



Prospective Evaluation of Opioid Consumption in Multimodal Analgesia following Isolated Hallux Valgus Correction or First MTP Joint Arthrodesis

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Introduction

Postoperative pain management following orthopaedic surgery is critical as the amount of pain is the most important element of patient satisfaction after surgery.¹ Prescription opioids are commonly used to manage postoperative pain. The number of opioid prescriptions has been increasing dramatically over the past few decades in the United States²⁻⁴ approximately tripling from 76 million in 1991 to 207 million in 2013.⁵

The consequences of increased opioid prescriptions in the United States includes deaths due to opioid-related overdoses tripling, increasing from approximately 17,500 in 2006 to 42,200 in 2016.⁶ Furthermore, the US Department of Health and Human Services declared the opioid crisis a national public health emergency in October 2017.⁷ Orthopaedic surgeons are the fourth-highest group of opioid prescribers (7.7% of total prescriptions) among physicians based on private pharmacy prescription data in 2009 behind primary care physicians with 28.8%, followed by internists (14.6%), and dentists (8.0%). Multiple previous studies demonstrated that opioids were overprescribed after outpatient foot and ankle surgery.^{5,8,9} However, it is difficult to establish a guideline prescribing opioids because of wide variability in both prescription and consumption of opioids based on procedure type and location. A multimodal pain protocol proposed by Michelson et al.¹⁰ seems to have favorable outcomes including less adverse effects of opioid in patients undergoing ankle and hindfoot fusion. However, there is still limited evidence in foot and ankle surgery regarding the use of multimodal pain regimens. With a lack of evidence, the appropriate amount of opioid to prescribe following foot and ankle procedures is still controversial and unclear.

Hallux valgus is one of the most common forefoot deformities with a prevalence of 15.0% among people younger than 18 years and 26.3% for ages 18 to 65 years in a recent meta-analysis.¹¹ Operative correction of hallux valgus is one of the most common elective operative procedures in the field of foot and ankle. Hallux rigidus is

another common forefoot disorder with an estimated incidence of one in 40 in patients aged over 50 years.¹² Though there are many different operative techniques, first metatarsophalangeal (MTP) joint arthrodesis is a well-established procedure in the treatment of severe hallux rigidus. As these two most common forefoot operative procedures can reflect a pattern of opioid consumption following elective forefoot surgery, we chose them for this study.

The purpose of this study was to prospectively investigate opioid consumption using a multimodal analgesia regimen after two common forefoot surgeries: isolated hallux valgus correction or first MTP joint arthrodesis.

Methods

This is a prospective cohort study conducted at a single academic institution. Approval from our institutional review board was obtained prior to the initiation of this study and written informed consent was obtained from all patients before the study. We prospectively enrolled 21 patients who underwent isolated hallux valgus correction or first MTP joint arthrodesis with three foot and ankle fellowship-trained orthopaedic foot and ankle surgeons between January 2019 and December 2019. Patients were included if their age was between 18 and 80 years old and underwent an outpatient operative procedure for hallux valgus correction with distal soft tissue procedure and proximal first metatarsal crescentic osteotomy or first MTP joint arthrodesis in isolation. Exclusion criteria were (1) Individuals outside of age range (2) current or chronic opioid therapy (3) Inability to take ibuprofen or acetaminophen (4) Patients underwent any additional operative procedures (5) Inpatient procedures, and (6) Revision surgery. Patients were instructed to take 5mg of oxycodone every 4 hours as needed for pain, and 600 mg of ibuprofen as well as 1,000 mg of acetaminophen every 8 hours regularly. As a part of multimodal analgesia, all patients had the same type of regional ankle block with 20 ml of 0.5% bupivacaine and 20 ml of 2% lidocaine under monitored anesthesia care (MAC). In this study,

only one type of opioid, 5mg of oxycodone, was prescribed to patients. The number of oxycodone pills that the patient consumed was recorded at postoperative followup at 1 week, 2 weeks, 4 weeks, 8 weeks, and 12 weeks. This was performed in person or through a phone interview by a member of the research team. Any medication including Aspirin for deep vein thrombosis prophylaxis was not considered as patients were allowed to ambulate in the postoperative shoe immediately after the surgery.

