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ORIGINAL ARTICLE

The Utilization of Regional Anesthesia Among Pediatric Patients: A Retrospective Study

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Abstract *Background:* The use of regional anesthesia (RA) in pediatric patients remains understudied, although evidence suggests benefits over general anesthesia. *Questions/Purposes:* We sought to identify factors associated with RA use in patients under the age of 21 years undergoing ambulatory orthopedic surgery. *Methods:* Patients under the age of 21 who underwent anterior cruciate ligament (ACL) repair or reconstruction, knee arthroscopy (KA), or shoulder arthroscopy (SA) were identified from the NY Statewide Planning and Research Cooperative System (SPARCS) database (2005–2015). Frequencies of RA use (defined by femoral nerve block, spinal, epidural, caudal, or brachial plexus anesthesia) were calculated. Multivariable regression analysis identified patient- and healthcare system–related factors associated with the use of RA. Odds ratios (OR) and 95% confidence intervals (CI) were reported. *Results:* We identified 87,273 patients who underwent the procedures of interest (ACL $n = 28,226$; SA $n = 18,155$; KA $n = 40,892$). In our primary analysis, 14.4% ($n = 1404$) had RA as their primary anesthetic; this percentage increased for patients who had ACL or KA. When adjusting for covariates, Hispanic ethnicity (OR 0.78; CI 0.65–0.94) and Medicaid insurance (OR 0.75; CI 0.65–0.87) were associated with decreased odds for the provision of RA. Further, we identified increasing age (OR 1.10; CI 1.08–1.11), ACL versus SA (OR 1.91; CI 1.74–2.10), and sports injuries (OR 1.20; CI 1.10–1.31) as factors associated with increased odds of RA use. *Conclusion:* In this analysis, RA was used in a minority of patients under the age of 21 undergoing ambulatory orthopedic surgery. Older age was associated with increased use while Hispanic ethnicity and lower socioeconomic status were associated with lower use.

Keywords anesthesia · local anesthesia · general anesthesia · pediatrics · arthroscopy

Level of Evidence: Level III: Study design?

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Introduction

A number of studies have suggested that regional anesthesia (RA) may benefit patients undergoing orthopedic surgery [3, 5, 11]. However, data is rare on its use among pediatric and adolescent patients. With sport-related injuries increasing in this patient demographic, an increasing number of patients present for diagnostic and therapeutic surgery [4, 18]. In this population, for example, anterior cruciate ligament (ACL) injury has been shown to be more common than previously thought [4, 14, 18]. ACL injuries account for 6.3% of all sports injuries between the ages of 5 and 12 years and 10.3% between 13 and 17 years [14]. Dodwell et al. estimate that 50 per 100,000 pediatric patients ages 10 to 19 years old undergo ACL reconstruction per year [4]. Similar increases in shoulder procedures have been reported.

It has been suggested that the use of regional techniques, including peripheral nerve blocks, may be associated with more effective pain control and improved early recovery [17]. In pediatric patients undergoing ACL repair, benefits attributed to the use of peripheral nerve blocks include a reduction in opioid consumption, decreased post-operative pain scores, decreased hospital length of stay, and a reduction in post-operative admission rates [9, 13]. Therefore, experts recommend RA techniques to be used as part of a multimodal regimen [17]. With publications by the Pediatric Regional Analgesia Network suggesting that complications are extremely rare, RA techniques should be used routinely in pediatric anesthesia [12, 16].

Despite these suggested benefits, there are few studies exploring the use of RA on a population level. We therefore sought to analyze a state-wide cohort to explore trends and identify factors associated with the use of regional anesthesia in patients below the age of 21 years undergoing ambulatory orthopedic procedures over a 10-year period. We hypothesized that RA use would increase over time and that patient and healthcare system factors associated with its use could be identified.

Methods

Approval for this retrospective study was obtained from the Institutional Review Board, which waived the requirement for informed consent. Data collected for the NY Statewide Planning and Research Cooperative System (SPARCS) database was accessed for the years between 2005 and 2015. We identified patients from the ages of 3 to 21 years who had undergone the following events: shoulder arthroscopy, shoulder fracture, humerus/elbow arthroscopy, humerus/elbow fracture, forearm/wrist arthroscopy, forearm/wrist fracture, hand/fingers fracture, hip arthroscopy, pelvis/hip fracture, knee arthroscopy, anterior cruciate ligament repair, femur/knee fracture, leg/ankle arthroscopy, and leg/ankle fracture. Subsequently, the population of 144,965 procedures was narrowed to patients who had undergone ACL repair, knee arthroscopy (KA), and shoulder arthroscopy (SA) as our main cohort for further analysis ($n = 87{,}273$). Those who reported both ACL and KA were categorized as ACL. All were defined by the Current Procedural Terminology (CPT) diagnosis codes (see Appendix I for detailed definitions).

