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Operative Time Less Than 1.5 Hours, Male Sex, Dependent Functional Status, Presence of Dyspnea, and Reoperations Within 30 days Are Independent Risk Factors for Readmission After ACLR

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Original Article

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Purpose: The purposes of this study are to use a large, patient-centered database to describe the 30-day readmission rate and to identify predictive risk factors for readmission after elective isolated ACLR. **Methods:** The National Surgical Quality Improvement Program Database was retrospectively queried for isolated ACLR procedures between 2011 and 2017. Current Procedural Terminology (CPT) codes were used to identify isolated ACLR patients. Those undergoing additional procedures such as meniscectomy or multi-ligamentous reconstruction were excluded. Readmissions were analyzed against demographic variables with bivariate analysis. Multivariate logistic regression was used to find independent risk factors for 30-day readmissions after ACLR. **Results:** A total of 11,060 patients (37.2% female) were included with an average age of 32.2 ± 10.6 years and mean body mass index (BMI) of 27.9 ± 6.5 kg/m^2 (29.2% were >30). The overall readmission rate was 0.59%. The most reported reason for readmission was infection 0.22 (24 out of 11,060). The following variables were associated with significantly higher readmission rates: male sex ($P = .001$), history of severe chronic obstructive pulmonary disease (COPD) ($P = .025$), cardiac comorbidity ($P = .034$), operative time >1.5 hours ($P < .001$), partially dependent functional health status ($P = .002$), high preoperative creatinine ($P = .009$), normal preoperative albumin ($P = .020$), hypertension ($P = .034$), and reoperations ($P < .001$). Operative time >1.5 hours, male sex, dependent functional status, the presence of dyspnea, and undergoing a reoperation were identified as independent risk factors for 30-day readmissions ($P < .05$ for all). **Conclusions:** Isolated ACLR is associated with low 30-day readmission rates. Operative time >1.5 hours, male sex, dependent functional status, the presence of dyspnea, and 30-day reoperations are independent risk factors for readmission that should be considered in patient selection and addressed with preoperative counseling. **Level of Evidence:** Level III, retrospective cohort study.

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Introduction

Anterior cruciate ligament (ACL) ruptures are the most common ligament injury in the United States and one of the most frequent knee injuries overall.[1,2] Because of the poor healing response of the torn ligament, ACL reconstruction (ACLR) is also one of the most commonly performed sports medicine procedures with estimates ranging from 200,000 to 300,000 surgeries annually.[3-5] Isolated ACL tears, defined as tears without concomitant ligament injury, have been reported with a similar incidence.[6] ACLR has been established as a safe and effective outpatient procedure, and the factors contributing to its short- and long-term outcomes have been studied extensively.[3,7-10] However, despite the current health care system's shift toward outcome-based practices, the rates of short-term readmission after isolated ACLR are unclear.

A 2004 study found that hospital readmissions accounted for $17.4 billion of the annual $102 billion of Medicare expenditures.[11] This led to a proliferation in the study of postsurgical readmissions in orthopedics, as rehospitalizations became an important target for health care cost reduction.[12-26] Since the introduction of the Hospital Readmissions Reduction Program to the Social Security Act in 2012, health care payers and the Centers for Medicare and Medicaid Services have focused on unplanned readmissions and levied financial penalties for those deemed preventable.[27] Therefore, physicians must be cognizant of the impact of postsurgical readmissions on hospital costs, as well as the patient experience.

The estimated annual cost of ACLR to the healthcare system is $2 billion[28]; however, this estimate does not consider the impact of postsurgical hospital readmissions. Therefore, this is likely to be a conservative projection of the true financial impact of ACLR procedures. Currently, several studies have investigated the risk factors in ACLR, overnight admissions after isolated ACLR, and readmission rates in other types of knee surgery.[3,7,9,29] Bokshan et al. performed a retrospective study of 9,146 patients undergoing ACLR and found that Hispanic ethnicity, use of epidural anesthesia, a known bleeding disorder, increased body mass index (BMI), longer operation time, and younger age were all independently associated with readmissions after surgery.[3] In another study of 14,159 isolated ACLRs focused on the effect of increased operative times, a 15-minute increase led to significantly higher rates of readmission, postoperative complications, and extended lengths of stay in the hospital.[7] More recently, Min et al. performed a similar study of 20,819 standard ACLR patients and used multivariate regressions to determine that regional anesthesia alone, increasing concurrent procedures, and obesity contributed to hospital readmissions in the immediate postoperative period.[9] They also found that the same risk factors applied to their smaller subgroup analysis of isolated ACLRs.[9] To our knowledge, only this minor subanalysis reporting on hospital readmissions after isolated ACLR exist in the current literature.[9,15] The purposes of this study are to use a large, patient-centered database to describe the 30-day readmission rate and to identify predictive risk factors for readmission after elective isolated ACLR. We hypothesize that rates of readmission will be low and that obesity, surgical duration, and an increased number of comorbidities will be contributing risk factors.

