Predictive Factors for Postoperative Opioid Use in Elective Skull Base Craniotomies

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Abstract

Objective In 2017, the United States officially declared opioid overuse a public health emergency. Due to a paucity of published benchmark data in skull base neurosurgery, we quantified postoperative opioid use in patients undergoing skull base craniotomies and identified factors that influence postoperative opioid use.

Setting Tertiary academic medical center.

Participants Patients who underwent elective craniotomies by two skull base neurosurgeons between January 2015 and May 2020.

Main Outcome Measures Demographic and perioperative data were retrospectively extracted from the electronic medical record. Surgical approaches were categorized as having either "significant" or "minimal" muscle dissection. Univariate and multivariate linear regression analyses were performed to identify predictors of postoperative opioid use at 24, 48, and 72 hours.

Results We included 300 craniotomies, 206 were supratentorial and 94 were infratentorial. This included 195 women and 105 men, with a mean age of 54.9 years. In multivariable analysis, a history of anxiety or depression, preoperative opioid use, and a history of migraines independently predicted a significantly greater opioid use at 24, 48, and 72 hours. Increased age and minimal muscle dissection independently predicted lower opioid consumption. Sex, infratentorial versus supratentorial approach, length of surgery, and postoperative steroid use did not impact total opioid use.

Conclusion Younger age, history of anxiety or depression, preoperative opioid consumption, preexisting history of migraines, and significant intraoperative muscle dissection were associated with higher postoperative opioid consumption. These risk factors provide insight on potential targets for minimizing postoperative opioids in craniotomies.

Keywords
- opioid
- craniotomy
- skull base
- pain

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Introduction

Opioids are commonly used for postoperative analgesia, with surgeons prescribing up to 10% of all opioids in the United States.[1] According to the 2020 United Nations World Drug Report, 57.8 million people illicitly use opioids globally, with the highest global average use in North America.[2] The previous lack of awareness of the addictive potential of opioids has resulted in unintended consequences including physical and psychological dependence and overdose. In 2017, the United States officially declared the opioid crisis a public health emergency.[3] Health care providers in all disciplines have been tasked with better understanding the use of opioids in their respective practices.

As many as 80% of craniotomy patients report moderate to severe pain in the postoperative period,[4] but it is unclear which factors are associated with higher postoperative pain and opioid consumption.[4–6] Studies evaluating neurosurgical approaches and their role in the severity of postoperative pain and total postoperative opioid consumption have shown mixed results. Although Thibault et al suggested certain approaches are associated with less postoperative opioid use,[7] others have found no such correlation with postoperative pain.[8] Some studies suggest that age and gender may play a role in postoperative pain and opioid use,[5,7,9] but additional research, particularly in the skull base surgery population, is required to identify which factors truly correlate with higher opioid use in the postoperative period.

In this study, we investigated postoperative opioid use in patients who underwent craniotomies and studied various patient and surgical factors and how they influence postoperative opioid use.

Materials and Methods

This study was approved by our Institutional Review Board, and patient consent was waived due to minimal risk.

Patient Population

A total of 460 patients underwent supratentorial and infratentorial craniotomies by two neurosurgeons in an academic, primarily skull base practice between January 2015 and May 2020. The exclusion criteria was designed to exclude patients with an impaired ability to report their pain or request pain medication. Patients were excluded from this study due to the following reasons: nonelective procedures, altered levels of consciousness postoperatively, postoperative intubation, combined transsphenoidal operations, pregnancy, chronic kidney disease, or craniotomies for preexisting pain syndromes (e.g., trigeminal neuralgia). Patients who underwent staged operations or had a hospital length of stay less than 24 hours were excluded, as were patients who underwent stereotactic needle biopsies, were younger than 18 years, or underwent burr hole procedures (e.g., open biopsy or ventriculoperitoneal shunt) or awake craniotomies.

Both surgeons utilized ~5 to 15 mL (depending on incision size) of 0.5% lidocaine with epinephrine infiltrated into the incision prior to surgical prep. Postoperative pain control typically consisted of as needed administration of acetaminophen and oral and/or intravenous opioid medication depending on pain severity. Muscle relaxants were often prescribed on an as needed basis in cases where significant muscle dissection was performed. Non-steroidal anti-inflammatory drugs (NSAIDS) were occasionally used after 48 hours postoperatively if pain control was still suboptimal and there was no concern about postoperative bleeding.

