Regional Anesthesia for Children Undergoing Orthopedic Ambulatory Surgeries in the United States, 1996–2006

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Abstract *Background:* Our objective was to evaluate national trends in regional anesthetic techniques among children undergoing ambulatory orthopedic procedures. *Purpose and Questions:* We aimed to determine whether an increase in regional anesthetics was primarily driven by an increase in the number of peripheral nerve blocks performed rather than an increase in neuraxial techniques. We further aimed to determine whether the proportion of peripheral nerve blocks performed in conjunction with general anesthesia has increased over time. *Patients and Methods:* Our study sample included any pediatric patient (i.e., <18 years old) who underwent an orthopedic ambulatory procedure in 1996 and 2006. We obtained data on ambulatory surgical procedures by accessing the Centers for Disease Control and Prevention's National Survey of Ambulatory Surgery. Patient demographics (age, gender), procedure information, and anesthesia-related variables were analyzed for each year. *Results:* The proportion of peripheral nerve blocks performed for ambulatory surgery more than doubled from 1996 (4.4 %) to 2006 (8.1 %). A significantly larger proportion of orthopedic procedures were being performed with a combination of peripheral nerve blocks and general anesthesia (1.2 % in 1996 and 43 % 2006). The use of neuraxial anesthesia for lower extremity surgeries decreased over the 10-year period (1.1 and 0.4 %

in 1996 and 2006, respectively). *Conclusions:* There was a significant increase in the use of peripheral nerve blocks for children undergoing ambulatory orthopedic procedures in the USA, while neuraxial techniques became less common over the 10-year period. The peripheral nerve blocks were frequently performed in conjunction with general anesthesia.

Keywords regional anesthesia · pediatrics · ambulatory surgery

Introduction

The role of regional anesthesia in orthopedic ambulatory surgery is relevant because of its potential ability to provide postoperative analgesia and to decrease time to discharge [12]. At our own institution, we commonly perform neuraxial techniques and peripheral nerve blocks in children undergoing orthopedic ambulatory procedures to not only provide postoperative analgesia and therefore reduce opioid consumption but also to minimize exposure to general anesthetics given the unknown neurodevelopmental risk [10]. There are surprisingly few studies on the nationwide utilization of regional anesthesia, whether peripheral nerve blocks or neuraxial techniques, among children in the USA. The Pediatric Regional Anesthesia Network (PRAN) found that regional anesthetics are common at select academic centers and have a low complication rate [7]. The study did not comment on the use of regional anesthesia in addition to general anesthesia. Another recent study, based on the National Survey of Ambulatory Surgery (NSAS), examined changes in pediatric anesthetic care in the ambulatory surgery setting and found that the overall use of regional anesthesia increased by 18 % in a 10-year period [9]. However, it is unknown whether the increase in regional anesthesia in children is due to an increase in the utilization of peripheral nerve blocks and/or neuraxial techniques.

Level of Evidence: Therapeutic Study: Level IV. See "Levels of Evidence" for a complete description.

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The unique challenge in the pediatric population is the frequent need to perform the regional anesthetic while the patients are deeply sedated or under general anesthesia. Despite there being growing evidence and acceptance worldwide that pediatric regional anesthesia can be safe and effective under these circumstances [1–3, 11], little is known about temporal changes and the extent that regional anesthetics are being performed in such manner in the USA.

Therefore, the purpose of this study was to characterize changes in the practice of regional anesthesia in the US pediatric patient population and to evaluate the rate of utilization of peripheral nerve blocks in conjunction with general anesthesia in particular. We hypothesize that (1) the reported increase in regional anesthetics is largely the result of an increase in the number of peripheral nerve blocks performed, while the rates of neuraxial techniques have not significantly changed and (2) the proportion of peripheral nerve blocks performed in conjunction with general anesthesia has increased over time.

Methods

We obtained data on ambulatory surgical procedures by accessing the Centers for Disease Control and Prevention's (CDC) NSAS. The surveys, conducted by CDC's National Center for Health Statistics in 1994–1996 and again in 2006, compile nationally representative data on ambulatory surgery procedures performed at both hospital-based and free-standing ambulatory surgery centers. The hospital universe includes non-institutional hospitals exclusive of federal, military, and Department of Veterans Affairs hospitals located in the 50 states and the District of Columbia. The universe of freestanding facilities included ones that were regulated by states or certified by the Centers for Medicare & Medicaid Services for Medicare participation. Further detailed information regarding NSAS and its design is available online at <http://www.cdc.gov/nchs/nsas.htm>. Because NSAS is an administrative dataset that does not contain personal identifying information, the study was exempt from review by our institutional review board (documentation available).

