

Research Articles

Opioid Administration Patterns following Anterior Cruciate Ligament Reconstruction and Rotator Cuff Repair: A Multi-Center Analysis

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Objectives

Opioids are commonly administered following elective sports surgeries, contributing to the opioid epidemic. Understanding opioid administration patterns following commonly performed anterior cruciate ligament reconstruction (ACLR) and rotator cuff repair (RCR) is important to avoid inadvertent overprescribing of these drugs. The purpose of this study was to characterize opioid administration trends following these surgeries across various healthcare institutions.

Methods

A 5-year retrospective study was performed utilizing patient data collected by [Avalon.ai](#) from 3 large health systems around the United States. The data was screened for patients undergoing ACLR and RCR between 2018 and 2022 (n=2,129). Patient records were screened for administration of opioids following operation defined as the average morphine milligram equivalents (MME).

Results

The average MME for surgeries combined increased from 23 ± 11 in 2018 to 34 ± 24 in 2022 ($P < .0001$). ACLR has had a higher average MME than RCR in recent years, in addition to a significant variation in average MME for combined surgeries across institutions.

Conclusion

Opioid administration following ACLR and RCR increased annually over the study period with significant variation in average MME across healthcare institutions. Interventional efforts should continue to be made to reduce opioid prescriptions following these surgeries to mitigate long-term use and abuse.

INTRODUCTION

The United States is experiencing an opioid epidemic resulting in rising death tolls and increasing rates of opioid use disorder.¹ This health crisis has been aggravated by excessive overprescribing of opioids by medical providers, with causes often centering around poor provider understanding and awareness.^{2,3} Orthopedic surgeons account

for approximately 7.7% of prescribed opioids within the United States and represent the third highest prescribers amongst medical specialties.⁴

Anterior cruciate ligament injuries requiring reconstruction are common and growing in frequency, with an estimated 130,000 anterior cruciate ligament reconstructions (ACLRs) performed annually.⁵ Similarly, rotator cuff injury represents the most frequent shoulder injury, with a rising

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incidence rate of arthroscopic repair of 600%.^{6,7} Appropriate rehabilitation exercises and postoperative range of motion are essential for optimal recovery following operative intervention and are predicated upon appropriate pain management.⁸ However, opioids commonly administered in the postoperative period are prone to be overprescribed and potentially misused by patients.⁹ Overprescription of opioids following orthopedic surgery has been associated with worse postoperative outcomes and prolonged recovery.¹⁰⁻¹² Although studies examining opioid prescription patterns within orthopedic surgery have been performed, guidelines on opioid prescription across healthcare institutions have not been widely implemented, causing significant variation in prescription practices.^{13,14} Similarly, there are few studies examining the administration of opioids following these surgeries.

This study aims to characterize opioid administration patterns across individual healthcare institutions and explore trends in administrations following ACLR and RCR in recent years.

METHODS

An institutional review board was not required as the data analyzed was drawn from [Avalon.ai](#) (Philadelphia, PA), a third-party agent, and all patient information provided was de-identified. [Avalon.ai](#) is a value-based data analytics company that provides healthcare-related data for payors, providers, and medical device/pharma companies.¹⁵

A retrospective study was performed utilizing de-identified patient data culled by [Avalon.ai](#), consisting of 3 geographically diverse academic health systems: Institution #1 in New York state (representing the Northeast) between 2020 to 2022, Institution #2 in Iowa (representing the Midwest) between 2018 to 2022, and Institution #3 in Louisiana (representing the South) between 2021 to 2022. The data was screened for patients undergoing ACLR and RCR between 2018 and 2022 (n=2,129). Patient cohorts were determined by procedure type: ACLR (n=1,047) and RCR (n=1,082). This study did not utilize patient-identifiable information and was subsequently exempted by the Internal Review Board (IRB).

The primary outcome was the administration of opioids on the same day of surgery while still in the healthcare institution. Opioid values were defined as morphine millimeter equivalents (MME), representing the potency of the opioid dose relative to morphine. Analyses were performed to determine MME trends by procedure and healthcare institution.

