Subcutaneous sumatriptan: association with decreases in postoperative pain and opioid use after elective cranial surgery

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OBJECTIVE Sumatriptan, a serotonin receptor agonist, has been used in the management of primary headache disorders and has been shown to affect trigeminal dural afferents. There is limited literature on the safety and efficacy of sumatriptan for postcraniotomy pain management. This study aimed to identify whether subcutaneous sumatriptan is a safe and efficacious pain management strategy after elective craniotomy.

METHODS The authors retrospectively reviewed patients who underwent supratentorial or suboccipital craniotomy between 2016 and 2019 that was performed by a single provider at a single institution to identify patients given subcutaneous sumatriptan in the postoperative period. Pain scores and intravenous and oral opioid use were compared in patients with (n = 15) and without (n = 45) sumatriptan administration.

RESULTS Patients with and without sumatriptan administration had no significant differences in baseline characteristics or surgery type. There were no sumatriptan-related complications. The average pain score decreased from 3.9 to 1.3 within 1 hour after sumatriptan administration (p = 0.014). In both adult and pediatric patients there was decreased postoperative pain (adults: pain score of 1.1 vs 7.1, p < 0.001; pediatric: 1.1 vs 3.9, p = 0.007) within the first 48 hours. There were decreases in intravenous opioid use, length of intravenous opioid use, maximum dose of intravenous opioid used, oral opioid use, length of oral opioid use, and maximum dose of oral opioid used in both adult and pediatric patients.

CONCLUSIONS The authors identified subcutaneous sumatriptan as a safe and efficacious tool for postoperative pain management after craniotomy. Large multicenter randomized controlled studies are needed to further evaluate the specific role of sumatriptan in postoperative pain management after craniotomy.

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KEYWORDS craniotomy; opioid; pain management; sumatriptan

CRANIOTOMY is among the most common neurosurgical procedures and involves the surgical removal of a bone flap from the skull to expose the meninges and brain. Postoperative neurosurgical pain is quite common, occurring in up to 60% of patients, and most frequently within the first 48 hours of surgery.⁴ Postcraniotomy headaches, ranging from tension-type to migraine headaches with associated nausea, vomiting, and photophobia, have an incidence of 70%–90% and can negatively affect the quality of neurosurgical recovery.^{28,29,36} There is significant need to expand therapeutic options for the treatment of postcraniotomy pain.

Although opioids are the main analgesics used for moderate to severe acute postneurosurgical pain,⁵ their use is far from ideal. Opioids are known to confound the neurological examination by increasing sedation and invoking miosis, and they may potentiate nausea and vomiting. Furthermore, postcraniotomy headaches may not respond well to the usual opioid analgesics,³⁶ and nonaspirin analgesics such as acetaminophen or paracetamol.^{2,37} Although the mechanism of postcraniotomy headaches is not completely understood, several studies suggest activation of nociceptors on the dura mater, mediated by trigeminal afferents involving serotonin-based molecular mechanisms.^{12,17}

ABBREVIATIONS PACU = postanesthesia recovery unit; SAH = subarachnoid hemorrhage; 5-HT = 5-hydroxytryptamine (serotonin); 5-HT(1B/1D) = serotonin receptor.

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Sumatriptan is a serotonin receptor (5-HT[1B/1D]) agonist that has been effective in the treatment of primary headache disorders, particularly acute migraine pain. It acts through multiple mechanisms that include inhibition of the release of vasoactive peptides by trigeminal afferents, inhibition of nociceptive transmission in the upper spinal cord and brainstem, and facilitation of vasoconstriction of distended intracranial extracerebral vasculature.³⁴ Recent studies have demonstrated the benefit of sumatriptan beyond acute migraine pain, including headache caused by subarachnoid hemorrhage (SAH) and aseptic meningitis, and most recently, acute postcraniotomy pain following microvascular decompression.^{14,27,30,33,36}

In this study we evaluated a retrospective database of both adult and pediatric patients undergoing craniotomy. We identified patients who received subcutaneous sumatriptan and evaluated their postoperative hospital course, specifically in regard to pain and opioid use. We hypothesize that sumatriptan can safely serve to manage pain after craniotomy as an alternative to more traditional opioid-based strategies.