Our study sample included any pediatric patient (i.e., <18 years old) who underwent an orthopedic procedure in 1996 and 2006 as identified by the ICD-9-CM procedure

codes 77–84, which include fracture reductions and arthroscopies (Appendix). Patient demographics (age, gender), procedure information, and anesthesia-related variables were analyzed for each year.

All statistical analyses were performed using SAS, version 9.2 (SAS Institute, Cary, NC). Using the weighting procedures provided by NSAS, frequencies are presented as national estimates. To facilitate analysis of the data collected in a complex survey design and to obtain consistent estimates of mean and variance parameters, SAS procedure SURVEYFREQ was utilized for descriptive analyses. The proportional changes between the two years, 1996 and 2006, were analyzed for each variable category using binomial tests. For these statistical tests, the FREQ procedure was used in SAS.

Results

A total of 600,234 ambulatory orthopedic procedures were performed in 1996 and 2006 in the pediatric population in the USA. The patients were more frequently male, above the age of 10, and covered by private insurance (Table 1).

Between 1996 and 2006, the number of upper extremity procedures increased by 64.8 % and that of the lower extremity by 36.1 %. For upper extremity procedures (ICD-9CM 77.2–77.4, 78.2–78.4, 79.1–79.4, 82), the proportion of anesthetics involving a peripheral nerve block increased from 6.4 to 9.5 % (Table 2). However, the majority of cases continued to be performed with a general anesthetic as the sole technique.

For lower extremity procedures (ICD-9CM 77.5–77.8, 78.5–78.8, 79.5–79.8), a larger increase in the proportion of anesthetics involving a peripheral nerve block was seen (2.2 % in 1996 versus 9.2 % in 2006, $p<0.0001$; Table 3). Neuraxial techniques were less frequently used in 2006 (0.4 %) compared to 1996 (1.1 %, $p<0.0001$), as were general-only anesthetics (79.7 % in 1996 and 73.5 % in 2006, $p<0.0001$).

Overall, the number of peripheral nerve blocks performed more than tripled from 1996 to 2006 (1996: $n=9,856$; 2006: $n=30,197$). In 1996, only a small minority (1.2 %) of peripheral nerve blocks were performed in combination with general anesthesia (Table 4). By 2006, there

Table 1 Patient characteristics

	GA		Neuraxial +/- GA, MAC		PNB +/- GA, MAC		MAC		Other only	
	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006
<i>N</i>	175,289	288,169	2,887	740	9,856	30,197	10,474	34,275	5,910	3,887
Sex										
Male (%)	58.7	55.2	74.8	60.7	48.5	67.9	31.9	48.4	78.2	36.3
Female (%)	41.3	44.8	25.2	39.3	51.5	32.1	68.1	51.6	21.8	63.7
Age										
Less than 1 year (%)	2.3	2.2	0.6	0.0	1.2	0.0	0.5	0.0	0.0	5.4
1–4 years (%)	7.3	12.8	0.0	0.0	0.1	0.6	8.4	0.0	4.4	6.7
5–9 years (%)	19.2	16.8	0.0	0.0	0.7	1.1	3.5	6.0	11.9	0.0
10–14 years (%)	34.1	35.6	27.2	20.0	30.4	25.4	47.0	35.8	48.7	52.2
15–17 years (%)	37.2	32.6	72.2	80.0	67.6	72.9	40.6	58.2	35.0	35.6

Table 2 Upper extremity procedures (ICD-9CM 77.2–77.4, 78.2–78.4, 79.1–79.4, 82)

	1996	2006	<i>p</i> value
<i>N</i>	108,729	179,151	
GA only	76.1 %	75.3 %	<0.0001
Neuraxial	n/a	n/a	<0.0001
PNB	6.4 %	9.5 %	<0.0001
MAC only	2.1 %	7.7 %	<0.0001
Other only	2.1 %	0.8 %	<0.0001

n/a not applicable

was a significantly larger proportion of procedures (43.4 %) being performed with a combination of peripheral nerve blocks and general anesthesia ($p<0.0001$).

Discussion

The aim of this study was to determine whether the recently observed increase in regional anesthetics performed in children was due to an increase in peripheral nerve blocks and not of neuraxial techniques. We found that peripheral nerve blocks have in fact increased threefold over the 10-year study period, while the proportion of neuraxial techniques have significantly decreased; therefore, peripheral nerve blocks have been the main driver of the increase in regional anesthetics in children undergoing ambulatory orthopedic procedures. Our second aim was to determine whether an increasing number of peripheral nerve blocks are being performed with general anesthetics, which we found to be true.

