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A Retrospective Analysis of Superficial Cervical Plexus Blockade for Children Undergoing Otologic Surgery

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ABSTRACT

Superficial cervical plexus blocks (SCPB) are well documented for anterior and lateral neck surgeries in adults. Their role in the pediatric population is less clear. Our objective was to determine whether superficial cervical plexus blockade reduced postoperative nausea and vomiting (PONV) in children undergoing otologic surgery. This single-center retrospective cohort study evaluated patients aged 1–18 years old undergoing cochlear implantation, tympanomastoidectomy, tympanoplasty, or myringoplasty via a postauricular incision over a 27-month period. Patients undergoing bilateral surgery, concurrent surgery (exclusive of myringotomy or endoscopic otologic procedures), or transcanal-only otologic procedures were excluded. The primary outcome was PONV as measured by antiemetic use or documented nausea or vomiting among patients who received a SCPB compared to patients who did not receive a block. Secondary outcomes included opioid use, length of stay in the postoperative anesthesia care unit and hospital, time to oral intake, postoperative pain scores, and adverse events. Multilinear regression analyzed the effect of independent variables on the primary outcome. Analyses were stratified by surgery type. A total of 237 patients met inclusion criteria; 121 patients (51%) received a SCPB. There was no statistically significant difference in PONV outcomes between the two groups (proportion difference 4.5%, 95% CI −7.5% to 16.5%) despite lower intraoperative opioid administration to patients in the SCPB group (intravenous morphine equivalents per kg −0.04 mg, 95% CI −0.08 to 0, $p = 0.030$). Addition of a SCPB did not reduce PONV for pediatric patients undergoing otologic surgery via a postauricular incision. No adverse events were attributed to the block in this study.

Abbreviations: AEs, adverse events; AIC, Akaike information criterion; ASA, American Society of Anesthesiologists; BIC, Schwarz's Bayesian criterion; CI, confidence interval; CoI, cochlear implant; CPT, current procedural terminology; CTSA, Clinical and Translational Science Award; EHR, electronic health record; IRB, institutional review board; IV, intravenous; IVME, intravenous morphine equivalents; LMMs, linear mixed models; LOS, length of Stay; PACU, postanesthesia care unit; PONV, postoperative nausea and vomiting; RCT, randomized control trial; rFLACC, revised Face Legs Activity Cry and Consolability; SCPB, superficial cervical plexus block; SLCH, St. Louis children's hospital; TM, Tympanomastoidectomy; TP, Tympanoplasty.

1 | Introduction

Cervical plexus nerve blocks have long been utilized in adults. Classically, the cervical plexus block has been differentiated into the superficial and deep cervical plexus blocks. The superficial cervical plexus block (SCPB) is easier to perform with less risk of complications; therefore, its use is more widespread [1]. Recent studies on SCPBs for adults undergoing thyroid surgery have shown improvement in postoperative pain scores, decreased analgesic needs, and less postoperative nausea and vomiting (PONV) [1–3]. The most common use for cervical plexus blocks has been carotid endarterectomy surgery [4]. Although its use is well documented in adults, its use in the pediatric population has not been established. The evidence supporting cervical plexus blocks specifically in pediatric otologic surgery is particularly scarce.

PONV is common after the use of general anesthesia with opioids and can be problematic as the forceful motion of vomiting can lead to wound dehiscence, bleeding, hematoma formation, destabilization of tympanic membrane grafts, or even aspiration. Postoperative pain and PONV also cause distress and can worsen patient anxiety. Performing a SCPB for otologic surgery via a postauricular incision may decrease the use of opioid analgesics, which in turn may decrease side effects such as PONV. Complications related to a SCPB, such as intravascular anesthetic injection, phrenic nerve injury, and spinal accessory or vagus nerve palsy [4], are uncommon. Accuracy of injection can be enhanced with the use of ultrasound, potentially decreasing the risk of complications [4].

Pediatric anesthesiologists at St. Louis Children's Hospital (SLCH) often perform SCPBs on children undergoing otologic surgery with a postauricular incision. Our goal was to determine whether there is a difference in postoperative outcomes between patients receiving a SCPB for otologic surgery versus children who did not receive a SCPB. We hypothesize that children who received a SCPB intraoperatively would have decreased PONV. Additionally, we sought to compare the effect of the block on postoperative rFLACC pain scores, opioid consumption, time to oral intake, length of stay, and the incidence of adverse effects.

2 | Materials and Methods

A single institution retrospective cohort study was performed on all consecutive pediatric patients who underwent otologic surgery at SLCH from January 2017 to March 2020. Approval for the study was obtained from the Washington University Institutional Review Board (IRB) (IRB ID# 202003176). The requirement for written informed consent was waived by the IRB. The applicable STROBE checklist was followed as per Equator guidelines.

