Decreasing Inpatient Opioid Use Following Orthognathic Surgery

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Purpose: Strategies to decrease postoperative opioid use are important for mitigating the immediate and long-term risks associated with their use. We aimed to investigate the impact of perioperative various factors on inpatient opioid needs for patients undergoing orthognathic surgery.

Methods: This was a retrospective cohort study of all patients who underwent orthognathic surgery performed by the senior author from 2012 to 2018. Patients were grouped into intravenous (IV) acetaminophen and no-IV acetaminophen cohorts. Opioid medications received by patients during hospital stay were converted to mean morphine equivalents (MME) for comparison. Additional factors that influenced opioid consumption, such as tranexamic acid (TXA) and postoperative nausea and vomiting (PONV), were identified using univariate analysis. Factors found to have statistical significance were added to a multivariate linear regression model.

Results: 319 patients were included. Those who received IV acetaminophen had lower rates of total opioid use (57.3 versus 74.8 MME; \( P = 0.002 \)) and postoperative opioid use (24.0 versus 37.7 MME; \( P < 0.001 \)). Perioperative prothrombotic agents, such as TXA, were associated with lower total and postoperative MME (\( P = 0.005, P = 0.002 \)). Multivariate regression analysis showed that increased PONV resulted in increased postoperative opioid use, whereas perioperative acetaminophen lowered total and postoperative quantities.

Conclusions: Perioperative IV acetaminophen is an effective method for decreasing inpatient opioid analgesia after orthognathic surgery. Intravenous TXA and PONV control may provide additional benefit to decreasing inpatient opioid consumption. More research as to the mechanisms and ideal clinical applications for both IV acetaminophen and TXA are warranted.

Key Words: Acetaminophen, mean morphine equivalents, opioids, orthognathic surgery, postoperative nausea and vomiting, postoperative pain control, quality improvement

METHODS

Patient Selection

This was a retrospective cohort study of orthognathic surgery patients treated at a single institution (Yale New Haven Hospital.) This study was approved by the Yale New Haven Hospital Institutional Review Board. Patients who received orthognathic surgery by the senior author (from 2012 to 2018) were included. Patients with inadequate follow-up, those who did not receive orthognathic surgery (genioplasty alone), and those receiving other concurrent procedures were excluded.

The number of opioid-related deaths has become a major public health concern over the past 2 decades. In October 2017, the opioid crisis in the United States was declared a national public health emergency by the Department of Health and Human Services. Several events have been suspected as lending responsibility to this rapid increase in opioid use dating back to the 1990’s. As a result of this epidemic, opioid-related deaths have increased four-fold from 1999 to 2011, with a 900% increase in individuals seeking treatment for addiction through the same timeframe. To combat the staggering increase in opioid-related adverse events, the medical and surgical community has advocated for adjuvant and multimodal non-opioid pain relief.

Historically, postoperative pain intensity in maxillofacial surgery has been shown to be correlated to surgical procedure, with orthognathic surgery having the highest postoperative pain intensity. Limited range of motion of the mouth after orthognathic surgery adds a layer of complexity to pain management given increased difficulty for oral pain management and increased overall discomfort from liquid only diets. Recent studies have investigated various perioperative and postoperative interventions that decrease opioid use. However, current literature is conflicted when discussing the use of perioperative acetaminophen to decrease postoperative narcotic use. This study’s purpose was to answer the following clinical question: ‘Among patients who are undergoing orthognathic surgery, do patients receiving perioperative or acetaminophen have decreased inpatient opioid use compared to those who do not?” We hypothesized that perioperative intravenous (IV) acetaminophen would be effective in decreasing total inpatient opioid use. We aimed to investigate the use of this medication as a way to mitigate the immediate and long-term risks associated with narcotics in patients undergoing orthognathic surgery.
Mean Morphine Equivalents Conversion

