Comparison of intraoperative and early postoperative outcomes of caudal versus dorsal penile nerve blocks for outpatient penile surgeries

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Abstract

Objective: To compare intraoperative and 1-hour postoperative outcomes in caudal versus dorsal penile nerve block (DPNB) patients undergoing penile surgeries.

Material and Methods: We performed a retrospective cohort study of males <10 years old undergoing penile procedures (2013-2015) using the Pediatric Regional Anesthesia Network, Pediatric Health Information System databases and our medical records. The primary outcome was a maximum Faces Limbs Activity Crying Consolability pain score > 3. Secondary outcomes were intraoperative/post-anesthesia care unit (PACU) narcotics, pre-incision anesthesia time, adjusted operating room charges and complications. We performed bivariate and multivariable analyses controlling for demographic/procedure characteristics and clustering by surgeon.

Results: Of 738 patients, (mean age 2.1 years) 74.1% had a caudal. DPNB patients were more likely to have a maximum pain score >3 (19.5% vs. 8.1%, p<0.0001), receive intraoperative (33.0% vs.2.9%, p<0.0001) and PACU narcotics (15.7% vs. 7.5% vs. p=0.0009), had shorter pre-incision anesthesia time (19.5 vs. 27.9 minutes, p<0.0001) and lower adjusted operating room charges ($9,402 vs. $12,760, p<0.0001). In a bivariate logistic regression, DPNB patients had 2.7 times the odds of a maximum pain score > 3 (95% CI 1.7- 4.4, p<0.0001) and 5.2 times the odds of intraoperative/PACU narcotic administration (95% CI 3.3-8.1, p<0.0001). In multivariable analyses, caudal patients had longer pre-incision anesthesia time (27.9 ± 7.4 vs. 19.5 ± 6.6 minutes, p<0.0001) and higher adjusted operating room charges ($12,760 ± 4077 vs. $9,402 ± 3741, p=0.01).

Conclusion: Caudal blocks may offer a small advantage in the immediate postoperative period although cost-effectiveness is unproven.

Introduction

Various local and regional anesthetic techniques have been employed to optimize pain control following penile procedures in children.[1] Two of the most common blocks are caudal epidural blocks and dorsal penile nerve blocks (DPNB). A caudal block involves the introduction of local anesthetic by the anesthesiologist into the sacral part of the caudal epidural space where the nerves that supply the penis are located.[2] Potential but rare complications of caudal block include infection, inadvertent subarachnoid or intravascular injection, urinary retention and motor blockade.[3]'[4] In addition, caudal blocks require extra time and presumably, extra expense for their performance. They have become increasingly popular due to improved dosage and composition of local anesthetics and a low incidence of adverse effects.[5] A more recent observational study of more than 18,000 patients reported a complication rate of 1.9% including block failure, blood aspiration and intravascular injection.[6] DPNB is typically performed by the surgeon who injects local anaesthetic through the skin just below the pubic bone at the base of the penis.[2] Although DPNB's may provide effective analgesia they may be associated with localized hematoma formation, systemic toxicity and ischemia of the penis.[7-11] In a systematic review of methods of postoperative pain relief for circumcision in boys there was no difference in

the need for rescue or other analgesia for caudal block compared with DPNB.[1] The caudal group had a higher relative risk of motor block and motor or leg weakness compared to the DPNB group.[1] Weksler et al reported no significant different in pain scores between caudal analgesia and DPNB and shorter procedural times with DPNB.[12] To our knowledge, there are few studies comparing validated pain scale scores and only one prior study comparing procedural time.[12-15] In addition, prior studies comparing analgesic efficacy consist of small retrospective case series.[12-20]

The purpose of this study was to compare intraoperative and 1-hour postoperative outcomes of caudal blocks vs. DPNBs in pediatric patients undergoing outpatient penile surgeries. The primary outcome was a maximum pain scale score of > 3 indicating moderate or severe pain in the PACU. Secondary outcomes were intraoperative/PACU narcotic administration, pre-incision anesthesia time, adjusted operating room charges and block-related complications. We hypothesized that caudal patients would have better pain control, higher charges, longer anesthesia times and a higher risk of block-related complications than DPNB patients.