2.1 | Subject Selection

Included patients were 12 months–18 years old presenting for tympanoplasty (TP), myringoplasty, tympanomastoidectomy (TM), or cochlear implant (CoI) via a postauricular incision. Patients were excluded if they underwent transcanal-only otologic procedures (e.g., ossicular chain reconstruction, stapes surgery, endoscopic ear surgery without mastoidectomy, myringotomy and tympanostomy tube placement without mastoidectomy), bilateral surgery, concurrent surgery (other than myringotomy and tympanostomy tube placement), or who remained intubated after completion of surgery. The study period was determined as a convenience sample, beginning with the year SCPBs were performed frequently at SLCH, through the start of data collection.

2.2 | Protocol

Current procedural terminology (CPT) codes for TP, myringoplasty, TM, and CoI were used to identify eligible participants from the Epic electronic health record (EHR). Data was manually extracted by the researchers from patient peri-anesthetic records and entered into a REDCap database. Due to low numbers and similarity in surgical procedure, myringoplasty cases were also classified as TP. The study population was dichotomized into two groups: patients who received a block (SCPB+) and patients who did not (SCPB−).

The SCPB is performed by the anesthesiologist at SLCH via ultrasound guidance under general anesthesia. After the airway has been secured, the head is turned to the contralateral side and the ipsilateral neck is prepared in sterile fashion. A high frequency 5–10 Hz linear ultrasound probe is placed at the posterior border of the midpoint of the sternocleidomastoid muscle. A 22-gauge needle is then inserted posteriorly to the sternocleidomastoid and passed through the skin, platysma, and investing layer of the deep cervical fascia. The end point of the needle tip is directed to the plane between the prevertebral fascia and the investing layer of the deep cervical fascia. After negative aspiration, local anesthetic is injected to observe spread between the fascial layers.

The choice of whether a patient received a block was made by collaboration between the surgeon and the anesthesiologist. Otolaryngologists could request a SCPB when booking the procedure. For surgical cases with a postauricular incision where a block was not specified, a member of the anesthesiology team would reach out to the surgeon via email or in person to discuss the possibility of a block. A SCPB would only be performed if agreed upon by both the otolaryngologist and the anesthesiologist. All patients received general anesthesia with sevoflurane for maintenance. Most children older than 9 years of age had an intravenous (IV) catheter placed preoperatively whereas younger patients typically underwent a mask induction with sevoflurane, with or without nitrous oxide. Patients with separation anxiety received oral or IV midazolam. PONV prophylaxis and analgesic administration were not protocolized and at the discretion of the intraoperative anesthesiology clinician. Hydromorphone and fentanyl opioid analgesics are routinely used at SLCH. Typically, an initial dose of opioid medication would be given with induction. Additional opioids may have been given at any point during the procedure, including for clinically significant increases in heart rate or blood pressure.

2.3 | Measurements

Predictor variables were demographic data and medical and surgical histories, American Society of Anesthesiologists (ASA)

classification, surgical revision, and history of PONV. The primary outcome was PONV, defined as the proportion of patients who had at least one episode of nausea or emesis as recorded by nursing notes or administration of an antiemetic medication in the EHR postoperatively through hospital discharge. The decision to administer an antiemetic medication postoperatively was not protocolized and at the discretion of the postanesthesia care unit (PACU) or floor nursing teams with orders from the anesthesiologist or surgeon.

Secondary outcomes were perioperative pain control, defined as the amount of opioid administered intraoperatively and up to 12 h after surgery, and calculated as equianalgesic intravenous morphine equivalents (IVME) per kilogram [5, 6], length of stay (LOS) in the PACU and in the hospital, time to first oral intake, hospital disposition, postoperative revised Face Legs Activity Cry and Consolability (rFLACC) pain score [7, 8], and adverse events (AEs) (e.g., hemodynamic instability, respiratory distress, supplemental oxygen requirement, or neurovascular injury secondary to SCPB) [9]. See Appendix A for complete definitions of the list of variables.

2.4 | Statistical Analysis

Descriptive statistics characterized patient demographics, primary, and secondary outcomes for both groups, using the chi-square test for independence (or Fisher exact test, if necessary) for categorical-level variables, and the Mann–Whitney *U*-test for continuous-level variables. The strength of each association was measured using proportion difference or median difference and the corresponding 95% confidence interval (CI) around these differences.

Multivariable logistic regression analysis was used to analyze factors associated with PONV. Variables meaningfully associated with the clinical response with an alpha value of less than 0.2 based on a bivariate analysis were entered into the multivariable logistic regression model. The SCPB status was automatically added into the multivariable logistic regression analysis given this was the primary variable being tested for possible effect on PONV. The assessed variables were sex, surgery length, hospital LOS, SCPB status, ondansetron, dexamethasone, antimuscarinic antiemetics (scopolamine patch or diphenhydramine either IV or oral), propofol infusion for nausea prophylaxis, midazolam, age, and type of surgery.

