

Multicenter study on the effect of nonsteroidal anti-inflammatory drugs on postoperative pain after endoscopic sinus and nasal surgery

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Background: The taboo of avoiding nonsteroidal anti-inflammatory drugs (NSAIDs) after functional endoscopic sinus surgery (FESS) has been waning. The impetus to reduce opioid prescriptions in view of the opioid epidemic led the authors to change their practices to include NSAIDs after sinus surgery. This study's aim was to analyze the differences between patients before and after we began recommending NSAIDs after FESS.

Methods: A prospective cohort study was performed on patients undergoing FESS or other endoscopic nasal surgeries at 3 institutions, by 5 rhinologists and 1 facial plastic surgeon. Before introducing NSAIDs, all patients were given a prescription for hydrocodone-acetaminophen 5/325 mg and also recommended preferentially to use acetaminophen 325 mg. After the addition of NSAIDs, ibuprofen 200 mg and acetaminophen 325 mg were recommended preferentially, using the narcotic as a rescue medication. Patients kept a pain diary and medication log, and gave a visual analog scale (VAS) score for overall pain. Demographics, surgical variables, and comorbidities were also analyzed.

Results: One hundred sixty-six total patients were recruited and had data that could be analyzed (65 without

NSAIDs, 101 with NSAIDs). Overall, mean pain VAS score was 3.12 ± 1.95 for the non-NSAID group and 2.33 ± 2.30 for the NSAID group (p value = 0.006). The day with the highest mean pain was the first postoperative day. The mean number of total opioid pills taken was 6.94 ± 6.85 without NSAIDs vs 3.77 ± 4.56 with NSAIDs (p = 0.018). Age and gender were found to be the only consistently significant patient variables to affect pain. There were no bleeding complications.

Conclusion: NSAID use was introduced into the practices of 5 practicing rhinologists and 1 facial plastic surgeon. No bleeding complications were seen. Both pain and overall opioid usage were reduced significantly. © 2019 ARS-AAOA, LLC.

Key Words:

analgesia; pain; NSAID; sinus surgery; opioid; narcotic

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Both prescribed and illicit opioid usage in the United States has skyrocketed over the last decade. Controlling the opioid epidemic has become part of the national agenda, and physicians have been tasked with diminishing opioid prescriptions. In order for a surgeon to both provide sufficient postoperative analgesia and to avoid overprescribing potentially dangerous narcotic medications, it is important to know the expected pain level and analgesic requirements for any given surgery. Endoscopic and minimally invasive surgeries typically require less postoperative analgesia when compared with open surgeries.¹ Several studies have also suggested that postoperative pain after functional endoscopic sinus surgery (FESS) is typically mild and that patients gain their normal functioning within approximately 8 to 10 days.^{2–6} A recent study also suggested that opioid use after FESS is typically low and that most surgeons are likely overprescribing these medications.⁷

Traditionally, pain medications such as nonsteroidal anti-inflammatory drugs (NSAIDs) have not been popular for otolaryngologic surgeries, because many of these procedures involve open wounds and have potential for airway compromise if postoperative bleeding ensues. Specifically, NSAIDs have been avoided after FESS because of the risk of epistaxis. However, NSAIDs have been shown to be safe and effective in perioperative pain management after FESS and nasal surgeries in several recent studies.⁸⁻¹² There is growing evidence that NSAIDs may decrease the requirement for rescue analgesics, including opioids.^{13,14} The purpose of this study was to investigate the effects of a commonly available over-the-counter NSAID, ibuprofen, on postoperative pain, overall opioid consumption, and potential bleeding after FESS.

Patients and methods

A prospective cohort study was performed on patients undergoing endoscopic nasal surgery at 3 institutions by 6 surgeons after receiving institutional review board (IRB) approval from each individual institution involved. Patients were candidates for the study if they had endoscopic sinus surgery, inferior turbinate surgery, septoplasty, or endoscopic dacryocystorhinostomy (DCR). Patients also could have concomitant nasal valve surgery, but were required to have had another endoscopic nasal procedure as well. The extent of sinus surgery was not recorded except in those cases that were considered expanded cases, such as Draf III procedures. Before introducing NSAIDs, all consecutive surgical patients were given a prescription for hydrocodone-acetaminophen 5/325 mg, but were recommended preferentially to use acetaminophen 325 mg. At each institution, a date was chosen after which all patients would be offered NSAIDs. This date varied by about 1 month across institutions due to the different dates of IRB approval and the subsequent different start dates of patient accrual. After the addition of NSAIDs, ibuprofen 200 mg and acetaminophen 325 mg were recommended preferentially to all consecutive surgical patients unless patients had NSAID allergy. After the introduction of ibuprofen, patients were informed that the medication has previously been thought to increase the potential for bleeding, but that recent adoption of the drug into other facets of otolaryngologic practice as well as recent studies has shown little to no evidence of this potential. Patients kept a pain diary and medication log, and provided an overall pain visual analog scale (VAS) score. The overall pain VAS score was given on the day of first postoperative visit (day 7) and was the patient's general impression of the entire postoperative period, which is distinct from their average daily pain diary VAS scores. The mean pain VAS score (average from days 1-7) was also calculated.