Materials and Methods

Data sources

The PHIS is an administrative database that contains inpatient, emergency department, ambulatory surgery and observation encounter-level data from over 45 not-for-profit, tertiary care pediatric hospitals in the United States that are affiliated with the Children's Hospital Association (CHA) (Overland Park, KS). The PRAN database is a multi-center collaboration containing non-randomized, prospectively collected

information about pediatric regional anesthetic techniques and complications.[21],[3] The Institutional Review Board approved the study.

Study population

We performed a retrospective cohort study of all males ≤ 9 years of age undergoing initial outpatient penile surgery from July 2013-March 2015 using institutional data from the PRAN and PHIS databases and the medical record. We included patients up to age 9 in order to capture all patients who were potentially eligible for either type of block. The anesthesiologists at our institution consider all patients up to the age of 9 as potential candidates for a caudal block unless they encounter significant anatomic challenges at the time of block placement. We included patients who had procedures in our ambulatory surgery center and the operating rooms of our main hospital. We excluded patients who had concurrent non-penile procedures, those with a non-caudal regional block, missing/no block or DPNB following a failed caudal. We also excluded those undergoing hypospadias repairs because the overwhelming majority of these patients receive caudal blocks at our institution. We collected data on demographic variables (age, weight, gender, race, insurance type, zip code) and procedure characteristics (procedure type, surgeon, block type and timing and block-related complications). We divided patients into the American Academy of Pediatrics age categories as described in the PHIS database: infant (< 1 year), early childhood (1-4 years), late childhood (5-9 years). We extracted median income by Indiana zip code utilizing data from the 2014 U.S. Census.[22] We extracted cost and charge data from the PHIS database for procedures that were performed in our main operating room. We collected data on the time spent on each patient care activity in the operating room and

PACU (e.g. in room-time, anesthesia start time, incision time, etc). We utilized an approximation for the time required for a caudal block called the "pre-incision anesthesia time" defined as the number of minutes from the anesthesia start time to the surgical incision time. We defined "PACU time" as the time the patient spent in the Phase 1 of the PACU immediately after leaving the operating room (i.e. the immediate postoperative phase that continues until the patient has adequate pain control, is awake enough to answer questions and begins to drink clear liquids).

We also collected data on intraoperative and PACU narcotic and anti-emetic medications from our pharmacy database. We determined milligrams per kilogram for intra- and postoperative narcotics and anti-emetics and converted all narcotic dosages to ME's as per the Centers for Disease Control and Prevention.[23] We collected pain scores determined by nursing staff in the PACU using the Faces, Limbs, Activity, Crying, Consolability (FLACC) scale (0-10).[24] FLACC is a behavioral scale validated for assessment of postoperative pain in children between ages 2 months-7 years. The target pain score at our institution is 3 or less which indicates adequate pain control. This is a widely accepted cut-off with a score of 0 indicating no pain and scores of 1-3 indicating mild pain.[24]

Block techniques

Caudal blocks are performed in a standardized fashion at our institution by 26 experienced pediatric anesthesiologists with resident/fellow participation using anatomic landmarks (sacral hiatus and cornu) to identify the injection site. A 21-gauge needle is used to inject 0.2% ropivicaine at a dose of 1 milliliter/kilogram with 1:200,000 epinephrine. The vast majority of blocks also include 1-2 micrograms/milliliter of

clonidine. Dorsal penile nerve blocks are performed with 0.25% bupivacaine at a dose of 1 milliliter/kilogram by the vast majority of surgeons in our group at the end of the case using the technique described previously.[2]

Statistical analysis

The primary outcome was a maximum FLACC pain scale score > 3 indicating moderate or severe pain in the PACU.[24, 25] Secondary outcomes were intraoperative/PACU narcotic administration, pre-incision anesthesia time, adjusted operating room charges and block-related complications. We utilized PRAN definitions of block-related complications including urinary retention or motor blockade, vascular puncture and failed/abandoned blocks. We compared patients who received a caudal versus an DPNB using analysis of variance, Wilcoxon and Chi-square/Fisher's exact tests. We analyzed operating room charges for the subset of patients who had cost and charge data available in the PHIS database. We also analyzed morphine equivalents (ME's) for the subset of patients who received intraoperative or PACU narcotics. We defined "cumulative ME's" as the total number of ME's a patient received intraoperatively and in the PACU.