Methods

Data Collection

This retrospective study was approved by the institutional review board. Informed consent for hospitalization and treatment was obtained from patients prior to all hospitalizations. Patients who underwent elective cranial procedures by the senior author (A.C.W.) were identified. Preoperative characteristics, operative characteristics, and postoperative course were retrospectively reviewed. Opioid medication doses administered to patients were converted to morphine milligram equivalents by using the Opioid Morphine Equivalent Conversion Factors published by the Centers for Disease Control and Prevention; for patient-to-patient comparison see <https://www.cms.gov/Medicare/Prescription-Drug-Coverage/PrescriptionDrugCovContra/Downloads/HPMSSupplementalGuidanceRelated-toImprovingDURcontrols.pdf>.

Sumatriptan Administration

We began administering sumatriptan for elective uncomplicated cranial procedures with increased frequency in 2017. We identified a total of 15 patients who received subcutaneous sumatriptan postoperatively. Each patient was taken from the operating room to the postanesthesia recovery unit (PACU) or ICU. There, each patient was connected to monitors and cleared by the anesthesia team. Before administration, monitors were checked to ensure that there were no arrhythmias, evidence of myocardial ischemia, or hypertension. A neurological examination was obtained immediately postoperatively. Each patient received 6 mg of sumatriptan succinate subcutaneously via abdominal injection.

Pain Scales

Postoperatively, pain levels were assessed every hour by using the FACES Pain Rating Scale (<https://wongbakerfaces.org/>) (Fig. 1A).^{8,9} This previously validated score is commonly used in both the pediatric and adult settings.

The score ranges from 0 (no pain) to 10 (highest amount of pain). In patients who could not use the FACES Pain Rating Scale (e.g., young pediatric patients), the FLACC (Face, Legs, Activity, Cry, Consolability) pain scale was used.^{22–24,26} This is a previously validated observational pain assessment tool used in patients who are unable to communicate their pain. The score also ranges from 0 (least likely in pain) to 10 (most likely in pain). In addition to pain scores, any pain-related medication administered to the patient was recorded, including postoperative day, route of administration (oral or intravenous), and dosage.

Potential sources of bias from this retrospective source were identified. Whereas the inclusion criteria for sumatriptan use was standard (uncomplicated elective craniotomy), the group was heterogeneous. This was addressed by identifying potential confounders (patient characteristics, type of surgery, pathology) and comparing the differences in the cases versus controls. In addition, we carried out a more in-depth analysis of other nonopioid pain medications by performing a multivariate regression analysis with these medications and sumatriptan to see the contributing effects to our variables of interest. We did not exclude any additional case that met the inclusion criteria during the period studied; therefore, this was an analysis of 60 consecutive elective cases. Differences in opioid type were uncommon, but for direct comparison all opioid medications were converted to morphine equivalents.

Statistical Analysis

All statistical analyses were carried out using SPSS Statistics for Mac (version 26.0, 2019, IBM Corp.). Statistical analyses included the following: independent sample t-test, paired sample t-test, chi-square test, and univariate and multivariate regression in which a *p* value < 0.05 was prospectively determined to indicate a significant difference. Subgroup analyses between pediatric and adult patients were carried by stratifying the population to age < 18 years (pediatric) or ≥ 18 years (adult). All potential confounding variables were evaluated to confirm no significant difference between case and control groups prior to all analyses. All patients had medication data available. Patients without recorded pain scores were removed from the pain analysis.