Patient-related variables included age, sex, race (Asian, black, white, other, and unknown), Hispanic ethnicity, NY state residency, type of insurance (Medicaid, private, other, and unknown), and whether the injury was a sports injury. Hospital-related variables included location (urban, rural), procedure type, and year of procedure. Anesthesia type is a SPARCS-defined variable derived from patient anesthesia records. If more than one anesthesia type was administered, primary anesthesia was defined by the database in hierarchical order: general, regional, other, and local. Those without anesthesia information were categorized as "unknown."

Use of RA was the main outcome of interest. It was defined as including spinal anesthesia, epidural anesthesia, caudal anesthesia, brachial plexus anesthesia (including axillary block, interscalene block, and supraclavicular block), and femoral nerve block.

Statistical Analysis

First, overall trends of major orthopedic ambulatory procedures were assessed over time by the Cochran-Armitage tests. Then, individual trends of ACL, KA, and SA by sports injury and year, as well as anesthesia type by year, were obtained. Use of RA over time was also assessed by the Cochran-Armitage test and explored by patient, hospital, and procedure characteristics. χ-squared tests evaluated group differences. Standardized differences, in addition to p values, were included to further measure relationships due to our large sample size [1, 20]. Multilevel multivariable regression analysis was subsequently performed to identify factors associated with the use of RA, which accounted for the correlation of patients within hospitals.

Due to a large number of individuals with missing anesthesia information, those with "unknown" anesthesia type were excluded from the initial model. To further examine the effect this had on our initial results, two models were run: unknown coded as "RA = no" and unknown coded as "RA = yes." Subsequently, evaluating hospital-specific percentage of RA use allowed us to identify a potential issue with zero-inflation. Additional sensitivity analysis was then performed where hospitals with 0% RA use were excluded from the model.

All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC, USA), and statistical significance was defined as a 2-sided p value of < 0.05.

Results

A total of 159,629 pediatric patients were identified who underwent ambulatory orthopedic surgeries between 2005 and 2015. Table 1 provides information on surgeries and total sports injuries by year. The incidence of surgeries increased within the decade observed, although the proportion of sports injuries decreased over time.

Our primary cohort consisted of 28,226 ACL, 18,155 KA, and 40,892 SA patients. The Cochran-Armitage tests found significant trends within the three procedures over time. When further assessing the trends, ACL frequencies increased the most (Fig. 1a, b), SA increased modestly, and KA did not appear to follow a trend until decreasing after 2013. While the percentage of cases related to sports injuries declined among those undergoing KA and SA, those related to ACL increased over time. Trends of anesthesia type are shown in Fig. 2 a–c. General anesthesia was used most often throughout the years across all three procedures. Patients who underwent KA received local anesthesia more often than patients who had ACL or SA. After conducting a Cochran-Armitage test on RA use, significant trends were identified among ACL and KA cohorts (p values < 0.05).

Table 2 presents patient-, healthcare-, and procedure-related variables by RA use. Of the 79,190 patients undergoing ACL, KA, and SA surgeries with information on types of anesthesia, 11,404 (14.4%) had RA as the primary anesthetic. Higher frequencies of RA use were observed among those who were non-Hispanic, living in an urban location, and residents of the NY state. Those on Medicaid, having sports injury, or having an ACL received RA more frequently. The incidence of RA use appeared to increase annually, starting at 12.6% in 2005 and reaching 17.0% in 2015.

Results of the multivariable regression model are presented in Table 3. When adjusting for covariates, Hispanic ethnicity (OR 0.78; CI 0.65–0.94) and Medicaid insurance status (OR 0.75; CI 0.65–0.87) were associated with decreased odds for the provision of RA. In addition, we identified increasing age (OR 1.10; CI 1.08–1.11), ACL versus shoulder surgery (OR 1.91; CI 1.74–2.10), and surgery for sports injuries (OR 1.20; CI 1.19; 1.31) as factors for increased use of RA. The C-statistic for the model was > 0.9.

There were 8083 (10.2%) records removed from the primary analysis because anesthesia technique was listed as "unknown." Online resource 1 presents the results of including missing data. When unknown anesthesia technique was included as RA = no, in-state status became significant. NY state residents were more likely to have RA administered (OR 1.11; CI 1.00–1.22) than those from other states. While Hispanic status was statistically significant in our original model at a p value of 0.01, including the missing cases as RA = no caused the variable to lose effect, and the p value changed to 0.051. When unknown anesthesia technique was included as RA = yes, sports injury was no longer found to be a significant predictor.