Linear mixed models (LMMs) were used to analyze rFLACC scores, because the scores were repeated measures and violated the assumptions of generalized linear modeling. Fixed between-subjects' factors for the LMMs included age, surgery type, SCPB status and the interaction of SCPB status and time (categorized as 3, 6, 9, and 12 h from the end of surgery). A random intercept for subject was included to account for within-subject correlations. The mixed model with the minimum Akaike information criterion (AIC) and Schwarz's Bayesian criterion (BIC) was chosen [10].

Data with missing values were excluded. Post hoc subgroup analysis, stratifying patients by surgery type (TP, myringoplasty, TM, CoI), was performed. Statistical analyses were conducted using SPSS Statistics version 27 (IBM Corporation, Armonk, NY) and SAS version 9.4 (SAS Institute Inc., Cary, NC).

3 | Results

Of the 294 otologic surgery cases occurring from January 2017 to March 2020 examined, 237 cases met eligibility criteria and were analyzed (Figure 1). Table 1 describes patient demographics between the SCPB+ (121 patients, 51%) and SCPB− groups (116 patients, 49%). The groups were not statistically different from one other, except for surgery type and revision status. Specifically, more SCPB+ patients underwent TM (proportion difference 31%, 95% CI 5.7%–20%) and had revision surgery (proportion difference 23%, 95% CI 11%–35%). Table S1 describes details about the local anesthetic used for the SCPB procedure. The most common local anesthetic received was ropivacaine at a concentration of 0.5% (56 out of 121 patients, 46%).

Table 2 describes the primary and secondary outcomes. There was no statistically significant difference in PONV outcomes between the two groups. A SCPB was associated with lower intraoperative opioid administration: median difference −0.04 IVME, 95% CI −0.08 to 0.00 (Figure 2). Postoperatively, there was no statistically significant difference in amount of opioid IVME administered (Figure 2). Other postoperative secondary outcomes, except for hospital disposition and hospital LOS, were not significantly different between both groups. A significantly higher proportion of SCPB+ patients were admitted overnight after surgery and had a significantly longer hospital LOS compared to SCPB− patients. SCPB+ patients tended to have longer surgeries than SCPB− patients. The median (range) length of surgery was 134 (18–337) min in the SCPB+ group versus 123 (40–373) min in the SCPB− group.

The multivariable regression model explained 18% of the variability in PONV event(s). After controlling for sex, surgery length, hospital LOS, SCPB status, ondansetron, dexamethasone, antimuscarinic antiemetics (scopolamine patch or diphenhydramine either IV or oral), propofol infusion for nausea prophylaxis, midazolam, age, and surgery type, the variables most associated with the presence of PONV event(s) were hospital LOS (unadjusted odds ratio 1.09, 95% CI 1.05–1.13) and age > 3 (age 4–12 years unadjusted odds ratio 9.50, 95% CI 2.19–41.29, and age 13–18 unadjusted odds ratio 7.90, 95% CI 1.71–36.47), as shown in Table 3. Given the relatively high unadjusted odds ratios in children > 3, the multivariable analysis was performed only in children older than 3 years of age. The number of antiemetic medications a patient received during the anesthetic, both preoperatively and intraoperatively, did not affect the primary outcome.

Regarding rFLACC pain scores, age showed a statistically significant effect on the LMM ($p = 0.007$); however, there was not a significant interaction effect between SCPB status and time category ($p = 0.241$). Figure S1 shows the mean differences in rFLACC scores for both groups, and there was no statistically significant difference in average rFLACC pain scores at 3, 6, and 9 h postoperatively. Beyond the first 9 h after surgery, only

