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Preoperative thrombocytopenia and thrombocytosis predict complications after arthroscopic rotator cuff repair

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Background: The purpose of this study was to investigate the association between preoperative platelet count and 30-day postoperative complications following arthroscopic rotator cuff repair (aRCR).

Methods: The American College of Surgeons National Surgical Quality Improvement database was queried for all patients who underwent aRCR between 2015 and 2021. The study population was divided into 5 groups based on preoperative platelet count: normal (200-450k, reference cohort), low-normal (150-200k), mild thrombocytopenia (100-150k), moderate-to-severe thrombocytopenia (<100k), and thrombocytosis (>450k). Thirty-day postoperative complications following aRCR were collected. Multivariate logistic regression analysis was conducted to investigate the relationship between preoperative platelet counts and postoperative complications.

Results: 24,779 patients were included in this study: 18,697 (75.5%) in the normal group, 4730 (19.1%) in the low-normal group, 1012 (4.1%) in the mild thrombocytopenia group, 171 (0.7%) in the moderate-to-severe thrombocytopenia group, and 169 (0.7%) in the thrombocytosis group. Low-normal platelets were an independent predictor of urinary tract infection (odds ratio [OR] 2.06, 95% confidence interval [CI] 1.12-3.77; $P = .020$). Mild thrombocytopenia was not an independent predictor of any complications. Moderate-to-severe thrombocytopenia was an independent predictor of sepsis (OR 9.39, 95% CI 1.48-59.47; $P = .017$), pneumonia (OR 6.62, 95% CI 1.32-33.24; $P = .022$), and nonhome discharge (OR 3.34, 95% CI 1.20-9.25; $P = .021$). Thrombocytosis was an independent predictor of urinary tract infection (OR 4.91, 95% CI 1.16-20.78; $P = .030$).

Conclusion: Abnormal preoperative platelet counts, both low and high, were independent risk factors for 30-day postoperative complications following aRCR.

Arthroscopic rotator cuff repair (aRCR), an orthopedic procedure to repair rotator cuff tears, has rapidly increased in incidence in the United States over the past decades.[4,5] Rapidly growing surgical volume of aRCR necessitates a better understanding of the risk factors in order to minimize complications. Previous studies contributing to the risk stratification of aRCR have investigated demographic factors, smoking, chronic opioid use, and comorbidities as risk factors that predict adverse postoperative events following aRCR.[6,9,10,21]

Typically, preoperative evaluation includes routine laboratory testing which consists of complete blood counts, coagulation studies, and metabolic panels. Preoperative lab tests provide valuable information for physicians to risk stratify their patients. Several studies have highlighted the utility of preoperative labs, such as vitamin D levels, complete blood count, hemoglobin A1C, glucose, thyroid stimulating hormone, T4, and albumin, in predicting adverse postoperative outcomes following aRCR.[2,8,17,18]

One particular lab value of interest as a predictor of outcomes following aRCR is preoperative platelet count because of the role of intraoperative platelet administration during aRCR. Platelet-rich plasma has a role in augmenting aRCR procedures intraoperatively and has demonstrated efficacy in reducing pain and improving postoperative functional outcome of the shoulder.[1,12,20] Preoperative platelet counts have previously been studied as a tool for risk stratification for other orthopedic surgeries. In the

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setting of total knee, hip, and shoulder arthroplasties, abnormal preoperative platelet counts have been found to be associated with higher rates of adverse 30-day postoperative events.[11,14,15] However, no such studies exist in the context of aRCR.

The objective of this study was to investigate the association between preoperative platelet counts and 30-day postoperative complication rates in patients who underwent aRCR. We hypothesize that abnormal platelet counts predict higher postoperative complication rates.

Methods

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database was queried for all patients who underwent aRCR between 2015 and 2021. The NSQIP database is a fully deidentified database to track outcomes in surgery. Therefore, this study was exempt from approval by our university's institutional review board. Data in the NSQIP database are obtained from over 600 hospitals in the United States and are collected by trained surgical clinical reviewers.