Hospital-level RA use was also explored (Fig. 3), where the number of hospitals were presented by percentage of use (categorized) for ACL, KA, and SA. Across the three procedures, hospitals with 0%

Table 1 Pediatric orthopedic ambulatory surgeries identified in SPARCS (2005–2015)

Procedure	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Shoulder arthroscopy	1167	1433	1530	1644	1768	1867	1792	1840	1792	1677	1685
Shoulder fracture	52	70	124	133	150	187	232	260	279	287	343
Humerus/elbow arthroscopy	69	95	85	98	93	100	91	101	106	111	85
Humerus/elbow fracture	315	396	389	444	445	449	475	604	627	695	737
Forearm/wrist arthroscopy	123	157	144	200	163	150	121	160	120	125	147
Forearm/wrist fracture	210	233	543	645	638	727	697	741	733	750	702
Hand/fingers fracture	968	1067	1156	1246	1297	1310	1242	1317	1314	1409	1397
Pelvis/hip arthroscopy	63	103	121	164	241	274	342	373	438	485	478
Pelvis/hip fracture	8	4	5	7	6	8	4	13	8	10	6
Femur/knee arthroscopy	4130	4691	4591	4928	5046	5351	5105	5323	5314	5186	4910
ACL repair	1690	1996	2104	2224	2569	2764	2687	2941	3002	3156	3119
Femur/knee fracture	64	81	75	88	76	114	103	109	125	142	134
Leg/ankle arthroscopy	164	223	244	241	262	293	264	271	313	277	310
Leg/ankle fracture	453	448	486	475	533	554	613	593	641	648	686
Total	9476	10,997	11,597	12,537	13,287	14,148	13,768	14,646	14,812	14,958	14,739
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Sports injury	1496	1679	1758	1841	1885	2067	1917	2028	2032	2053	1985
% (accidents of total procedures)	15.8	15.3	15.2	14.7	14.2	14.6	13.9	13.9	13.7	13.7	13.5

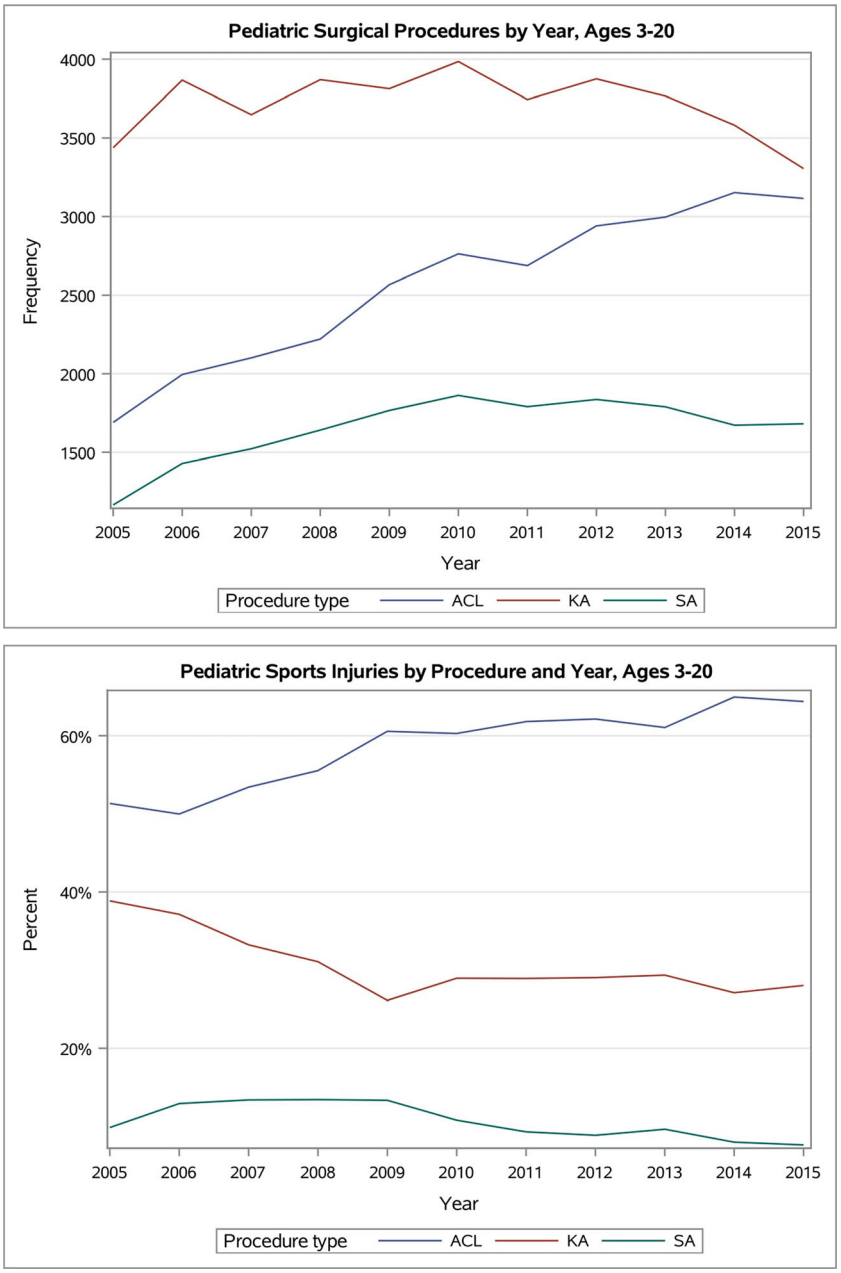

Fig. 1. Pediatric surgical procedures identified by year (2005–2015), by **a** frequency and **b** percent