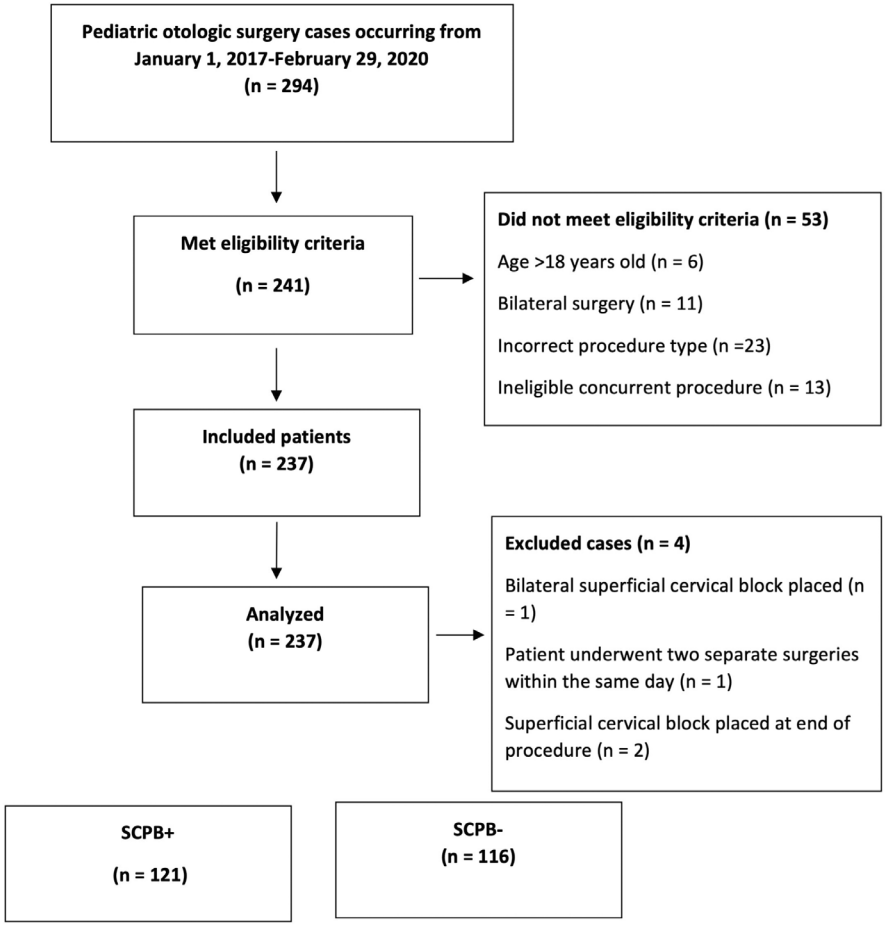

FIGURE 1 | Study flow diagram.

11 patients had rFLACC scores charted. Of these, 10 patients reported rFLACC scores of 0 and only one patient reported an rFLACC score of 3. Thus, rFLACC data in the time category of 9–12 h after surgery were excluded. Finally, only three recorded AEs were reported for each group; all were related to either the surgery (intraoperative cerebrospinal fluid leak (two patients) and dizziness (one patient)) or to intubation (bronchospasm or laryngospasm without need for reintubation (three patients)). There were no recorded AEs related to administration of the SCPB.

Post hoc analysis was performed, stratifying patients by surgery type: TM, TP, or CoI (Table S2). The most common surgery performed for SCPB+ patients was TM, which had a longer average surgery time than the most common surgeries performed for SCPB− patients, CoI and TP. The median (range) surgery time for TM was 163 (40–373) min and the median (range) surgery times for CoI and TP were 115 (57–228) and 116 (18–237) min, respectively. Stratification by surgery type revealed similar trends in the primary and secondary outcomes as above.

The only variables with missing data were rFLACC pain scores in 25 out of 237 patients and the name of local anesthetic used in 3 out of 121 SCPB+ patients. These missing data were excluded from analysis.

4 | Discussion

The results of this retrospective study do not demonstrate an association between placement of a SCPB and decreased PONV for children who underwent otologic surgery via a postauricular incision. Reduction in opioid related adverse effects is more clinically meaningful than opioid dose reduction alone. It is the adverse effects of opioids such as PONV, respiratory depression, and constipation that worsen patient outcomes [11]. Our study evaluated whether the addition of a SCPB resulted in less PONV. Despite decreased intraoperative opioid administration among children who received a block, the opioid reduction was not conjoined with a statistically significant difference in PONV, postoperative opioid use or average postoperative rFLACC scores, challenging its clinical significance. Other secondary outcomes, such as PACU LOS and time to first oral intake, were not significantly different between SCPB+ and SCPB- groups. Interestingly, a statistically significant increase in hospital LOS was detected in the SCPB+ group, particularly in the TP subgroup. Adverse events were uncommon and did not vary between groups, although it is possible non recorded adverse events occurred.

Prior studies evaluating the use of SCPBs in pediatric patients showed more promising results. Tobias et al. [12] published a case report of two pediatric patients receiving superficial and deep cervical plexus blocks for thyroid and lymph node biopsy.

TABLE 1 | Demographic and clinical data for the study population.

