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RESEARCH

Postoperative outcomes of peripheral nerve block versus general endotracheal anesthesia for orthopedic upper limb surgery among pediatric patients: cohort study

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ABSTRACT

Background. Compared to adult patients undergoing upper limb surgery who receive general endotracheal anesthesia (GETA), those who receive peripheral nerve block (PNB) have better postoperative outcomes.

Objective. To compare postoperative outcomes of PNB and GETA for orthopedic upper limb surgery among pediatric patients.

Design. Cohort study.

Setting. Southern Philippines Medical Center, Davao City, from December 2015 to May 2016.

Participants. 94 boys and girls, 3 to 18 years old, who received either PNB or GETA for orthopedic upper limb surgery.

Main outcome measures. Postoperative pain by visual analogue scale (VAS), need for postoperative rescue opioid doses.

Main results. Of the 94 patients in this study, 47 (50%) received PNB, and the rest received GETA prior to surgery. Patients in the two anesthesia groups were comparable at baseline. The PNB group had lower mean VAS scores compared to the GETA group both at the post-anesthesia care unit (0.70 ± 1.52 versus 4.15 ± 1.78; p<0.001) and at the Orthopedics Ward (0.45 ± 1.49 versus 4.13 ± 1.68; p<0.001). The proportion of patients given postoperative rescue opioid doses was significantly lower in the PNB group (6/47; 12.77%) than in the GETA group (21/47; 44.62%; p=0.0006).

Conclusion. Pediatric patients for orthopedic upper limb surgery who received PNB had less pain postoperatively and needed postoperative rescue opioid doses less frequently compared to those who received GETA.

Keywords. regional anesthesia, Modified Aldrete Score, Pasero Opioid-Induced Sedation Scale, postoperative nausea and vomiting

INTRODUCTION

The advantages of peripheral nerve block (PNB) over general endotracheal anesthesia (GETA) as an anesthetic technique for upper limb surgery include longer duration of analgesia, lower pain scores, lower opioid consumption leading to less nausea or vomiting,[1-4] decreased need for recovery room admission,[4 5] and earlier hospital discharge.[1 2 4 5]

While there are studies that compare PNB and GETA in adult patients requiring upper limb surgery,[1 2 4 5] similar studies involving pediatric patients had not been reported.[6] Upper limb injuries, such as metacarpal, radius/ulnar, and multiple hand fractures, are highest among children aged 0 to14 years old.[6] PNB has been used among patients needing upper limb surgeries.[7] Nerve block techniques that have been designed for adults may have to be modified when used among children in order to take into account the pediatric patient's age, weight, and ability to cooperate, as well as the clinician's ability to evaluate pain response.[8]

In our institution, GETA has been the traditional anesthetic approach for all orthopedic upper limb surgery procedures. Three years ago, however, some practitioners started using PNB for these same procedures with success, and with no recorded complications. We hypothesize that pediatric patients who receive PNB for upper limb surgery will show better postoperative outcomes compared to those who receive GETA. This study compared the postoperative pain scores, sedation scores, nausea and vomiting

IN ESSENCE

The use of peripheral nerve block (PNB) for upper limb surgeries among adults is associated with lower pain scores and lower rescue opioid consumption postoperatively.

In this study, pediatric patients who received PNB for orthopedic upper limb surgery experienced less pain and sedation, and needed less rescue opioid doses postoperatively, compared to patients who received general endotracheal anesthesia (GETA).

Administration of PNB in lieu of GETA in appropriate surgical procedures makes pain management more efficient and can result in faster recovery and reduced health care costs.

scores, rescue medications given, duration of post-anesthesia care unit (PACU) stay, and PACU discharge scores of pediatric patients given PNB versus GETA for orthopedic upper limb surgery.

METHODS

Study design and setting

We did a cohort study on pediatric patients who underwent orthopedic upper limb surgery at Southern Philippines Medical Center (SPMC) in Davao City, from December 2015 to May 2016. Approximately 1,200 orthopedic upper limb operations are performed in SPMC annually, with 23% of these involving pediatric patients. The choice of anesthesia (PNB versus GETA) is usually discussed by the anesthesiologist with the patient and the patient's adult representative prior to surgery. In this institution, PNB for pediatric patients for orthopedic upper limb surgery is done by some practitioners using a mixture of ropivacaine 3 mg/kg body weight and lidocaine 5 mg/kg body weight. Depending on the surgical procedure, the mixture of local anesthetics is injected into the axillary, interscalene, or subclavian perivascular area with the guidance of ultrasound and peripheral nerve stimulator. Patients for GETA are induced using standard intubation procedures. General anesthesia is usually administered using intravenous fentanyl at 1-2 mcg/kg, and intravenous propofol at 2 mg/kg, intravenous atracurium at 0.5 mg/kg. Patients are usually maintained on 2-2.2% inhaled sevoflurane intraoperatively.