RA use were most common (197, 184, and 199, respectively). The percentage of use appeared to decrease exponentially by category. For ACL and KA, two hospitals used RA in the range of 41 to 60%, and two in range of 81 to 100%, respectively. For SA, three hospitals showed 61 to 80% use, and only one had 81 to 100% use, respectively. Results were validated by identifying our own hospital's percentage of RA use in the database and comparing it with that found in the SPARCS database. Supplementary Table 1 presents the results after excluding procedures done at hospitals with 0% RA use (n = 46,171; 58.3% of original cohort). Here, sex and race lost effect, but in-state status was significant (OR 1.12; CI 1.0–1.23).

Discussion

In this study of population-based data collected in the NY state between 2005 and 2015, we found that despite previously reported benefits associated with RA and low related

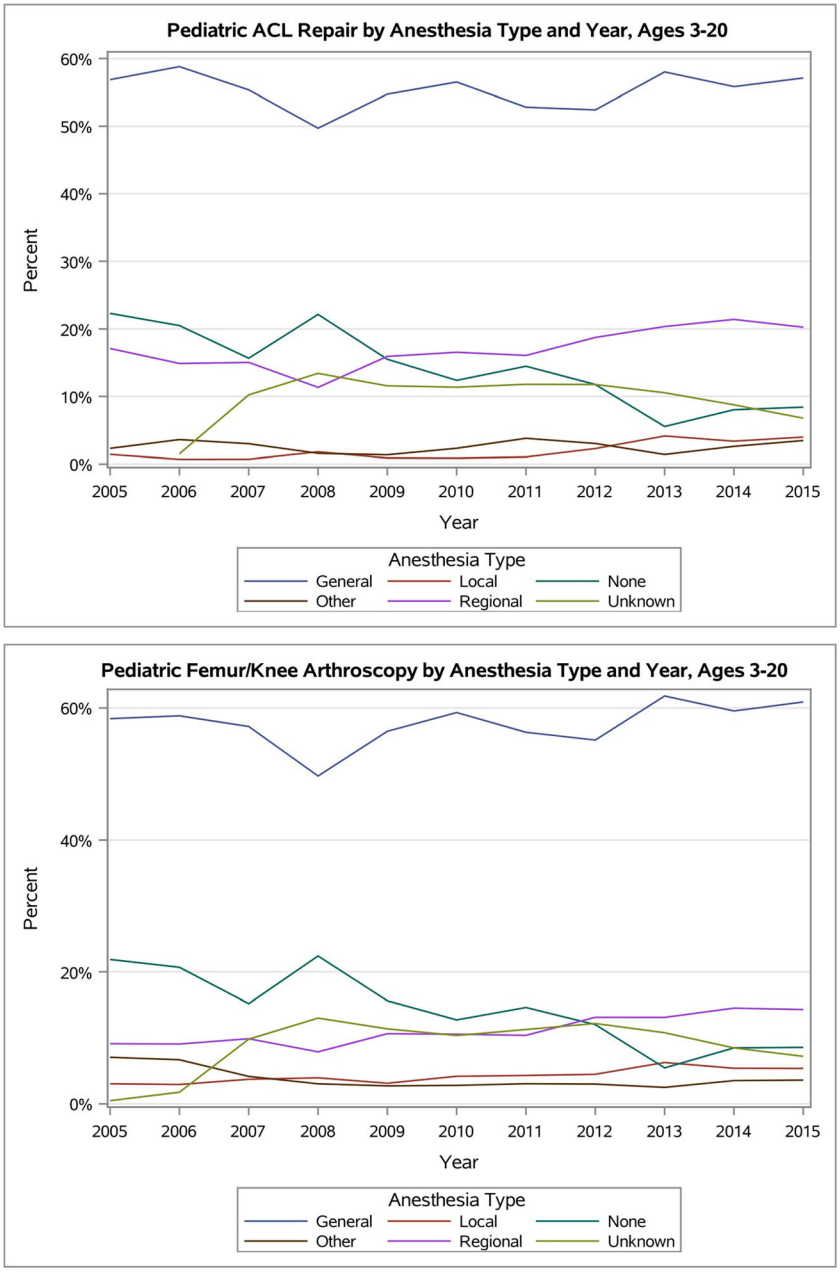

Fig. 2. **a**, **b** Trends of primary anesthesia type (2005–2015), by procedure type

complication rates, these techniques were performed for a minority of patients.