Variables	Overall ($n=237$)	SCPB+ ($n=121$)	SCPB− ($n=116$)	Difference between SCPB+ and SCPB−, 95% CI	p
Age in years, med (R)	9.0 (1–18)	10 (1–17)	8.5 (1–18)	−1.0, −2.7 to 0.7 years	
Weight in kg, med (R)	31 (7.5–138)	34.0 (7.7–78)	28.9 (7.5–138)	−5.1, −12 to 1.7 kg	
Sex, *n* (%)					
Female	105 (44)	43 (36)	62 (53)	−17%, −29% to −4.5%	
Male	132 (56)	78 (64)	54 (47)		
Race, *n* (%)					
White	208 (88)	107 (88)	101 (87)	1.0%, −7.4% to 9.4%	
Non-White	26 (11)	13 (11)	13 (11)		
Asian	3 (1.3)				
African American	22 (9.3)				
Native American/ Pacific	1 (0.4)				
Islander					
Unknown	3.0 (1.0)	1.0 (1.0)	2.0 (2.0)		
Ethnicity, *n* (%)					
Hispanic/Latino	6.0 (2.5)	3.0 (2.5)	3.0 (2.6)	−0.1%, −5.1% to 4.8%	
Not Hispanic/Latino	230 (97.1)	118 (97.5)	112 (96.5)		
Unknown	1.0 (0.4)	0 (0)	1 (0.9)		
Surgery type, *n* (%)					**< 0.001**
Cochlear implant	71 (30)	22 (18)	49 (42)	−24%, −35% to −13%	
Tympanomastoidectomy	75 (32)	57 (47)	18 (16)	31%, 5.7% to 20%	
Tympanoplasty	91 (38)	42 (35)	49 (42)	−7.0%, −19% to 5.4%	
Revision surgery, *n* (%)					**< 0.001**
Yes	83 (35)	56 (46)	27 (23)	23%, 11% to 35%	
No	154 (65)	65 (54)	89 (77)		
ASA category, *n* (%)					0.940
Class 1	109 (46)	57 (47)	52 (45)	2.0%, −11% to 15%	
Class 2	114 (48)	57 (47)	57 (49)		
Class 3	14 (6.0)	7.0 (6.0)	7.0 (6.0)		
History of PONV, *n* (%)					0.225
Yes	70 (30)	40 (33)	30 (26)	7.3%, −4.3% to 19%	
No	167 (70)	81 (67)	86 (74)		

Note: The median difference is calculated for age. The proportion differences are calculated for the first category of the categorical-level variables, except for surgery type, for which the proportion difference is calculated for all three surgery types. The "Unknown" race and ethnicity categories were excluded for violating chi-square assumptions. Bold is statistically significant.

Abbreviations: ASA = American Society of Anesthesiologists; kg = kilogram; med = median; PONV = postoperative nausea or vomiting; R = range; SCPB = superficial cervical plexus block.

TABLE 2 | Comparison of primary and secondary outcomes between superficial cervical plexus block (SCPB+) and non-SCPB (SCPB−) groups.

	SCPB+ (*n* total = 121)	SCPB− (*n* total = 116)	Difference between SCPB+ and SCPB−, 95% CI	*p*
Primary outcomes				
PONV, *n* (%)	43 (35.5)	36 (31.0)	4.5%, −7.5% to 16.5%	0.462
Secondary outcomes				
Intraoperative IVME, med (R) Total *n* = 236[c]	0.12 (0.0–0.69) *n* = 121	0.16 (0.0–0.71) *n* = 115	−0.04, −0.08 to 0	**0.030**[b]
Received postoperative opioids, *n* (%)	77 (64)	83 (72)	−8.0%, −20% to 3.8%	0.193
Postoperative IVME, med (R) Total *n* = 235[c]	0.03 (0.0–0.14) *n* = 120	0.03 (0.0–0.20) *n* = 115	0, −0.02 to 0.02	0.850[b]
Admitted for observation, *n* (%)	81 (67)	58 (50)	17%, 4.5% to 29%	**0.008**
PACU LOS in min, med (R) Total *n* = 236[c]	80.5 (26–270) *n* = 120	74 (24–288) *n* = 116	5.0, −11.5% to 21.5	0.706[b]
Hospital LOS in hrs, med (R) Total *n* = 236[c]	17 (1.7–26) *n* = 121	5.8 (1.2–40)	11.2, 5.7% to 16.6	**0.011**[b]
Time to first PO in min, med (R) Total *n* = 233[c]	94 (22–626) *n* = 117	64 (16–593) *n* = 116	27, −2.7% to 56.7	0.072[b]
Adverse events, *n* (%)	3.0 (2.5)	3.0 (2.6)	−0.1%, −5.1% to 4.8%	1.000[a]
Mild	3	2		
Moderate	0	1		
Severe	0	0		

Note: Bold is statistically significant.
Abbreviations: hrs = hours; IV ME = intravenous morphine equivalents per weight in kg; LOS = length of stay; med = median; min = minutes; PACU = postanesthesia care unit; PONV = postoperative nausea or vomiting; R = range.
[a]Fisher exact test.
[b]Mann–Whitney *U*-test.
[c]Cases that were identified as outliers or cases with missing data were excluded from this analysis.