Methods

In December 2019, the American College of Surgeons National Surgical Quality Improvement Program database (ACS-NSQIP) was queried for isolated ACLR procedures between 2011 and 2017, as this was the only interval during which readmission data were collected. The American College of Surgeons National Surgical Quality Improvement Program database ACS-NSQIP is a deidentified database with information on procedure type and outcomes data from 684 hospitals across the United States.[30] Current Procedural Terminology (CPT) codes were used to identify elective knee arthroscopies involving ACLR. The CPT code, 29888, was then used to identify isolated ACLR cases. Surgeries involving concomitant procedures such as meniscectomy or multiligamentous reconstruction were excluded. CPT codes used for patient identification are provided in a complete list in Table 1.

Variables Collected

Demographic information retrieved from the ACS-NSQIP included age, sex, race, ethnicity, and inpatient/outpatient status. Age was categorized into five groups (16-20, 21-30, 31-40, 41-50, and >50). Patient variables were recorded, including body mass index, American Society of Anesthesiologist (ASA) class, diabetes, dyspnea, chronic obstructive pulmonary disease (COPD), hypertension, renal disease, heart disease, smoking history, alcohol intake, bleeding disorders, functional health status, steroid use, and recent weight loss. Examined laboratory values included hematocrit, creatinine, and serum albumin. Perioperative factors, including principal anesthesia technique and operative time, were recorded. Thirty-day reoperation and 30-day readmission rates were compiled from International Classification of Diseases (ICD) 9/10 codes along with frequency of readmission. Readmissions were defined as postoperative hospital admissions related to and within 30-days of the index isolated ACLR procedure.

Statistical Analysis

Bivariate analysis of the collected demographics, patient variables, laboratory values, and perioperative factors was conducted against the isolated ACLR cases that resulted in a readmission. Categorical comparisons between variables were then made using chi-squared tests. Finally, multivariate logistic regression was used to find independent risk factors for readmission after ACLR by calculating odds ratios (OR) and 95% confidence intervals (CI). All statistical analyses were conducted using SAS 9.2 software (SAS Institute Inc., Cary, NC), and the alpha was set at $P < .05$ to define significance.

Results

Retrospective analysis of the ACS-NSQIP database identified 11,060 patients (37.2% female) that met the eligibility criteria of undergoing an isolated ACLR between 2011 and 2017. The mean age of included patients was 32.2 ± 10.6 years and the average body mass