We performed bivariate analysis using Chi-square and Fisher's exact tests of the association between patient demographics (age, race insurance status, median income), procedure characteristics (block type, ketorolac use and procedure type) with a maximum pain score greater than 3 (primary outcome). We performed bivariate analysis using a logistic regression model with a random effect for surgeon (controlling for clustering of similar patients and block techniques by surgeon) of the association between patient/ procedure characteristics and intraoperative/PACU narcotic

administration. We also performed bivariate analysis using one-way mixed model ANOVAs with random effect for surgeon (controlling for similar patients and block techniques by surgeon) of the association between patient/procedure characteristics and each of the following outcomes: pre-incision anesthesia time and adjusted operating room charges.

We used a backwards selection technique to create a mixed effects multivariable logistic regression model (controlling for similar patients and block techniques by surgeon) to assess the association of block type with maximum pain score greater than 3 (primary outcome) and intraoperative/PACU narcotic administration. We initially included variables with a p-value of ≤0.2 on bivariate analysis in the multivariable model and removed variables that did not remain significant. We performed a similar multivariable linear regression using a mixed effects model for the outcomes of pre-incision anesthesia time and adjusted operating room charges. A p-value of <0.05 was considered statistically significant.

Results

Patient selection/demographics

1089 patients underwent outpatient penile surgeries during the study period. Of these, 208 had a missing block type, 16 had an DPNB and caudal, 43 were ≥10 years old, 4 had missing gender information and 80 had concurrent inguinal procedures, leaving 738 patients for analysis. Mean age was 2.1 (±2.2) years, 521/738 (70.6%) were white, 393/738 (53.3%) had public insurance and 547/738 (74.1%) received a caudal block. DPNB patients were significantly older (mean 3.5 (±2.9) vs. 1.6 (±1.6) years,

p<0.0001), more likely to be African-American (23.6% vs. 18.8%, p=0.004) and have public insurance (61.8% vs. 50.3%, p=0.04) than caudal patients (Table 1). They were also more likely to undergo a circumcision than caudal patients (84.8% vs. 39.7%, p<0.0001) (Table 1). Patients undergoing chordee/buried penis repair were significantly younger than those undergoing circumcision/circumcision/revision (median age 1 (interquartile range 1,2) vs. median age 1 (interquartile range 1,3), p<0.0001).

Primary outcome

DPNB patients were significantly more likely to have a worst PACU pain score greater than 3 (19.5% vs. 8.1%, p<0.0001) as were patients ages 5-9 (ages 5-9: 20.0%, ages 1-4: 8.4%, <1 year of age: 11.6%; p=0.01) (Table 2). There was no statistically significant association between any of the other variables, including timing of the DPNB, and a PACU pain score greater than 3. In a bivariate logistic regression, DPNB patients had 2.7 times the odds of a maximum pain score > 3 (OR 2.7, 95% CI 1.7- 4.4, p<0.0001).

Secondary outcomes

Intraoperative/PACU narcotic administration

DPNB patients were more likely to receive narcotics intraoperatively (33.0% vs. 2.9%, p<0.0001) and in the PACU (15.7% vs. 7.5% vs. p=0.0009). Among those patients who received MEs, there were no differences in intraoperative ME's (DPNB: 0.05 mg/kg (IQR 0.04, 0.08) vs. caudal: 0.04 mg/kg (IQR 0.03, 0.08, p=0.3) or PACU ME's (DPNB: 0.25 mg/kg (IQR 0.12, 0.36 vs. caudal: 0.31 mg/kg (IQR 0.23, 0.4,

p=0.09) between the two block types (Table 2). When we compared cumulative ME's (intraoperative and PACU) between the two block types, however, we found that the DPNB patients received fewer cumulative ME's (median 0.10 mg/kg (IQR 0.05, 0.25 vs. 0.29 mg/kg (IQR 0.19,0.36, p<0.0001) than caudal patients (Table 2). This is likely due to the fact that 41/547 (7.5%) of caudal patients received PACU narcotics. This may be due to incompletely effective caudal blocks in this subset of patients. Notably, the vast majority of caudal patients did not receive any intraoperative or PACU narcotics (496/547, 90.7%). In contrast, (75/191) 39.3% of DPNB patients received some intraoperative or PACU narcotics. There was a 49.4% increase in the number of caudal patients who did not need any narcotics compared to DPNB patients.