Although, a trend toward increased use of RA was found over time, it remained well below 25%. After adjusting for covariates, Hispanic ethnicity and Medicaid insurance status were associated with decreased odds for the provision of RA, while increasing age, ACL versus SA, and surgery for sports injuries were factors associated with increased use of RA.

Recent literature has suggested an increase in the use of ambulatory pediatric orthopedic surgery in the USA [4, 15]. Using the SPARCS database, we found an increase in frequencies across multiple pediatric orthopedic procedures from 2005 to 2015. The percentage of these procedures that were ACL repairs increased, especially in comparison with KA and SA. We also observed an increase in ACL repairs categorized as sports injury cases, which supports the speculation that increased ACL repairs may be a result of higher sports participation at a younger age and earlier specialization in sports [2, 4, 6]. The rise of this particular procedure within young athletes may also be a result of the changing attitude from non-operative injury management to interventional approaches [7].

Across the three surgeries of interest, we found that general anesthesia was the main technique used. However, an upward trend of RA use in ACL and KA cohorts was observed. A lack of significant use in in shoulder procedures may be related to proximity to sensitive structures in the

Table 2 Regional anesthesia use in pediatric anterior cruciate ligament reconstruction, knee arthroplasty, and shoulder arthroplasty procedures (n = 11,404)

Characteristics	n	%	p value	Standardized difference
Age group			0.006	0.035
3–10	101	16.7		
11–14	1376	14.7		
15–18	6821	14.1		
19–20	3106	15.0		
Sex			0.002	0.031
Female	4888	14.9		
Male	6516	14.1		
Race			< 0.001	0.235
Asian	89	9.8		
Black	575	9.7		
Other	1289	10.8		
Unknown	1007	23.5		
White	8444	15.0		
Hispanic status			< 0.001	− 0.138
No	11,117	14.7		
Yes	287	7.6		
Procedure year			< 0.001	0.203
2005	791	12.6		
2006	801	11.2		
2007	897	13.8		
2008	708	10.7		
2009	944	13.1		
2010	1068	13.9		
2011	927	12.8		
2012	1230	16.2		
2013	1366	17.9		
2014	1389	18.1		
2015	1283	17.0		
Location			< 0.001	− 0.318
Rural	120	2.1		
Urban	11,284	13.8		
In-state			< 0.001	− 0.717
No	3374	53.8		
Yes	8030	11.0		
Insurance			< 0.001	0.391
Medicaid	390	5.7		
Other	142	6.2		
Private	6717	19.0		
Unknown	4155	12.0		
Sports injury			< 0.001	0.481
No	7515	11.4		
Yes	3889	28.9		
Procedure type			< 0.001	0.298
ACL repair	4919	19.2		
Knee arthroscopy	4071	10.9		
Shoulder arthroscopy	2414	15.0		

*8083 missing anesthesia variable not included

neck, making precise needle placement necessary. Many practitioners may believe this procedure requires ultrasound guidance, as suggested by Veneziano et al. [19]. However, the lower use of RA might also be explained by the fact that practitioners may not be as familiar with its use.

In our main multivariable model, variables significantly associated with the provision of RA included race, Hispanic status, and insurance type. Race and socioeconomic factors are known to be important components in determining patient outcomes, and previous research indicates that related variables influence perioperative management of patients. In a prospective study by Ochroch et al., the authors reported that willingness to accept a different analgesic method as part of care for elective surgery was strongly affected by these factors [10]. Patient preferences could be a result of cultural considerations, and access to education on treatment can cause a nonmedical bias with negative perceptions to unfamiliar practices. Language barriers can also affect communication between patient and clinicians, causing difficulties especially when explaining complex treatment options that require patient participation. Finally, unconscious bias introduced by physicians (anesthesiologists and surgeons) may affect the choice of anesthesia,

Table 3 Multivariable multilevel regression results for regional anesthesia use

Characteristics	OR [95% CI]	*p* value
Age, continuous	1.10 [1.08, 1.11]	< 0.001
Sex		
Female	0.99 [0.92, 1.06]	0.742
Male	Reference	
Race		
Asian	0.76 [0.54, 1.09]	< 0.001
Black	0.93 [0.81, 1.07]	
Other	1.11 [0.99, 1.24]	
Unknown	1.39 [1.19, 1.63]	
White	Reference	
Hispanic status		
Yes	0.78 [0.65, 0.94]	0.009
No	Reference	
Procedure year		
2006	0.76 [0.65, 0.89]	< 0.001
2007	0.92 [0.78, 1.08]	
2008	0.51 [0.43, 0.60]	
2009	0.63 [0.54, 0.75]	
2010	0.68 [0.53, 0.87]	
2011	0.45 [0.34, 0.58]	
2012	0.60 [0.46, 0.77]	
2013	0.81 [0.63, 1.05]	
2014	1.04 [0.80, 1.35]	
2015	0.96 [0.74, 1.24]	
2005	Reference	
Provider volume	1.02 [0.81, 1.30]	0.854
Location		
Rural	0.66 [0.25, 1.75]	0.400
Urban	Reference	
In-state		
No	1.10 [1.00, 1.21]	0.052
Yes	Reference	
Insurance		
Medicaid	0.75 [0.65, 0.87]	< 0.001
Other	0.95 [0.75, 1.22]	
Unknown	0.81 [0.66, 0.99]	
Private	Reference	
Sports injury		
Yes	1.20 [1.19, 1.31]	< 0.001
No	Reference	
Procedure type		
ACL repair	1.91 [1.74, 2.10]	< 0.001
Knee arthroscopy	1.19 [1.09, 1.30]	
Shoulder arthroscopy	Reference	
	C-statistic, 0.967	