Table 1. Definitions of the CPT Codes for NSQIP Query

CPT Code	Definition	Included or Excluded
29888	Arthroscopically aided anterior cruciate ligament repair/augmentation or reconstruction	Included
27403	Arthrotomy with meniscus repair, knee	Excluded
29868	Arthroscopy, knee, surgical; meniscal transplantation (includes arthrotomy for meniscal insertion)	Excluded
29880	Arthroscopy, knee, surgical; with meniscectomy (medial AND lateral, including any meniscal	Excluded
29881	Arthroscopy, knee, surgical; with meniscectomy (medial OR lateral, including any meniscal shaving)	Excluded
29882	Arthroscopy, knee, surgical; with meniscus repair (medial OR lateral)	Excluded
29883	Arthroscopy, knee, surgical; with meniscus repair (medial AND lateral)	Excluded
29889	Arthroscopically aided posterior cruciate ligament repair/augmentation or reconstruction	Excluded
27557	Open treatment of knee dislocation, with or without internal or external fixation; with primary ligamentous repair	Excluded
27558	Open treatment of knee dislocation, with or without internal or external fixation; with primary ligamentous repair, with augmentation/reconstruction	Excluded
27412	Autologous chondrocyte implantation, knee	Excluded
27415	Osteochondral allograft, knee, open	Excluded
29877	Arthroscopy, knee, surgical; debridement/shaving of articular cartilage (chondroplasty)	Excluded
29885	Arthroscopy, knee, surgical; drilling for osteochondritis dissecans with bone grafting, with or without internal fixation (including debridement of base of lesion)	Excluded
29886	Arthroscopy, knee, surgical; drilling for intact osteochondritis dissecans lesion	Excluded
29887	Arthroscopy, knee, surgical; drilling for intact osteochondritis dissecans lesion with internal fixation	Excluded
29879	Arthroscopy, knee, surgical; abrasion arthroplasty (includes chondroplasty where necessary)	Excluded
29866	Arthroscopy, knee, surgical; osteochondral autograft(s) (e.g., mosaicplasty) (includes harvesting of the autograft(s)	Excluded
29867	Arthroscopy, knee, surgical; osteochondral allograft (e.g., mosaicplasty)	Excluded
27405	Repair, primary, torn ligament and/or capsule, knee; collateral	Excluded
27409	Repair, primary, torn ligament and/or capsule, knee; collateral and cruciate ligaments	Excluded

CPT, Current Procedural Terminology.

index (BMI) was 27.9 ± 6.5 kg/m^2 with 29.2% of patients having a BMI > 30. Of the total patient cohort, 65 (0.59%) were readmitted within 30 days of the index surgery, and the most frequent reason for readmission was postoperative infection (0.22%). A complete list of reported reasons for readmissions is presented in Table 2, while rates of readmission have been differentiated by year in Table 3 and reproduced graphically using a Cochran-Armitage Trend Test in Fig 1. Readmission rates were not significantly associated with year ($P = .315$).

Bivariate analysis revealed that the following patient characteristics was significantly associated with higher readmission rates: male sex ($P = .001$), history of severe COPD ($P = .025$), cardiac comorbidity ($P = .034$), operative time >1.5 hours ($P < .001$), partially dependent functional health status preoperatively ($P = .002$), high preoperative creatinine ($P = .009$), normal preoperative albumin ($P = .02$), history of hypertension ($P = .034$), and undergoing a reoperation ($P < .001$) (Table 4). Multivariate analysis determined that operative time >1.5 hours ($P < .05$), male sex ($P < .05$), dependent functional status ($P > .005$), the presence of dyspnea ($P < .05$) and undergoing a reoperation within 30 days of the index procedure ($P < .001$) were all independent risk factors for 30-day readmission after ACLR (Table 5).

Discussion

In this study, we found that 30-day readmission rates were low at just 0.59% of patients. Within that cohort, operative time >1.5 hours, male sex, dependent functional status, the presence of dyspnea, and undergoing a reoperation within 30 days of the index procedure were identified as independent risk factors for readmission after ACLR using multivariate logistic analysis. Notably, postsurgical infection was the most common cause of readmission and bivariate analysis associated male sex, history of severe COPD, cardiac comorbidity, operative time >1.5 hours, partially dependent preoperative functional health status, high preoperative creatinine, normal preoperative serum albumin, history of hypertension, and 30-day reoperations with an increased likelihood for readmission.

Table 2. Reported Reasons for 30-Day Readmission After Isolated ACLR and Their Incidence rates.

Readmission Reasons	Frequency	Percentage (%)
Infection of Any Type	**24**	**0.22**
Deep Infection	8	0.07
Organ/Space Infection	7	0.06
Superficial Infection	5	0.05
Graft-Related Infection	1	0.01
Abscess/Furuncle/Carbuncle	1	0.01
Cellulitis	1	0.01
Unspecified Infection	1	0.01
Venous Thromboembolism	**12**	**0.11**
Vein Thrombosis requiring Therapy	6	0.05
DVT Requiring Therapy	2	0.02
Pulmonary Embolism	4	0.04
Structural and Stability Problems	**29**	**0.26**
Disruption of ACL	1	0.01
Hematoma	1	0.01
Effusion	3	0.03
Joint instability	1	0.01
Sprain of ACL	1	0.01
Intestinal Obstruction	1	0.01
Hiccough	1	0.01
Atelectasis	1	0.01
Ankylosis	1	0.01
Dermatitis	1	0.01
Residual Pain	6	0.05
Other	11	0.10
Not Readmitted	10995	99.41
Total	11060	100.00