Results

Patient Characteristics

We identified a total of 60 elective cranial cases during the period in which sumatriptan administration began (Table 1). The average patient age was 29 years (SD 22.9; range 1–69 years). There were 27 (45.0%) pediatric patients (< 18 years old). Thirty-five patients (58.3%) were female. Pathologies included glioma in 13 (21.7%), unruptured intracranial aneurysm in 10 (16.7%), arteriovenous malformation in 8 (13.3%), cavernous malformation in 6 (10.0%), meningioma in 3 (5.0%), Chiari I malformation in 3 (5.0%), craniopharyngioma in 2 (3.3%), pineal tumor in 2 (3.3%), sarcoma in 2 (3.3%), and moyamoya disease in 2 (3.3%), as well as pituitary adenoma, metastasis, endolymphatic hydrops, CSF leak, dural ectasia, choroid plexus cyst, medulloblastoma, hemangioblastoma, and oculomo-

FIG. 1. The Wong-Baker FACES Pain Rating Scale was used in both adult and pediatric patients to record pain levels throughout the postoperative period (A). Average pain scores were significantly decreased after administration of sumatriptan in the ICU or PACU after surgery (B). Most patients had a decrease in postoperative pain after administration of sumatriptan (C).

tor perineurinoma in 1 (1.7%) each. Each patient underwent elective craniotomy; approaches included suboccipital craniotomy or craniectomy in 18 (30.0%), right supratentorial craniotomy in 19 (31.7%), left supratentorial craniotomy in 17 (28.3%), bilateral supratentorial craniotomy in 4 (6.7%), and burr hole in 2 (3.3%). Significant postoperative events included CSF leak in 2 patients (3.3%), aseptic meningitis in 2 patients (3.3%), seizure in 2 patients (3.3%), hemorrhage in 1 patient (1.7%), and pulmonary embolism in 1 patient (1.7%). The average length of stay was 6.5 days (range 1–42 days) and ICU stay was 3.4 days (range 0–19 days). Disposition after hospitalization included home in 50 (83.3%), acute rehabilitation in 9 (15.0%), and skilled nursing facility in 1 (1.7%). We evaluated differences in these factors between patients given and not given subcutaneous sumatriptan. There were no significant differences using chi-square analysis in any patient or surgical characteristic listed above ($p > 0.05$) (Table 2).

Sumatriptan Administration and Safety

A total of 15 patients (25.0%) were given subcutaneous

sumatriptan. All patients received sumatriptan in the immediate postoperative period in either the ICU or PACU. There were no complications or adverse reactions to sumatriptan administration in any of these patients, including evidence of myocardial ischemia, arrhythmias, stroke, hypertension, or seizures. Two of the 60 patients analyzed developed seizures in their postoperative courses, but neither of these patients were part of the sumatriptan administration group.

Subcutaneous Sumatriptan Decreases Pain After Administration

Pain scores using the FACES Pain Rating Scale were recorded prior to sumatriptan use once the patient recovered and had a stable neurological examination. The average pain score of all patients was 4.2 (range 0–10) in the immediate postoperative period. The average pain score of patients who were to receive sumatriptan was 3.9 (range 0–9) prior to administration; this difference was not statistically significant. The average pain score within 1 hour after receiving sumatriptan was 1.3. This difference was