Current Procedural Terminology code 29827 was used to identify 47,601 patients who underwent aRCR from 2015 to 2021 in both inpatient and outpatient surgery centers. Patients with missing preoperative platelet count were excluded, leaving 25,213 patients. Further exclusion criteria included patients younger than 18 years of age, had disseminated cancer at the time of surgery, and were missing variables from the following: height, weight, functional status, American Society of Anesthesiologists (ASA) classification, and discharge destination. The remaining study population of 24,779 (Fig. 1) was then indexed into 5 cohorts based on their preoperative platelet count: moderate-to-severe thrombocytopenia (<100k), mild thrombocytopenia (100-150k), low-normal preoperative platelet count (150-200k), normal (200-450k, reference cohort), and thrombocytosis (>450k).[7]

Variables collected in this study included patient demographics, comorbidities, preoperative laboratory values, and 30-day postoperative complication data. Patient demographics included sex, body mass index, age, functional status, ASA classification, smoking status, and chronic steroid use. Patient comorbidities included congestive heart failure (CHF), diabetes, hypertension, severe chronic obstructive pulmonary disease, and bleeding disorder. Complications that occurred within 30 days postoperatively were included in the analysis. Complications included sepsis, septic shock, pneumonia, unplanned intubation, urinary tract infection, stroke, cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction, bleeding transfusion, deep vein thrombosis requiring therapy, pulmonary embolism, on a ventilator >48 hours, deep incisional surgical site infection (SSI), superficial incisional SSI, organ/space SSI, wound dehiscence, readmission, reoperation, nonhome discharge, and mortality.

Statistical analyses for this investigation were conducted using SPSS Software version 28.0 (IBM Corp., Armonk, NY, USA). Bivariate logistic regression analysis was conducted to compare patient demographics and comorbidities between each abnormal platelet cohort and the reference cohort. Multivariate logistic regression analysis was done to adjust for all significantly associated demographic and comorbidity variables to investigate the independent association between preoperative platelet count and postoperative complications. Calculated odds ratios (ORs) were reported in relation to the 95% confidence interval (CI). The level of statistical significance was set at $P < .05$.

Results

After exclusion criteria, a total of 24,779 patients who underwent aRCR between 2015 and 2021 were included in this study. Of these patients, 18,697 (75.5%) had normal platelet counts, 4730 (19.1%) had low-normal platelet counts, 1012 (4.1%) had mild thrombocytopenia, 171 (0.7%) had moderate-to-severe thrombocytopenia, and 169 (0.7%) had thrombocytosis (Table I). All demographic, comorbidity, and complication rates were analyzed for abnormal platelet cohorts with reference to the normal platelet cohort.

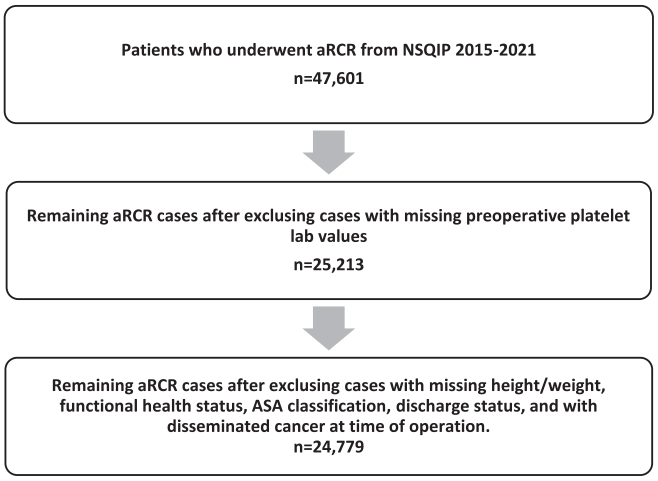

Figure 1 Case selection schematic. *aRCR*, arthroscopic rotator cuff repair; *NSQIP*, National Surgical Quality Improvement Program; *ASA*, American Society of Anesthesiologists.