Opioid and non-opioid pain medication for each patient was recorded with medication type, strength, dosage, and frequency for the entire length of hospital stay. The opioid medications consisted of fentanyl citrate IV (24 or 48 mcg), morphine IV (24 or 48 mg), hydromorphone IV (24 or 48 mg), meperidine IV (24 or 48 mg), hydromorphone per os (PO) (24 or 48 mg), oxycodone PO (24 or 48 mg), hydrocodone/acetaminophen PO (7.5–325 mg/15 mL), and oxycodone hydrochloric acid/acetaminophen PO (5–325 mg/5 mL). Non-opioid medication consisted of IV or PO acetaminophen and IV or PO non-steroidal anti-inflammatory (NSAIDs) (aspirin and naproxen) with varying doses. The total quantity of opioid medication that was administered perioperatively, postoperatively, and throughout the entire length of stay (LOS) was converted to MME for standard comparison using MME conversion factors (Supplementary Digital Content, Table 1, http://links.lww.com/SCS/D17).

Statistical Analysis

Chi-squared analysis and unpaired student t tests were used to compare demographic variables and mean perioperative, postoperative, and total opioid analgesic consumption between IV acetaminophen and no-acetaminophen cohorts. Univariate linear regression was performed to identify correlations between operative characteristics and total, perioperative, and postoperative opioid use. Variables that were statistically significant in regards to impacting opioid levels and/or were unequally distributed across acetaminophen and non-acetaminophen groups were added to a multivariate regression model. Mixed method stepwise regression was then utilized to build a multivariate linear regression model. A P value < 0.05 represented statistical significance.

RESULTS

Patient Demographics

Out of 383 patients receiving orthognathic surgery, 319 patients were able to be included. Out of the 64 that were excluded, 46 had concurrent surgeries (such as rhinoplasties, canthoplasties, and free flap reconstruction), 9 did not receive jaw surgery (had genioplasty alone), and 9 patients had incomplete medical records. The average age of patients meeting inclusion criteria was 23.1 ± 9.2 years old. About half were female (57.5%). The vast majority of patients received concurrent Le Fort I, bilateral sagittal split, and genioplasty (“triple jaw” surgery) (71.5%, n = 228) as shown in Supplementary Digital Content, Table 2, http://links.lww.com/SCS/D18. The average operation length was 278.64 ± 78.66 minutes (from procedure start to procedure conclusion) with a mean LOS of 2.23 days. The average total, perioperative, and postoperative opioid consumptions were 70.9 ± 36.7 MME, 36.8 ± 15.4 MME, and 34.5 ± 32.4 MME, respectively.

Opioid Use and Intravenous Acetaminophen

There were 57 (17.9%) patients that received perioperative IV acetaminophen. There were no significant differences in demographic factors and medical history such as average age, BMI, gender distribution, or history of cleft or syndromic diagnoses across the IV acetaminophen and no-acetaminophen groups (Supplementary Digital Content, Table 2, http://links.lww.com/SCS/D18). There were no differences between the acetaminophen and no-acetaminophen cohorts with regards to administration of other perioperative medications with the exception the blood-limiting agents such as tranexamic acid (TXA), desmopressin (DDAVP), and Aminocaproic Acid (referred to together as ‘TXA+’ in this study, Supplementary Digital Content, Table 3, http://links.lww.com/SCS/D19), which was more frequently administered with the acetaminophen group (94.7% versus 22.9%, P < 0.001). All patients in the IV acetaminophen group received at least 700 mg throughout the course of their procedure. A higher percentage of patients receiving IV acetaminophen underwent more extensive procedures (triple jaw rather than single-jaw or double-jaw) compared to those who did not receive IV acetaminophen (P = 0.021). Operating room (OR) Time and hospital LOS did not differ significantly across either group. Patients who received perioperative IV acetaminophen had lower rates of total opioid use (57.32 MME compared to 73.79; P = 0.001) and postoperative opioid use (24.03 versus 36.65 MME; P = 0.001). Perioperative MME did not differ significantly between these groups.