Demographic and Surgical Variables

Using the electronic medical record, we retrospectively collected relevant demographic and surgical variables. Patients who were using opioids preoperatively (within 3 months of surgery) were also noted.

Surgical operative reports were reviewed, and patients were broadly categorized by surgical approach: supratentorial craniotomy or infratentorial craniotomy. Patients undergoing craniotomies were further classified as having either significant or minimal muscle dissection. Minimal muscle dissection was defined as approximately less than 4 cm linear length of muscle dissection at our institution. Pterional, orbitozygomatic, middle fossa, and suboccipital approaches (including midline, paramedian, and far lateral) were defined as significant muscle dissection, whereas supraorbital, bifrontal, convexity (frontal, parietal, and occipital), and retrosigmoid approaches were defined as minimal muscle dissection. Total inpatient opioid consumption was calculated for the first 24, 48, and 72 hours postoperatively. All opioids were converted to oral morphine milligram equivalents (MMEs).

Statistical Analysis

Baseline patient and surgical parameters were summarized with mean ± standard deviation or N (%). Univariable linear regression analysis was performed to identify variables that correlated with total postoperative opioid use at 24, 48, and 72 hours including: age, sex, history of depression or anxiety, preoperative opioid use, surgical approach (i.e., supratentorial and infratentorial), preexisting migraines, extent of muscle dissection, postoperative steroid use, and length of surgery. Variables with $p < 0.2$ were included in a multivariable linear regression analysis to identify independent predictors of opioid consumption at 24, 48, and 72 hours.

To understand any trends in opioid use over time in this group, we dichotomized the study period into two groups: 2015 to 2017 and 2018 to 2020, in relationship to the declaration of the opioid epidemic in the United States in 2017. Nonopioid analgesics were quantified, and the Fisher's exact test was used to compare nonopioid analgesic between time groups. All statistics were performed using RStudio (RStudio Team, Boston, Massachusetts, United States), and $p < 0.05$ was defined as statistically significant.

Results

Patient and Surgical Characteristics

A total of 300 patients undergoing distinct operations were included in this study as follows: 206 (68.7%) supratentorial and 94 (31.3%) infratentorial (►**Table 1**). Seventy-three

Table 1 Baseline patient and surgical parameters

Characteristic	*N* (%) or mean ± SD
N	300
Age, mean ± SD (y)	54.9 ± 14.0
Sex	
Female	195 (65.0%)
Male	105 (35.0%)
Time period	
2015–2017	159 (53.0%)
2018–2020	141 (47.0%)
Anxiety/depression	73 (24.3%)
Anxiety	36 (12.0%)
Depression	53 (17.7%)
Preoperative opioid use	32 (10.7%)
History of migraines	23 (7.7%)
Surgical approach	
Infratentorial	94 (31.3%)
Supratentorial	206 (68.7%)
Extent of muscle dissection	
Minimal	173 (57.7%)
Significant	127 (42.3%)
Length of surgery (min)	346.5 ± 176.0
Length of stay (d)	3.6 ± 2.4

Abbreviation: SD, standard deviation.

Table 2 Postoperative opioid analgesia use

Opioid analgesic	*N* = 300
Oral codeine	1 (0.3%)
IV fentanyl	51 (17.0%)
Oral hydrocodone	11 (3.7%)
Oral hydromorphone	2 (0.6%)
IV hydromorphone	77 (25.7%)
IV meperidine	9 (3.0%)
IV morphine	127 (42.3%)
Oral morphine	2 (0.6%)
Oral oxycodone	224 (74.7%)
Oral tramadol	2 (0.6%)

Abbreviation: IV, intravenous.

(24.3%) patients had a preexisting diagnosis of depression or anxiety. Thirty-two (10.7%) patients used opioids preoperatively. A total of 23 (7.7%) patients had a preexisting history of migraines.

Surgical Approaches

Craniotomies were dichotomized into significant and minimal muscle dissection. There were 173 (57.7%) patients who underwent craniotomies that were classified as minimal muscle dissection. Within this cohort, there were 16 bifrontal, 77 convexity, 67 retrosigmoid, and 13 supraorbital cases. There were 127 (42.3%) patients who underwent craniotomies with significant muscle dissection. Further breakdown of this cohort included 10 far lateral, 13 middle fossa, 11 orbitozygomatic, 76 pterional, and 17 suboccipital cases.

Benchmarks of Postoperative Opioid Use

Postoperative opioid analgesia consisted of oral and IV administration. The most used opioid analgesic was oral oxycodone with 224 (74.7%) patients using it postoperatively. Patients also used IV morphine (42.3%), IV hydromorphone (25.7%), and IV fentanyl (17.0%). A full list of opioids used during the study period is shown in ►**Table 2**.