TABLE 1. Characteristics in 60 patients who underwent craniotomies

Characteristic	Value
Age, yrs	29.1 (SD 22.9), range 1–69
Pediatric patient	27 (45.0%)
Female sex	35 (58.3%)
Pathology	
Glioma	13 (21.7%)
Unruptured aneurysm	10 (16.7%)
Arteriovenous malformation	8 (13.3%)
Cavernous malformation	6 (10.0%)
Meningioma	3 (5.0%)
Chiari I	3 (5.0%)
Craniopharyngioma	2 (3.3%)
Pineal tumor	2 (3.3%)
Sarcoma	2 (3.3%)
Moyamoya disease	2 (3.3%)
Other*	9 (15.0%)
Craniotomy type	
Suboccipital craniotomy/craniectomy	18 (30.0%)
Rt supratentorial craniotomy	19 (31.7%)
Lt supratentorial craniotomy	17 (28.3%)
Bilat supratentorial craniotomy	4 (6.7%)
Burr hole	2 (3.3%)
Postop event	8 (13.3%)
CSF leak	2 (3.3%)
Aseptic meningitis	2 (3.3%)
Seizure	2 (3.3%)
Hemorrhage	1 (1.7%)
Pulmonary embolism	1 (1.7%)
Length of stay, days	6.5 (SD 7.4), range 1–42
Length of ICU stay, days	3.4 (SD 3.7), range 0–19
Disposition	
Home	50 (83.3%)
Acute rehabilitation	9 (15.0%)
Skilled nursing facility	1 (1.7%)

Values are expressed as the number of patients (%) or the average value (SD), as indicated.

* See text for details.

found to be statistically significant by using a paired sample t-test ($p = 0.014$) (Fig. 1B). Of a total of 15 patients, 12 (80%) had a significant decrease in pain, 2 had no significant change in pain (13.3%), and 1 had an increase in pain (6.7%) (Fig. 1C).

Subcutaneous Sumatriptan Decreases Early Postoperative Pain and Opioid Use in Adult Patients

A total of 33 patients included in this study were adults, and 7 (21.2%) of these patients were given subcutaneous sumatriptan in the immediate postoperative period. Using independent sample t-tests and Pearson chi-square tests, there were no significant differences in patient character-

istics between these 2 groups, including sex, age at surgery, pathology, type of craniotomy, use of preoperative opioids, and disposition (Table 2). The average postoperative pain score for patients on the day of surgery was 7.1 in patients without sumatriptan and 1.1 in patients with sumatriptan ($p < 0.001$). This benefit did not extend to the day after surgery, when the postoperative pain score for patients given sumatriptan was 5.3 and for those not given sumatriptan it was 5.0 ($p = 0.80$) (Fig. 2A). There continued to be no significant difference in pain scores after the first 24 hours postoperatively. There was a trend toward decreased use of intravenous opioids (43% in patients given sumatriptan and 77% in patients not given sumatriptan); decreased length of intravenous opioid use (0.57 days in patients given sumatriptan and 1.77 days in patients not given sumatriptan); and maximum intravenous opioid dose given in morphine equivalents (0.5 mg in patients given sumatriptan and 1.77 mg in patients not given sumatriptan); however, these trends did not reach statistical significance ($p = 0.086$, $p = 0.202$, and $p = 1.26$, respectively) (Fig. 2B–D). There was a statistically significant decrease in postoperative oral opioid use (57% in patients given sumatriptan and 92% in patients not given sumatriptan); decreased length of oral opioid use (1.0 days in patients given sumatriptan and 4.1 days in patients not given sumatriptan); and maximum oral opioid dose given in morphine equivalents (6 mg in patients given sumatriptan and 15.5 mg in patients not given sumatriptan) ($p = 0.021$, $p = 0.044$, and $p = 0.006$, respectively) (Fig. 2E–G). There was no difference in length of stay or length of ICU stay between the 2 groups.

Subcutaneous Sumatriptan Decreases Early Postoperative Pain and Opioid Use in Pediatric Patients

