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Comorbidity effect on speed of recovery after arthroscopic rotator cuff repair

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Background: Comorbidities have been shown to affect rotator cuff healing and postoperative outcomes. The purpose of this study was to analyze the effect of comorbidities on speed of recovery (SOR) and overall outcomes after arthroscopic rotator cuff repair (RCR).
Methods: We identified 627 patients who underwent primary arthroscopic RCR from 2006 to 2015. Measured motion and patient-reported outcome measures for pain and function were analyzed for preoperative, 3-month, 6-month, and 1-year intervals. Subgroup analysis of overall outcome and plateau in maximum improvement was performed for diabetes, smoking, obesity, hypercholesterolemia, and age.
Results: Diabetic patients had worse pain (visual analog scale for pain) and functional outcome (American Shoulder and Elbow Surgeons function, Simple Shoulder Test, visual analog scale for function, and elevation) scores at 6 months and 1 year ($P < .05$), with an earlier plateau in recovery (6 months) for nearly all variables. Smoking had no impact on postoperative outcome scores; however, plateaus occurred earlier in smokers (6 months). Obese patients had worse American Shoulder and Elbow Surgeons function score and external rotation at 1 year ($P < .05$) with similar plateau points. No significant differences were observed in outcomes for patients with hypercholesterolemia; however, plateaus for Single Assessment Numeric Evaluation and motion occurred earlier (6 months). Outcome scores for patients older than 65 years were not significantly different from those for younger patients.
Conclusion: After arthroscopic RCR, SOR for pain outpaced that for function and motion. Diabetic patients had worse outcomes and earlier plateau points. Earlier plateaus were seen for smokers and for motion in patients with obesity or hypercholesterolemia. Obese patients showed lower functional scores and external rotation. Age did not significantly influence SOR.

Advancements in arthroscopic surgical techniques for rotator cuff repair (RCR) have led to decreased complication rates with equivalent functional outcomes compared with mini-open techniques, and biomechanical performance has been shown to be improved.[11] An abundance of evidence exists regarding 2-year outcomes after RCR, but little is known about what patients can expect during the recovery process. Our institution recently examined the speed of recovery (SOR) after arthroscopic RCR, and recovery of pain, function, and range of motion (ROM) was shown to plateau at 1 year.[17] This previous work focused on the overall SOR and examined the impact of tear size and retraction.

Various comorbidities have been shown to be associated with rotator cuff tear occurrence[1,4,14,24,25] and to affect rotator cuff tear size, degree of rotator cuff healing, and tear recurrence.[2,4-6,12,14,15,27] Rotator cuff healing has been associated with maximal postoperative restoration of motion and function in RCR patients,[16] and smaller tear size has been associated with a faster SOR.[17] The effect of comorbidities and body mass index (BMI) on SOR in RCR patients is largely unknown. It has previously been suggested that the number of comorbidities should not preclude a patient from undergoing RCR.[26] However, a better understanding of how comorbidities affect the SOR would be helpful in counseling patients about postoperative expectations. It may also prove useful in guiding a physician's

This study was granted an Institutional Review Board exemption determination (Protocol No. 2016-010-EX) before initiation of this research. This study was designed as a retrospective review and analysis of data collected from a Western Institutional Review Board (WIRB)–approved Levy Elbow and Shoulder Surgical Repository (WIRB Study No. 1138999, WIRB Protocol No. 20130731).

All work was performed at the Holy Cross Orthopedic Institute and Holy Cross Hospital.

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decision to operate on the basis of a patient's ability to cope with prolonged recovery periods that may be associated with certain comorbidities.

The purpose of this study was to analyze the effect of comorbidities including diabetes, smoking, obesity, hypercholesterolemia, and age on the SOR and overall outcomes after RCR. Given the volume of data required to analyze numerous comorbidities and patient-reported outcome measures (PROMs), it was thought necessary to perform a separate study focusing on comorbidities using the same cohort of patients previously examined.[17] This would allow a more concentrated analysis of the impact of comorbidities on both the SOR and overall outcomes. We hypothesized that the presence of any of the studied comorbidities will result in a slower SOR and worse overall outcomes.