Participants

Patients 3 to 18 years old with preoperative American Society of Anesthesiologists (ASA) classification of either I or II, and who were given either PNB or GETA for orthopedic upper limb surgery, were eligible for inclusion in the study. We excluded patients with multiple fractures, those that required complicated surgeries, those with Glasgow Coma Scale of less than 10, and those with mental disorders or who were otherwise uncooperative. Also excluded were patients who were converted from PNB to GETA, those with history of local anesthetic allergy, and those with deranged bleeding parameters. The sample size for this study was computed using the software SampSize. Estimation was made on the assumption that patients for orthopedic upper limb surgery under GETA have a mean postoperative visual analogue scale (VAS) score of 6.11 ± 3.40 out of 10.[9] A detection of a 2-point difference in mean VAS scores between two groups was considered statistically significant. In a test for comparison of two independent means carried out at <0.05 level of significance, a sample size of 47 per group will have 80% power of rejecting the null hypothesis (no significant difference in mean VAS scores between the two groups) if the alternative holds. For this study, we recruited 47 consecutive patients who had PNB and another 47 patients who had GETA for orthopedic upper limb surgery.

Data collection

We reviewed the medical records of each patient included in this study in order to collect data for type of anesthesia (PNB versus GETA), age, sex, ASA classification, comorbidities, pain scores at the PACU (taken 30 minutes after entry) and at the Orthopedics Ward (taken 24 hours after surgery), postoperative sedation scores, postoperative nausea and vomiting (PONV) scores, rescue medications given, PACU discharge score, and duration of PACU stay.

The main outcome measures of the study were the postoperative mean VAS scores of patients at the PACU and at the Orthopedics Ward, and the need for postoperative pain medications. VAS scores were assessed by nurses-on-duty using an 11-point scale (range: 0 = 'no pain' to 10 = 'worst pain'). The need for pain medications was determined by getting the proportion of patients who received postoperative rescue opioid doses per group, and by getting the mean cumulative postoperative rescue opioid dose per group among those who received the rescue medications. The secondary outcome measures of the study were: the Pasero Opioid-Induced Sedation Scale (POISS) scores (range: 1= 'awake' to 4 = 'somnolent');[10,11] the PONV Impact Scale scores (range: 0 = 'no nausea/no vomiting' to 3 = 'nauseated all of the time/vomited 3 or more times');[12] the Modified Aldrete Score to measure the eligibility for discharge from the PACU [0, 1, or 2 for each of the following: activity, respiration, circulation, consciousness, and oxygen saturation; total score of 0-7 (not dischargeable from the PACU); total score of 8-10 (dischargeable from the PACU)];[13] and the duration of PACU stay. POISS and PONV Impact Scale scores were both measured upon entry to PACU and upon entry to the Orthopedics Ward postoperatively, while the

Modified Aldrete Score was measured 30 minutes after entry to the PACU.

Statistical analysis

We analyzed the data using Epi Info™ 7.2.1.10. Continuous data were summarized as means ± standard deviations and compared using independent t-test, while categorical data were summarized as frequencies and percentages and compared using chi-square or Fisher's exact test. The level of significance was set at <0.05.

RESULTS

A total of 94 patients were included in this analysis, with 47 patients in the PNB group and another 47 in the GETA group. Table 1 shows that the two groups were comparable at baseline in terms of mean age, sex distribution, ASA classification distribution, and presence of comorbidities.

Postoperative outcomes are shown in Table 2. The mean VAS scores of the PNB group were significantly lower than those of the GETA group both at the PACU 30 minutes after entry (p<0.0001) and at the Orthopedics Ward 24 hours after surgery (p<0.0001). Likewise, the mean POISS scores of the PNB group were significantly lower than those of the GETA group both upon entry to the PACU (p=0.0015) and upon entry to the Orthopedics Ward (p=0.0247). There were no significant differences in mean PONV Impact Scale scores between the PNB and the GETA groups both upon entry to the PACU and upon entry to the Orthopedics Ward.