Statistical analysis

Before starting enrollment at the various sites, an initial power analysis of a small cohort of 25 patients determined

that 29 patients in each group would detect a 1.5-point change in pain VAS score. Wilcoxon rank sum tests were performed to determine the effect of adding NSAIDs to postoperative pain and opioid use. There were 2 pain VAS outcomes: overall pain VAS score and mean pain diary VAS score (an average of scores from days 1-7 from the pain diary). The 2 scores were compared using a paired *t* test to determine whether they were significantly different. The differences in pain VAS by day were analyzed using a repeated-measures model with comparisons of each other day vs day 1. Multivariate analysis of variance (MANOVA) was calculated first using the overall pain VAS score and then the mean pain VAS score as dependent variable. All patients had demographic (age, sex) and surgical variable data, but only a subset of patients also had comorbidity data; MANOVA was performed on both cohorts separately. All calculations were performed using SAS version 9.4 (SAS Institute, Inc, Cary, NC).

Results

Roughly equal numbers of patients were enrolled from each institution, with 175 patients recruited in total (74 without NSAIDs, 101 with NSAIDs). Nine patients were excluded as their overall pain VAS score was not recorded, so a total of 166 patients remained for analysis. The vast majority of patients had FESS; only 27 patients did not have FESS and had separate, endoscopic nasal procedures. Patients' demographics are presented in Table 1. Mean overall pain VAS score was 3.12 ± 1.95 (mean $\pm$ standard deviation) for the non-NSAID group and 2.33 ± 2.30 for the NSAID group ($p = 0.006$). The day with the highest mean pain level was the first postoperative day and statistical analysis demonstrated that pain VAS did significantly decrease over the course of the week ($p < 0.0001$). The pain VAS score on day 1 was significantly higher compared with all other days ($p = 0.015$ vs day 2; $p < 0.0001$ vs days 2-7). The pain VAS score from each preceding day was significantly higher than the subsequent day from days 1 to 5, after which there was no further statistically significant decrease in pain to day 7. The daily pain VAS for both the NSAID and non-NSAID groups is shown in Figure 1. The mean overall pain VAS score was 2.44 ± 2.17 , and the mean pain VAS score (average from days 1-7) was 3.05 ± 2.17 for those patients who completed the pain diary ($n = 147$). The mean difference between these scores was 0.61, which was highly significant ($p < 0.0001$); Figure 2 illustrates this relationship. The average number of total opioid pills taken was 6.94 ± 6.85 vs 3.77 ± 4.56 (without NSAIDs vs with NSAIDs, $p = 0.018$).

All 166 patients included in the base analysis had demographics data available and surgical variables and overall pain VAS scores. MANOVA performed on this cohort demonstrated that older age and male sex were significantly associated with lower overall pain VAS scores (Table 2). None of the surgical variables were associated with higher pain, although a low volume of dacryocystorhinostomy,

TABLE 1. Baseline patients' characteristics

Variable	Minimum	Maximum	Mean	SD	N	%	Non-NSAID	NSAID
Non-NSAID					65	39.2		
NSAID					101	60.8		
Age (years)	16	87	49.3	17.1				
Gender								
Male					81	48.7	30	51
Female					85	51.3	35	50
Migraine					23	13.9	23	0
Depression					21	12.7	16	5
Fibromyalgia					4	2.4	3	1
Baseline opioid use					2	1.2	1	1
FESS					139	83.7	59	80
Septoplasty					108	65.1	43	65
Turbinate reduction					101	60.8	35	66
Nasal valve repair					25	15.1	0	25
Dacryocystorhinostomy					3	1.8	0	3
Expanded case (Draf III, medial maxillectomy)					12	7.2	9	3

FESS = functional endoscopic sinus surgery; NSAID = nonsteroidal anti-inflammatory drug; SD = standard deviation.

nasal valve repair, and expanded endoscopic cases were performed in this cohort. The same analysis was performed in patients who completed their pain diaries ($n = 146$), with mean pain VAS score as the dependent variable with similar findings (Table 3). Because earlier studies suggested that septoplasty may be an important negative factor for pain in patients undergoing FESS,⁷ patients with septoplasty with or without turbinate reduction ($n = 25$) were compared to patients with FESS alone ($n = 59$), and there was no statistical difference found in pain scores on univariate analysis. In addition, patients who had FESS alone ($n = 59$) were compared with those who had FESS with septoplasty ($n = 80$). The lack of significance was also borne out in the multivariate analysis, as previously noted.

