ORIGINAL ARTICLE

A retrospective review of interscalene nerve blockade for shoulder surgery in the pediatric population

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ABSTRACT

Purpose: To retrospectively investigate the efficacy of interscalene nerve blockade in reducing postoperative pain and minimizing inpatient hospital admission after shoulder surgery in the pediatric population.

Methodology: Thirty-four consecutive patients undergoing shoulder surgery under general anesthesia both with and without the addition of an interscalene nerve block were included in the study. After induction of general anesthesia, those patients receiving regional anesthesia had an interscalene nerve block placed using real-time ultrasonographic guidance with the deposition of 20-30 mL of local anesthetic solution into the interscalene groove. Postoperative pain scores, the use of supplemental analgesic medications, post-anesthesia care unit (PACU) length of stay, hospital course, and any acute or non-acute complications were recorded and evaluated.

Results: There were no cardiac events, neuropathies, seizures, pneumothoraces, or other major complications. There was a statistically significant reduction in the pain scores in patients who received an interscalene nerve block versus those who did not. There was also a significant difference found in the need for postoperative inpatient hospital admission. Eleven of the 14 patients (79%) who received a combined general and regional anesthetic technique were discharged home on the day of surgery versus 9 of 20 patients (45%) who did not receive an interscalene block ($p = 0.036$). Postoperative opioid requirements were significantly reduced in patients receiving an interscalene block within the first six hours of inpatient hospital admission ($p = 0.035$). There was no difference in PACU length of stay or adverse effects (postoperative nausea and vomiting) between the groups.

Conclusion: Interscalene nerve block offers a safe and effective method of providing superior postoperative analgesia and minimizing inpatient hospital admissions in pediatric patients undergoing shoulder surgery.

Key words: Interscalene nerve block; Postoperative nausea and vomiting; PACU; Postoperative pain; Ultrasonographic guidance

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INTRODUCTION

Major shoulder surgery can be associated with significant postoperative pain, often requiring inpatient hospital admission due to inadequate analgesia or opioid-related adverse effects. Regional anesthesia has become widely accepted in the current era of clinical anesthesia and the combination of general and regional anesthesia has been shown to provide superior and long-lasting analgesia in the pediatric population.[1,2] Brachial plexus blockade via the interscalene approach offers an alternative to parenteral opioids for pain control after shoulder surgery in the pediatric population.

Although the efficacy of interscalene blockade has been demonstrated[3,4], there have been differing opinions regarding the placement of an interscalene nerve block in anesthetized patients. In 2008, the American Society of Regional Anesthesia and Pain Medicine (ASRA) Practice Advisory on Neurologic Complications initially published recommendations indicating that interscalene nerve blockade should not be performed on anesthetized or heavily sedated adult or pediatric patients due to the possibility of masking paresthesia and the perceived risk of neurologic damage.[5] DeVera et al. responded that the panel's recommendations were unwarranted and overly restrictive.[6]

They contended that interscalene nerve blockade can be accomplished safely if performed or supervised by a practitioner experienced in pediatric regional anesthetic techniques. This group reviewed 2236 regional anesthetic procedures over a five year period, all performed with patients under general anesthesia, and reported no serious or permanent complications. Giaufre et al. also found pediatric regional anesthesia to be safe with no long-term adverse sequelae or medico-legal actions in more than 20,000 regional techniques that were prospectively studied.[7] In addition, the introduction of ultrasound guidance to pediatric regional anesthesia in the late 1990's allows for real-time visualization of the anatomy, needle position, and deposition of the injected local anesthetic agent. Several studies have subsequently demonstrated the advantages of performing peripheral nerve blocks under ultrasound guidance.[8]

The majority of studies regarding the safety and efficacy of interscalene nerve blockade focus on the adult population with only a limited number of case studies demonstrating the effective use of interscalene nerve blockade in the pediatric patient population.[8,9] Furthermore, there are limited outcome data demonstrating a significant clinical benefit with the use of regional anesthesia. In July 2010, a regional anesthetic service was established at our pediatric hospital whereby all patients operated on after that time were offered a regional anesthetic technique for postoperative analgesia. This provided a unique opportunity to examine the efficacy of regional anesthesia by comparing the postoperative course of patients operated on before that time with those who subsequently received a regional anesthetic technique. We report the results of a retrospective chart review of patients undergoing shoulder surgery after the implementation of a regional anesthesia program at a tertiary care pediatric institution.

