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Limiting Opioid Prescription after Anterior Cruciate Ligament Reconstruction: A Study of 749 Consecutive Cases

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Abstract

Purpose: We document the postoperative opioid use in 749 consecutive patients after Anterior Cruciate Ligament Reconstruction (ACLR). We define three groups of total postoperative opioid usage: 0-1 week, 1-2 weeks and greater than 3 weeks; and define characteristics correlated to each group. Postoperative opioid used was measured by the number of prescriptions given.

Methods: Opioid was prescribed in quantities not to exceed a one-week supply. In Group 1, a single prescription of opioid converted to a maximum of 300-375 Morphine Milligram Equivalent (MME) or less(which is equivalent to hydrocodone 7.5 mg per tablet with a total number of 40-50 tablets or less). In Group 2, two prescriptions of opioid, converted to 376-750 MME. In Group 3, three prescriptions or more converted to 751 or greater MME. The following demographics and characteristics were identified for each group: age, gender, tobacco smoke, regular alcohol use, diabetes, anxiety or depression, worker's compensation, history of chemical dependence, and history of intravenous drug use. The following concomitant surgical procedures were identified for each group: menisectomy, chondroplasty, meniscal repair, and microfracture.

Results: The great majority of patients, 634 (85%), were in Group 1 requiring no more than a single prescription, one week or less, of opioid. The 115 patients (15%) that exceeded the typical range of the Group 1 opioid requirement (Group 2 & 3) had a statistically significant ($p<0.05$) association with increased age, alcohol usage, tobacco smoking; anxiety or depression (Group 2 only); and concomitant microfracture.

Conclusion: We recommend limiting the initial opioid prescription not to exceed a one-week supply or less (300-375 MME or less) after ACLR. This amount satisfied the opioid requirement for 85% of our patients undergoing primary allograft ACLR. In the last year of this study, opioid prescription did not exceed 300 MME and no opioid prescription exceeded forty tablets. Increased age, alcohol use, tobacco smoking, anxiety or depression and microfracture were significantly associated with increased opioid usage.

Clinical Significance: This information should help leave fewer unused opioid in the possession of patients, leaving fewer pills vulnerable to misuse, abuse, and diversion. Another goal would be to use this information to help develop a postoperative pain management protocol or guidelines after ACLR.

Keywords: ACL reconstruction; Opioid; Age; Alcohol; Tobacco; Anxiety; Depression; Microfracture

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Introduction

Physicians and surgeons are at the forefront of a now recognized opioid epidemic with more than 130 people in the United States dying daily from an opioid overdose [1]. The total "economic burden" of prescription opioid misuse alone in the United States is $78.5 billion dollars a year, including the costs of healthcare, lost productivity, addiction treatment and criminal justice [2]. One in five adolescents and emerging adults have reported prescription opioid misuse, posing significant risks for opioid-related adverse outcomes [3]. About 80% of people who use heroin first misused prescription opioid [4].

In the recent past, acute pain was often considered undertreated and addiction thought to be rare [5,6]. Aggressive postoperative pain management was promoted and eventually mandated

[7,8]. As a result, opioid have become the most common class of medication prescribed in the United States [9]. Orthopedists, by the nature of many musculoskeletal injuries and surgeries, are one of the top three specialties prescribing opioid medication across all medical specialties [10].

Anterior Cruciate Ligament Reconstruction (ACLR) is one such surgery that often requires opioid medication in the immediate postoperative period. With an annual incidence of 68.6 per 100,000 person-years, isolated ACL tears remain a common orthopedic injury [11]. Pain management after ACLR has been studied to varying degrees [12-17]. Approximately three decades ago, ACLR was done on an inpatient basis. A few years later, ACLR was transitioning to an outpatient surgery; one of the primary concerns was the challenge of pain management in the outpatient setting [17].