Table 1 Demographic and clinical characteristics of patients according to type of anesthesia

Characteristics	PNB (n=47)	GETA (n=47)	p-value
Mean age ± SD, *years*	9.98 ± 3.96	9.02 ± 4.22	0.2596
Sex, *frequency (%)*			1.0000
Male	9 (19.15)	9 (19.15)	
Female	38 (80.85)	38 (80.85)	
ASA classification, *frequency (%)*			1.0000
I	41 (87.23)	41 (87.23)	
II	6 (12.77)	6 (12.77)	
Pneumonia, *frequency (%)*	2 (4.26)	1(2.13)	1.0000*
Bronchial asthma, *frequency (%)*	2 (4.26)	5 (10.64)	0.4349*
URTI, *frequency (%)*	1 (2.13)	0 (0.00)	1.0000*
VSD, *frequency (%)*	1 (2.13)	0 (0.00)	1.0000*

*using Fisher's exact test.
ASA—American Society of Anesthesiologists; CHD—coronary heart disease; GETA—general endotracheal anesthesia; PNB—peripheral nerve block; URTI—upper respiratory tract infection; VSD—ventricular septal defect.

The number of patients given postoperative rescue opioid doses was significantly lower in the PNB group than in the GETA group (p=0.0006). In this subgroup of patients, mean age was higher among those who received PNB than among those who received GETA, but the difference was not significant (p=0.2138). Also in this subgroup, the mean cumulative postoperative rescue opioid dose actually given to patients was significantly higher in the PNB group than in the GETA group (p=0.0477).

Compared to the GETA group, the PNB group had a significantly higher mean Modified Aldrete Score 30 minutes after entry to the PACU (p=0.0026) and a significantly higher proportion of patients dischargeable from the PACU 30 minutes after entry to the unit (p<0.0001). The mean duration of stay of the GETA group at the PACU was longer compared to that of the PNB group, but the difference between the two was not significant (p=0.1456).

DISCUSSION

Key results

In this study, patients who received PNB for orthopedic upper limb surgical procedures had lower pain and sedation scores compared to those who received GETA. The PNB group also had a higher proportion of patients dischargeable from the PACU 30 minutes after entry to the unit. More patients in the GETA group needed postoperative rescue opioid doses, but the mean opioid dose they received was significantly lower compared to that received by patients in the PNB. There was no significant difference in mean PONV Impact Scale scores and mean duration of PACU stay between patients given PNB and those given GETA.

Strengths and limitations

In this study, we were able to directly compare the postoperative outcomes of pediatric patients given PNB to those given GETA for orthopedic upper limb surgery. We were also able to demonstrate favorable outcomes among patients given PNB using a combination of ropivacaine and lidocaine. However, this study had some limitations. First, allocation of the anesthetic approach was not randomized. We left the choice of the anesthetic approach to the patients and their anesthesiologists, and we only started observing the patients for outcomes after the administration of either PNB or GETA. With this

Table 2 Postoperative outcomes of patients according to type of anesthesia

Characteristics	PNB (n=47)	GETA (n=47)	p-value
Mean VAS score 30 minutes after entry to the PACU ± SD	0.70 ± 1.52	4.15 ± 1.78	<0.0001*
Mean VAS score at the Orthopedics Ward 24 hours after surgery ± SD	0.45 ± 1.49	4.13 ± 1.68	<0.0001*
Mean POISS score upon entry to the PACU ± SD	0.04 ± 0.29	0.48 ± 0.86	0.0015*
Mean POISS score upon entry to the Orthopedics Ward ± SD	0.09 ± 0.41	0.38 ± 0.80	0.0247*
Mean PONV Impact Scale score upon entry to the PACU ± SD	0	0.06 ± 0.32	0.1792
Mean PONV Impact Scale score upon entry to the Orthopedics Ward ± SD	0	0	1.0000
Patients given postoperative rescue opioid dose, *frequency (%)*	6 (12.77)	21 (44.62)	0.0006*
Mean age ± SD, *years*†	11.33 ± 3.08	9.10 ± 3.95	0.2138
Mean cumulative postoperative rescue opioid dose ± SD, *mg*†	6.17 ± 3.87	3.98 ± 1.65	0.0477*
Mean Modified Aldrete Score 30 minutes after entry to the PACU ± SD	8.45 ± 1.54	7.66 ± 0.82	0.0026*
Eligible for discharge from the PACU after 30 minutes, *frequency (%)*	44 (93.62)	27 (57.45%)	<0.0001*
Mean duration of PACU stay ± SD, *minutes*	119.64 ± 43.70	134.60 ± 54.51	0.1456

*Statistically significant.
†n(PNB)=6; n(GETA)=21.
GETA—general endotracheal anesthesia; PACU—post-anesthesia care unit; PNB—peripheral nerve block; PONV—postoperative nausea and vomiting; POISS—Pasero opioid-induced sedation scale; VAS—visual analogue scale.

method of allocation of anesthetic approach, several known and unknown factors (e.g., patient's weight or age) could possibly have influenced the decision of the anesthesiologist to choose one approach over another, and the factors could possibly have affected the outcomes of interest. Second, one of the main outcome measures of this study was postoperative pain scores using VAS, which is an observer-dependent assessment. For example, what was scored as 5/10 for one patient by one observer could be scored as 8/10 by another observer. Finally, the present study did not measure the duration of hospital stay of patients in either group. As an outcome, the duration of hospital stay can potentially reflect clinically significant postoperative events related to the effectiveness and safety of the anesthetic approach.