Table I
Platelet cohorts based on preoperative lab values in patients who underwent aRCR in NSQIP between 2015 and 2021.

Platelet cohort (platelet count)	N = 24,779 (%)
Normal (200-450k)	18,697 (75.5)
Low-normal (151-200k)	4730 (19.1)
Mild thrombocytopenia (101-150k)	1012 (4.1)
Moderate-to-severe thrombocytopenia (≤100k)	171 (0.7)
Thrombocytosis (≥450k)	169 (0.7)

aRCR, arthroscopic rotator cuff repair; *NSQIP*, National Surgical Quality Improvement Program.

Compared to the normal platelet cohort, the low-normal platelet cohort had significantly higher rates of patients of male gender ($P < .001$), age ≥65 ($P < .001$), BMI < 18.5 and 30-34.9 ($P = .001$), ASA classification ≥3 ($P < .001$), nonsmoking status ($P < .001$), and with comorbid CHF ($P = .035$), hypertension ($P = .001$), and bleeding disorders ($P < .001$) (Table II). The mild thrombocytopenia cohort had higher rates of patients of male gender ($P < .001$), age ≥65 ($P < .001$), ASA classification ≥3 ($P < .001$), chronic steroid use ($P = .045$), and with comorbid diabetes ($P < .001$), hypertension ($P < .001$), and bleeding disorders ($P < .001$). The moderate-to-severe thrombocytopenia cohort had higher rates of patients of male gender ($P < .001$), ASA classification ≥3 ($P < .001$), and with comorbid CHF ($P = .005$), diabetes ($P < .001$), and bleeding disorders ($P < .001$). The thrombocytosis cohort had higher rates of patients of female gender ($P < .001$), dependent functional status prior to surgery ($P = .0021$), ASA classification ≥3 ($P = .018$), smoking status ($P = .007$), and with chronic steroid use ($P < .001$).

The 30-day postoperative complication data of each abnormal platelet cohort were compared to the normal platelet cohort (Table III). The low-normal platelet cohort was associated with higher rates of urinary tract infection ($P = .034$). The mild thrombocytopenia cohort was associated with higher rates of urinary

Table II
Patient demographics and comorbidities for patients with preoperative normal platelet count, low-normal platelet count, mild thrombocytopenia, moderate-to-severe thrombocytopenia, and thrombocytosis.