It is essential to try and define the minimal amount of opioid necessary for a particular procedure to better understand over-prescription [18]. A recent study of 182 patients undergoing ACLR found the mean time to discontinue opioid medication was 9 days after surgery [16]. Anthony et al. [13] found that opioid demand after ACLR dropped significantly in the vast majority of patients by the 3rd postoperative month. Surprisingly, 35% of patients undergoing ACLR were found to be using opioid medications preoperatively. Preoperative opioid usage resulted in a 5 to 7-fold increase in postoperative opioid demand [13].

Prescribing patterns vary widely, and a large amount of opioid medications remain unused following elective orthopaedic surgical procedures. Effective prescribing protocols are needed to limit this source of potential abuse and opioid diversion within the community [19]. Earp et al. [20] demonstrated that by utilizing a simple postoperative consensus protocol, the number of opioid prescribed decreased without leading to an increase in the number of secondary prescriptions written by providers. Recently, the Hospital for Special Surgery developed a prescriber education program and followed up with consensus-based guidelines for postoperative opioid prescriptions. These interventions resulted in a significant decrease in excessive opioid-prescribing practices after ambulatory orthopaedic surgery [14].

We present a six-year experience, with a single surgeon using the same primary ACLR technique. We document the postoperative opioid use in 749 consecutive patients. We define three groups of total postoperative opioid usage after ACLR; 0-1 week, 1-2 weeks and greater than 3 weeks; and define demographics, characteristics, and concomitant procedures associated each group. Our goal was to find the minimal amount of opioid medication necessary to provide adequate pain relief for the majority of patients, while at the same time practice responsible opioid stewardship. This data should help with protocol driven guidelines for opioid prescription after ACLR.

Statistical significance was recognized at a p-value less than our α of 0.05, which would allow us to reject the null hypothesis, that the 3 opioid risk groups are independent of the specific demographic, characteristic, or concomitant surgical procedure.

Methods

Seven-hundred-forty-nine consecutive primary ACLR from 2013-2018 were reviewed. The average age was 31 years old. There were 325 (43%) females and 424 (57%) males. All patients included in the study had a fresh-frozen, age-matched; posterior tibial is allograft with EndoButton (Smith & Nephew Endoscopy) femoral fixation and Intrafix (Mitek) tibial fixation. Auto graft ACLR and revision ACLR were excluded in order to keep the group as homogenous as possible with regard to pain management requirements.

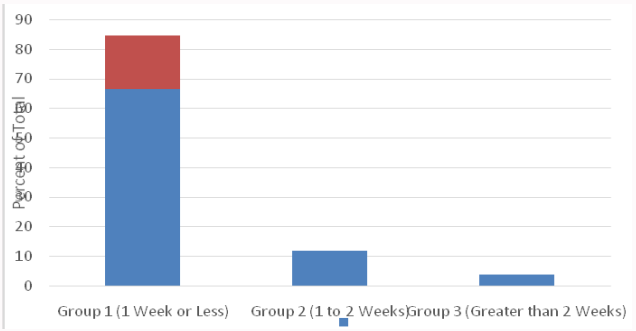

Figure 1: The majority of patients (85%) were in Group 1, using 1-week or less of opioid medication after ACLR (one prescription of 375 morphine milligram equivalents or less). In the last year of the study, 137 (22%) of Group 1 patients did not exceed 300 morphine milligram equivalents with their single 1-week prescription.
Eighty-eight (12%) patients were in Group 2, using 1-2 weeks of opioid medication after ACLR (two prescriptions of 376-750 morphine milligram equivalents or less).
The minority of patients, twenty-seven (3.65%), were in Group 3, using greater than 2-weeks of opioid medication after ACLR (three prescriptions of more than 751 morphine milligram equivalents).

All patients received ketorolac 30 mg and/or acetaminophen 1000 mg intravenously during the ACLR, unless there was a contraindication. No regional nerve blocks were used. All patients received 10 cc bupivacaine 0.25% bupivacaine with epinephrine injected locally into the incisions and joint at the end of the procedure, unless there was a contraindication. Compression cryotherapy with a gravity fed Cryocuff (Aircast) was used regularly for the first four weeks postoperatively. All patients used anti-inflammatory medication for at least 4 weeks after surgery unless there was a contraindication.