Interpretation

Results of the study indicate favorably lower mean VAS and mean POISS scores and favorably higher mean Modified Aldrete score among patients who received PNB for orthopedic upper limb surgeries.

Postoperative pain is well-controlled after nerve blocks because the duration of action of the local anesthesia extends beyond the entire duration of the surgical procedure.[14 15] Hence, as with adult patients in other studies on either hand-and-wrist surgeries[1 2 4] or rotator cuff surgeries,[5] pediatric patients in this study who received PNB experienced less pain postoperatively. This experience also lessens the need for postoperative analgesia. In this study, there was a significantly lesser proportion of patients in the PNB group, compared to those in the GETA group, who needed rescue opioid medications postoperatively. Although the difference in mean ages between the two groups was not statistically significant, patients who received PNB had higher mean age (11 years) compared to those who received GETA (9 years), possibly implying higher mean weight, and therefore higher absolute opioid doses, among patients who received PNB.

The POISS score reflects sedation levels, and higher scores (maximum of 4) indicate deep sedation.[12] Sedation is one of the effects of anesthetics and opioid analgesics used in GETA or PNB. Sedation helps in the management of intraoperative and postoperative pain, but is associated with higher incidence of PONV, constipation, urinary retention, respiratory depression, somnolence, and sleep disturbances.[5] A heavily sedated patient requires longer stay at the PACU.[13] In this study, the higher mean POISS among patients who received GETA possibly reflects the greater amount of opioids and other sedating anesthetics used intraoperatively during general anesthesia, as well as the more frequent need for postoperative rescue opioid doses in this group of patients.

PONV is an important side effect of sedating agents. To some patients, PONV can be more bothersome than postoperative pain.[16] In this study however, PONV did not

occur among patients who received PNB, and its incidence was almost nil among patients who received GETA.

The Modified Aldrete scoring system is commonly used to determine when patients can be safely discharged from the PACU to the post-surgical ward.[13] The scoring system reflects activity, respiration, circulation, consciousness, and oxygen saturation of the postoperative patient.[17] A score of 8-10 is considered adequate to discharge a patient from the PACU.[13] A higher score indicates better readiness for discharge.

Performing PNB among pediatric patients undergoing upper limb surgery is a relatively new practice in our setting. To date, it is still standard procedure in our institution to admit patients to the PACU immediately after surgery, regardless of the anesthesia used. In this study, the PNB group showed a significantly higher mean Modified Aldrete score and a significantly higher proportion of patients who were eligible for discharge from the PACU 30 minutes after admission to the unit, compared to the GETA group. These results imply earlier return to pre-anesthesia conditions and immediate post-operative recovery from the surgical procedure among patients given PNB.

In general, patients given regional anesthesia, including PNB, have been observed to have shorter PACU stay compared to those given GETA.[5 18 19] In other studies,[2 5] 76% to 79% of adult patients who received PNB bypassed the PACU. In our study, while there was a trend towards longer PACU stay in the GETA group, the PNB and GETA groups did not significantly differ in terms of duration of PACU stay. At least part of the reason for this finding can be attributed to our practice of admitting all postoperative patients to the PACU, regardless of the type of anesthesia given to the patients.

Generalizability

We can use the results of this study to support a postoperative management procedure for our institution that skips PACU admission among pediatric patients given PNB for orthopedic upper limb surgery. Our findings in this study may also apply to other types of surgery or anesthesia administration wherein regional blocks can be done in lieu of general anesthesia. Efficient anesthesia and pain management increases postoperative comfort and satisfaction, enhances mobilization, incurs fewer pulmonary and cardiac complications, and leads to faster recovery and reduced costs of care.[20]

CONCLUSION

In this cohort study, the group of pediatric patients given PNB for orthopedic upper limb surgery experienced less pain and sedation, needed postoperative rescue opioid doses less frequently, and had a significantly higher proportion of dischargeable patients from the PACU 30 minutes after entry to the unit compared to the group of patients who were given GETA for the procedure. The two groups were comparable in terms of PONV Impact Scale scores and mean duration of PACU stay.

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Ethics approval
This study was reviewed and approved by the Department of Health XI Cluster Ethics Review Committee (DOH XI CERC reference P15050501).

Reporting guideline used
STROBE Checklist (http://www.strobe-statement.org/fileadmin/Strobe/uploads/checklists/STROBE_checklist_v4_combined.pdf)

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