glenohumeral OA. In addition, moderate-to-severe OA is associated with worse strength and FF compared with those with mild OA.

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