The mean cumulative postoperative opioid use at 24, 48, and 72 hours for supratentorial craniotomies was 85.6 ± 62.3, 118.4 ± 85.4, and 135.2 ± 97.4 MME, and for infratentorial craniotomies was 87.3 ± 52.6, 118.7 ± 73.4, and 149.6 ± 99.3 MME, respectively. There was no significant difference overall between supratentorial and infratentorial craniotomies in postoperative opioid use at 24, 48, or 72 hours.

Predictors of Postoperative Opioid Use

Univariate analyses were performed to identify variables that correlated with postoperative opioid use (►**Table 3**), and those variables whose *p*-value was less than 0.2 were selected for multivariable analysis.

In multivariable analysis, younger age, history of anxiety or depression, preoperative opioid use, history of migraines, and significant muscle dissection independently predicted higher postoperative opioid use when controlling for other variables (►**Table 4**). A preexisting history of migraines was the strongest predictor of greater opioid use, as these patients required 65.3 more MME at 24 hours ($p < 0.001$), 85.1 more MME at 48 hours ($p < 0.001$), and 116.3 more MME at 72 hours ($p < 0.001$) postoperatively. For each 10-year increase in age, patients used 9.8, 19.0, and 20.6 fewer MME in the first 24 ($p < 0.001$), 48 ($p < 0.001$), and 72 ($p < 0.001$) hours after surgery. Patients with a history of anxiety or depression consumed 19.2 more MME at 24 hours ($p = 0.008$), 27.1 more MME at 48 hours ($p = 0.005$), and 45.5 more MME at 72 hours ($p = 0.002$) postoperatively. Patients who used opioids preoperatively consumed 25.8 more MME at 24 hours ($p = 0.010$), 36.2 more MME at 48 hours ($p = 0.007$), and 46.4 more MME at 72 hours ($p = 0.015$) than patients who did not use opioids preoperatively.

Patients who underwent craniotomies with significant muscle dissection used 15.7 more MME at 24 hours ($p = 0.012$), 23.3 more MME at 48 hours ($p = 0.006$), and 36.9 more MME at 72 hours ($p = 0.003$) when compared with patients who underwent craniotomies with minimal muscle dissection.

Trends Over Time and Nonopioid Analgesics Use

We found that mean postoperative opioid consumption decreased in 2018 to 2020 as compared with 2015 to 2017 at 24, 48, and 72 hours postoperatively. Between 2015 and

Table 3 Univariate linear regression analysis of variables affecting total opioid use in the first 24, 48, and, 72 hours after surgery

Variable	24 h		48 h[a]		72 h[b]	
	Coefficient	*p*-Value	Coefficient	*p*-Valu	Coefficient	*p*-Valu
Age	−1.12	<**0.001**	−2.10	<**0.001**	−2.47	<**0.001**
Sex						
Female	Reference		Reference		Reference	
Male	−6.21	0.389	−7.16	0.475	−19.76	0.186
Anxiety/depression	23.28	**0.003**	32.17	**0.003**	55.92	<**0.001**
Preoperative opioid use	27.83	**0.012**	37.77	**0.013**	63.88	**0.004**
History of migraines	75.62	<**0.001**	103.76	<**0.001**	142.07	<**0.001**
Surgical approach						
Infratentorial	Reference		Reference		Reference	
Supratentorial	−1.72	0.817	−0.31	0.976	−14.42	0.335
Muscle dissection						
Minimal	Reference		Reference		Reference	
Significant	10.53	0.129	15.06	0.118	21.23	0.137
Length of surgery	0.01	0.664	<0.01	0.890	0.04	0.370
Steroid use	2.93	0.848	−2.51	0.908	−28.88	0.366

Note: Bold denotes statistically significant values.
[a]In 293 patients with minimum 2-day hospital length of stay.
[b]In 191 patients with minimum 3-day hospital length of stay.