as has been previously suggested in patients undergoing joint arthroplasty [8].

While there are benefits to large-scale observational studies, one of the limitations in using an administrative database includes the lack of clinical details. No causalities can be established and no mechanisms behind trends can be determined. However, observed associations allow for the formation of hypotheses for future research. Variable accuracy and classification may also differ when reported by various centers. Errors in data collection and uncertain compliance are further factors, despite rigorous quality checks put in place to minimize such bias. In addition, because the data was collected in the NY state, our results may not be generalizable to a wider population, including other US states. The results of our study are also limited by missing data.

To address this issue, we performed sensitivity analyses. Interestingly, "unknown" anesthesia type caused effects of a number of study variables to change significance, and thus, related results need to be interpreted with caution. Exploring how demographic variables differ within this subset of patients may be of interest.

In conclusion, our analysis found that RA, despite reported benefits and low complication rates, is used in a minority of pediatric patients undergoing ambulatory orthopedic surgery, although the rate is increasing with time. The factors associated with increased use were older age and type of surgery. Lower rates of use were associated with minority race and lower socioeconomic status. Reasons for the low utilization and for observed disparities require further evaluation and research.

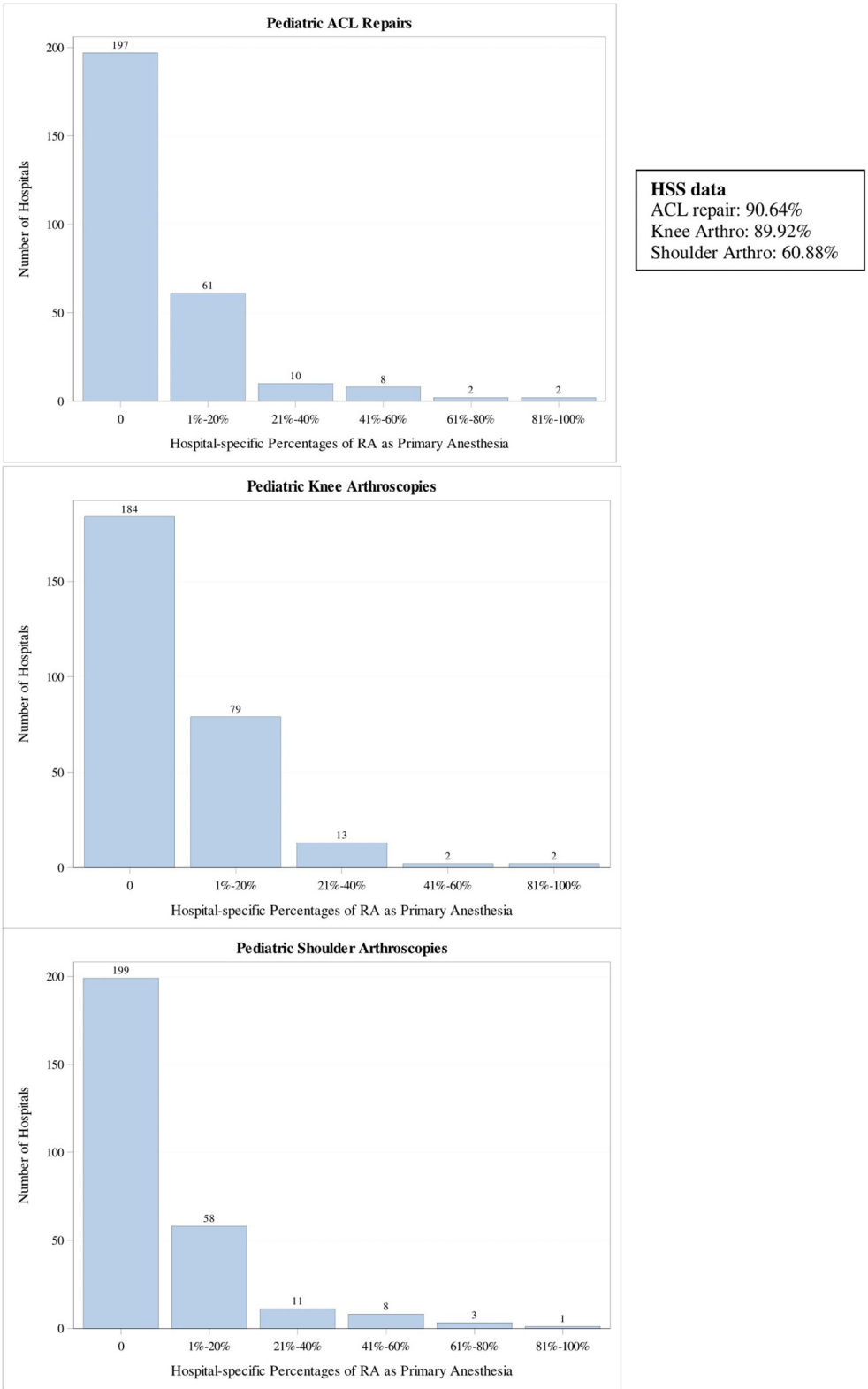

Fig. 3. **a**–**c** Hospital-level percentage of regional anesthesia use, by procedure

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Compliance with Ethical Standards