Postoperative opioid used was measured by the number of prescriptions given. Opioid was prescribed in quantities not to exceed a one-week supply. All opioid prescriptions were converted to morphine milligram equivalents (Table 1). The patients were stratified into three groups dependent on the amount and length of time that opioid was used. In Group 1, a one-week, single prescription of opioid converted to a maximum of 300-375 morphine milligram equivalents or less (which is equivalent to hydrocodone 7.5 mg per tablet with a total number of 40-50 tablets or less). In Group 2, two prescriptions not exceeding a two-week supply of opioid, converted to 376-750 morphine milligram equivalents. In Group 3, three prescriptions or more exceeding a two-week supply of opioid, converted to 751 or greater morphine milligram equivalents (Figure 1).

In the last year of this study, no opioid prescription exceeded a maximum of 300 morphine milligram equivalents and no opioid prescription exceeded forty tablets. The following demographics and characteristics were identified for each of the three groups: age, gender, tobacco smoke, regular alcohol use, diabetes, anxiety or depression, worker's compensation, history of chemical dependence, and history of intravenous drug use. The following concomitant surgical procedures were identified for each of the three groups: menisectomy, chondroplasty, meniscal repair, and microfracture. Statistical testing was done with a Fischer's Exact Test for Count Data

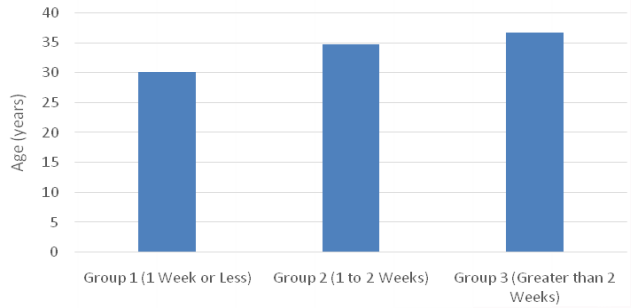

Figure 2: The average patient age demonstrated a statistically significant ($p<0.05$) increase as opioid usage increased from Group 1, to Group 2, and to Group 3.

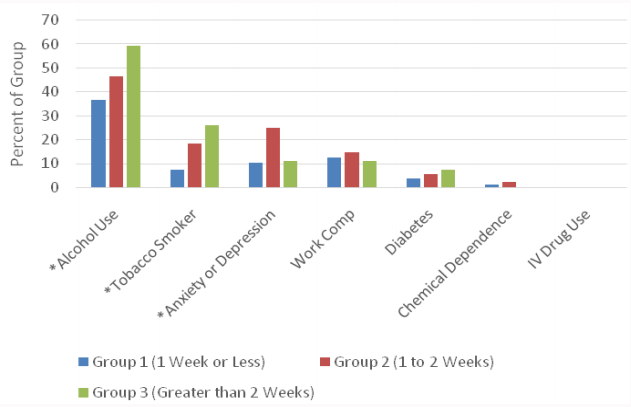

Figure 3: There was a statistically significant ($p<0.05$)* increased opioid usage with alcohol usage, tobacco smoking, and anxiety or depression. There was no statically significant difference ($p>0.05$) between increased opioid usage and diabetes, worker's compensation, chemical dependence history, or intravenous drug use history.

between Group 1, Group 2, and Group 3. The same statistical testing was also applied between Group 1 and Group 2, between Group 1 and Group 3, and between Group 2 and 3. This was done for all the above listed demographics, characteristics, and concomitant surgical procedures.