A chart review was performed to investigate patient demographic and operative data from the electronic medical record. Demographics included age, sex, body mass index (BMI), smoking, diabetes mellitus, rheumatoid arthritis, and other comorbidities. Operative data review confirmed anesthesia type, type of procedure, prescription type and amount written at the time of surgery, and perioperative nerve block type. Only those who underwent hallux valgus correction or first MTP joint arthrodesis in isolation without any concomitant procedures were included to evaluate opioid consumption following these two most common forefoot surgeries. Three subgroup analysis were performed in this study. The first subgroup analysis was to evaluate opioid consumption according to the prescription type: Only oxycodone was prescribed in group A (n = 10) while oxycodone as well as prescription strength ibuprofen and acetaminophen were prescribed in group B (n = 11). The prescription type between prescription strength and OTC was determined by patients' preferences. However, the same dosages of ibuprofen and acetaminophen were utilized for all patients in this study. The second subgroup analysis was performed based on the quantity of opioid prescription. Patients were stratified into two subgroups: ≤ 30 pills in group C (n = 10) while > 30 pills in group D (n = 11). The third subgroup analysis was based upon the procedure type: Hallux valgus correction group (n = 10) vs first MTP joint arthrodesis group (n = 11).

A total of 21 patients were included in the final analysis. The mean age of the cohort was 55.8 ± 13.8 (range, 25 to 74) years. Most patients were female (85.7%). The proportion

of hallux valgus correction and first MTP joint arthrodesis in this study was 38.1 % (8/21) and 61.9 % (13/21), respectively. Patient demographics data is shown in Table 1.

All statistical analyses were performed with SPSS software (version 21.0; IBM, Armonk, NY, USA). The Mann-Whitney test was used to compare continuous or continuously ranked data, including the amount of oxycodone consumption between subgroups. The chi-square test or Fisher exact test was used to access categorical values between the subgroups. Statistical significance was set as $p < 0.05$.

Results

The overall mean opioid consumption following isolated hallux valgus correction with distal soft tissue procedure and proximal first metatarsal crescentic osteotomy or first MTP joint arthrodesis at 12 weeks postoperatively was 16.2 ± 14.7 (median, 9; range, 0 to 51) pills while 37.3 ± 9.4 (median, 40; range, 28 to 60) pills were prescribed on the average. The amount of opioid consumption at each followup was shown in Table 2. Five out of 21 patients required oxycodone at 2 weeks postoperative followup, and two patients consumed oxycodone at 4 weeks postoperative followup. Only one patient consumed oxycodone at 12 weeks postoperative followup.

Patients were asked to complete a survey at each postoperative followup, which included pain score during activity and pain control satisfaction with our multimodal analgesia protocol. The average VAS pain score during activity including walking, climbing stairs, or housework at each postoperative followup is shown in Table 3. Regarding patients' satisfaction with pain control, 10 out of 21 patients were extremely satisfied, six patients were satisfied, three patients were neutral, and one patient was unsatisfied at 1 week postoperative followup. Beyond the postoperative 2 weeks followup, 100 % of patients were satisfied or extremely satisfied in pain control: 62.5 % were extremely satisfied, and 37.5 % were satisfied at 2 weeks; 60 % were extremely satisfied,

Table 1. Patient demographics

Characteristic	
Age, yr, mean \pm SD (range)	55.8 \pm 13.8 (25 to 74)
Sex, n, male/female	3/18
Body mass index (BMI), kg/m ² , mean \pm SD (range)	26.6 \pm 4.8 (20.7 to 36.8)
Active smoker, n, yes/no	1/20
Diabetes Mellitus, n, yes/no	0/21
Rheumatoid arthritis, n, yes/no	0/21