Ninety-seven patients had complete demographics data available as well as surgical variable and comorbidity data. MANOVA in this cohort using overall pain VAS score as the dependent variable demonstrated that age, sex, and baseline opioid use were the only significant variables (Table 4). MANOVA using mean pain VAS score as the dependent variable ($n = 77$) demonstrated that age, sex, and fibromyalgia were the only significant variables (Table 5). There were very limited numbers of patients with both fibromyalgia and baseline opioid use.

Discussion

The opioid epidemic is a national and international crisis, and surgeons must evaluate their own prescription

practices to avoid contributing to this dilemma. Studies have demonstrated a wide variation in prescription practices across ear-nose-throat surgeries, and the predominant trend is that surgeons overprescribe narcotic medications.^{7,15-18} To change practice habits broadly, sinus surgeons must know: (1) how much pain a patient should expect after surgery; and (2) which types and how much pain medication are needed to control that pain.

Studies regarding pain control after FESS are limited and most have been published quite recently, despite the technique having been established approximately 40 years ago. Most studies showed that postoperative pain after FESS is generally mild to moderate.^{2-6,19,20} Our study corroborates these observations with the mean overall pain VAS score being 3.12 ± 1.95 (on 1-10 scale). Opioid pain medication is routinely given to most patients undergoing FESS or other endoscopic nasal surgeries. However, it is clear that the pain experienced by most patients after surgery is only mild to moderate. As suggested by Sethi et al, narcotic medications are likely being overprescribed for these procedures.⁷ In their study, a majority of patients (94.8%) were prescribed opioids after FESS and most of these prescriptions were filled (91.4%). However, a significant portion (73.1%) reported no opioid use. In our study, 23% ($n = 41$) of our patients took no narcotic pain medication at all after surgery based on a medication diary. Nearly all patients do not dispose of narcotic medication in the manner recommended by the US Food and Drug Administration,