Descriptive analyses compared average MME across years, surgery type, and healthcare institution. Differences between categorical exposure and continuous outcome measures were compared using 2-tailed z-tests and Analysis of Variance (ANOVA) tests as appropriate. All *P*-values presented were 2-sided, with a *P*-value of $\leq .05$ considered statistically significant. Tukey HSD (honest significant difference) post hoc analyses were conducted using ANOVA testing to indicate significant differences between groups.

RESULTS

OPIOID ADMINISTRATION PATTERNS ACROSS COMBINED INSTITUTIONS

A total of 2,129 combined ACLR and RCR surgeries were performed between 2018 and 2022 within included healthcare institutions. [Table 1] There was a significant difference in average MME for annual groups of combined surgeries ($P < .0001$), with a significant increase from 23 ± 11 in 2018 to 34 ± 24 ($P < .0001$). [Figure 1] Similarly, ACLR had a significant difference in average MME between annual groups ($P < .0001$), with a significant increase from 27 ± 10 in 2018 to 37 ± 26 in 2022 ($P = .0007$). RCR had a significant difference between annual groups ($P < .0001$) and a significant increase from 20 ± 11 in 2018 to 31 ± 22 in 2022 ($P < .0001$).

INSTITUTIONAL OPIOID ADMINISTRATION PATTERNS

There were significant differences in average MME administered across institutions when combining surgery types in 2021 and 2022 ($P < .0001$). [Table 2]

SURGERY TYPE OPIOID ADMINISTRATION PATTERNS

ACLR had a significantly higher average MME when compared to RCR in 2021 (34 ± 27 vs 30 ± 22 , $P = 0.0451$) and 2022 (37 ± 26 vs 31 ± 22 , $P = 0.0022$).

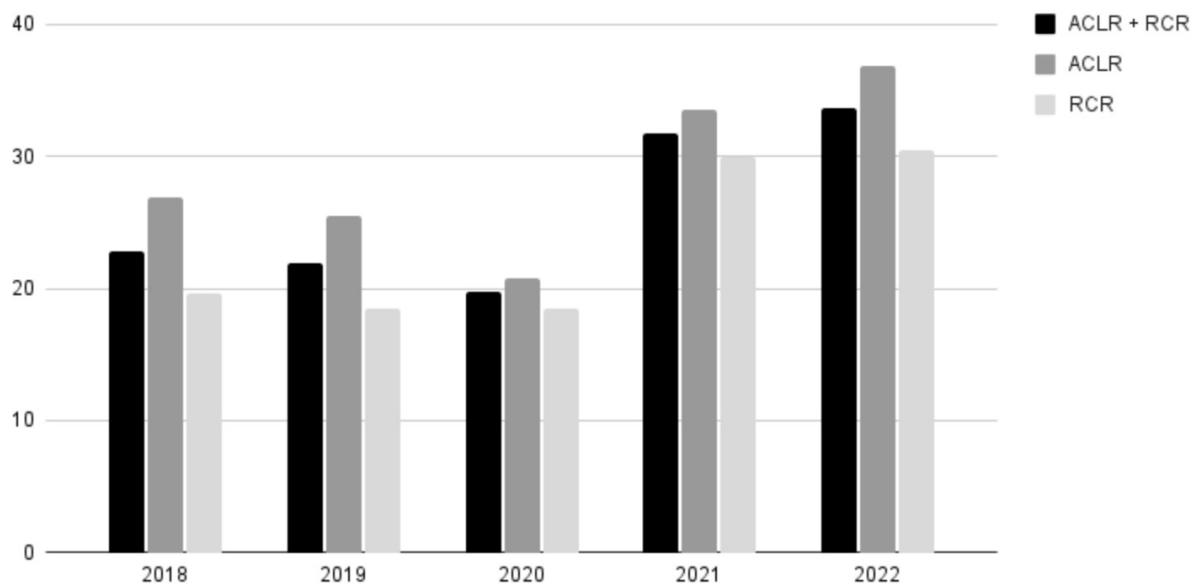
DISCUSSION

Anterior cruciate ligament and rotator cuff tears are commonly encountered orthopedic pathologies that often require operative intervention.^{16,17} As a result, annual volumes of arthroscopic procedures performed in the US have risen, accounting for a significant portion of orthopedic surgeries.¹⁸ Patients of younger age are more likely to sustain ACL injury, in contrast to older age groups who are more likely to sustain rotator cuff tears.^{17,19} As such, it is pertinent to understand the prescription patterns of these procedures to avoid inappropriate inadvertent overprescribing of opioids affecting multiple age groups. The study yielded several patterns in opioid administration following ACLR and RCR, including an overall increasing MME trend and higher MME post-ACLR compared to RCR, with variation in MME amongst healthcare institutions in recent years.