Table 2. The amount of opioid consumption at each postoperative followup

	1 week	2 weeks	4 weeks	8 weeks	12 weeks
Opioid consumption (Pills, mean \pm SD (median, range))	12.8 \pm 11.2 (median, 7; range: 0 to 32)	2.9 \pm 6.6 (median, 0; range: 0 to 26)	0.7 \pm 1.6 (median, 0; range: 0 to 5)	1.3 \pm 3.6 (median, 0; range: 0 to 12)	0.7 \pm 2.4 (median, 0; range: 0 to 8)

Table 3. The average VAS pain score at each postoperative followup

	1 week	2 weeks	4 weeks	8 weeks	12 weeks
VAS pain score (mean \pm SD (median, range))	3.7 \pm 2.5 (median, 2.8; range: 0 to 9.1)	2.8 \pm 2.2 (median, 2.8; range: 0 to 7.4)	0.5 \pm 0.6 (median, 0.5; range: 0 to 1.6)	0.7 \pm 0.7 (median, 0.5; range; 0 to 2)	1.0 \pm 1.1 (median, 0.5; range: 0 to 3.3)

and 40 % were satisfied at 4 weeks; 90.9 % were extremely satisfied, and 9.1 % were satisfied at 8 weeks; 76.9 % were extremely satisfied, and 23.1 % were satisfied at 12 weeks.

In our first subgroup analysis, significant lower opioid consumption was noted in group B when prescription-strength ibuprofen and acetaminophen were prescribed compared to group A when patients took over-the-counter (OTC) ibuprofen and acetaminophen: 24.1 \pm 15.9 (median, 24.5; range, 0 to 51) pills in group A vs 9.0 \pm 9.4 (median, 6; range, 0 to 31) pills in group B ($p = 0.036$) (Table 4). The second subgroup analysis was performed to evaluate the opioid consumption based on the amount of opioid prescription. Group C, which was given less than or equal to 30 pills, consumed 9.8 \pm 9.4 (median, 7; range, 0 to 28) and group D, which was given greater than 30 pills, consumed 22.0 \pm 16.6 (median, 21; range, 0 to 51). There was a trend showing higher opioid consumption in group D prescribed more oxycodone. However, it did not reach a significant difference between the two subgroups ($p = 0.099$) (Table 5). The group of hallux valgus correction consumed 15.8 \pm 17.0 (median, 7; range, 0 to 51) while the group of first MTP joint arthrodesis consumed 16.5 \pm 13.9 (median, 16; range, 0 to 40). There was no significant difference in opioid consumption between the two subgroups ($p = 0.750$) (Table 6).

Discussion

Our findings in this study demonstrated that the average use of 5mg oxycodone was 16.2 pills while the average number of opioid prescribed was 37.3 pills after isolated

hallux valgus correction or first MTP joint arthrodesis using our multimodal analgesia regimen. Only 43.4 % of the opioids that were prescribed were actually used, which is comparable with previous studies. Saini et al.⁵ assessed opioid consumption patterns following outpatient orthopaedic foot and ankle procedures. They found that the utilization rate of opioid was only 50%: a median amount of opioid consumption was 20 pills whereas the median number of pills prescribed was 40. A similar opioid consumption pattern was noted following outpatient foot and ankle procedures in a prospective cohort study of Bhashyam et al.¹³. In their study, 37.4 pills were prescribed, and 18.9 pills were used on average representing 47.6% utilization. Recently, Rogero and colleagues¹⁴ investigated postoperative opioid consumption in patients undergoing operative correction of hallux valgus, including chevron osteotomy, proximal osteotomy, soft tissue/proximal phalanx osteotomy, and first MTP joint arthrodesis. They included only patients who underwent hallux valgus correction and demonstrated that patients consumed a median of 27 pills. Compared with their study which included only forefoot surgeries, our result in opioid consumption was lower. This could be explained with the multimodal analgesia in the current study.