Conflict of Interest: Kathryn DelPizzo MD, Megan Fiasconaro MS, Lauren A. Wilson MPH, Jiabin Liu MD PhD, Jashvant Poeran MD PhD, and Carrie Freeman BS declare that they have no conflicts of interest. Stavros G. Memtsoudis, MD, PhD, MBA, FCCP, is a director on the boards of the American Society of Regional Anesthesia and Pain Medicine (ASRA) and the Society of Anesthesia and Sleep Medicine (SASM); he is a one-time consultant for Sandoz Inc. and Teikoku, is a medical advisory board member for HATH, and has a US patent application pending for a multicatheter infusion system: US-2017-0361063; and he is the owner of SGM Consulting, LLC, and co-owner of FC Monmouth, LLC.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013.

Informed Consent: Informed consent was waived from all patients for being included in this study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

Appendix

Appendix I Procedure cohort definitions based on Common Procedural Terminology (CPT) codes

Procedure Cohort	CPT Codes
Shoulder Arthroscopy	29805, 29806, 29807, 29819, 29820, 29821, 29822, 29823, 29824, 29825, 29826, 28927, 29828
Shoulder Fracture	23515, 23585, 23615, 23616, 23630, 23670, 23680
Humerus/Elbow Arthroscopy	29830, 29834, 29835, 29836, 29837, 29838
Humerus/Elbow Fracture	24515, 24516, 24538, 24545, 24546, 24560, 24566, 24575, 24579, 24582, 24586, 24587, 24615, 24635, 24665, 24666, 24685
Forearm/Wrist Arthroscopy	29840, 29843, 29844, 29845, 29846, 29847, 29900, 29901, 29902
Forearm/Wrist Fracture	25515, 25525, 25526, 25545, 25574, 25575, 25606, 25607, 25607, 25608, 25609, 25628, 25645, 25651, 25652
Hand/Fingers Fracture	26608, 26615, 26650, 26665, 26727, 26735, 26746, 26756, 26765
Pelvis/Hip Arthroscopy	29860, 29861, 29862, 29863, 29914, 29915, 29916
Pelvis/Hip Fracture	27215, 27216, 27217, 27218, 27220, 27226, 27227,27228, 27235, 27236, 27244, 27245, 27248
Femur/Knee Arthroscopy	29850, 29851, 29855, 29856, 29870, 29871, 29873, 29874, 29875, 29876, 29877, 29879, 29880, 29881, 29882, 29883, 29884, 29885, 29886, 29887
Anterior Cruciate Ligament Repair	29888, 29889, 27409, 27427, 27428, 27429
Femur/Knee Fracture	27506, 27507, 27509, 27511, 27513, 27514, 27519, 27524, 27530, 27535, 27536, 27540, 27556,27557, 27558, 27566
Leg/Ankle Arthroscopy	29891, 29892, 29894, 29895, 29897, 29898, 29899
Leg/Ankle Fracture	27756, 27758, 27759, 27766, 27769, 27784, 27792, 27814, 27822, 27823, 27826, 27827, 27828, 27829, 27832, 27846, 27848