In this retrospective study, the average MME for combined ACLR/RCR increased from 23 ± 11 in 2018 to 34 ± 24 in 2022 ($P < .0001$). ACLR increased from 26 ± 10 to 37 ± 26 ($P < .0001$) when administered in the hospital setting. Similarly, Marrache et al. found a significant increase in the number of opioid prescriptions from 2010 to 2017 (62% in 2010 and 83% in 2017; $P < 0.001$).²⁰ In contrast to this trend, Kamci et al. found a 65% reduction in opioid prescriptions following ACLR from 475 ± 124 to 311 ± 115 ($P < .001$) following legislation limiting allowed provider prescription.²¹ Average MME administered post RCR increased from 20 ± 11

Table 1. Average 5-year MME means with standard deviation (SD) for combined ACLR/RCR and individual surgeries with respective P-values included.

Year	Average MME $\pm$ Standard Deviation (SD) (%)					P-Value
	2018 (N=248)	2019 (N=266)	2020 (N=282)	2021 (N=775)	2022 (N=558)	
Combined Institutions	23 $\pm$ 11	22 $\pm$ 10	20 $\pm$ 10	32 $\pm$ 24	34 $\pm$ 24	<.0001
ACLR	27 $\pm$ 10 (43%)	23 $\pm$ 9.9 (49%)	21 $\pm$ 11 (55%)	34 $\pm$ 27 (49%)	37 $\pm$ 26 (50%)	<.0001
RCR	20 $\pm$ 11 (57%)	19 $\pm$ 9.6 (51%)	19 $\pm$ 9.3 (45%)	30 $\pm$ 22 (51%)	31 $\pm$ 22 (50%)	<.0001

Combined Institutions**Figure 1. Average 5-year MME trend by surgery type.****Table 2. Average MME trend by institution and surgery type.**

Institution	Average MME $\pm$ Standard Deviation (SD) (%)			P-Value
	Institution 1	Institution 2	Institution 3	
2021	23 $\pm$ 9.5	15 $\pm$ 12	42 $\pm$ 27	<.0001
2022	23 $\pm$ 8.5	23 $\pm$ 17	38 $\pm$ 26	<.0001
Surgery	ACLR	RCR		
2021	34 $\pm$ 27	37 $\pm$ 26		0.0451
2022	30 $\pm$ 22	31 $\pm$ 22		0.0018

to 31 $\pm$ 22 ($P < .0001$). Day et al. similarly found an opposing trend between 2010 and 2020, with a 66% reduction in opioid prescription following RCR from 1001.5 MME to 341.1 MME.²² Geographic trends in opioid prescribing have been noted, with West Coast and Southern states accumulating higher proportions of opioid prescriptions when compared to East Coast states. Marrache et al. found New York to prescribe opioids following ACLR with a proportion of

61%-67%, followed by increased proportions in Louisiana, in which Oschner Health System is based, (67%-70%) and Iowa (70%-74%).^{20,23}

When comparing opioid administration patterns post ACLR and RCR, there was higher opioid consumption post-ACLR in 2021 (34 $\pm$ 27 vs 30 $\pm$ 22, $P = 0.0451$) and 2022 (37 $\pm$ 26 vs 31 $\pm$ 22, $P = 0.0022$). In contrast, a systematic review by Sheth et al. found patients undergoing RCR had