	Normal (200-450k)	Low-normal (151-200k)		Mild thrombocytopenia (101-150k)		Moderate-to-severe thrombocytopenia (≤100k)		Thrombocytosis (≥450k)	
	Number (%)	Number (%)	*P* value	Number (%)	*P* value	Number (%)	*P* value	Number (%)	*P* value
Overall	18697 (100)	4730 (100)		1012 (100)		171 (100)		169 (100)	
Sex			**<.001**		**<.001**		**<.001**		**<.001**
Female	9121 (48.8)	1216 (25.7)		214 (21.1)		58 (33.9)		113 (66.9)	
Male	9576 (51.2)	3514 (74.3)		798 (78.9)		113 (66.1)		56 (33.1)	
Age			**<.001**		**<.001**		.175		.235
18-39	530 (2.8)	98 (2.1)		8 (0.8)		3 (1.8)		6 (3.6)	
40-64	12023 (64.3)	2595 (54.9)		546 (54)		107 (62.6)		112 (66.3)	
65-74	5022 (26.9)	1591 (33.6)		344 (34)		46 (26.9)		45 (26.6)	
≥75	1122 (6)	446 (9.4)		114 (11.3)		15 (8.8)		6 (3.6)	
BMI (kg/m^2)			**.001**		.825		.220		.947
<18.5	8748 (46.8)	2254 (47.7)		456 (45.1)		78 (45.6)		81 (47.9)	
18.5-29.9	71 (0.4)	18 (0.4)		5 (0.5)		0 (0)		2 (1.2)	
30-34.9	5178 (27.7)	1416 (29.9)		303 (29.9)		35 (20.5)		43 (25.4)	
35-39.9	2705 (14.5)	664 (14)		157 (15.5)		36 (21.1)		19 (11.2)	
≥40	1995 (10.7)	378 (8)		91 (9)		22 (12.9)		24 (14.2)	
Functional status prior to surgery			.245		.766		.811		**.021**
Dependent	86 (0.5)	28 (0.6)		4 (0.4)		1 (0.6)		3 (1.8)	
Independent	18611 (99.5)	4702 (99.4)		1008 (99.6)		170 (99.4)		166 (98.2)	
ASA classification			**<.001**		**<.001**		**<.001**		**.018**
≤2	11089 (59.3)	2589 (54.7)		462 (45.7)		61 (35.7)		85 (50.3)	
≥3	7608 (40.7)	2141 (45.3)		550 (54.3)		110 (64.3)		84 (49.7)	
Smoker			**<.001**		.570		.612		**.007**
No	15896 (85)	4133 (87.4)		867 (85.7)		143 (83.6)		131 (77.5)	
Yes	2801 (15)	597 (12.6)		145 (14.3)		28 (16.4)		38 (22.5)	
Steroid use			.099		**.045**		.186		**<.001**
No	18147 (97.1)	4612 (97.5)		971 (95.9)		163 (95.3)		156 (92.3)	
Yes	550 (2.9)	118 (2.5)		41 (4.1)		8 (4.7)		13 (7.7)	
Comorbidities									
CHF	63 (0.3)	26 (0.5)	**.035**	4 (0.4)	.757	3 (1.8)	**.005**	0 (0)	.997
Diabetes mellitus	3692 (19.7)	977 (20.7)	.162	258 (25.5)	**<.001**	54 (31.6)	**<.001**	34 (20.1)	.904
Hypertension	9513 (50.9)	2530 (53.5)	**.001**	584 (57.7)	**<.001**	93 (54.4)	.362	97 (57.4)	.093
COPD	630 (3.4)	179 (3.8)	.163	37 (3.7)	.623	5 (2.9)	.748	6 (3.6)	.897
Bleeding disorder	238 (1.3)	113 (2.4)	**<.001**	65 (6.4)	**<.001**	44 (25.7)	**<.001**	3 (1.8)	.565

BMI, body mass index; *ASA*, American Society of Anesthesiologists; *CHF*, congestive heart failure; *COPD*, chronic obstructive pulmonary disease.
Bold *P* values indicate statistical significance with $P < .05$.

Table III
Bivariate analysis of 30-day postoperative complications in patients with preoperative normal platelet count, low-normal platelet count, mild thrombocytopenia, moderate-to-severe thrombocytopenia, and thrombocytosis.