Table 3. A Summary of 30-Day Isolated ACLR Readmission Rates by Year From 2011 to 2017

Operative Year	Readmission Rate (%)
2011	0.38
2012	0.93
2013	0.48
2014	0.24
2015	0.71
2016	0.64
2017	0.63

As hypothesized, surgical duration and number of comorbidities were identified as risk factors for ACLR readmission. Obesity, however, was not predictive of readmission in this analysis. This result contrasts with our hypothesis as well as the findings of a recent study by Cooper et al. in which obesity was, in fact, determined to be a predictive risk factor for ACLR readmission.[15] However, two important distinctions exist between our study methodologies. First, Cooper et al. investigated all elective ACLR cases in their readmission analysis, not just isolated ACLR. The inclusion of concomitant procedures may have impacted operative times, and therefore, complication and readmission rates, confounding the results. Second, in a multivariate analysis, Cooper et al. found a BMI $\geq$ 40 (class III) to be predictive of readmission. While the authors concluded that obesity is a risk factor for ACLR readmission, BMI >40 is often classified as morbid obesity.[15] By contrast, our analysis used a BMI of $\geq$ 30 (classes I-III) to report obesity without substratification by class. Our larger study size and inclusion of BMI $\geq$ 30 allowed us to capture far more obese patients (3,224 vs 46) and provides a more complete assessment of the effect of obesity on isolated ACLR readmission rates. Currently, the knee arthroplasty and arthroscopy literature is conflicted in establishing patient obesity as a predictive factor of readmissions,[8,13,15,21,31-33] but it is well known that obesity is associated with increased surgical times and postoperative complications, and so

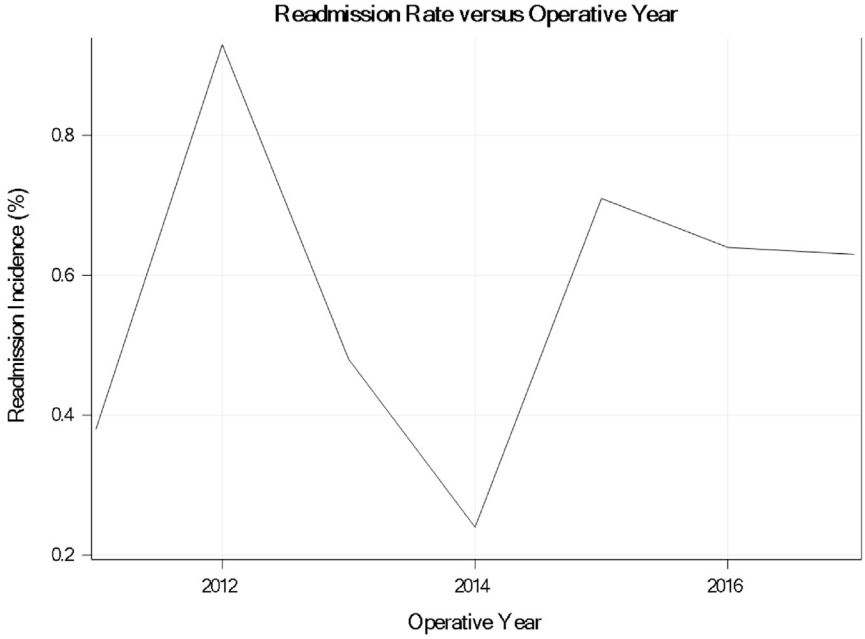

Fig 1. Cochran-Armitage Trend Test of 30-day readmission rates from 2011-2017 indicated no significant relationship between readmission rate and year (P = .3145).