Mean Pain VAS by Day

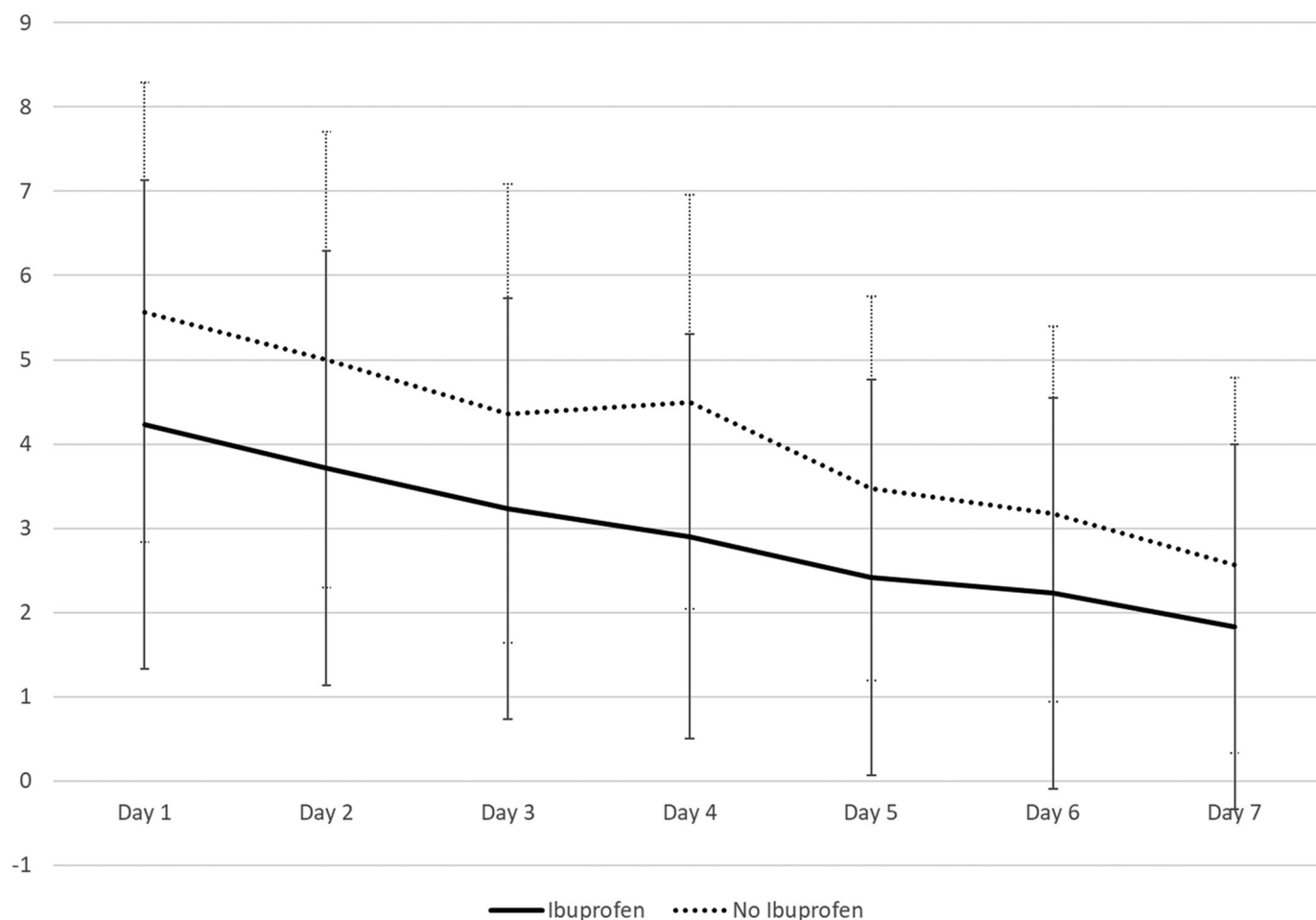


FIGURE 1. Pain VAS mean by day for patients with and without ibuprofen. VAS = visual analog scale.

and leftover prescriptions could conceivably be a nidus for abuse.²¹

To avoid narcotic analgesics, other medications must be studied. NSAIDs have traditionally been avoided in otolaryngologic surgery. However, recent studies and recommendations have attempted to assuage the long-held fear of postoperative bleeding with these medications. For example, our academy guidelines now recommend the use of NSAIDs specifically for children after tonsillectomy,²² and a recent study seemed to suggest that even ketorolac use after tonsillectomy may not lead to increased bleeding risk.²³ A few studies also indicated that perioperative NSAID use for FESS is also safe and effective. Nguyen et al investigated postoperative pain status in patients undergoing the full gamut of otolaryngologic surgeries while giving them opioid or ibuprofen postoperatively and reported significantly reduced pain in the ibuprofen group without an increased bleeding risk.¹⁴ Church et al randomized 28 FESS patients and gave either rofecoxib or hydrocodone/acetaminophen after surgery and found equivalent postoperative pain control in the 2 groups.²⁴ In another randomized, controlled

trial, Moeller et al compared intraoperative intravenous ketorolac with fentanyl and found them to be equivalent for pain control perioperatively, with no significant change in bleeding or complications.²⁵ Our study included 101 patients who were recommended ibuprofen, and there were no bleeding complications, further supporting the evidence of a lack of increased bleeding with NSAID use postoperatively.

When taken into context of a recent review of the literature,²⁶ our study is the largest to date investigating pain control after FESS and nasal surgery, with 166 patients analyzed. We found that there was significant improvement in pain control when NSAIDs were recommended.

Postoperative pain was measured in this study using several methods. First, an overall pain VAS score was given at the time of the first postoperative visit as a general impression of the surgery and postoperative recovery period. Next, patients recorded a day-by-day assessment of their pain via a pain diary that included daily pain VAS scores. Third, pain was measured indirectly by the patients' self-administration of narcotic pain medication. The mean