Results

The great majority of patients, 634 (85%), were in Group 1 requiring no more than a one week or less, single prescription, supply of opioid (which is equivalent to hydrocodone 7.5 mg per tablet with a total number of 40-50 tablets or less) (Figure 1). The average age was 30 years old (Figure 2) and 268 (42%) were female and 366 (58%) were male. 46 (7%) were tobacco smokers, 233 (37%) were regular alcohol users, 23 (4%) were diabetic, 65 (10%) had anxiety or depression, 79 (12%) had a worker's compensation claim, 7 (1%) had a history of chemical dependence, and 4 (0.1%) had a history of intravenous drug use (Figure 3). Partial menisectomy was done in 492 (78%) patients, meniscal repair was done in 26 (4%) of patients, microfracture was done in 11 (1%) patients, and chondroplasty was done in 152 (20%) of patients (Figure 4).

In the last year of this study, no opioid prescription exceeded 300 morphine milligram equivalents and no opioid prescription exceeded forty tablets. This reduced opioid prescription represented 137 (22%) of the patients in Group 1. (Figure 1) Six patients in this group, who had a history of chemical dependence or for other reasons, at their

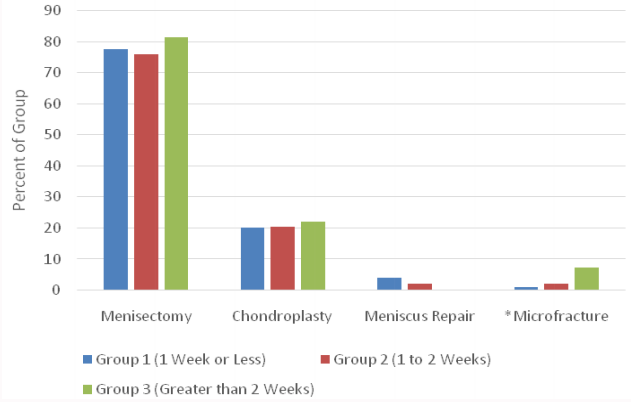

Figure 4: There was a statistically significant ($p<0.05$)* increased opioid usage with the concomitant procedure of microfracture with ACLR. There was no statically significant difference ($p>0.05$) between increased opioid usage and the concomitant procedures of menisectomy, chondroplasty or meniscal repair.

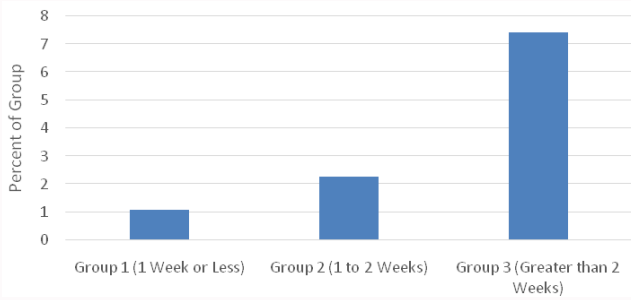

Figure 5: There was a statistically significant ($p<0.05$) increased opioid usage with the concomitant procedure of microfracture with ACLR.

request, received no opioid prescription in the postoperative period after ACLR.

Of the 749 patients, 88 (12%) were in Group 2, requiring no more than two prescriptions of opioid for a supply of two weeks or less (Figure 1). The average age was 35 years old (Figure 2) and 45 (51%) were female and 43 (49%) were male. 16 (18%) were tobacco smokers, 41 (47%) were regular alcohol users, 5 (6%) were diabetic, 22 (25%) had anxiety or depression, 13 (15%) had a worker's compensation claim, 2 (2%) had a history of chemical dependence, and 0 (0%) had a history of intravenous drug use (Figure 3). Partial menisectomy was done in 67 (76%) patients, meniscal repair was done in 2 (2%) of patients, microfracture was done in 2 (2%) patients, and chondroplasty was done in 18 (20%) of patients (Figure 4).