Opioid Use and Other Medications

Perioperative prothrombotic and blood-limiting agents were found to be associated with lower total (63.2 compared to 76.4, P = 0.005) and postoperative MME (28.2 compared to 39.1, P = 0.001). Intravenous Propofol also showed decreases in these aforementioned values (P = 0.025, P = 0.023, respectively) as shown in Supplementary Digital Content, Table 3, http://links.lww.com/SCS/D19. Perioperative IV NSAIDs were associated with lower rates of total, perioperative, and postoperative MME (P = 0.001, P = 0.001, P = 0.027, respectively). Other medications such as perioperative dexamethasone, dexametomidine, ketamine, local anesthetic, nitrous oxide, other inhaled anesthetics (ie sevoflurane and isoflurane), anticonvulsants (ie pregabalin and gabapentin), and postoperative nonopioid medications did not affect inpatient opioid consumption (Supplementary Digital Content, Table 3, http://links.lww.com/SCS/D19).

Multivariate Linear Regression Analysis

Stepwise regression was utilized to identify the variables with the strongest correlation to opioid consumption quantity in order to build a multivariate regression model. These variables included perioperative IV acetaminophen, perioperative IV Propofol, perioperative IV NSAIDs, PONV and OR Time. Though TXA and other prothrombotic factors were significant in univariate analysis, they were found to have a degree of collinearity with IV acetaminophen use and thus the stronger predictor (perioperative IV acetaminophen) was included in the model. The model showed lower rates of total and postoperative MME were associated with perioperative IV acetaminophen administration (P = 0.006, P = 0.015, respectively) and perioperative IV Propofol administration.
(P = 0.016, P = 0.034, respectively). Increased PONV, however, was correlated with higher rates of postoperative opioid use (P = 0.040) as shown in Supplementary Digital Content, Table 4, http://links.lww.com/SCS/D20. Of note, when TXA was replaced in this model for IV acetaminophen, it also showed to result in statistically significant lower rates of postoperative narcotic use (P = 0.004). Increased OR Time was correlated with both increased perioperative and total opioid use (P = 0.001). Perioperative IV NSAIDs were no longer significant for total, perioperative or postoperative MME when included in our model.

DISCUSSION

There are several documented factors that can influence postoperative pain and opioid consumption, ranging from demographic factors, medical comorbidities, and medication interventions including non-opioid analgesia, local anesthetic, steroids, and sedatives.16–23 The purpose of this study was to investigate the use of perioperative medications in order to decrease inpatient opioid consumption. We hypothesized that patients receiving perioperative non-opioid pain medication would have lower rates of postoperative opioid use. Taken together, our data suggests that perioperative IV acetaminophen may be an effective intervention for decreasing inpatient opioid use. Our data also suggest a potential opioid-reducing role for intraoperative TXA and other blood-limiting agents.

Perioperative Medication Use and Acetaminophen

Previous studies of acetaminophen’s efficacy on reducing opioid consumption across various surgical specialties have been inconclusive, with some studies reporting opioid reduction with their use and others reporting no difference.3,8–12,16 These conflicts may be influenced by various factors including surgical procedure and/or location, medication dosing, and time of administration with respect to surgery (perioperative versus postoperative). In our cohort perioperative IV acetaminophen, typically administered within 1 hour of the end of surgery with an IV bolus of 1000 mg, was able to successfully decrease patient opioid requirements. The timing of this administration may be ideal, as IV acetaminophen takes about 15 minutes to induce pain relief and about 1 hour to reach peak effects, giving patients immediate relief upon arousal from surgery.13 One study in particular consisting of 40 patients receiving bimaxillary surgery found that a single-dose of IV ibuprofen decreased pain scores and use of patient-controlled analgesia 3 hours after surgery. However, the sample size of this study was significantly smaller than the 1 described herein with differing methods of acetaminophen administration.12 Our findings implicate a role for IV acetaminophen use for intraoperative TXA and other blood-limiting agents.

