Interscalene Brachial Plexus Blocks Under General Anesthesia in Children: Is This Safe Practice?

A Report From the Pediatric Regional Anesthesia Network (PRAN)

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Background and Objectives: A practice advisory on regional anesthesia in children in 2008, published in this journal, supported the placement of regional blocks in children under general anesthesia (GA). Interscalene brachial plexus (IS) blocks were specifically excluded, based on case reports (level 3 evidence) of injury, which occurred predominantly in heavily sedated or anesthetized adult patients. Apart from case reports, there is a paucity of data that explore the safety of IS blocks placed in patients under GA, and the level of evidence available on which to base recommendations is limited.

Methods: Querying the database of the Pediatric Regional Anesthesia Network (PRAN), we report on the incidence of postoperative neurological symptoms, local anesthetic systemic toxicity, and other reported adverse events in children receiving IS blocks under GA or sedated.

Results: A total of 518 interscalene blocks were performed, 390 under GA and 123 with the patient sedated or awake (5 cases had missing status); 472 of these were single injection, and 46 involved the placement of infusion catheters. Eighty-eight percent of blocks were placed with ultrasound guidance, 7.7% with no location device, and 2.5% with a nerve stimulator. No local anesthetic systemic toxicity, postoperative neurological symptoms, cardiovascular complications, or dural puncture was reported in this cohort. There were 1 vascular puncture and 1 postoperative infection. These negative results are compatible with 0 to 7.7/1000 events for each of these complications for IS blocks placed under GA. There was no paralysis, motor block, or sensory deficit beyond the expected block duration time.

Conclusions: Analyzing interscalene blocks in children placed under GA, we identified no serious adverse events. The upper limit of the confidence interval for these events is similar to that in awake or sedated adults receiving IS blocks. Based on these prospectively collected data, placement of IS blocks under GA in children is no less safe than placement in awake adults, calling into question the American Society of Regional Anesthesia and Pain Medicine advisory proscribing GA during IS block in pediatric patients.

(*Reg Anesth Pain Med* 2014;39: 502–505)

A regional anesthesia practice advisory published in this journal in 2008 supported placing blocks under general anesthesia (GA) in pediatric patients, with the exception of interscalene brachial plexus (IS) blocks. The evidence for this exception was based on expert opinion and a few case reports of adverse events of IS blocks in adults under anesthesia. The authors stated, "For instance, most reports of injury involve interscalene block in anesthetized or heavily sedated patients; thus, the panel makes a separate recommendation specific to interscalene block."[1]

With this article, we aim to address the problem of a lack of evidence of safety or danger of IS blocks performed in children under GA by providing empirical data gathered from a prospective database. For this report, we queried the database of the Pediatric Regional Anesthesia Network (PRAN). Pediatric Regional Anesthesia Network is a collaborative effort of pediatric anesthesiologists from participating hospitals caring for children. It was established to define prevailing practice patterns and the incidence of complications, in order to increase patient safety and quality of care. The collaborative collects data prospectively on every regional anesthetic performed in patients younger than 18 years by anesthesiologists in participating institutions, with an emphasis on data completeness and accuracy with audit verification of data.

The objective of this report was to define the incidence of postoperative neurological symptoms (PONSs), local anesthetic systemic toxicity (LAST), and other adverse events related to interscalene blocks for patients who were under GA at the time of block placement.

METHODS

With institutional review board approval of all participating centers (see Appendix), data submitted from April 2007 through May 2013 were analyzed. Each PRAN study center collected data of every regional anesthetic performed by an anesthesiologist in patients younger than 18 years. For the purpose of this study, we selected patients who had IS blocks performed using either single-injection or indwelling catheter placement. Patients who received additional nerve blocks were excluded from the analysis. Details regarding the PRAN collaboration, the data collection, and the verification and validation process are described in previous publications.[2,3]

Each patient's clinical status during the block placement was recorded in the database. This "patient state" was categorized as GA, GA without neuromuscular blockade (NMB), GA with NMB, sedated, or awake.

Two primary outcomes were used for this analysis: PONSs of any severity or duration, and LAST, either cardiovascular or neurologic.

Outcomes are reported as number of occurrences and rates per 1000 blocks with corresponding 95% confidence intervals (CIs). The latter were calculated using R (version 3.1.1; R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

A total of 518 IS blocks were performed, 390 under GA and 123 with the patient sedated or fully awake (5 cases had missing status and were excluded from analysis in regard to status at time

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Accepted for publication August 21, 2014.
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The authors declare no conflict of interest.