The patients were able to tolerate the procedures well with sedation and required no intravenous opioids [12]. Suresh et al. [13] completed a double-blinded randomized controlled trial (RCT) of 40 children receiving landmark-based great auricular nerve blocks for tympanomastoid surgery (mastoidectomy or cochlear implant, (CoI)). One group of patients (20) received unilateral greater auricular nerve blocks with local anesthetic, both prior to incision and 1 h before completion of the surgery. The other group (20 patients) received a sham block with normal saline prior to incision, followed by a local anesthetic nerve block 1 h prior to completion of surgery [13]. There were no significant differences in pain scores, postoperative pain medication use, or PONV between the two groups [13]. Kim et al. [14] conducted a 1:1 double-blind RCT of 32 pediatric patients with congenital torticollis receiving an ultrasound-guided intermediate cervical plexus block for sternocleidomastoid release with myectomy versus a standard care control group without intraoperative analgesia [14]. The patients in the cervical plexus block group had improved pain scores and fewer required rescue analgesia in the PACU compared to patients who did not receive a block [14].

Compared to the case report by Tobias et al. [12] where no intravenous opioids were administered to the two patients, intraoperative opioids were administered to most of the patients in our cohort. This could have increased the total PONV in the SCPB+ group to a rate similar to the CPB- group. The lymph node biopsies and thyroid nodule resections these two patients underwent were shorter and less complex compared to the procedures included in this study. Suresh et al. [13] showed a block at the beginning and the end of surgery had no benefit compared to a block only at the end for tympanomastoid surgery. At SLCH, the SCPB is performed at the beginning of surgery in an effort to reduce intraoperative opioid administration while maintaining normal hemodynamics. Alternatively, a block at both the beginning and the end, or a block only at the end, could potentially extend postoperative analgesia resulting in less postoperative opioid administration and/or PONV. Kim et al. [14] compared a cervical plexus block to no preemptive analgesia for torticollis surgery and found a reduction in pain based on rFLACC scores, opioid dosing, and time to analgesic administration. Clinicians at SLCH do not perform surgery with anticipated postoperative pain without analgesics.

Intraoperative medications, particularly opioids, may influence postoperative outcomes. In a study by Long et al. [15],

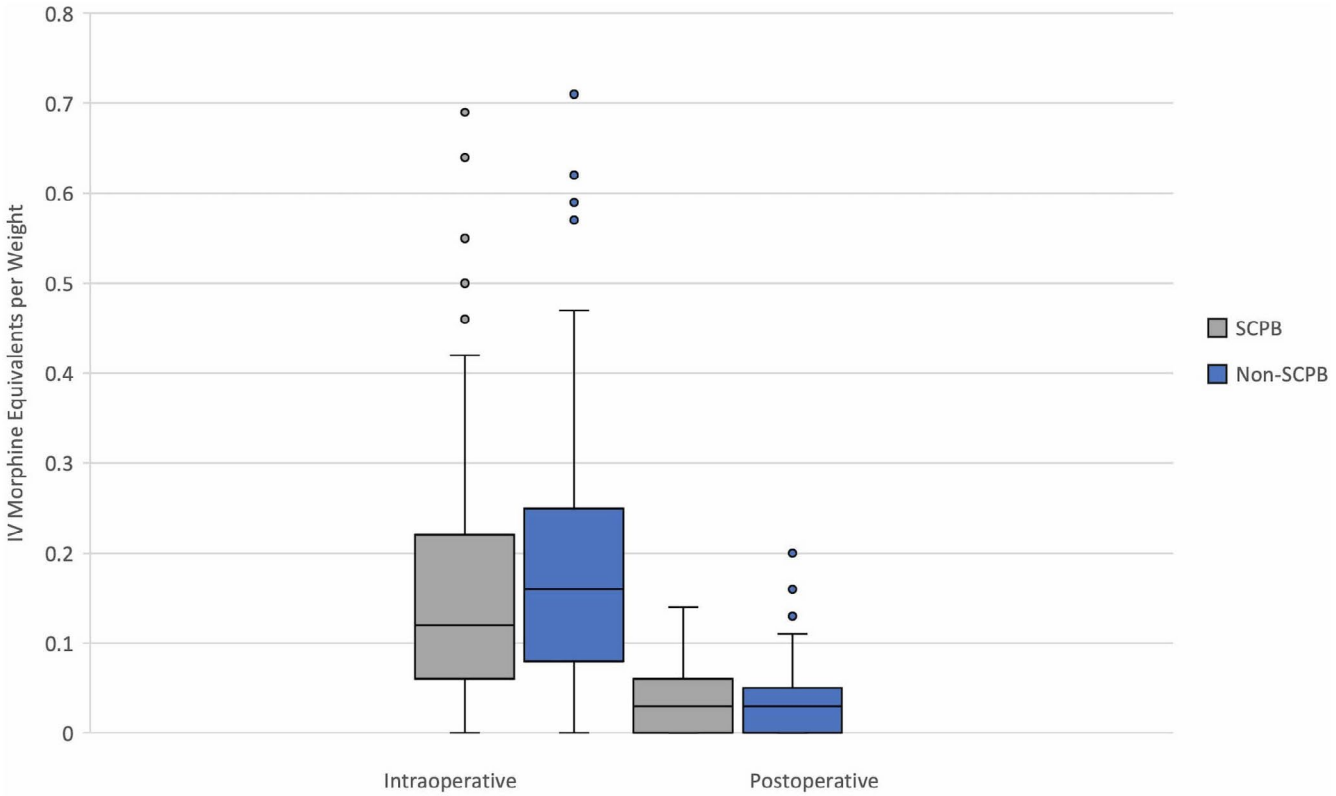

FIGURE 2 | Comparison of intraoperative and postoperative opioid equivalents per weight between superficial cervical plexus block (SCPB+) and non-SCPB (SCPB−) groups.