References

1. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivar Behav Res*. 2011;46:399-424. doi:https://doi.org/10.1080/00273171.2011.568786
2. Beck NA, Ganley TJ. Pediatric ACL injuries: Challenges and solutions, from prevention to operative reconstruction. *University of Pennsylvania Orthopaedic Journal*. 2011;21:50-55. https://doi.org/10.1007/978-3-662-56127-0_17
3. Chelly JE, Ben-David B, Williams BA, Kentor ML. Anesthesia and post-operative analgesia: Outcomes following orthopedic surgery. *Orthopedics*. 2003;26:S865-S871. https://doi.org/10.1111/os.12535
4. Dodwell ER, LaMont LE, Green DW, Pan TJ, Marx RG, Lyman S. 20 years of pediatric anterior cruciate ligament reconstruction in New York state. *Am J Sports Med*. 2014;42:675-680. https://doi.org/10.1177/0363546513518412
5. Iannotti JP. A delayed physical therapy protocol that limited passive range of motion was similar to a protocol with early passive range of motion after rotator cuff repair. *J Bone Joint Surg Am*. 2012;94:2094. https://doi.org/10.2106/JBJS.9422.ebo365
6. Janssen R, Lind M, Engebretsen L, Moksnes H, Seil R, Faunø P, et al. Pediatric ACL injuries: treatment and challenges. In: ESSKA instructional course lecture book. Edited by Kerkhoffs GMMJ, Haddad F, Hirschmann MT, Karlsson J, Seil R: Berlin, Heidelberg, Springer. 2018, pp 241-259. https://doi.org/10.1007/978-3-662-56127-0_17
7. Mall NA, Paletta GA. Pediatric ACL injuries: Evaluation and management. *Curr Rev Musculoskelet Med*. 2013;6(2):132-140. https://doi.org/10.1007/s12178-013-9169-8

8. Memtsoudis SG, Poeran J, Zubizarreta N, Rasul R, Opperer M, Mazumdar M. Anesthetic care for orthopedic patients: Is there a potential for differences in care? *Anesthesiology.* 2016;124:608-623. https://doi.org/10.1097/ALN.0000000000001004
9. Micalizzi RA, Williams LA, Pignataro S, Sethna NF, Zurakowski D. Review of outcomes in pediatric patients undergoing anterior cruciate ligament repairs with regional nerve blocks. *J Pediatr Nurs.* 2014;29:670-678. https://doi.org/10.1016/j.pedn.2014.07.002
10. Ochroch EA, Troxel AB, Frogel JK, Farrar JT. The influence of race and socioeconomic factors on patient acceptance of perioperative epidural analgesia. *Anesth Analg.* 2007;105:1787-1792. https://doi.org/10.1213/01.ane.0000290339.76513.e3
11. Paul JE, Arya A, Hurlburt L, et al. Femoral nerve block improves analgesia outcomes after total knee arthroplasty: a meta-analysis of randomized controlled trials. *Anesthesiology.* 2010;113:1144-1162. https://doi.org/10.1097/MD.0000000000018056
12. Polaner DM, Martin LD, PRAN Investigators. Quality assurance and improvement: The pediatric regional anesthesia network. *Paediatr Anaesth.* 2012;22:115-119. https://doi.org/10.1111/j.1460-9592.2011.03708.x
13. Schloss B, Bhalla T, Klingele K, Phillips D, Prestwich B, Tobias JD. A retrospective review of femoral nerve block for postoperative analgesia after knee surgery in the pediatric population. *J Pediatr Orthop.* 2014;34:459-461. https://doi.org/10.1097/BPO.0000000000000113
14. Stracciolini A, Casciano R, Levey Friedman H, Meehan III WP, Micheli LJ. Pediatric sports injuries: An age comparison of children versus adolescents. *Am J Sports Med.* 2013;41:1922-1929. https://doi.org/10.1177/0363546513490644
15. Tepolt FA, Feldman L, Kocher MS. Trends in pediatric ACL reconstruction from the PHIS database. *J Pediatr Orthop.* 2018;38:e49-e494. https://doi.org/10.1097/BPO.0000000000001222
16. Walker BJ, Long JB, De Oliveria GS, et al. Peripheral nerve catheters in children: An analysis of safety and practice patterns from the pediatric regional anesthesia network (PRAN). *Br J Anaesth.* 2015;115:457-462. https://doi.org/10.1093/bja/aev220
17. Wardhan R, Chelly J. Recent advances in acute pain management: Understanding the mechanisms of acute pain, the prescription of opioids, and the role of multimodal pain therapy. *F1000Res.* 2017;6. https://doi.org/10.12688/f1000research.12286
18. Werner BC, Yang S, Looney AM, Gwathmey FW. Trends in pediatric and adolescent anterior cruciate ligament injury and reconstruction. *J Pediatr Orthop.* 2016;36:447-452. https://doi.org/10.1097/BPO.0000000000000482
19. Veneziano G, Betran R, Bhalla T, Martin DP, Tobias JD. Peripheral regional anesthesia in infants and children: An update. *Anaesth Pain Intensive Care.* 2019;18:59-71. https://doi.org/10.1016/j.accpm.2019.02.011
20. Yang D, Dalton JE. A unified approach to measuring the effect size between two groups using SAS®. *SAS Global Forum.* 2012;335:1-6. https://support.sas.com/resources/papers/proceedings12/335-2012.pdf