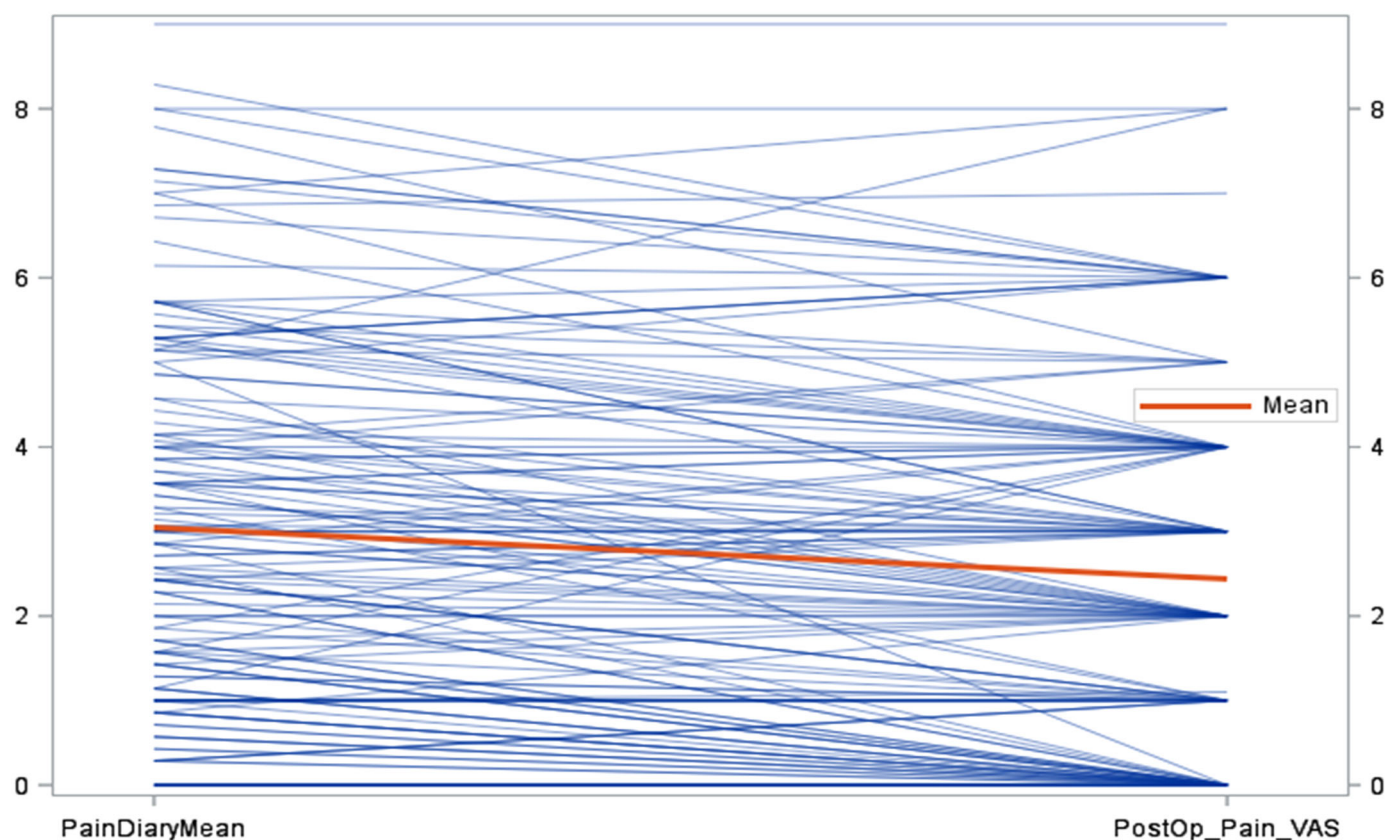


FIGURE 2. Paired profiles for mean pain VAS scores (left) and overall pain VAS scores (right) with mean difference in bold. VAS = visual analog scale.

overall pain VAS score was significantly higher than the mean pain VAS score (average from days 1-7 in the pain diary; Fig. 2). This could potentially be explained by more time having passed since the more painful part of the recovery. In our study we also found that the first postoperative day was significantly more painful than subsequent days after surgery, which corroborates previous findings in the literature (Fig. 1).¹⁹ We found that pain decreased day by day for the first 5 days in a statistically significant manner. After the fifth day, pain was already quite low and did not change significantly from days 5 to 7. The time at which patients were queried about their postoperative pain and experience significantly affected responses in this study. This is an important lesson for interpreting future studies and previous literature.