One of the main goals of multimodal postoperative analgesia is to improve patient recovery while reducing the need for opioids and decreasing side effects related to opioids. The multimodal protocol provides more effective pain control than a single intervention by blocking pain generation and perception through multiple pathways.¹⁵⁻¹⁷ Inhibition of the perception of pain is provided by acetaminophen,

Table 4. Opioid consumption according to the prescription type of ibuprofen and acetaminophen

	Group A (n = 10)	Group B (n = 11)	P value
Opioid consumption (Pills, mean \pm SD (median, range))	24.1 \pm 15.9 (median, 24.5; range, 0 to 51)	9.0 \pm 9.4 (median, 6; range, 0 to 31)	0.036

Table 5. Opioid consumption according to the amount of opioid prescribed

	Group C (n = 10)	Group D (n = 11)	P value
Opioid consumption (Pills, mean \pm SD (median, range))	9.8 \pm 9.4 (median, 7; range, 0 to 28)	22.0 \pm 16.6 (median, 21; range, 0 to 51)	0.099

Table 6. Opioid consumption according to the procedure type

	Hallux valgus correction (n = 10)	First MTP joint arthrodesis (n = 11)	P value
Opioid consumption (Pills, mean \pm SD (median, range))	15.8 \pm 17.0 (median, 7; range, 0 to 51)	16.5 \pm 13.9 (median, 16; range, 0 to 40)	0.750

opioids, and possibly COX-2 inhibitors within the central pathway including the brain. Inhibition of inflammation and pain generation is achieved through nonsteroidal anti-inflammatories, specifically the COX-2 inhibitors through the peripheral pathway.¹⁰ Previous studies have demonstrated an opioid sparing effect of multimodal analgesia therapy following total hip replacement, total knee replacement, spine surgery, and shoulder rotator cuff repair.¹⁸⁻²¹ However, there is limited literature regarding multimodal analgesia regimens in the field of foot and ankle. Michelson and colleagues¹⁰ provided evidence that multimodal therapy reduced the length of stay for patients undergoing major hindfoot or ankle fusion surgery in their retrospective study. Further, a systematic review demonstrated that the use of multimodal analgesia in foot and ankle surgery provided superior pain relief, reduction in dependence on opioids, and decreased opioid-related side effects.²² To our knowledge, there is no study investigating the effect of multimodal analgesia focusing on forefoot surgeries. We used a multimodal analgesia regimen as a part of the effort to decrease the amount of opioid that patients consume. With the regimen in the present study, patients were 100% satisfied or extremely satisfied in pain control beyond the postoperative 2 weeks followup representing that pain was controlled adequately in the postoperative period. Furthermore, the consumption of opioid was lower compared with previous studies.^{5,13,14}

Nonsteroidal anti-inflammatory (NSAID) was used as a part of the multimodal analgesia regimen in this study although we acknowledge the concern that it can delay bony healing and possibly increase the risk of nonunion. NSAIDs may affect bony healing by inhibiting cyclooxygenase (COX) enzymes. Previous animal studies provided evidence that COX inhibition slows fracture healing.²³⁻²⁵ However, the data on the effect of NSAIDs on human fracture healing are still controversial.²⁶⁻²⁸ A systematic review investigating the effect of NSAID on acute phase fracture-healing reported that there was not enough clinical evidence to demonstrate patient detriment resulting from the short-term use of NSAIDs following fracture.²⁹ Recently, Hassan and Karlock³⁰ demonstrated that short-term use of oral ibuprofen and ketorolac in the postoperative period following elective foot and ankle surgeries was not associated with nonunion. Opioids are another option to manage postoperative pain, and emerging basic science has been showing that opioids may also inhibit bone formation.³¹ Moreover, they are associated with adverse effects such as nausea, vomiting, respiratory depression, constipation, rising tolerance, and overdose related deaths. Drug overdoses resulted in 70,237 deaths in 2017. Among these, 47,600 (67.8%) involved opioids (14.9 per 100,000 population), representing a 12.0% rate increase from 2016.³² In light of the opioid crisis in the United States, more alternative pain management is required and multimodal analgesia protocols including NSAIDs can contribute in reducing opioid consumption. Several studies reported that the use of NSAIDs reduced the side effects related to opioids as well as the need for higher opioid doses in postoperative pain management.^{33,34}