	Normal (200-450k)	Low-normal (151-200k)		Mild thrombocytopenia (101-150k)		Moderate-to-severe thrombocytopenia (≤100k)		Thrombocytosis (≥450k)	
	Number (%)	Number (%)	*P* value	Number (%)	*P* value	Number (%)	*P* value	Number (%)	*P* value
Sepsis	11 (0.1)	3 (0.1)	.908	29 (2.9)	.115	2 (1.2)	**<.001**	0 (0)	.999
Septic shock	1 (0)	0 (0)	1.000	2 (0.2)	1.000	1 (0.6)	**<.001**	0 (0)	1.000
Pneumonia	25 (0.1)	6 (0.1)	.949	0 (0)	.767	2 (1.2)	**.003**	0 (0)	.998
Reintubation	6 (0)	1 (0)	.699	1 (0.1)	.298	1 (0.6)	**.007**	0 (0)	.999
Urinary tract infection	36 (0.2)	17 (0.4)	**.034**	1 (0.1)	**.048**	2 (1.2)	**.013**	2 (1.2)	**.012**
Stroke	7 (0)	2 (0)	.879	5 (0.5)	.999	0 (0)	.999	0 (0)	.999
Cardiac arrest	2 (0)	1 (0)	.578	0 (0)	.999	0 (0)	1.000	0 (0)	1.000
Myocardial infarction	10 (0.1)	6 (0.1)	.094	0 (0)	.091	0 (0)	.999	0 (0)	.999
Bleeding transfusions	3 (0)	0 (0)	.999	2 (0.2)	.999	0 (0)	.999	0 (0)	.999
Deep vein thrombosis	26 (0.1)	6 (0.1)	.839	0 (0)	.632	0 (0)	.998	1 (0.6)	.155
Pulmonary embolism	27 (0.1)	4 (0.1)	.318	2 (0.2)	.237	0 (0)	.998	0 (0)	.998
Failure to wean off ventilator	3 (0)	1 (0)	.276	3 (0.3)	.999	1 (0.6)	**.002**	0 (0)	.999
Deep incisional SSI	10 (0.1)	0 (0)	.999	0 (0)	.558	0 (0)	.999	0 (0)	.999
Superficial incisional SSI	31 (0.2)	3 (0.1)	.112	1 (0.1)	.610	0 (0)	.998	0 (0)	.998
Organ/space SSI	11 (0.1)	3 (0.1)	.908	1 (0.1)	.999	0 (0)	.999	0 (0)	.999
Wound dehiscence	3 (0)	2 (0)	.288	0 (0)	.999	0 (0)	.999	0 (0)	.999
Readmission	199 (1.1)	51 (1.1)	.934	0 (0)	**.017**	3 (1.8)	.388	3 (1.8)	.377
Reoperation	50 (0.3)	18 (0.4)	.199	19 (1.9)	.675	0 (0)	.998	1 (0.6)	.431
Nonhome discharge	102 (0.5)	25 (0.5)	.887	2 (0.2)	.311	5 (2.9)	**<.001**	3 (1.8)	**.044**
Mortality	2 (0)	1 (0)	.578	8 (0.8)	.069	1 (0.6)	**.001**	0 (0)	1.000

SSI, surgical site infection.
Bold *P* values indicate statistical significance with $P < .05$.

Table IV
Multivariate analysis of 30-day postoperative complications in patients with preoperative low-normal platelet count, mild thrombocytopenia, moderate-to-severe thrombocytopenia, and thrombocytosis.

Complication	Low-normal (151-200k)	Mild thrombocytopenia (101-150k)	Moderate-to-severe thrombocytopenia (≤100k)	Thrombocytosis (≥450k)
	Odds ratio, *P* value (95% CI)	Odds ratio, *P* value (95% CI)	Odds ratio, *P* value (95% CI)	Odds ratio, *P* value (95% CI)
Sepsis	–	–	9.39, **.017** (1.48-59.47)	–
Septic shock	–	–	15.67, .133 (0.43-570.15)	–
Pneumonia	–	–	6.62, **.022** (1.32-33.24)	–
Reintubation	–	–	2.72, .438 (0.22-34.11)	–
Urinary tract infection	2.06, **.020** (1.12-3.77)	2.44, .077 (0.91-6.55)	3.56, .120 (0.72-17.66)	4.91, **.030** (1.16-20.78)
Failure to wean off ventilator	–	–	9.15, .139 (0.49-171.73)	–
Readmission	–	1.42, .164 (0.87-2.31)	–	–
Nonhome discharge	–	–	3.34, **.021** (1.20-9.25)	2.52, .134 (0.75-8.45)
Mortality	–	–	15.97, .123 (0.47-538.47)	–

CI, confidence interval.
Bold *P* values indicate statistical significance with $P < .05$.

tract infection ($P = .048$) and readmission ($P = .017$). The moderate-to-severe thrombocytopenia cohort was associated with higher rates of sepsis ($P < .001$), septic shock ($P < .001$), pneumonia ($P = .003$), unplanned intubation ($P = .007$), urinary tract infection ($P = .013$), still on ventilator >48 hours ($P = .002$), nonhome discharge ($P < .001$), and mortality ($P = .001$). The thrombocytosis cohort was associated with higher rates of urinary tract infection ($P = .012$) and nonhome discharge ($P = .044$).