Table 4 Multivariate linear regression analysis of variables affecting total opioid use in the first 24, 48, and, 72 hours after surgery

Variable	24 h		48 h[a]		72 h[b]	
	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
Age	−0.98	<**0.001**	−1.90	<**0.001**	−2.06	<**0.001**
Anxiety/depression	19.23	**0.008**	27.11	**0.005**	45.51	**0.002**
Preoperative opioid use	25.85	**0.010**	36.26	**0.007**	46.46	**0.015**
History of migraines	65.34	<**0.001**	85.11	<**0.001**	116.38	<**0.001**
Muscle dissection						
Minimal	Reference		Reference		Reference	
Significant	15.70	**0.012**	23.33	**0.006**	36.93	**0.003**

Note: Bold denotes statistically significant values.
[a]In 293 patients with minimum 2-day hospital length of stay.
[b]In 191 patients with minimum 3-day hospital length of stay.

2017, patients used a mean of 98.9 ± 61.5, 136.8 ± 86.6, and 158.8 ± 107.5 MME at 24, 48, and 72 postoperatively, respectively. Patients who underwent surgery between 2018 and 2020 had lower mean MME consumption of 71.8 ± 53.5, 97.3 ± 70.1, and 118.3 ± 80.9 at 24 ($p < 0.001$), 48 ($p < 0.001$), and 72 ($p < 0.004$) hours postoperatively, respectively.

To understand this further, we analyzed trends in postoperative nonopioid analgesic use (►**Table 5**). We analyzed eight nonopioid analgesics and found that ketorolac (12.1 vs. 0.0%, $p < 0.001$) and methocarbamol (29.8 vs. 4.4%, $p < 0.001$) were used more in the 2018 to 2020 time period. The most used nonopioid medication was oral acetaminophen, but this was used to a similar degree throughout the study period (73.0% of patients from 2015–2017 vs. 75.9% of patients from 2018–2020 [$p = 0.598$]).

Discussion

Benchmarking Opioid Consumption across Surgical Specialties

In our study, we quantified opioid consumption up to 72 hours after surgery for craniotomies. In an attempt to compare skull base craniotomies to other surgical procedures, we identified studies in the literature that report MME over 24 to 72 hours postoperatively for other surgical procedures (►**Table 6**).[10–15] In comparison, patients undergoing head and neck procedures require significantly fewer opioids

Table 5 Postoperative nonopioid analgesic use

Nonopioid analgesic	Time period (2015–2017) ($N=159$)	Time period (2018–2020) ($N=141$)	*p*-Value
Acetaminophen (PO)	116 (73.0%)	107 (75.9%)	0.598
Acetaminophen (IV)	44 (27.7%)	37 (26.2%)	0.796
Cyclobenzaprine	4 (2.50%)	4 (2.8%)	>0.999
Diazepam	21 (13.2%)	21 (14.9%)	0.740
Ibuprofen	0 (0.0%)	3 (2.1%)	0.103
Ketorolac	0 (0.0%)	17 (12.1%)	<**0.001**
Methocarbamol	7 (4.4%)	42 (29.8%)	<**0.001**
Tizanidine	0 (0.0%)	1 (0.71%)	0.470

Abbreviations: PO, oral; IV, intravenous.
Note: Bold denotes statistically significant value.

Table 6 24 hours mean and median postoperative opioid use in surgical procedures

Study	Procedure	24 h postoperative median/mean MME consumption
Our results	Supratentorial craniotomy	85.6 ± 62.3
	Infratentorial craniotomy	87.3 ± 52.6
Badash et al[10]	Endoscopic sinus surgery	23.1
Stephenson et al[12]	Nonaerodigestive head and neck surgery	40.5 ± 30.6
Mobini et al[11]	Orthognathic surgery	48.0
Sanford et al[13]	Lumbar decompression	19.7 ± 0.9
	Lumbar decompression with fusion	105.3 ± 4.1
	Cervical decompression with fusion	65.0 ± 2.0
Bernstein et al[14]	Revision total hip arthroplasty	135.5
	Primary total hip arthroplasty	44.03
Roof et al[15]	Total knee arthroplasty	38.43 ± 0.42

Abbreviation: MME, morphine milligram equivalent.

than skull base craniotomies. Published benchmarks include endoscopic sinus surgery (23.1 mean MME at 24 hours postoperatively),[10] orthognathic surgery (48.0 mean MME at 24 hours postoperatively),[11] and nonaerodigestive head and neck surgery (40.5 ± 30.6 MME within the 24-hour postoperative period).[12]

Skull base craniotomy fell within the range seen in other spine and joint procedures. Patients who underwent lumbar decompression, lumbar decompression with fusion, or cervical decompression with fusion consumed 19.7 ± 0.9, 105.3 ± 4.1, and 65.0 ± 2.0 MME postoperatively daily, respectively.[13] Bernstein et al[14] identified that patients who underwent primary total hip arthroplasty required 44.03 mean MME, significantly less compared with patients who underwent revision total hip arthroplasty, who required 135.5 mean MME at 24 hours after surgery. Total knee arthroplasty was found to require an average of 38.43 ± 0.42 MME per day when adjusting for patient factors such as body mass index, smoking status, insurance, and race according to Roof et al.[15]