Materials and methods

A retrospective analysis of data collected for patients undergoing primary arthroscopic RCR included in our institution's shoulder and elbow surgery registry between November 2006 and December 2015 was performed using the same cohort of patients previously described.[17] As part of the standard registry protocol, BMI and the presence of comorbidities are noted preoperatively, which was the focus of this study. PROMs and shoulder motion (forward elevation [FE] and external rotation [ER]) assessments by best-effort goniometer measurements are collected preoperatively and at 3 months, 6 months, and 1 year and subsequent annual intervals postoperatively. PROMs included in this study were visual analog scale (VAS) scores for pain and function, American Shoulder and Elbow Surgeons (ASES) function score, Simple Shoulder Test (SST) score, and Single Assessment Numeric Evaluation (SANE) score. Subgroup analysis was performed on the basis of the presence or absence of the following preoperative comorbidities: diabetes mellitus, smoking, obesity, hypercholesterolemia, and older age. Obesity was defined as having a BMI ≥30 kg/m^2. Patients were stratified into 2 age groups—older than 65 years and younger than 65 years.

All patients undergoing an arthroscopic primary repair of a full-thickness rotator cuff tear were included. Patients undergoing a partial or revision RCR were excluded. For each outcome variable, only those patients with minimum 6-month follow-up data were included in the analysis. Missing data were replaced using specific time point group means.

The senior author (J.C.L.) performed all operations arthroscopically in a beach chair position using the surgical technique previously described.[17] Postoperatively, all patients were maintained in a shoulder immobilizer for 6 weeks, with rehabilitation protocols determined on the basis of the tear size and not the presence of comorbidities. Patients with small tears were started in a physical therapist–directed protocol that allowed early active assisted and passive motion. Patients with larger tears were placed in a self-directed home program for the first 3 months that called for pendulum exercises only for the first 6 weeks followed by active assisted stretching exercises for the subsequent 6 weeks. No strengthening exercises were prescribed for the first 3 months for all patients.

Plateau in maximal improvement

Using methodology previously described,[19] the plateau in maximal improvement was defined as the follow-up point at which no subsequent statistically significant improvement was observed compared with the immediately preceding follow-up interval. Using the VAS function column in Table I as an example, diabetic patients improved their mean scores from 4.2 preoperatively to 6.4 at 3 months, 7.1 at 6 months, and 7.3 at 1 year postoperatively. However, the improvement from 6 months to 1 year was not

Table I
Comparison of outcomes at various time points in recovery and the speed of recovery and plateau in maximal improvement for each outcome in patients with or without diabetes

	Diabetes		ASES function	SST	SANE	VAS function	VAS pain	FE	ER
Outcomes	Preoperative	Nondiabetic	23.1	5.1	46	4.6	5.5	133.4	49.6
		Diabetic	19.4	3.9	43.1	4.2	6	118	44.2
		P value	***.036****	***.026****	.45	.201	.163	***.005****	***.025****
	3 months	Nondiabetic	30.1	7.2	67.5	6.7	2.5	137.5	43.7
		Diabetic	27.4	6.2	64.9	6.4	3.4	135.2	42.5
		P value	.05	***.045****	.502	.3	***.028****	.579	.599
	6 months	Nondiabetic	38.2	9.3	78.9	7.8	1.9	151.8	49.9
		Diabetic	35.4	8.1	71.9	7.1	2.9	144.5	50.3
		P value	***.037****	***.01****	.58	***.032****	***.008****	***.03****	.852
	1 year	Nondiabetic	41.7	10.1	83	8.5	1.5	157.2	52.1
		Diabetic	39.3	8	73.1	7.3	2.6	142.4	45.5
		P value	***.015****	***.022****	.106	***.038****	***.017****	***.003****	.157
Speed of recovery	No diabetes	3 months	38%	42%	58%	54%	75%	17%	†
		6 months	81%	84%	89%	82%	90%	77%	12%
		1 year	100%	100%	100%	100%	100%	100%	100%
	Diabetes	3 months	40%	55%	73%	71%	76%	65%	†
		6 months	80%	100%	96%	94%	91%	100%	100%
		1 year	100%	98%	100%	100%	100%	92%	21%
Plateau		6 months		Diabetes	Diabetes	Diabetes	Diabetes	Diabetes	Diabetes
		1 year	Diabetes and no diabetes	No diabetes	No diabetes	No diabetes	No diabetes	No diabetes	No diabetes

ASES, American Shoulder and Elbow Surgeons; *SST*, Simple Shoulder Test; *SANE*, Single Assessment Numeric Evaluation; *VAS*, visual analog scale; *FE*, forward elevation; *ER*, external rotation.

* Significant difference.

† ER decreased compared with preoperative value and thus is excluded.