We found that both age and sex play significant roles in postoperative pain. Age had less of an effect, with a difference of 10 years causing a corresponding decrease of 0.23 point on the VAS scale (10×-0.023 slope; Table 2). However, female sex corresponded to a large increase of 1.13 points on the VAS when viewed in relation to the mean score of only 2.64 ($p = 0.0006$). These factors are relatively well-known predictors of pain, but it is worth noting that they are still borne out in this study where overall pain was quite low.²⁷ Both age and sex were also consistently significant when all variables were considered (Tables 4 and 5), whereas baseline opioid use and fibromyalgia were

TABLE 2. Multivariate ANOVA for overall pain VAS scores

Variable	df	Parameter estimate	Standard error	t value	p-value
Intercept	1	3.22558	0.54276	5.94	<0.0001
Age	1	-0.02357	0.00963	-2.45	0.0154
Female	1	1.13419	0.32565	3.48	0.0006

ANOVA = analysis of variance; df = degrees of freedom; VAS = visual analog scale.

only significant in 1 analysis each. The relatively low numbers of patients with some of our variables does make it hard to make definitive conclusions of their effects. Larger numbers of patients with comorbidities that could augment the patient pain experience, as well as larger numbers of expanded FESS, nasal valve repair, and DCR, will likely be required to answer these questions. One interesting finding is that septoplasty was not found to be a significant negative factor for pain on uni- or multivariate analysis, yet it was found to be a negative contributor in a previous study.⁷

In the United States, deaths associated with prescribed opioid analgesics increased by more than 3-fold from 1999 to 2007, and opioid-related deaths are now more common than deaths from human immunodeficiency virus or alcoholic liver disease.²⁸ In our study, we found that

TABLE 3. Multivariate ANOVA for mean pain VAS scores

Variable	df	Parameter estimate	Standard error	t value	p-value
Intercept	1	3.67353	0.57085	6.44	<0.0001
Age	1	-0.02566	0.01006	-2.55	0.0118
Female	1	1.24845	0.33796	3.69	0.0003

ANOVA = analysis of variance; df = degrees of freedom; VAS = visual analog scale.

TABLE 4. Multivariate ANOVA for overall pain VAS score and all variables

Variable	df	Parameter estimate	Standard error	t value	p-value
Intercept	1	4.18294	0.59976	6.97	<0.0001
Age	1	-0.03029	0.01076	-2.82	0.0059
Female	1	0.85739	0.37514	2.29	0.0245
Baseline opioid use	1	2.80332	1.08952	2.57	0.0116

ANOVA = analysis of variance; df = degrees of freedom; VAS = visual analog scale.

both direct and indirect measures of pain were reduced in patients who were recommended use of NSAIDs after FESS. Pain VAS scores and the number of opioid pills used decreased significantly when we recommended acetaminophen and ibuprofen as first-line analgesics over prescribed hydrocodone/acetaminophen.

We hypothesize that the addition of ibuprofen as a potential first-line agent may make patients more comfortable in avoiding the narcotic prescription, knowing that there are several non-narcotic options. If the only 2 options for patients are acetaminophen and an acetaminophen-narcotic combination medication, then patients may be deterred from taking acetaminophen alone due to warnings about potential acetaminophen overdose and hepatotoxicity. Unfortunately, patients in this study were not required to record the number of acetaminophen or ibuprofen tablets they took on a daily basis, so a direct comparison of usage could not be made. We also should not discount that acetaminophen alone is a reasonable postoperative analgesic after FESS. Kempainen et al investigated the efficacy of intravenous acetaminophen in perioperative analgesia after FESS and found a significant reduction in pain just with acetaminophen. The findings suggest that prescribing acetaminophen alone to be taken regularly may effectively control postoperative pain without the need for opioid analgesics.²⁹

Other non-narcotic analgesics can also be effective after FESS. Gabapentin has been demonstrated to be effective in multiple surgical procedures, including FESS, when given pre- and perioperatively.^{26,30} Sphenopalatine blockade with lidocaine or longer acting anesthetics have also been shown to be effective in perioperative pain

TABLE 5. Multivariate ANOVA for mean pain VAS score and all variables

Variable	df	Parameter estimate	Standard error	t value	p-value
Intercept	1	3.97830	0.68367	5.82	<0.0001
Age	1	-0.02965	0.01197	-2.48	0.0155
Female	1	0.87725	0.42005	2.09	0.0402
Fibromyalgia	1	2.13063	0.93722	2.27	0.0259

ANOVA = analysis of variance; df = degrees of freedom; VAS = visual analog scale.

control.^{31,32} Using a combination of these strategies may offer sinus surgeons the best method to avoid the deleterious side effects of any single drug.