Chronic Migraines and Postoperative Opioid Use

In our study, we found that a preexisting diagnosis of migraines was the strongest predictor of increased postoperative opioid consumption when controlling for other variables. Recent research has identified migraines a prognostic factor for prolonged postoperative opioid consumption and increased postoperative pain within multiple surgical fields.[16–18] A 2021 study by Gill et al[18] identified migraine disorder as a positive predictive factor for increased postoperative pain and opioid consumption in sinonasal surgery. Similarly, Kim et al[16] showed that patients who have a migraine disorder were predictors of persistent opioid use defined as opioid use up to 12 months after hip or knee arthroplasty. In concordance with recent research, a systematic review showed that patients with migraines are one to five times more likely to have prolonged (more than 1 week) postoperative opioid use following orthopaedic procedures.[17] First-line treatment for migraines typically includes nonsteroidal anti-inflammatory pharmacotherapies, however, when refractory, triptans and dopamine antagonist have been shown to be effective in the treatment of migraines.[19–22] In patients with migraines, opioids are not considered first line due to their limited efficacy in providing adequate pain relief as compared with nonsteroidal anti-inflammatory drugs (NSAIDs) and other analgesics.[21,22] Patients with migraines who undergo craniotomies may have increased opioid requirements due to a lack of response of opioids to the inflammatory and neuropathic nature of migraine pain or possibly due to preexisting differences in pain sensitivity.[23] Alternatively, irritation of the meninges through surgical manipulation can provoke a migraine causing greater postoperative pain not best relieved by opioids. In our study, patients with a history of migraines required increased opioid consumption to attain adequate pain relief, and perhaps, these patients may benefit from greater use of nonopioid options or preoperative optimization of migraine management and control.

Muscle Dissection and Surgical Approach

In this study, we found that the extent of muscle dissection correlated with postoperative opioid. Prior studies have not categorized individual approaches as significant or minimal muscle dissection, which is important to parse out in the analysis. For example, a 2.5-cm retrosigmoid craniectomy has much less muscle dissection than a midline suboccipital craniotomy. A 2007 study by Thibault et al[7] found that patients who underwent frontal craniotomies used fewer opioids than patients who underwent posterior fossa surgery, but did not differentiate between frontotemporal, bifrontal, supraorbital craniotomies or further categorize different posterior fossa surgeries. De Benedittis et al[5] reported that patients undergoing subtemporal or suboccipital approaches—both approaches with significant muscle dissection—had higher postoperative pain.

A 2003 study by Irefin et al[8] evaluated patients undergoing supratentorial, infratentorial, and spinal surgery and found no difference in 24-hour postoperative pain among the three approaches. When comparing supratentorial and infratentorial craniotomies, we found no significant difference in postoperative opioid use. Given that supratentorial and infratentorial craniotomies can involve either minimal or significant muscle dissection, postoperative pain may be more accurately reflected by the extent of muscle dissection.

In many neurosurgical approaches, muscle dissection and retraction may be unavoidable. However, direct infiltration of local anesthetic into the muscle may be one option to help reduce immediate postoperative pain. Postoperative muscle relaxers may also benefit patients who undergo surgeries with significant muscle dissection, as suggested by a 2019 study by Bourazani et al[24] in which muscle relaxers reduced postoperative pain and opioid consumption in patients undergoing mastectomies and breast reconstruction procedures. In a meta-analysis conducted by Perera et al,[25] patients who underwent lumbar spine surgery with postoperative anesthetic infiltration into the muscle required less postoperative analgesics and a reduction in postoperative opioid use. Overall, our study suggests that muscle dissection may play a significant role in postoperative pain, and nonopioid pain-alleviating strategies should be targeted at patients in whom significant muscle dissection is unavoidable.