The minority of patients, 27 (3.6%), were in Group 3 using opioid for greater than two weeks; requiring 3 opioid prescriptions or more (Figure 1). The average age was 37 years old (Figure 2) and 12 (44%) were female and 15 (56%) were male. 7 (26%) were tobacco smokers, 16 (59%) were regular alcohol users, 2 (7%) were diabetic, 3 (11%) had anxiety or depression, 3 (11%) had a worker's compensation claim, 0 (0%) had a history of chemical dependence, and 0 (0%) had a history of intravenous drug use (Figure 3). Partial menisectomy was done in 22 (81%) patients, meniscal repair was done in 0 (0%) of patients, microfracture was done in 2 (7.4%) patients, and chondroplasty was done in 6 (22%) of patients (Figure 4).

There was a statistically significant ($p=0.0002$) association between increasing opioid usage after ACLR and increasing age

Table 1: Morphine Milligram Equivalent (MME) conversion chart.

Opioid	Conversion Factor (convert to MMEs)
Codeine	0.15
Fentanyl (MCG/hr)	2.4
Hydrocodone	1
Hydromorphone	4
Morphine	1
Oxycodone	1.5
Oxymorphone	3
Tramadol	0.1

(Figure 2). Gender difference was not associated with a statistically significant ($p>0.05$) increase in opioid usage.

There was a statistically significant increased opioid usage and alcohol usage between the three Groups ($p=0.007$) and between Group 1 and 2 ($p=0.030$) and between Group 1 and 3 ($p=0.024$). There was no statistically significant difference between Group 2 and 3 ($p>0.05$) (Figure 3).

There was a statistically significant increased opioid usage and tobacco smoking between the three Groups ($p=0.0001$) and between Group 1 and 2 ($p=0.002$) and between Group 1 and 3 ($p=0.004$). There was no statistically significant difference between Group 2 and 3 ($p>0.05$) (Figure 3).

There was a statistically significant increased opioid usage and anxiety or depression between the three Groups ($p=0.0001$) and between Group 1 and 2 ($p=0.003$). There was not a statistical difference ($p>0.05$) between Group 1 and 3 or between Groups 2 and 3 (Figure 3). There was no statistically significant ($p>0.05$) differences between increased opioid usage and diabetes, worker's compensation, chemical dependence history, or intravenous drug use history for the three groups (Figure 3).

There was a statistically significant ($p=0.032$) positive association between increased opioid usage and the concomitant procedure of microfracture with ACLR (Figures 4 and 5). There was no statistically significant ($p>0.05$) association between increased opioid usage and the concomitant procedures of menisectomy, meniscal repair, or chondroplasty with ACLR (Figure 4).

Discussion

In elective orthopedic surgery, prescribing patterns vary widely, and a large amount of opioid medication remains unused [9]. We define the morphine milligram equivalents required for 749 patients undergoing ACLR in order to help establish protocol guidelines. Effective prescribing protocols are needed to limit this source of potential abuse and opioid diversion within the community [9].

Opioid use after orthropaedic surgery has been a significant issue [10,12,13-17,19,21,22]. After ACLR acute pain management is routinely necessary. Scully et al. [23] found that the median time and early nadir for opioid prescription use after musculoskeletal procedures was 6-15 days. Obermeier et al. [16], in a recent study of 182 patients undergoing ACLR found a 9 day mean time to discontinue opioid medication. The majority of patients in our study, 85%, fell into Group 1 and required no more than one week of opioid medication or 300-375 morphine equivalents or less. This would translate into a typical maximum prescription of forty-fifty 7.5 mg hydrocodone tablets with 325 mg of acetaminophen. Only 3.6% of patients, Group 3, required more than 751 morphine equivalents or greater than one-hundred, 7.5 mg hydrocodone tablets with 325 mg of acetaminophen. One milligram of hydrocodone is equal to one morphine milligram equivalent (Table 1).

We have studied the characteristics and found that the small number of patients that exceed the typical range of the Group 1 opioid requirement have a statistically significant ($p<0.05$) association with increasing age, alcohol usage, tobacco smoking, anxiety or depression, and concomitant microfracture. There were more than twice as many patients with anxiety or depression in Group 2 compared to either Group 1 or Group 3; making the significance uncertain.