Our study has some limitations. The study design utilized did not call for surgeons to record the extent of FESS, except with regard to whether or not it was expanded, as in a Draf III procedure. Therefore, we cannot compare pain levels between a full FESS and a single sinus surgery, such as a unilateral maxillary antrostomy and all the variations in between. Our study design also did not call for patients to adhere to a specific medication regimen and instead offered the choice to the patient as to whether to take a medication. Patients were encouraged to choose the non-narcotic analgesics first and to use the narcotic pain medication for breakthrough or severe pain. Unfortunately, this makes it impossible to directly compare acetaminophen, hydrocodone/acetaminophen, and ibuprofen. However, these directions are likely more similar to postoperative instructions for the majority of surgeons. As the literature and our study demonstrated, pain levels after FESS are low overall, so forcing patients to take any pain medication regularly may be overprescribing. NSAIDs, acetaminophen, and opioids can all cause side effects, so minimizing overall medication use is optimal. In addition, our surgeons' prescriptions for hydrocodone/acetaminophen varied between 20 and 30 pills, so there exists the possibility that those patients prescribed more may have been more likely to take more opioids, thus skewing the results. Patients were not required to record the number of ibuprofen or acetaminophen tablets they took, so it can only be assumed that an increase in consumption of these non-narcotic medications led to lower opioid usage and lower pain scores. In addition, although all patients were recommended saline rinses and antibiotics, the surgeons did vary practices on the use of postoperative steroids, with one surgeon using it in almost all cases and the others using it some of the time for severe inflammation and/or polyps. The anti-inflammatory effects of steroids could obviously also impact postoperative pain levels, but we did not find any statistical differences when site/surgeon was considered as a variable. Thus, in this study we were able to demonstrate in a relatively large cohort that pain levels are low after sinus surgery; pain medication use

is low overall; opioids are likely overprescribed; and alternative analgesics, like NSAIDs, can reduce opioid use.

Conclusion

In this work we have demonstrated that offering NSAIDs after FESS is a safe and effective means to reduce postoperative pain and decrease opioid use. Surgeons should consider reducing the number of opioid pills

prescribed after FESS, as the overall pain level is usually low and pain can be typically controlled using a variety of non-narcotic analgesics. 