A total of 27 pediatric patients were included in this study. A patient was identified who developed postoperative aseptic meningitis and chronic headaches; the patient had a long postoperative course and was excluded from the analysis. Seven of the 26 remaining patients were given subcutaneous sumatriptan in the immediate postoperative period (27%). Using independent sample t-tests and Pearson chi-square tests, there were no significant differences in patient characteristics between these 2 groups in sex, age at surgery, pathology, type of craniotomy, use of preoperative opioids, and disposition. The average postoperative pain score for patients on the day of surgery was 2.9 in patients without sumatriptan and 0.9 in patients with sumatriptan ($p = 0.095$). On the day after surgery, average pain scores were 3.9 for patients not given sumatriptan and 1.1 for patients given sumatriptan ($p = 0.007$) (Fig. 3A). There was no significant difference in pain scores after this early postoperative period. There was a statistically significant decrease in postoperative intravenous opioid use (0% in patients given sumatriptan and 63% in patients not given sumatriptan [$p = 0.003$]) (Fig. 3B). There was a trend toward decreased use of oral opioid (14% in patients given sumatriptan and 42% in patients not given sumatriptan); length of oral opioid use (0.1 days in patients given sumatriptan and 1.5 days in patients not given sumatriptan); and maximum oral opioid dose given in morphine equivalents (1.1 mg in patients given sumatriptan and 1.7

TABLE 2. Subgroup characteristics in 60 patients who underwent craniotomies

Characteristic	Sumatriptan (n = 15)	No Sumatriptan (n = 45)	p Value
Average age, yrs	27.6	29.9	0.74
Pediatric patient	53%	42%	0.46
Female sex	40%	64%	0.10
Craniotomy type			
Suboccipital craniotomy/craniectomy	47%	24%	0.11
Rt supratentorial craniotomy	33%	31%	0.88
Lt supratentorial craniotomy	13%	33%	0.14
Bilat supratentorial craniotomy	7%	7%	1.00
Burr hole	0%	4%	0.42
Postop event	7%	16%	0.39
Length of stay, days	5.7	6.8	0.65
Length of ICU stay, days	2.3	3.7	0.21

mg in patients not given sumatriptan) ($p = 0.201$, $p = 0.103$, and $p = 0.609$, respectively) (Fig. 3C–E).

Use of Additional Alternative Nonopioid Medication

NSAID medications were used in select patients based on clinical course and need. There was significant heterogeneity in the type of NSAID and length of administration

in this cohort. A total of 39 patients were given intravenous ketorolac postoperatively, and there was an association between ketorolac administration and subcutaneous sumatriptan administration ($p = 0.01$). To evaluate the potential confounding nature of NSAID use on our results, we constructed multivariate regression models for each outcome measure (Table 3). Although NSAID use was negatively associated with opioid use by most measures, subcutane-

FIG. 2. In adult patients, average pain scores were lower on the day of surgery in patients given sumatriptan (A). There was a trend toward decreased intravenous opioid use, length of use, and maximum dose in morphine equivalents (B–D) and a statistically significant decrease in oral opioid use, length of use, and maximum dose (E–G). * $p = 0.80$ (A), $p = 0.021$ (E), $p = 0.044$ (F), $p = 0.006$ (G).

FIG. 3. In pediatric patients, average pain scores were lower on the day after surgery in patients given sumatriptan (A). There was a no intravenous opioid use in patients given sumatriptan (B), and a trend toward decreased oral opioid use, length of use, and maximum dose (C–E). * $p = 0.007$ (A), $p = 0.003$ (B).

TABLE 3. Multivariate regression of nonopioid pain medication

Dependent Variable	R Value	Sumatriptan		NSAIDs	
		B	p Value	B	p Value
Pain score POD0	0.628	-3.28	0.002	-2.83	0.003
Pain score POD1	0.229	-1.06	0.270	-0.662	0.459
IV opioid use	0.432	-0.479	0.002	-0.047	0.722
IV opioid length of use	0.322	-1.47	0.014	0.531	0.306
IV opioid max dose	0.356	-0.834	0.012	-0.078	0.788
Oral opioid use	0.313	-0.341	0.030	-0.035	0.798
Oral opioid length of use	0.327	-2.51	0.015	0.214	0.811
Oral opioid max dose	0.455	-3.593	0.172	-6.7	0.005

IV = intravenous; max = maximum; POD = postoperative day.

ous sumatriptan was the only significant variable in every opioid measurement other than the maximum dose of oral opioid. In terms of pain score, both NSAID and sumatriptan use were independent significant predictors of lower pain only on the day of surgery.