Preoperative Optimization: Mood Disorders and Preoperative Opioid Use

In our study, patients with anxiety or depression used more postoperative opioids than patients without anxiety or depression. In other surgical specialties, several studies have shown a similar association,[26–28] but a systematic review by Dadgostar et al, however, reported mixed results regarding anxiety and depression and postoperative pain outcomes across multiple surgical specialities.[29] Our results suggest that preoperative evaluation of patients undergoing neurosurgical procedures should include a thorough assessment of mental health, and it may be important to optimize the medical management of these disorders prior to surgical intervention. Standardized screening tools for assessing mental illness and mood disorders such as the Mood Disorder Questionnaire and Patient Health Questionnaire-9 before surgery may help identify undiagnosed mental health disorders and allow an opportunity for targeted treatment preoperatively. Patient's physical pain may then be addressed appropriately without overtreatment to compensate for psychiatric influences on patient's pain.

Our study also found that preoperative opioid use was also a powerful predictor of the quantity of opioids used postoperatively. This would suggest that this is an important target for preoperative optimization to implement nonopioid pain regimens and wean opioid use preoperatively.

Alternatives to Opioids

While opioids remain a first-line option for postoperative analgesia, they may be combined with nonopioid pain medications. Several studies have shown that adding nonopioid analgesics such as, anticonvulsants, NSAIDs, anesthetics, and adrenergic agonists, reduces total postoperative opioid consumption and postoperative pain.[6,30–36]

Local anesthetics are another option to reduce postoperative pain and opioid consumption. Song et al showed that the intraoperative use of 0.5% ropivacaine and 1% lidocaine reduced opioid consumption within the first 24 hours, with these patients also requesting opioids later than controls.[33]

Two studies showed that the intraoperative use of dexmedetomidine decreased postoperative opioid consumption in craniotomies as compared with controls in the first 12 hours.[37,38] In a 2019 study by Zeng et al, preoperative gabapentin decreased postoperative pain scores in craniotomies within 48 hours; however, cumulative opioid dosage and the number of patients requiring rescue tramadol were the same between the experimental and control groups.[30]

The dosing and timing of nonopioid analgesics are important factors to consider, as some medications require more frequent doses compared with their opioid counterparts, and nonopioid alternatives may pose additional risks such as gastrointestinal bleeding or inhibition of clotting and may not be appropriate for all patients.[30] Overall, these opioid alternatives are valuable options, but future research is needed to understand how best to optimize pain regimens to minimize opioid use.

Limitations

Our results should be interpreted within the context of this study's limitations. Given the retrospective nature, our study is subject to unavoidable selection bias. We excluded patients with surgery for the treatment of trigeminal neuralgia as we did not want these conditions to confound our findings. This does limit the generalizability to those patient populations. During the study period, there was no standardized pain management protocol in these patients. Although we saw a significant drop in opioid consumption after the 2017 public health emergency declaration, this was not a result of any formal inpatient protocol for decreasing opioid consumption. This may have been in part due to increased public awareness and patient expressed preference to minimize consumption of opioids. Although we found that younger age was associated with increased opioid requirements postoperatively, given that pain medications were administered 'as needed', we cannot rule out that nursing may have been more cautious or restrictive with opioid use in the elderly. Because many different non-opioid analgesics were utilized in this study and the lack of existing conversion units between them, we were unable to quantify and summate non-opioid analgesic consumption in a way that would allow statistical analysis. Due to retrospective nature, we were unable further investigate the character of pain experienced by patients with a history of migraines, but this is certainly an important topic worthy of additional study to identify an optimal postoperative pain algorithm in those with migraine history. In the study, there was no formal anesthetic regimen; however, many patients had short-acting remifentanil which may have influenced postoperative pain management. However, due to the short half-life of remifentanil (10–20 minutes), one might not expect a significant impact on postoperative opioid consumption. Finally, given that we were not comparing different pain control regimens, we did not collect information on postoperative subjective pain scores. For example, if certain populations had higher subjective pain scores, it would be difficult to determine if the corresponding opioid consumption was because of increased pain requirements or improved pain control.

Conclusion

In this study, we found that younger age, preoperative opioid use, a history of anxiety or depression, migraines, and extensive muscle dissection predicted higher postoperative opioid use at 24, 48, and 72 hours in patients undergoing craniotomies. Sex, surgical approach (supratentorial vs. infratentorial), steroid use, and length of surgery did not predict opioid use. Multimodal methods for pain control should be focused on patients with greater intraoperative muscle dissection and on preoperative optimization of patients with anxiety or depression, migraines, or preoperative opioid use. Future studies may be useful to tailor alternative analgesic approaches to patients who are likely to consume more opioids in the postoperative period.

Conflict of Interest
P.F.R. is the consultant for Stryker; V.R.K. is a consultant for Stryker and Integra. The other authors report no conflict of interest.

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