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References

- Kılıç S, Kılıç SS, Baredes S, et al. Comparison of endoscopic and open resection of sinonasal squamous cell carcinoma: a propensity score-matched analysis of 652 patients. *Int Forum Allergy Rhinol*. 2018;8:421-434.
- Al-Qudah M, Rashdan Y. Role of dexamethasone in reducing pain after endoscopic sinus surgery in adults: a double-blind prospective randomized trial. *Ann Otol Rhinol Laryngol*. 2010;119:266-269.
- Cho D, Drover DR, Nekhendzy V, et al. The effectiveness of preemptive sphenopalatine ganglion block on postoperative pain and functional outcomes after functional endoscopic sinus surgery. *Int Forum Allergy Rhinol*. 2011;1:212-218.
- Wise SK, Wise JC, DelGaudio JM. Evaluation of postoperative pain after sinonasal surgery. *Am J Rhinol*. 2005;19:471-477.
- Mehta U, Huber TC, Sindwani R. Patient expectations and recovery following endoscopic sinus surgery. *Otolaryngol Head Neck Surg*. 2006;134:483-487.
- Kemppainen TP, Tuomilehto H, Kokki H, et al. Pain treatment and recovery after endoscopic sinus surgery. *Laryngoscope*. 2007;117:1434-1438.
- Sethi RKV, Miller AL, Bartholomew RA, et al. Opioid prescription patterns and use among patients undergoing endoscopic sinus surgery. *Laryngoscope*. 2019;129:1046-1052.
- Miller C, Humphreys IM, Davis GE. Effect of postoperative ibuprofen on pain after surgery for chronic rhinosinusitis: a prospective cohort pilot study. Presented at the Annual Meeting of the American Rhinologic Society, October 2018, Atlanta, GA.
- Ndon S, Spock T, Manes RP. Patterns in pain and opiate use after endoscopic sinus surgery. Presented at the Annual Meeting of the American Rhinologic Society, October 2018, Atlanta, GA.
- Riley C, Kim M, Sclafani AP, et al. Opioid analgesic use and patient-reported pain outcomes after rhinologic surgery. *Int Forum Allergy Rhinol*. 2019;9:339-344.
- Saini A, Jiang ZY, Yao WC, et al. Are NSAIDs effective enough for postoperative pain control after sinonasal surgery? Presented at the Annual Meeting of the American Rhinologic Society, October 2018, Atlanta, GA.
- Azmy M, Patel NM, Siddiqui SH, et al. Have otolaryngologists responded with non-opioid prescriptions for pain with the rising 'opioid epidemic'? Presented at the Annual Meeting of the American Rhinologic Society, October 2018, Atlanta, GA.
- Watcha MF, Issioui T, Klein KW, White PF. Costs and effectiveness of rofecoxib, celecoxib, and acetaminophen for preventing pain after ambulatory otolaryngologic surgery. *Anesth Analg*. 2003;96:987-994.
- Nguyen KK, Liu YF, Chang C, et al. A randomized single-blinded trial of ibuprofen- versus opioid-based primary analgesic therapy in outpatient otolaryngology surgery. *Otolaryngol Head Neck Surg*. 2019;160:839-846.
- Long SM, Lumley CJ, Zeymo A, Davidson BJ. Prescription and usage pattern of opioids after thyroid and parathyroid surgery. *Otolaryngol Head Neck Surg*. 2019;160:388-393.
- Nooromid MJ, Blay E, Holl JL, et al. Discharge prescription patterns of opioid and nonopioid analgesics after common surgical procedures. *Pain Rep*. 2018;3:e637.
- Bicket MC, Long JJ, Pronovost PJ, Alexander GC, Wu CL. Prescription opioid analgesics commonly unused after surgery: a systematic review. *JAMA Surg*. 2017;152:1066-1071.
- Patel S, Sturm A, Bobian M, Svider PF, Zuliani G, Kridel R. Opioid use by patients after rhinoplasty. *JAMA Facial Plast Surg*. 2018;20:24-30.
- Finkensieper M, Poller K, Wittekindt C, Meissner W, Guntinas-Lichius O. Postoperative pain assessment after functional endoscopic sinus surgery (FESS) for chronic pansinusitis. *Eur Arch Otorhinolaryngol*. 2013;270:157-166.
- Becker SD, Becker DG. Review and update on postoperative opioid use after nasal and sinus surgery. *Curr Opin Otolaryngol Head Neck Surg*. 2018;26:41-45.
- US Department of Health and Human Services. Results from the 2012 national survey on drug use and health: summary of national findings. <https://www.samhsa.gov/data/sites/default/files/NSDUHresults2012/NSDUHresults2012.pdf>. Accessed August 1, 2019.
- Mitchell RB, Archer SM, Ishman SL, et al. Clinical practice guideline: tonsillectomy in children (update). *Otolaryngol Head Neck Surg*. 2019;160(Suppl):S1-S42.
- McClain K, Williams AM, Yaremchuk K. Ketorolac usage in tonsillectomy and uvulopalatopharyngoplasty patients. *Laryngoscope*. 2019 May 30. <https://doi.org/10.1002/lary.28077>. [Epub ahead of print].
- Church CA, Stewart C IV, O-Lee TJ, Wallace D. Rofecoxib versus hydrocodone/acetaminophen for postoperative analgesia in functional endoscopic sinus surgery. *Laryngoscope*. 2006;116:602-606.
- Moeller C, Pawlowski J, Pappas AL, Fargo K, Welch K. The safety and efficacy of intravenous ketorolac in patients undergoing primary endoscopic sinus surgery: a randomized, double-blinded clinical trial. *Int Forum Allergy Rhinol*. 2012;2:342-347.
- Svider PF, Nguyen B, Yuhan B, Zuliani G, Eloy JA, Folbe AJ. Perioperative analgesia for patients undergoing endoscopic sinus surgery: an evidence-based review. *Int Forum Allergy Rhinol*. 2018;8:837-849.
- Ip HY, Abrishami A, Peng PW, Wong J, Chung F. Predictors of postoperative pain and analgesic consumption: a qualitative systematic review. *Anesthesiology*. 2009;111:657-677.
- Rudd RA, Aleshire N, Zibbell JE, Gladden RM. Increases in drug and opioid overdose deaths—United States, 2000-2014. *MMWR Morb Mortal Wkly Rep*. 2016;64:1378-1382.
- Kemppainen T, Kokki H, Tuomilehto H, Seppä J, Nuutinen J. Acetaminophen is highly effective in pain treatment after endoscopic sinus surgery. *Laryngoscope*. 2006;116:2125-2128.
- Mohammed MH, Fahmy AM, Hakim K. Preoperative gabapentin augments intraoperative hypotension and reduces postoperative opioid requirements with functional endoscopic sinus surgery. *Egypt J Anaesth*. 2012;28:189-192.
- DeMaria S Jr, Govindaraj S, Chinosorvatana N, Kang S, Levine AI. Bilateral sphenopalatine ganglion blockade improves postoperative analgesia after endoscopic sinus surgery. *Am J Rhinol Allergy*. 2012;26:e23-27.
- Kim DH, Kang H, Hwang PH. The effect of sphenopalatine block on the postoperative pain of endoscopic sinus surgery: a meta-analysis. *Otolaryngol Head Neck Surg*. 2019;160:223-231.