Table 4. Bivariate Analysis of ACLR Patient Demographics by Readmission Status

Readmission Bivariate Analysis				
	No (n = 10995)	Yes (n = 65)	Total (n = 11060)	P Value
Age Group				.142[1]
16-20	1335 (99.8%)	3 (0.2%)	1338 (12.1%)	
21-30	4294 (99.4%)	25 (0.6%)	4319 (39.1%)	
31-40	2927 (99.2%)	25 (0.8%)	2952 (26.7%)	
41-50	1743 (99.5%)	9 (0.5%)	1752 (15.8%)	
>50	696 (99.6%)	3 (0.4%)	699 (6.3%)	
Sex				**.001**[1]
Female	4108 (99.7%)	11 (0.3%)	4119 (37.2%)	
Male	6887 (99.2%)	54 (0.8%)	6941 (62.8%)	
Race				.360[1]
American Indian or Alaska Native	173 (100.0%)	0 (0.0%)	173 (1.6%)	
Asian	533 (99.8%)	1 (0.2%)	534 (4.8%)	
Black or African American	941 (99.2%)	8 (0.8%)	949 (8.6%)	
Hispanic	882 (99.0%)	9 (1.0%)	891 (8.1%)	
Native Hawaiian or Pacific Islander	133 (99.3%)	1 (0.7%)	134 (1.2%)	
White	5475 (99.4%)	31 (0.6%)	5506 (49.8%)	
Other/Not Reported	2858 (99.5%)	15 (0.5%)	2873 (26.0%)	
Hispanic Ethnicity				.241[1]
Yes	1030 (99.0%)	10 (1.0%)	1040 (9.4%)	
No	6805 (99.5%)	37 (0.5%)	6842 (61.9%)	
Unknown	2760 (99.5%)	14 (0.5%)	2774 (25.1%)	
NULL	400 (99.0%)	4 (1.0%)	404 (3.7%)	
Obese				.267[1]
No	7794 (99.5%)	42 (0.5%)	7836 (70.8%)	
Yes	3201 (99.3%)	23 (0.7%)	3224 (29.2%)	
ASA				.520[1]
≤3	10501 (99.4%)	61 (0.6%)	10562 (95.5%)	
>3	494 (99.2%)	4 (0.8%)	498 (4.5%)	
Diabetes				.315[1]
No	10827 (99.4%)	65 (0.6%)	10892 (98.5%)	
Yes	168 (100.0%)	0 (0.0%)	168 (1.5%)	
History of severe COPD				**.025**[1]
No	10971 (99.4%)	64 (0.6%)	11035 (99.8%)	
Yes	24 (96.0%)	1 (4.0%)	25 (0.2%)	
Current smoker within one year				.404[1]
No	9062 (99.4%)	51 (0.6%)	9113 (82.4%)	
Yes	1933 (99.3%)	14 (0.7%)	1947 (17.6%)	
Cardiac comorbidity				**.034**[1]
No	10334 (99.5%)	57 (0.5%)	10391 (94.0%)	
Yes	661 (98.8%)	8 (1.2%)	669 (6.0%)	
Renal comorbidity				.913[1]
No	10993 (99.4%)	65 (0.6%)	11058 (100.0%)	
Yes	2 (100.0%)	0 (0.0%)	2 (0.0%)	
Bleeding disorders				.712[1]
No	10972 (99.4%)	65 (0.6%)	11037 (99.8%)	
Yes	23 (100.0%)	0 (0.0%)	23 (0.2%)	
Inpatient/outpatient				.090[1]
Inpatient	640 (98.9%)	7 (1.1%)	647 (5.8%)	
Outpatient	10355 (99.4%)	58 (0.6%)	10413 (94.2%)	
Operative Time				**<.001**[1]
≤1.5 hours	5271 (99.7%)	16 (0.3%)	5287 (47.8%)	
>1.5 hours	5724 (99.2%)	49 (0.8%)	5773 (52.2%)	
Functional health status prior to surgery				**.002**[1]
Independent	10887 (99.4%)	62 (0.6%)	10949 (99.0%)	
Partially Dependent	16 (94.1%)	1 (5.9%)	17 (0.2%)	
Unknown	92 (97.9%)	2 (2.1%)	94 (0.8%)	
Steroid use for chronic condition				.079[1]
No	10961 (99.4%)	64 (0.6%)	11025 (99.7%)	
Yes	34 (97.1%)	1 (2.9%)	35 (0.3%)	
>10% loss body weight in last 6 months				.818[1]
No	10986 (99.4%)	65 (0.6%)	11051 (99.9%)	
Yes	9 (100.0%)	0 (0.0%)	9 (0.1%)	