Limitations of our study are those inherent to using an administrative database. There is the lack of certain clinical details such as patients' ASA classification, regional anesthetic type (i.e., interscalene, supraclavicular) and anesthetic purpose (intraoperative anesthesia versus postoperative analgesia), and anesthesia-related complications. We were also unable to determine the timing of when a regional anesthetic was performed in relation to the general anesthetic. Accuracy and classification of the anesthetic may vary from center to center.

Table 3 Lower extremity procedures (ICD-9CM 77.5–77.8, 78.5–78.8, 79.5–79.8)

	1996	2006	<i>p</i> value
<i>N</i>	83,609	113,803	
GA only	79.7 %	73.5 %	<0.0001
Neuraxial	1.1 %	0.4 %	<0.0001
PNB	2.2 %	9.2 %	<0.0001
MAC only	7.1 %	15.0 %	<0.0001
Other only	3.4 %	1.2 %	<0.0001

Group	Required to be in group	Additional anesthesia
GA	General	Topical, other
Neuraxial +/- GA, MAC	Neuraxial	GA, MAC, topical, other
PNB +/- GA, MAC	PNB	GA, MAC, topical, other
MAC	MAC	Topical, other
Other only	Topical or other	

Table 4 Peripheral nerve blocks and type of intraoperative anesthetic

	1996 Weighted <i>N</i> (%)	2006 Weighted <i>N</i> (%)	<i>p</i> value
PNB +/- MAC	9,742 (98.8)	17,078 (56.6)	<0.0001
PNB + GA	114 (1.2)	13,119 (43.4)	<0.0001
Total	9,856	30,197	

For example, one anesthesia provider performing deep sedation may classify the anesthetic as a general anesthetic, while another may classify it as MAC (monitored anesthesia care). Therefore, our data have to be interpreted in the context of the database construct. A further limitation comes with the only sporadic collection of data for the NSAS, thus limiting our temporal comparisons to the single years of 1996 and 2006.

As the number of pediatric ambulatory orthopedic procedures increased from 1996 to 2006, so did the number of peripheral nerve blocks (PNB) performed. The cause of the increasing utilization of PNBs has to remain speculative using our data source, but may be related to the rising availability of ultrasound and advanced nerve localization techniques over the last few years [6]. Ultrasound guidance has been a particularly helpful aid in performing regional anesthesia in children because they are often anesthetized or heavily sedated, precluding communication of paresthesias. With the availability of long-acting local anesthetics and non-opioid adjuncts, providers may also be performing more PNBs for improved postoperative pain control.

The sharp decline in the number of neuraxial anesthetics performed (1996: $n=2,887$; 2006: $n=740$) was surprising given the study of Rabbitts et al. [9] finding that the overall utilization of regional anesthetics increased. There are several potential explanations for the decrease. Anesthesia providers may have increasingly turned to PNBs because of the adverse effects associated with neuraxial techniques, such as post-dural puncture headaches, transient neurologic symptoms, and urinary retention. There are also efficiency concerns in the ambulatory surgery setting with neuraxial techniques in that they are associated with longer induction and delayed discharge times [5].

Peripheral nerve blocks were increasingly being performed in conjunction with general anesthesia. The combination of general anesthesia with PNB may reflect either or both anesthesia providers' and surgeons' changing preferences and comfort over the past 10-year period of study.

In conclusion, when using nationally representative data, we were able to describe the anesthetic practices and temporal changes in children undergoing orthopedic ambulatory procedures. The increasing use of regional anesthesia in the USA is largely the result of more peripheral nerve blocks being performed. Although the absolute number of peripheral nerve blocks more than tripled from 1996 to 2006, peripheral nerve blocks were utilized for just 8.1 % of all anesthetics, with the majority being performed in older children. The PRAN is currently collecting more recent data on pediatric regional anesthetics at select institutions and will be able to determine whether the increase in peripheral nerve blocks has continued in the USA [8]. Given the

evidence of regional anesthesia's safety in children, there is room for further growth of regional anesthesia in the orthopedic ambulatory setting. Teaching residents and current practitioners how to perform PNB under general anesthesia could help in achieving this growth.

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Disclosures Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has waived the requirement for informed consent for this investigation and that all investigations were conducted in conformity with ethical principles of research.

Appendix

Table 5 ICD-9-CM procedures [4]

ICD-9-CM	Procedure type
77	Incision, excision, and division of other bones
78	Other operations on bones, except facial bones
79	Reduction of fracture and dislocation
80	Incision and excision of joint structures
81	Repair and plastic operations on joint structures
82	Operations on muscle, tendon, and fascia of hand
83	Operations on muscle, tendon, fascia, and bursa, except hand
84	Other procedures on musculoskeletal system

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