ISSN: 1098-7339
DOI: 10.1097/AAP.0000000000000166

of block); 472 of these blocks were single injection, and 46 were catheter placement. Patients had GA without NMB for 301 single-injection and 37 catheter blocks, GA with NMB for 50 single-injection blocks, and 2 catheter blocks; were sedated for 98 single and 5 catheter blocks; and were awake for 18 single and 2 catheter blocks. Four hundred fifty-eight patients (88.4%) were between 10 and 18 years old, 36 (6.9%) between 3 and 10 years, 19 (3.7%) between 1 and 3 years, and 5 (0.1%) were younger than 12 months (Table 1).

Of the 518 IS blocks, 40 (7.7%) were placed using an anatomic landmark technique alone, 456 (88.0%) with ultrasound imaging, 70 (13.5%) with nerve stimulation (as an adjunct to ultrasound 57 times and as the sole placement aid in 13 cases [2.5%]), and 3 with fluoroscopy. Interscalene brachial plexus catheter insertions were performed with no aid in 6 cases, 38 (82.6%) with ultrasound, and 10 with nerve stimulation (8 times as an adjunct to ultrasound, twice [4.3%] alone).

No LAST, PONSs, or dural punctures were reported for any patient (95% CI, 0–5.8/1000 for all blocks, 0-7.7/1000 for blocks under GA). There was 1 reported vascular puncture and 1 postoperative infection associated with a continuous infusion catheter. One patient developed a transient Horner syndrome, which subsided as expected as the block waned. There were no cases of intraspinal injection, paralysis, or motor/sensory blockade persisting beyond the expected block duration time.

DISCUSSION

In this prospective data collection, IS blocks were performed in children and adolescents 390 times under GA without adverse events or complications that may be attributed to the use of GA and specifically with no accidental intraspinal injection, PONSs, or LAST. The overall risk of neurologic or cardiovascular complications of IS under GA was not statistically different than the risk in the awake patient. The fact that no significant adverse events, LAST or PONSs, were found in 518 blocks is encouraging and adds a significant body of experience to the scarcity of evidence in this field that is dominated by case reports of adverse events with no known denominator.

Zero event reports must be carefully interpreted[4]; our zero event rate is equivalent to an adverse event rate that is equal to or less than 7.7/1000 for all pediatric IS blocks placed under GA, which is comparable to the adverse event rate we have reported for PONSs for pediatric patients receiving a variety of blocks under GA by PRAN.

In their 1-year audit of pediatric regional anesthesia in France, Ecoffey et al[5] included 126 "parascalene" blocks and 16 continuous catheters. No serious complications were reported. De Vera et al[6] published their experience with performing a variety of pediatric blocks under GA, including 146 interscalene blocks. There was 1 episode of severe hypotension in a patient who received both interscalene and contralateral axillary blocks. The hypotension was attributed to an allergic reaction to a concomitantly administered antibiotic. The same group also reported an additional 218 pediatric interscalene blocks placed under GA without complication.[7]

In the literature reporting the experience in adult patients, there are numerous single-center and multicenter reports with event rates for long-term nerve injury after IS blocks ranging from 0:1000 to 10:1000 with corresponding CIs ranging from 0:1000 to 26:1000.[8–12] There are also 2 large case series of IS blocks under GA. Misamore et al[13] described their experience with 910 IS blocks placed with nerve stimulation under GA. They reported a short-term complication rate of 4.4% (40/910), with 30 of 40 complications (mostly paresthesia) resolved within 10 days. Long-term complications were described in 8 (0.8%; 95% CI, 3.8:1000–17:1000) patients, with 1 patient (0.1%; 95% CI, 0:1000–6.1:1000) having a persistent severe radial nerve palsy. The other long-term complications were sensory and did not interfere with patients' daily activities. Bogdanov and Loveland[14] retrospectively examined 548 IS blocks performed with nerve stimulation under GA. They reported no significant neurologic injuries at 4- to 8-week follow-up (95% CI, 0:1000–6.7:1000). The authors asserted that needle direction (ie, a "modified" Winnie

TABLE 1. Summary of Interscalene Brachial Plexus Blocks by Patient Age and State at Time of Block

	GA						
	All GA	No NMB	With NMB	Sedated	Awake	Missing	All
Single							
<1 mo	0						0
1 to <6 mo	3	3					3
6 mo to <1 y	1	1					1
1 to <3 y	15	13	2	4			19
3 to <10 y	31	28	3	2			33
10 to <18 y	301	256	45	92	18	5	416
Single total	351	301	50	98	18	5	472
Catheter							
<1 mo	1	1					1
1 to <6 mo	0						0
6 mo to <1 y	0						0
1 to <3 y	0						0
3 to <10 y	3	3					3
10 to <18 y	35	33	2	5	2		42
Catheter total	39	37	2	5	2		46
Total	390	338	52	103	20	5	518

approach with caudal-lateral needle direction) was more predictive of nerve injury than patient state at the time of block placement.