METHODOLOGY

After obtaining approval from the hospital's institutional review board, a retrospective chart review of consecutive patients undergoing shoulder surgery over a two-year period was performed. This included a one-year period prior to and a one-year period after the implementation of the regional anesthesia program. The surgeons involved in the care of these patients were the same during this 2-year period. The anesthetic records including the preoperative evaluation, intraoperative record, and post-anesthesia record, were obtained from the electronic anesthesia information management system (PICIS™, Wakefield MA). Postoperative records, including hospital course and physician notes, were viewed in the electronic hospital information management system (EPIC™, Verona WI). Patient demographics, surgical procedure, intraoperative anesthetic, and PACU course were recorded. If patients received an interscalene block, the chosen technique, local anesthetic agent, its concentration, and volume were noted. Standard contraindications to placement of the nerve block included parent or patient refusal, coagulopathy, drug allergy, and infection at the intended site.

In accordance with hospital protocol, appropriate informed consent and assent were obtained from either the patient or the parent of the child. Patients were premedicated with oral or intravenous midazolam at the discretion of the attending anesthesiologist. Anesthetic induction was performed by either an inhalation technique with sevoflurane or intravenously with propofol. Standard ASA monitors were used, and intravenous access was secured either prior to or immediately after induction, depending on the induction technique. The airway was secured with either an endotracheal tube or a laryngeal mask (LMA), depending on the preference of the attending anesthesiologist. All intraoperative medications, including opioids or other analgesics, neuromuscular blocking agents, and prophylactic anti-emetics were recorded.

A pediatric anesthesiologist experienced in ultrasound-guided regional anesthesia either performed or supervised the interscalene nerve blocks. An S-Nerve SonoSite portable ultrasound unit (SonoSite®, Bothell WA) with a 13-6 MHz, six centimeter linear ultrasound probe was used for identification of the interscalene groove and the target roots of the brachial plexus. In some instances, a nerve stimulator technique using Stimuplex needles and stimulators (EZ Stim™, Stafford TX) was used in addition to the ultrasound for supplementary

guidance. After sterile preparation, 20-30 mL of either 0.2% ropivicaine or 0.25% bupivacaine was injected in incremental doses after confirming negative aspiration for blood. The distribution of the local anesthetic agent was monitored under real-time ultrasound imaging.

At the completion of the procedure, the patient's trachea was extubated and they were transported to the post anesthesia care unit (PACU) for recovery. Pain scores, using a VAS pain scale, were documented every 15 minutes. PACU length of stay, defined as arrival to PACU until the time of discharge to the surgery unit (phase 2 recovery) or inpatient room, was recorded. All medications administered during the PACU course including additional analgesics or anti-emetics, were noted. For patients who were admitted to the hospital, the hospital length of stay, administered analgesic medications, opioid-related side effects, and any acute or non-acute complications related to the nerve block were documented and reviewed in the electronic hospital information management system. Administered opioid analgesics were evaluated using morphine equivalents, with a comparison ratio of 1:8 (hydromorphone to morphine in milligrams intravenous).

Categorical data were compared between the groups by using appropriate chi-square or Fisher's exact tests, depending on whether any one cell had an expected value less than 5. Continuous data were compared using either *t* test or nonparametric method Wilcoxon two-sample test, depending on normality. The Mixed model was used to compare the total amount of opioid administered to the admitted patients (in morphine equivalents) in hours 0-6, 6-12, and 12-24 after their admission. Statistical significance was defined as p value less than 0.05. All tests were conducted in SAS 9.2 (by SAS Institute Inc., Cary, NC, USA).

RESULTS

The retrospective chart review conducted on all shoulder surgeries over the two year period yielded a total of 34 patients for analysis. The age (mean ± SD) was 17.9 ± 1.6 years with 28 males and 6 females. The weight was 74.1 ± 18.5 kilograms with a body mass index ranging from 18.2 to 41.2 kg/M^2. All patients were either ASA I or II classification (Table 1). There were no differences in the demographics of the two groups. An interscalene nerve block (ISB) was performed under general anesthesia on 14 of the 34 patients (41%). The ISB was performed after the induction of anesthesia under ultrasound guidance, both with and without the additional assistance of nerve stimulation. There were no reported cardiac events, neuropathies, seizures, pneumothoraces, or other major complications.