exposure to high intraoperative opioid dosing increased 30-day readmission rate in adults. In our study, only one patient was readmitted; however, this patient did not receive a SCPB, and the readmission was related to a surgical complication. Any decrease in intraoperative opioid use afforded by a SCPB may lead to decreased opioid exposure, which is a risk factor for hospitalizations and opioid-related AEs [16–18]. Given the low amounts of opioid received in the postoperative period for either group, the data presented speak to the relatively low degree of pain associated with the otologic procedures included in our study. In the setting of the opioid epidemic, it may be possible to identify a subset of patients undergoing otologic surgery whose postoperative pain may be appropriately controlled using multimodal therapies without opioids [19, 20].

Trends in secondary postoperative outcomes after stratified subgroup analysis suggest that a degree of confounding by indication may have been present. Notably, patients having shorter surgeries (CoI, TP) had less hospital LOS and time to oral intake; however, a majority of these patients did not receive a SCPB. In contrast, many of the SCPB+ patients received TM, a longer and potentially more painful surgery based on surgical involvement. Children who underwent a revision were also more likely to receive a SCPB. One possible explanation for the results of the secondary outcomes is selection bias among surgeons who may have been more likely to request a SCPB for longer surgical cases, more complicated repairs, or for patients they intended to keep overnight for observation as part of institutional standard care. This variability in case duration and complexity likely effected intraoperative opioid administration and postoperative outcomes making it more difficult to detect a difference between groups. In addition to surgery start time and length, the distance a patient lives from the hospital, while not specifically analyzed in this paper, could have a significant impact on the decision to admit a patient postoperatively. For example, a surgeon may have decided to admit a patient who underwent TM and was the last case of the day, rather than if the patient was the first case of the day and could theoretically have been observed for a longer time in PACU after surgery. A controlled study comparing SCPB to local infiltration from the surgeon with strict parameters defining PACU LOS and admission criteria or comparing the efficacy of SCPB in patients undergoing similar types of surgery would help characterize these outcomes with less bias. This study demonstrated no reported AEs related to the SCPB, which conveys the relative safety of this procedure.

Our study had the following limitations. SCPB placement was not standardized, specifically in terms of patient selection (often decided by clinician judgment or other reasons that could not be ascertained from the EHR), the choice of local anesthetic used (including concentration and dose), and the use of ultrasound guidance. Among the SCPB+ group, all clinicians at SLCH utilize the US guided intermediate approach to the SCPB, however it is possible a small subset of patients received a classical subcutaneous SCPB via landmark technique. The previous EHR at SLCH did not require specification of US vs. landmark technique in the block note which made retrospective analysis of US use impossible. Postoperative endpoints could not be standardized, nor did every child receive a rFLACC score. Also, rFLACC scores were assigned postoperatively by nurses for children older than 7 years of age, despite this tool not being traditionally used for children > 7 years old unless there is developmental delay.

TABLE 3 | Results of multivariable logistic regression model.

	Bivariate analysis			Multivariable analysis[a]		
	Unadjusted odds ratio	**95% CI**	***p***	**Adjusted odds ratio**	**95% CI**	***p***
Female sex	0.58	0.33–1.08	0.053	0.63	0.32–1.23	0.175
Surgery length (min)	1.01	1.00–1.02	< 0.001	1.01	1.00–1.01	0.054
Hospital length of stay (hrs)	1.09	1.05–1.13	< 0.001	1.10	1.05–1.14	**< 0.001**
Received SCPB	1.23	0.71–2.11	0.463	0.56	0.27–1.16	0.119
Ondansetron	3.16	0.69–14.50	0.138	2.57	0.19–34.63	0.477
Dexamethasone	1.79	0.36–8.80	0.477			
Antimuscarinic antiemetic	0.68	0.26–1.80	0.440			
Propofol infusion	0.90	0.48–1.70	0.747			
Midazolam	0.97	0.56–1.68	0.926			
Age (years)						
1–3	Ref		0.011			
4–12	9.50	2.19–41.29	0.003			
13–18	7.90	1.71–36.47	0.008			
Surgery type						
TP	Ref		0.001	Ref		0.593
TM (1)	2.31	1.22–4.37	0.010	0.88	0.38–2.05	0.768
CoI (2)	0.64	0.31–1.31	0.220	0.62	0.25–1.55	0.307