(continued)

Table 4. Continued

Readmission Bivariate Analysis	No (n = 10995)	Yes (n = 65)	Total (n = 11060)	P Value
EtOH > 2 drinks/day in 2 weeks before admission				.512[1]
No	673 (99.3%)	5 (0.7%)	678 (6.1%)	
Yes	10 (100.0%)	0 (0.0%)	10 (0.1%)	
NULL	3384 (99.6%)	14 (0.4%)	3398 (30.7%)	
Missing	6928 (99.3%)	46 (0.7%)	6974 (63.1%)	
Hematocrit level				.134[1]
Low (<35.5%)	125 (100.0%)	0 (0.0%)	125 (1.1%)	
Normal	3083 (99.2%)	25 (0.8%)	3108 (28.1%)	
Null	7787 (99.5%)	40 (0.5%)	7827 (70.8%)	
Creatinine level				**.009**[1]
High (>1.21)	101 (97.1%)	3 (2.9%)	104 (0.9%)	
Normal	2355 (99.4%)	14 (0.6%)	2369 (21.4%)	
Null	8539 (99.4%)	48 (0.6%)	8587 (77.6%)	
Albumin level				**.020**[1]
Low (<3.4)	18 (100.0%)	0 (0.0%)	18 (0.2%)	
Normal	956 (98.8%)	12 (1.2%)	968 (8.8%)	
Null	10021 (99.5%)	53 (0.5%)	10074 (91.1%)	
Principal anesthesia technique				.960[1]
Epidural	22 (100.0%)	0 (0.0%)	22 (0.2%)	
General	10372 (99.4%)	61 (0.6%)	10433 (94.3%)	
MAC/IV Sedation	120 (100.0%)	0 (0.0%)	120 (1.1%)	
Regional	145 (99.3%)	1 (0.7%)	146 (1.3%)	
Spinal	328 (99.1%)	3 (0.9%)	331 (3.0%)	
Other	6 (100.0%)	0 (0.0%)	6 (0.1%)	
Unknown	2 (100.0%)	0 (0.0%)	2 (0.0%)	
Reoperation within 30-days of index procedure				**<.001**[1]
No	10971 (99.7%)	36 (0.3%)	11007 (99.5%)	
Yes	24 (45.3%)	29 (54.7%)	53 (0.5%)	
Hypertension requiring medication				**.034**[1]
No	10334 (99.5%)	57 (0.5%)	10391 (94.0%)	
Yes	661 (98.8%)	8 (1.2%)	669 (6.0%)	

Significantly different values are in bold.
[1]Chi-square

further study of this particular variable is warranted for this procedure.

Regarding the variables that were identified as predictors of readmission—operative time >1.5 hours, male sex, dependent functional status, the presence of dyspnea, and 30-day reoperations—these findings are consistent with what has been previously reported in the orthopedic literature. Longer procedural times have been repeatedly associated with an increase in postsurgical complications and occasionally with readmissions.[3,7,15] Meanwhile, the high predictive significance of 30-day reoperations indicates that the majority of such procedures required hospital admission in this cohort. Male sex has also been linked to a greater number of intra-articular pathologies in ACLR,[34] which may then translate to longer OR times. Additional systemic comorbidities and older age have been known to complicate surgeries as well and may require more involved perioperative management.[9,35-37] However, age was not significantly associated with ACLR readmission rates in our study. The effects of age on short-term ACLR outcomes may be better elucidated by future investigations of graft choice in varying age groups, especially since allografts tend to be favored in older ACLR patients. Although conflicting evidence exists regarding other demographic factors such as race and ethnicity, our results support previous studies that have found no significance in their predictive capacities in ACLR outcomes[8,29,38-40] or postoperative readmissions.[15]

Finally, readmissions for a procedure performed as commonly as ACLR are likely to be one contributor to hospital costs and may extend into the tens of millions of dollars when averaged annually across the United States. Although the average readmission rate found in this study was low (0.59%), this could amount to nearly 1,800 readmission events in the United States each year based on the estimated 300,000 ACLR procedures performed annually. Given its frequency, ACLR is a valuable target for studies aiming to identify predictive factors of postsurgical readmissions with the goal of preventing adverse events, maximizing hospital reimbursements, and improving patient outcomes. Although prior studies have investigated overnight