It should be noted that in the well-known case series from Benumof,[15] 3 of 4 blocks were performed with nerve stimulation and one using palpation and visual identification of surface landmarks alone. Needle approaches were not described for 3 of 4 cases, but the angle of approach of the needle can have significant implications for potential nerve injury due to the proximity and orientation of cervical transverse foramina.[16] More recently, a posterior approach has been advocated as a potentially safer needle trajectory (with better ultrasound needle visualization) when compared with traditional techniques.[17] Although the overwhelming majority of IS blocks were done using ultrasound in our study, the PRAN does not collect specific data beyond localization technique, so we cannot comment on the relative safety of alternative needle approaches.

Our results are from observational data and need to be carefully interpreted keeping in mind several limitations. Our data need to be interpreted acknowledging that 88% of these cases were in children between 10 and 18 years old; therefore, our conclusions are most applicable for patients in that particular age group. A further limitation to our results is that neonates or children with severe neurodevelopmental disorders would not be able to report mild sensory or motor PONSs, but more severe motor deficits would likely have been detected. The data collected are prospective and observational with patients accrued from 20 academic teaching hospitals with their corresponding patient populations; hence, they may not be a representative sample of all children receiving IS blocks in the United States or the world, where operator skill, technology availability, and underlying patient health status may vary widely. Pediatric Regional Anesthesia Network institutions are academic teaching hospitals where blocks are supervised or performed by pediatric anesthesiologists.

At the time of this data collection, PRAN does not have a structured follow-up process for regional anesthesia that goes beyond a routine follow-up in the first 72 hours after discharge. While it is unlikely that in children a major complication such as paralysis or paresthesia goes undetected without the child returning to the pediatric care center where the procedure was performed, this is possible and a limitation of PRAN currently.

The different sizes of the subgroup denominators also affect reported incidence data, as the majority of patients were in the GA groups, with much smaller groups being awake or sedated. Because the major focus of this study was to investigate the safety of interscalene blocks in anesthetized patients, this does not cause a major statistical problem. Although we can state the placement of IS blocks in anesthetized pediatric patients is not of greater risk than doing so in awake adults, our data do not allow us to make the same statement for patients who are sedated or awake. Nor can we make more specific comments about different localizing techniques or anatomic approaches to IS blocks and associated risk or safety profiles. It also should be noted that children typically undergo operations that expose them to less risk of nerve damage from the surgical procedure than do adults (eg, total shoulder arthroplasty).

In the previous paragraphs, we discuss the frequency of complications with interscalene blocks in children and adults. Because the incidence of adverse events (including PONSs and LAST) with regional anesthesia is low, we are unable in this study or future research to state that the practice of placing interscalene blocks in children is safer than that in adults. That is because the lower limit of the CI in published data is almost always zero, and even if we would have 10,000 IS blocks in our database with no adverse event, the upper limit of the CI would be 0.0003 (0.3/1000). Hence, the CI would still be overlapping, and no statistical significance could be established. It would require a large adult series (which PRAN is not able to provide) to accomplish that desirable goal. However, based on our data, we can state that placing IS blocks in anesthetized pediatric patients is as safe as doing so in awake adult patients and that the upper limit of the CI in our cohort is consistently lower than that of adult studies.

CONCLUSIONS

We provide the largest overview of IS block complications based on patient state in children, lending credence to the belief that placement of IS blocks in children and adolescents under GA does not increase the risk of PONSs and LAST compared with performing them in an awake patient, or compared with other pediatric blocks performed under GA. The upper limit of the CI is similar to rates reported in adults with blocks placed both awake and under GA. Based on these prospectively collected data, placement of IS blocks under GA in children is no less safe than placement in awake adults, calling into question the American Society of Regional Anesthesia and Pain Medicine advisory proscribing GA during IS block in pediatric patients.

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APPENDIX

	Site	Name of Principal Investigators
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*No longer a PRAN member, but data included in this analysis.