One of the important findings in this study was the difference in opioid consumption according to the prescription type of ibuprofen and acetaminophen. Oxycodone was prescribed to all of the patients while prescription ibuprofen and acetaminophen were prescribed to 11 out of 21 patients. The remaining 10 patients took OTC ibuprofen and acetaminophen. All patients in this study were instructed to take oxycodone, ibuprofen and acetaminophen as our multimodal analgesia protocol. Significant lower opioid consumption was found when prescription ibuprofen and acetaminophen were prescribed ($P = 0.036$). This finding suggests that patients are more compliant when taking prescription medication rather than taking OTC medication.

The appropriate number of opioids required after various orthopedic operative procedures is unknown. Several previous reports demonstrated that the quantity of opioid prescribed is associated with higher patient-reported opioid consumption for postoperative pain management.³⁵⁻³⁷ Howard and colleagues³⁶ demonstrated that one of the strongest predictors of opioid consumption was the amount of opioids prescribed to the patient. They estimated that 5.3 more pills were consumed for every 10 additional pills prescribed. Similarly, a trend showing higher opioid consumption in patients who had more opioid prescribed was noted in this study. However, there was no significant difference statistically in opioid consumption according to the amount of opioid prescription in a subgroup analysis in this study ($P = 0.099$). Moreover, no difference was found in opioid consumption based on the type of procedures in this study despite the general preconception that postoperative pain is worse in hallux valgus correction than in first MTP joint arthrodesis.

This study has several limitations. First, the sample size of the subgroup is small, thereby limiting the ability to demonstrate significant differences in postoperative opioid consumption between subgroups. Second, there is a possibility that patients may be taking another pain medication in addition to our multimodal analgesia regimen, which could affect the results of the opioid consumption. Third, we only investigated the amount of opioid consumption for one type of hallux valgus correction, distal soft tissue procedure and proximal first metatarsal crescentic osteotomy. However, Rogero et al.¹⁴ reported that there was no significant difference in postoperative opioid consumption among four different hallux valgus correction procedures.

Despite these limitations, our findings provide beneficial information regarding opioid consumption following foot and ankle surgery, particularly forefoot procedures. One of the strengths in this study is that we only included isolated hallux valgus correction and first MTP joint arthrodesis without any additional procedures. Second, only one type of opioid, 5mg oxycodone, was used for the multimodal analgesia regimen, which allows us to evaluate the opioid consumption after these two procedures without distraction by the influences of different type and dose of opioid. Third, all of the patients in this study received the same type of anesthesia, regional ankle block under MAC. Given the lack of a specific guideline for opioid prescriptions in the field of foot and ankle, the results

in the current study may offer guidance on opioid prescribing for forefoot surgery using multimodal analgesia protocol.

Conclusion

Our cohort consumed 16.2 pills of 5mg oxycodone out of 37.3 pills prescribed after isolated hallux valgus correction or first MTP joint arthrodesis using our multimodal analgesia regimen, representing only 43.4% utilization. In addition, this study demonstrated the lower amount of opioid consumption in patients given alternative pain medication prescriptions (ibuprofen and acetaminophen) than in those who took the same medications over the counter. We recommend a multimodal analgesia protocol after forefoot surgeries to manage postoperative pain and decrease the amount of opioid prescribed and taken.

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