Table 5. Multivariate Logistic Regression for Predictive Factors of Readmission After Isolated ACLR

Outcome	Odds Ratio (95% Confidence Interval)	*P* Value
Age group		.1237
16-20	Reference	-
21-30	2.454 (0.739, 8.153)	.4724
31-40	3.881 (1.162, 12.962)	.1454
41-50	2.494 (0.652, 9.542)	.3485
>50	1.899 (0.356, 10.121)	.4210
Operative time >1.5 hours	2.769 (1.554, 4.931)	**.0298**
Non-White race	1.080 (0.659, 1.777)	.1766
BMI <30	0.830 (0.441, 1.595)	.5680
Smoker within 1 year	1.317 (0.633, 2.595)	.4403
Dyspnea	6.509 (1.324, 31.992)	**.0454**
Male sex	0.358 (0.185, 0.694)	**.0284**
Partially dependent Functional status	10.171 (1.203, 85.996)	**.0049**
Steroid use for a chronic condition	5.934 (0.694, 50.750)	.1356
No cardiac comorbidity	0.536 (0.235, 1.223)	.1060
No history of COPD	0.372 (0.043, 9.299)	.3177
ASA >3	0.847 (0.220, 2.467)	.2244
Low hematocrit	0.551 (0.265, 1.183)	.1167
High creatinine	3.396 (0.736, 11.064)	.0685
Low albumin	0.572 (0.240, 1.403)	.2118
Use of general anesthesia	1.508 (0.474, 6.373)	.5313
Reoperation within 30 days of index procedure	478.711 (234.233, >999.999)	**<.0001**
Hypertension requiring medication	1.483 (0.499, 3.920)	.4505

Operative time >1.5 hours, male sex, dependent functional status, presence of dyspnea, and a reoperation within 30 days of the index procedure were all independent risk factors for readmission. Significant values in bold.

admissions after isolated ACLR, risk factors for readmission after isolated ACLR have not been described in detail. A major strength of this study is the analysis of more than 11,000 cases using a large, national, and patient-centered database to identify pertinent patient and procedural risk factors. The present study confirms some familiar variables as risk factors including longer operative times, preoperative comorbidities, and male sex, but also better characterizes the roles of other variables debated in the literature, including obesity, age, race, and ethnicity. These results may help surgeons identify patients at risk for readmission, guide patient education, and improve perioperative management for those undergoing ACLR. Although not possible in this analysis, further investigations of ACLR readmissions by graft type and/or primary versus revision procedures, or predictors of PRO score quality in isolated ACLR would be of great interest to this topic.

Limitations

This study is not without limitations. A significant limitation is the inability to determine the type of graft or surgical technique used for each ACLR procedure from the NSQIP database. Graft type—hamstring autograft versus patellar bone-tendon-bone (BTB) versus quadriceps autograft versus allograft—can significantly influence operative times and has been shown to affect surgical outcomes.[41] In addition, the preferred use of allografts in older ACLR patients may have also affected the distribution of these findings. Second, the NSQIP database does not record information regarding the details of perioperative care. When one considers the variety of protocols and health care professionals that are involved in presurgical administration to postoperative management, it is possible that an event necessitating readmission could be initiated by circumstances extending beyond the variables included in this analysis. Finally, while the data of the NSQIP are known to be of high quality, the data reviewed for this study represent only a sample of ACLRs between 2011 and 2017. As a result, there is a gap of time between the most recently collected data and the date of our retrospective query, which may be a source of bias. Similarly, the NSQIP does not encompass all surgical settings, like independent surgical centers, and, therefore, may not be generalizable for all surgeons. This analysis has provided a focused assessment of an understudied outcome of isolated ACLR; however, a paucity of information on this topic remains and should continue to be investigated.

Conclusions

Isolated ACLR is associated with low 30-day readmission rates. Operative time >1.5 hours, male sex, dependent functional status, the presence of dyspnea, and 30-day reoperations are independent risk factors for readmission that should be considered in patient selection and addressed with preoperative counseling.

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