Compared to the normal platelet cohort, the low-normal platelet cohort was independently significantly associated with higher rates of urinary tract infection (OR 2.06, 95% CI 1.12-3.77; $P = .020$) (Table IV). Compared to the normal platelet cohort, the mild thrombocytopenia cohort was not independently associated with any postoperative complications. Compared to the normal platelet group, the moderate-to-severe thrombocytopenia cohort was independently significantly associated with higher rates of sepsis (OR 9.39, 95% CI 1.48-59.47; $P = .017$), pneumonia (OR 6.62, 95% CI 1.32-33.24; $P = .022$), and nonhome discharge (OR 3.34, 95% CI 1.20-9.25; $P = .021$). Compared to the normal platelet group, the thrombocytosis group was independently significantly associated with higher rates of urinary tract infection (OR 4.91, 95% CI 1.16-20.78; $P = .030$).

Discussion

In this study, we investigated 30-day postoperative complications associated with aRCR and found that the low-normal platelet cohort was independently associated with higher rates of urinary tract infection. The moderate-to-severe thrombocytopenia cohort was independently associated with higher rates of sepsis, pneumonia, and nonhome discharge. The thrombocytosis cohort was independently associated with higher rates of urinary tract infection.

Our analysis found that patients with abnormally low platelet counts tended to be male, of higher ASA classification, and more likely to have comorbid CHF, diabetes, hypertension, and bleeding disorders. This trend is consistent with existing literature that has established a relationship between thrombocytopenia and patients who are male and have significant comorbidities.[7,11] Our analysis also found that patients with abnormally high platelet counts tended to be female, with dependent functional status, of higher ASA classification, and associations with smoking and chronic steroid use. This trend is also consistent with existing literature that found a similar relationship between preoperative thrombocytosis and patients who are female and less functionally independent undergoing total shoulder arthroplasty.[11] The relationship between smoking and thrombocytosis has also been well-established in the literature.[3,13,16]

Our study showed that low-normal platelet count was an independent predictor of urinary tract infection, and moderate-to-severe thrombocytopenia was an independent predictor of sepsis, pneumonia, and nonhome discharge. Additionally, thrombocytosis was found to be an independent predictor of urinary tract infection. Overall, our findings support the association between abnormal platelet count and adverse postoperative outcomes that has been well-established in the literature.[7,19] Moreover, existing literature shows that both thrombocytopenia and thrombocytosis are associated with increased 30-day postoperative complications following other orthopedic joint surgeries, including total knee, hip, and shoulder arthroplasties.[11,14,15] Our study establishes that the same pattern holds true following aRCR.

This study was limited to the information available from the NSQIP database. As a result, we could not account for operative variables including the institution at which the procedure was performed, experience of the surgeon, and postoperative rehabilitation. Moreover, we were limited to postoperative complications that occurred within 30 days of the surgery and were thereby unable to consider any long-term postoperative complications such as retear and shoulder stiffness. Next, a substantial portion of the initial patient population was excluded due to missing preoperative platelet counts. The patients who receive more extensive preoperative laboratory testing are more likely to be sicker patients who are more prone to early postoperative complications. Therefore, there is likely some degree of inherent selection bias in this study. Additionally, this study does not account for any preoperative anticoagulation use, antiplatelet medications, or platelet transfusions, all of which may affect platelet levels and function intraoperatively and in the short perioperative period. Despite these limitations, this is the first study to investigate postoperative complications associated with abnormal preoperative platelet counts following aRCR.

Conclusion

Abnormal preoperative platelet counts, both low and high, were independent risk factors for 30-day postoperative complications following aRCR compared to normal preoperative platelet counts. With an increasing surgical volume of aRCR, it is important to understand preoperative laboratory parameters as a risk stratification tool. The findings of this study equip physicians to better identify surgical candidates and improve surgical outcomes.

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