the highest levels of opioid consumption when compared to other arthroscopic procedures, including ACLR.²⁴ It is important to note that Sheth et al. took into consideration total opioids prescribed following RCR, in contrast to this study, which only takes into account opioids administered immediately post-operatively, excluding subsequent prescriptions. Regional nerve blocks for relieving postoperative pain may explain this discrepancy as interscalene, suprascapular, and axillary nerve blocks have been successfully utilized to reduce postoperative pain up to 48 hours after RCR.²⁵ ACL injuries have been found to predominantly affect males between 19 and 25 years and females between 14 and 18 years.¹⁷ Postoperative analgesia is often the first opioid exposure for the pediatric population. With increasing rates of ACL injury and subsequent ACLR, adolescent athletes are at particularly high risk for developing opioid use disorder following operative repair.¹⁹ Cahhan et al. found the annual incidence of opioid use disorder of 0.7% following ACLR in pediatric patients, a possible increase from the baseline prevalence of 0.6% in the overall pediatric patient population.^{26,27} In contrast, advanced age is associated with a higher incidence of rotator cuff tears, with rates as high as 80% in patients older than 80, with operative repair more commonly performed for treatment.^{28, 29} However, female sex and younger age are predictors of higher MME prescription post-RCR, necessitating the need for appropriate prescriptions in the commonly opioid-naïve population.²²

In 2021 and 2022, there was a significant difference in average MME when comparing individual healthcare institutions ($P<.0001$). Similar studies found different opioid prescribing guidelines across different healthcare organizations.³⁰ In efforts to remedy these differences, the American Academy of Orthopedic Surgeons (AAOS) has called for standardization of opioid prescribing practices, but institutional guidelines do not yet exist.³¹ In a sample orthopedic department opioid safety strategy, the AAOS suggested prescription of no more than 30 opioid pills of a maximum of 5 mg of oxycodone (or equivalent) per pill, a single refill with no more than 15 pills, and discontinuation of opioids within two weeks of surgery following intermediate orthopedic surgery including arthroscopy. However, the AAOS does not support specific guidelines that can be utilized across all patient populations to replace clinical judgment or individualized patient-centered care.³²

Recent evidence-based opioid prescription guidelines following shoulder surgery by Graham et al. recommend dispensing reduced quantities of opioids after surgery and prioritizing prescription refill requests over potentially excessive initial prescriptions.³³ Risk factors for potential opioid abuse should be considered prior to prescription in addition to preoperative patient counseling on proper opioid use. Preoperative opioid education has been shown to significantly reduce opioid consumption postoperatively when compared to patients not receiving opioid education with no adverse effects on pain experience.³⁴ Multimodal nonopioid regimens have been shown to provide equivalent or better pain control compared to traditional opioid analgesics in patients undergoing arthroscopic RCR and

ACLR.^{35,36} Acetaminophen, when used in multimodal regimens, has been shown to significantly reduce opioid consumption following surgery when taken as a standing order rather than on an as-needed basis (PRN).³⁷ Non-steroidal anti-inflammatory drugs (NSAIDs) demonstrated a significant reduction in opioids postoperatively when compared to placebo groups.^{38,39} However, cyclooxygenase type-2 (COX-2) selective NSAIDs have been associated with poor osteotendinous healing in the rotator cuff and ACL-related studies with increased retear rates at follow-up visits compared to placebo groups.^{40,41} Peripheral nerve blocks have been shown to reduce time in the postoperative recovery unit and reduce opioid requirements during hospitalization after RCR. However, with no reduction in opioid requirement following ACLR.⁴²⁻⁴⁴

This study has several limitations. First, there were unequal proportions of patient data provided by the three individual institutions in addition to unequal proportions by surgery type and overall period of data contributed, which may influence the overall trends and pattern. The data also does not contain opioid prescriptions at follow-up visits, and the overall actual consumption of prescription opioids is not known. Additionally, the data does not include patient demographics such as age and sex, which can be pertinent to the patient population observed in this study. Lastly, opioid prescribing patterns at three institutions may be informative but cannot be representative of other centers or regions. Future studies should aim for more comprehensive and longitudinal data to better understand the root causes of opioid administration patterns.

CONCLUSION

Opioid administration following RCR and ACLR has increased in recent years with differences in average MME across individual healthcare institutions. Interventional efforts should continue to be made in reducing opioid prescriptions following these surgeries and standardizing prescription guidelines across all healthcare settings to continue mitigating long-term use and abuse.

DECLARATION OF CONFLICT OF INTEREST

Dr. Ahmed Siddiqi is a board member and stock options in AZ Solution LLC, stock options in ROMTech, stock options and board member of Stabl.

DECLARATION OF FUNDING

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DECLARATION OF ETHICAL APPROVAL FOR STUDY

Not Required; exempt from the IRB

DECLARATION OF INFORMED CONSENT

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There is no information in the submitted manuscript that can be used to identify patients.



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