In agreement with our study, Wojan et al. [22] also found that increased opioid consumption after knee arthroscopy was associated with smoking. Similarly, in agreement with our study, Anthony et al. [13] found a significant positive association with increased opioid consumption and microfracture done at the time of ACLR. We found a statistically significant ($p<0.05$) relationship of increased opioid consumption with increasing age at the time of ACLR. This is in contrast with Anthony et al. [13], who found that patients younger than 25 years of age had an increased risk of filling opioid prescriptions after ACLR at all time points of their study.

We did not see a statistically significant ($p<0.05$) difference for increased opioid usage and gender, diabetes, workers compensation claim, history of chemical dependence or history of intravenous drug usage. There was also not a positive association for increased opioid usage and concomitant menisectomy, meniscal repair, or chondroplasty done at the time of ACLR. In contrast, Wojan et al. [22] found increased opioid usage if meniscal repair was done at the time of knee arthroscopy without ACLR.

We used intra-articular bupivacaine injections, compression cryotherapy and non-steroidal anti-inflammatory medication in the post-operative period. All of which have been shown to decrease opioid consumption after ACLR [15]. A complexity of our study could be in how we identified our three groups based on the amount of medication given or number of weekly prescriptions. If a patient took the medication at a lesser dose or frequency than the regular intervals, they could have taken medication longer than one week. So some Group 1 patients may have taken their medication longer than one week, but still did not exceed the single initial one-week maximum prescription amount of opioid medication; 300- 375 morphine milligram equivalents. A weakness of our study is that we were not able to identify patients that did not use their complete prescription; thus leaving the potential unused opioid medication. There is also the possibility that a patient may have obtained opioid medication form another source that was not identified in the medical record.

In the last year of this study, in recognition of the growing opioid crisis, no one-week, opioid prescription exceeded 300 morphine milligram equivalents and no opioid prescription exceeded forty tablets. This represented 137 (22%) of the patients in Group 1 (Figure 1).

Six patients requested no opioid prescription after ACLR, typically at the patient request because of a history of chemical dependence, and had successful recovery.

Based on our results the vast majority of patients required no more than one prescription equal to maximum 300-375 morphine

milligram equivalents of opioid medication after ACLR. In this study population, certain factors were associated with increased opioid usage including increased age, alcohol usage, tobacco smoking, diabetes, and microfracture surgery. Marijuana usage was not identified in this patient population; which has recently shown a correlation with increased opioid use after orthopaedic trauma surgery [21]. We also could not accurately record patients that were using opioid medication preoperatively in this study group; there has been a correlation with increased opioid requirement after ACLR [13] and after knee arthroscopy [22]. Anthony et al. [13] also noted that in their patient population that opioid requirement after ACLR decreased significantly by the third postoperative month. That was much longer than what we observed in this current study population of 749 patients, where we observed the majority of patients, 85%, requiring no more than one week of opioid medication.

Earp et al. [20] demonstrated that by utilizing a simple postoperative consensus protocol, they decreased the number of opioid prescribed without leading to an increase in the number of secondary prescriptions written by providers [20].

We recommend limiting the initial opioid prescription not to exceed one-week supply or less (300-375 morphine milligram equivalents or less) after ACLR. For example, this would equate to a maximal dose of hydrocodone 7.5 mg per tablet with a total number of 40-50 tablets. This amount satisfied the total opioid requirement for 85% of our patients undergoing primary ACLR with allograft. Subsequent prescriptions should be done in an individualized manner recognizing certain risk factors (including increased age, alcohol use, tobacco smoking, anxiety or depression, and concomitant microfracture) for increased opioid demand, balancing analgesia with opioid stewardship. This information should help leave fewer unused opioid in the possession of patients, leaving fewer pills vulnerable to misuse, abuse, and diversion. Another goal would be to use this information to help develop a postoperative pain management protocol or guidelines after ACLR.

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