Discussion

In this article we investigate the use of sumatriptan, a selective 5-HT(1D) receptor agonist, for postcraniotomy pain control. Sumatriptan, classically used in the treatment of acute migraine, has been used in the treatment of other primary headache disorders, but its use beyond this has not been well studied. Prokhorov et al. identified 2 patients with aseptic meningitis in whom headache responded to sumatriptan.²⁷ Kanai et al. found that subcutaneous sumatriptan decreased facial pain in medically refractory trigeminal neuralgia in a randomized cohort of 24 patients, and Shimohata et al. found that nasal sumatriptan decreased facial pain in 3 cases of medically refractory trigeminal neuralgia.^{14,33} Last, Rosenberg and Silberstein report a case of headache associated with SAH responding to triptan therapy.³⁰

Meningeal nociception mediated by trigeminal afferents appears to play a role central to the pathophysiology of migraine.¹⁷ Calcitonin gene-related peptide (CGRP) is involved in nociceptive transmission through second- and third-order neurons along the trigeminal pain pathway, whereas peripherally it mediates vasodilation through smooth-muscle receptors.³⁵ In animal models, sumatriptan directly mediates dural sensory afferent excitability and response to inflammatory mediators,¹² and acts selectively to cause vasoconstriction in isolated human middle meningeal arteries. Sumatriptan is active specifically on the 5-HT(1D) receptor subtype on central terminals in the trigeminal nucleus caudalis, and the 5-HT(1F) receptor subtype on peripheral terminals in dura.^{1,13} Inhibition of evoked trigeminal nucleus firing by various selective 5-HT agonists suggests that triptans inhibit trigeminal activity centrally.³⁴

Safety in the use of sumatriptan and other selective 5-HT agonists regarding coronary and cerebral arterial constriction remains a serious concern. Triptan-related reversible cerebral vasoconstriction syndrome has been rarely reported.^{11,15,25,38} However, the aggregate normalization of extracerebral artery diameter in migraine sufferers occurs without visible arterial constriction, and sumatriptan has actually been shown to increase cerebral blood flow.³ In fact, vasodilation is increasingly doubted to play any role in migraine pathophysiology at all.^{10,32} Sumatriptan has been shown to act selectively to cause vasoconstriction in isolated human middle meningeal arteries; however, the selective 5-HT(1D) agonism appears to have a minimal effect on cerebral and coronary artery smooth muscle at therapeutic concentrations.^{6,7,19–21,31}

Sumatriptan has been approved by the FDA and has been used for years for primary headache disorders in adults. Subcutaneous sumatriptan has been used for years in pediatric patients and has been found to be both effective and safe in children.^{16,18} Sumatriptan has been safely given in disorders other than primary headache disorders such as aseptic meningitis and SAH in adults.^{14,27,30,33} In

this study we found no instances of sumatriptan-related complications in either adults or pediatric patients when given for postoperative pain control after craniotomy. Of note, sumatriptan was not administered to patients with moyamoya disease or other forms of cerebrovascular pathology dependent on extracerebral arterial collateralization.

One study has previously evaluated the ability of sumatriptan to decrease postcraniotomy pain in the immediate postoperative period.³⁶ In this study, 50 patients undergoing craniotomy for microvascular decompression were randomized to receive subcutaneous sumatriptan or saline postoperatively. The authors found a decrease in headache in patients receiving sumatriptan as early as hours after administration. Similarly, we found that sumatriptan decreased pain scores after administration in the immediate postoperative period. In both adult and pediatric patients we found that patients had decreased pain scores on either the day of or the day after surgery, although there was no difference in pain scores following this time period. The half-life of sumatriptan is approximately 2.5 hours, and this fact is in congruence with the early but not prolonged decrease in pain scores in patients given sumatriptan. However, the manufacturer's label for subcutaneous sumatriptan describes the maximum dose of this drug over a 24-hour period as being 12 mg, i.e., two 6-mg doses separated by at least 1 hour. The use of multiple doses is an area of future study. In regard to confounding factors for postoperative pain, previous studies have suggested that female and younger patients reported higher levels of postoperative pain.⁴ We did not find a significant difference in pain based on age or sex, and the differences in age and sex in the sumatriptan and no sumatriptan groups were not significant.