The impact of IV acetaminophen on opioid reduction is likely multifactorial. Intravenous acetaminophen has been shown to be safe and effective for mild-to-moderate postoperative pain and may have provided adequate pain control among patients in the absence of more potent opioid medications.3,11,12,13 In addition to decreasing pain levels, however, IV acetaminophen has also been shown to have other therapeutic benefits that may have contributed to our findings. For example, there is evidence that IV acetaminophen may decrease PONV through its mediation of superior pain control.23 As PONV can lead to prolonged hospital stays (and, in turn, increased opioid needs), PONV reduction may also mediate decreases in opioid needs.

Tranexamic Acid, Desmopressin, Aminocaproic Acid and Opioid Use

In addition to IV acetaminophen, intraoperative TXA, DDAVP, and aminocaproic acid were also associated with a decrease in inpatient narcotic use. However, almost all of our patients who received TXA+ also received IV acetaminophen during their surgeries (likely due to anesthesiologist preference to administer both), potentially confounding these findings. Still, multivariate regression controlling for other confounding factors showed significant reduction of opioids with TXA+ administration. Thus, despite limited research as to the efficacy of these medications for pain control (previous studies have focused on their roles in reducing blood loss and postoperative swelling) these findings suggest that they may play a role in decreasing postoperative opioid use.16,24 A potential explanation is that these medications may limit bleeding and the amount of blood swallowed by patients, decreasing PONV and LOS. Future studies should examine the role of TXA for this indication more closely.

Postoperative Nausea and Vomiting and Opioid Use

Postoperative nausea and vomiting was associated with higher rates of inpatient opioid consumption. This is likely related to longer lengths of hospital stay and, therefore, more inpatient opioid prescription. In fact, patients who reported PONV had, on average, longer hospital LOS than those who did not experience PONV (2.63 versus 1.80, P = 0.001). Thus, efforts to decrease PONV risk and LOS may also indirectly decrease inpatient opioid needs. Although further studies are needed to identify successful ways to decrease PONV in orthognathic surgery, strategies including various antiemetics alone or in combination (Serotonin receptor antagonists or Neurokinin-1 receptor antagonists), corticosteroids, butyrophone, antihistamines, anticholinergics, and alternative IV anesthesia methods may be effective.23,26 Notably, as opioids themselves are also a risk factor for PONV, strategies for decreasing opioid use discussed herein may also play a role in decreasing PONV.

Propofol and Opioid Use

Propofol is a sedative-hypnotic widely used for induction and maintenance of general anesthesia or maintaining sub-hypnotic states at lower doses. Our results suggest that Propofol administration has an association with decreased postoperative and total opioid use. There is evidence that Propofol infusion can decrease PONV and overall hospital LOS, which have implications on inpatient opioid use.26 These antiemetic properties typically occur at lower doses than those associated with general anesthesia (343 ng/mL for antiemetic properties, compared to 2–6 mcg/mL for general anesthesia).25–28 For these reasons, Propofol may provide another effective mechanism to decrease inpatient opioid use after orthognathic surgery. However, future studies examining the true efficacy of Propofol for this indication are needed.

Limitations

Our study has several limitations that warrant consideration. The retrospective design may have limited accuracy in data collection and may not have fully considered patients who did not take their full dose of pain medication. Although medications administered perioperatively and postoperatively were recorded and assessed with univariate analyses, the retrospective design of this study may have also limited the ability to fully control for the analgesic effects of these additional medications. Patient pain scales were also not recorded, making it difficult to distinguish a patient’s need for pain management compared to regularly scheduled administration. This study was also limited to data from a single institution, which may limit the generalizability of our results. Future prospective and/or randomized control trials, and studies involving multiple centers and geographic locations may help overcome these limitations.
CONCLUSIONS

Our findings suggest that perioperative IV acetaminophen is an effective method for decreasing inpatient opioid analgesia after orthognathic surgery. Perioperative blood-limiting agents such as TXA and PONV control may provide additional benefit to decreasing inpatient opioid consumption. More research as to the mechanisms and ideal clinical applications for both IV acetaminophen and TXA are warranted to mitigate the short-term and long-term side effects of narcotic pain medications.

ACKNOWLEDGMENTS

None.

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