Note: Multivariable logistic regression with the dependent variable as presence of any PONV event(s) and sex, surgery length, hospital length of stay, placement of superficial cervical plexus block (SCPB), antiemetics received (zofran, dexamethasone, antimuscarinic, propofol infusion), Midazolam administration, age, and surgery type (cochlear implant, CoI, tympanomastoidectomy, TM, and tympanoplasty, TP) as independent variables. Variables meaningfully associated with the clinical response with an alpha value of less than 0.2 based on a bivariate analysis were entered into the multivariable logistic regression model. Antimuscarinic antiemetic = IV or PO diphenhydramine or a scopolamine patch. Reference category for age = 1–3 years. Reference category for surgery type = TP. Bold = Statistically significant.

Abbreviations: CI = confidence interval; hrs = hours; min = minutes.

[a]Given the relatively high unadjusted odds ratios in children > 3, the multivariable analysis was performed only in children older than 3 years of age.

Emergence delirium could not be discerned via chart review. It is possible that confirmation bias related to the block impacted the decision of an anesthesiology clinician to give intraoperative opioids. Similar limitations related to selection bias can be attributed to surgeon preference for postoperative admission and choice of postoperative pain or antiemetic medication administered by nursing staff. A power analysis was not performed, and the cohort was examined in a retrospective nature. The difference in complexity and duration of surgery between the groups likely impacted outcomes and increased the treatment effect required to detect a difference between groups. The study was performed at a single tertiary care center; thus, results may not be generalizable to a wider study population. Finally, despite being the largest study to our knowledge assessing SCPB for pediatric otologic surgery, results were not powered to find differences in some outcomes, such as PONV and postoperative opioid IVME. Our preliminary findings suggest a future, randomized trial of more selective patients, such as those greater than 3 years of age and those with a longer anticipated hospital stay, receiving SCPB against patients receiving an ethically responsible control intervention would more effectively establish the relationship between SCPB and intraoperative and postoperative outcomes. Stricter protocols regarding usage of age-appropriate pain scales, regulated administration of opioid medication, and standardized documentation of PONV events would need to be enforced, but are understandably challenging in the pediatric population.

5 | Conclusion

Recently, an increase of data regarding the use of cervical plexus blocks in the pediatric population appear to support its efficacy. Our retrospective analysis failed to show a reduction in PONV among patients who received a SCPB despite decreased intraoperative opioid administration to those who received a block. Benefits of decreased intraoperative opioid administration portend potential postoperative benefits, however controlled prospective studies are needed to further analyze the SCPB for pediatric otologic surgery.

Author Contributions

Gregory C. Miller: this author helped design the study, draft the IRB protocol, develop the data logging systems, perform data collection and verification, analyze the data, and draft the manuscript.

Nneoma S. Wamkpah: this author helped design the study, draft the IRB protocol, perform data collection and statistical analysis, analyze the data, create the figures and tables, and draft the manuscript. **Ashley B. Weinhold:** this author helped develop the study idea and design, provide mentorship, analyze the data, and perform critical analysis and review of the manuscript. **David S. Leonard:** this author helped develop the study design, provide mentorship, analyze the data, and perform critical analysis and review of the manuscript. **Judith E. C. Lieu:** this author helped develop the study idea and design, provide mentorship, analyze the data, and perform critical analysis and review of the manuscript. **Jacob D. AuBuchon:** this author helped develop the study idea, provide mentorship, analyze the data, perform critical analysis and review of the manuscript, and is the corresponding author.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Appendix A

The *doses of opioids administered* during (intraoperative) and up to 12 h after (postoperative) surgery were converted into equianalgesic intravenous morphine equivalents (IVME) per kilogram.

Postoperative nausea/vomiting was defined as the presence of at least one instance of nausea, vomiting, or administration of an antiemetic following surgery through discharge, using a combination of physician progress notes, nurse charting notes or medication lists in the electronic health record.

Surgery time was calculated as the difference from surgery start to surgery end time. Surgery start time was either the incision time or the anesthesia start time; surgery end time was either the surgery close time or anesthesia end time. Anesthesia start or stop times were only used if surgical start or stop times were not available.

Length of stay (*LOS*) *in the postanesthesia care unit* (*PACU*) and *hospital LOS* were calculated as the difference between time at end-of-surgery and discharge times from the PACU (in minutes) and the hospital (in hours), respectively.

The time to first oral intake was calculated as the difference between surgery end time to the time at first recorded intake of food, liquid, or oral medication (in minutes).

Hospital disposition status was categorized into "discharged from PACU," "admitted for observation," or "admitted to the intensive care unit (ICU)."