One previous study has addressed changes in opioid consumption after sumatriptan administration following craniotomy.³⁶ This study evaluated median opioid consumption on the day of surgery and found no significant difference between patients given sumatriptan and those not given sumatriptan. The study did not evaluate intravenous versus oral opioids, maximum opioid dose used, and length of opioid use. In this study we used multiple additional specific variables to capture changes in opioid use and found that both adult and pediatric patients had decreased opioid use via these variables. Given our findings that patients in whom sumatriptan was administered 1) have decreased pain after sumatriptan administration, and 2) have decreased early postoperative pain relative to those who did not have sumatriptan, we hypothesize that sumatriptan decreases pain and the need for opioid medication. However, as reported previously,³⁶ we did not find any effect of sumatriptan on long-term patient outcome, length of ICU stay, total length of stay, and disposition. We hypothesize that sumatriptan has its greatest effects on patients early in the postoperative period and therefore does not change length of stay attributed to pain control and that length of stay is predominantly determined by the patient's medical course.

We found that NSAID use also was associated with decreased pain on the day of surgery and with decreased opioid use. When in a multivariate model with sumatriptan,

NSAID use was not a significant independent predictor of most variables capturing decreased opioid use. Specifically, measures of intravenous use were not significant, and only one variable capturing oral opioid use was significant. In regard to pain, both subcutaneous sumatriptan and NSAID use on the day of surgery were independent factors associated with decreased pain. We hypothesize that both sumatriptan and NSAIDs do prevent pain but that sumatriptan may play a larger role while medically active. However, future prospective evaluation with standard NSAID dosing schedules and with or without sumatriptan could help elucidate the relative contributions and optimal role of each medication.

Limitations of this study include the heterogeneity in patients. Although there were no significant differences in pathology and surgery type between the 2 groups (sumatriptan and no sumatriptan), there were multiple pathologies and types of surgeries included in this study. Another limitation of this study is the standardization of pain scores. We used the previously validated FACES pain score, but there are limitations to capturing pain with this score. There was no placebo control because this was a retrospective study, and the subjects and their caregivers were not blinded to intervention, introducing bias into these data. Last, we presented a small sample size of patients, introducing a beta error in our analysis. We believe that large randomized multicenter studies are necessary to evaluate the safety and efficacy of sumatriptan after craniotomy.

Conclusions

We identify subcutaneous sumatriptan as a safe and efficacious tool for postoperative pain management after craniotomy for a variety of neurosurgical procedures. We found no medication-associated complications in a series of adult and pediatric patients given subcutaneous sumatriptan. We found decreased pain scores after sumatriptan administration in the immediate postoperative period, but this effect did not persist. Patients given sumatriptan had decreased pain scores and less opioid use. There is a significant need for large multicenter randomized controlled studies to further evaluate the safety and efficacy of sumatriptan in postoperative pain management after craniotomy.

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Disclosures

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Author Contributions

Conception and design: Wang, Patel, Garrett. Acquisition of data: Wang, Patel, Laiwalla, DiCesare. Analysis and interpretation of data: Wang, Patel, Laiwalla, DiCesare. Drafting the article: Patel, Laiwalla, DiCesare. Critically revising the article: Wang, Patel, Laiwalla, DiCesare. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Wang. Statistical analysis: Patel. Administrative/technical/material support: Wang, Garrett. Study supervision: Wang, Garrett.

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