Table 1: Demographic data and ASA status of the two study groups

Parameter	GA + ISB (n=14)	GA (n=20)
Age (years)	17 ± 1.6	18.5 ± 1.5
Gender	Males = 13 (92.9%) Females = 1 (7.1%)	Males = 15 (75%) Females = 5 (25%)
Weight (kilograms)	76.9 ± 24.9	72.1 ± 12.5
BMI	24.4 ± 5.7	23.9 ± 3.4
ASA Classification	I = 6 (42.8%) II = 8 (57.1%)	I = 10 (50%) II = 10 (50%)

BMI = body mass index; GA = general anesthesia; ISB = interscalene block

There was no statistically significant difference in postoperative nausea and vomiting in patients receiving interscalene nerve block versus those receiving general anesthesia alone (p = 1.0). All, but one patient received intraoperative pre-emptive treatment with dexamethasone (4 mg) and ondansetron (4 mg) for the prevention of postoperative nausea and vomiting.

Mean PACU length of stay for patients receiving interscalene nerve block was 67.7 ± 32.9 minutes compared to 83.3 ± 41.8 minutes for patients receiving only general anesthesia (p = NS). Additionally, no statistically significant difference was found when comparing the time to first opioid administration and total opioid consumption in PACU between the groups (p values of 0.11 and 0.11 respectively).

There was a statistically significant difference in both the mean and median pain scores in the PACU in patients who received an interscalene nerve block versus those who did not (p = 0.01) (Table 2). Additionally, 7 of the 14 patients (50%) who received an ISB in addition to general anesthesia (50%) reported no pain (VAS score of zero) in the PACU compared to 4 of 20 patients (20%) who received general anesthesia alone ($p < 0.050$).

Table 2: PACU Pain Scores

	GA with ISB	GA
Mean ± SD	1.3 ± 1.8	3.6 ± 2.5, p = 0.01
Median	1.0	3.5, p = 0.01
No pain (VAS = 0)	7 of 14 patients	4 of 20 patients, $p < 0.05$
Required intravenous opioids during postoperative period	7 of 14 patients	18 of 20 patients, $p < 0.05$

VAS = visual analogue score

Eighteen of the 20 patients (90%) who did not receive an ISB required postoperative opioid administration, either in PACU or during an inpatient hospital admission. This is compared with the 7 of 14 patients (50%) who received an ISB and required supplemental intravenous opioids during their hospital course ($p < 0.05$). There was a reduction in total opioid consumption in patients who received an ISB in both the PACU and during postoperative hours 0-6, 6-12, and 12-24 (Table 3). These values reached statistical significance during postoperative hours 0-6 ($p = 0.035$).

There was a statistically significant difference found in the need for postoperative inpatient hospital admission. Eleven of the 14 patients (79%) who received a combined general and ISB were discharged home on the day of surgery compared with only 9 of the 20 patients who received general anesthesia and intravenous opioids ($p = 0.036$). In the patients who required hospital admission, there was no difference in the duration of hospitalization between those receiving ISB and those who received general anesthesia. With the exception of one patient, all patients were discharged home on postoperative day one.

Table 3: PACU and Postoperative Opioid Consumption

Time (postoperative hours)	Opioid consumption (mg of morphine equivalents)	
	GA + ISB	GA
PACU (mean ± SD)	2.4 ± 5 Median = 0	4.5 ± 6.3 Median = 1.4
0 to 6 ($p = 0.035$)	1.8 ± 3.1 Median = 0	9.7 ± 5.1 Median = 7.3
6 to 12	6.1 ± 3.4 Median = 4.2	7.2 ± 6.1 Median = 5.7
12 to 24	5.0 ± 4.4 Median = 3.3	13.9 ± 13.7 Median = 6.7

DISCUSSION

Regional anesthesia has become an integral part of modern anesthesia practice in the pediatric population, yet few studies have clearly demonstrated the clinical advantages of peripheral nerve blockade during the postoperative period. Specifically, this is the first study evaluating such parameters in the pediatric population undergoing major shoulder surgery.

Willschke et al. suggested that peripheral nerve blockade may be challenging in the pediatric population.[1] With poorly defined surface landmarks and variable location of the nerves, it is essential for these procedures to be performed or supervised by pediatric anesthesiologists who are experienced in pediatric regional anesthetic techniques. Children do not, in general, tolerate brachial plexus blockade without the use of heavy sedation or general anesthesia.[10] Several studies, including the ASRA Practice Advisory in 2008, highlight the risk of nerve injury in this setting because pain during placement is not detected. However, it is the accepted standard of care to perform peripheral nerve blockade in the pediatric population following the induction of general anesthesia. Within our limited patient sample, we were able to confirm that brachial plexus blockade under general anesthesia using ultrasound guidance is a safe and effective option for the provision of postoperative analgesia

Many studies have demonstrated the advantages of using ultrasound guidance for regional anesthetic techniques in both the adult and pediatric populations. With the possible challenges of anatomy and variability in children, ultrasound is invaluable in allowing direct visualization of the target nerve and surrounding structures, such as blood vessels, fascial planes, and pleura. This real-time demonstration of the structures can also prevent potential complications and within our study population, there were no instances of intravascular injection, pneumothorax, or nerve damage.

Our study demonstrated that patients who received an ISB in addition to general anesthesia had decreased postoperative pain, as represented by decreased mean and median pain scores in the recovery period. Improved comfort in the postoperative period may decrease stress and anxiety related to the surgical experience, particularly in children who may have heightened anxiety while separated from their parents. Improved pain scores may also decrease the need for supplementary opioid analgesia in the PACU, minimizing the risk of respiratory depression or opioid-related side effects such as pruritis, nausea, and vomiting. We did find a reduction in total opioid use during postoperative hours 0-6, although we did not determine further statistical significance when comparing the total amount of supplemental intravenous opioids (hydromorphone and morphine) administered in the PACU and during subsequent postoperative hours. We postulate that this may be due to a lack of familiarity with the recently established regional anesthesia program at our institution or the inherent anxiety that may be present in the adolescent population during the postoperative

period. These factors may have resulted in the delivery of supplemental opioids in spite of sufficient pain control provided by the regional technique given previous experiences with major shoulder surgery patients. Improved protocols may lead to standardization of practices with regard to postoperative opioid administration. Another factor which may have contributed to the lack of difference in opioid requirements is that there were a limited number of patients who required hospitalization in the ISB group. As such, there may have been inadequate power to demonstrate further statistical significance.

However, we did note a statistically significant reduction in the need for hospital admission in patients who received an ISB as well as a greater number of patients who reported that they were pain free in the PACU. The former is of significance as this factor may decrease health care associated costs and allow children to more quickly return to a more familiar, comfortable environment. One limitation of the short recovery time as well as the retrospective nature of the study was that we were unable to evaluate and compare analgesia in the non-hospital setting. However, children who received an ISB were able to be discharged home without pain more frequently and no patient or parent reported difficulties with pain management after hospital discharge.

This study included patients who had major shoulder surgery and ISB after the implementation of a regional anesthesia program at our institution. We believe that it clearly demonstrates how cooperation between the anesthesia, surgical and nursing teams can result in positive outcomes for patients. Patients and parents should ideally be introduced to the regional technique in the early pre-procedure period so that they are familiar and educated at the time of surgery. Surgeons must also be educated about the advantages of regional anesthetic techniques in addition to general anesthesia in children. While additional nonsurgical time in the operating room for placement of the peripheral nerve block under general anesthesia may be required, patients are ultimately more comfortable and are less likely to need hospital admission after major shoulder surgery.

In conclusion, our study shows that regional anesthesia serves an important role in pediatric anesthesiology and that the continued training and development of regional anesthesia programs can produce positive results. This retrospective review demonstrates that ultrasound-guided ISB is a safe and effective technique for providing superior analgesia after shoulder surgery in the pediatric population. ISB reduced pain during the postoperative period and resulted in a decreased need for hospital admission.

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