In a bivariate logistic regression model adjusting for clustering of similar patients by surgeon, DPNB patients had significantly higher odds of receiving intraoperative/PACU narcotics (OR 5.2, 95% CI 3.3-8.1, p<0.0001) compared to caudal patients. Patients ages 5-9 (OR 3.5, 95% 2.1-6.0 p<0.0001) and those who received ketorolac (OR 1.7, 95% CI 1.01-2.8, p=0.045) also had significantly higher odds of receiving intraoperative/PACU narcotics.

Pre-incision anesthesia time

DPNB patients had a significantly shorter pre-incision anesthesia time (19.5 ± 6.6 vs. 27.9 ± 7.4 minutes, p<0.0001) as did older children (ages 5-9: 22.2 ± 10.1 minutes; ages 1-4: 25.0 ± 6.7 minutes, <1 year: 27.6 minutes ± 8.4, p<0.0001), those undergoing circumcisions (23.3 ± 7.2 vs. 28.3 ± 8.1 minutes, p<0.0001) and those who received

ketorolac (21.1 ± 6.6 vs. 26.6 ± 8.0, p<0.0001). There was no association between any of the other variables and pre-incision anesthesia time.

In a multivariable linear regression model, controlling for block type, age, procedure type and clustering of similar patients and block techniques by surgeon, DPNB patients had a significantly shorter pre-incision anesthesia time (19.5 ± 6.6 minutes vs. 27.9 ± 7.4 minutes, p<0.0001), as did older children (ages 5-9: 22.2 ± 10.1 minutes, ages 1-4: 25.0 ± 6.7 minutes, <1 year: 27.6 ± 8.4 minutes, p=0.002) and those undergoing circumcisions (23.3 ± 7.2 minutes vs. 28.3 ± 8.1 minutes, p=0.005) (Table 3).

Operating room charges

Of the 171/738 (23.2%) patients who had cost and charge data available in the PHIS database DPNB patients had lower mean adjusted operating room charges than caudal patients ($9,402 ± 3,741 vs. 12,760 ± 4,077, p<0.0001) (Table 4). Patients undergoing circumcisions (vs. chordee repairs) also had lower adjusted OR charges ($9,670 ± 3,625 vs. 13,754 ± 3,867, p<0.0001) There was no statistically significant association between any of the other variables and adjusted operating room charges.

In a multivariable linear regression model, controlling for block type, procedure type and clustering of similar patients and block techniques by surgeon, DPNB patients had lower mean adjusted operating room charges than caudal patients ($9,402 ± 3,741 vs. $12,760 ± 4,077, p=0.01) as did those undergoing circumcisions ($9,670 ± 3,625 vs. $13,754 ± 3,867, p<0.0001 (Table 4).

Block-related complications

In the caudal group, 3/547 (0.5%) patients had complications: two abandoned blocks (unable to be placed) and one block with a positive test dose. The difference in complication rates between the two groups was not statistically significant (p=0.6).

Discussion

In this study of males undergoing penile surgeries, we found that caudal blocks provided better analgesia in terms of the likelihood of FLACC scores >3 and the need for intraoperative and PACU narcotics compared to DPNB. In the DPNB group, however, the worst pain score was ≤3 in 80.5% of patients, indicating adequate pain control in the majority of patients. The DPNB group was more likely to receive narcotics but received fewer ME's than the caudal group overall. This may be due to the small number of caudal patients who received both intraoperative and PACU narcotics at a high median dose, thus positively skewing the median ME's. This subgroup of patients may consist of failed caudal blocks that were not recognized as being failures at the time of caudal administration and thus were not excluded from the study.

It is impossible to determine from the current study whether intraoperative narcotics were administered in a reactionary manner to DPNB patients in response to changes in vital signs or pre-emptively in anticipation of future narcotic requirements in the PACU. Interestingly, there was no difference in PACU ME's between the two groups. This could be due to the fact that DPNB patients were "frontloaded" with narcotics intraoperatively. We do not have a specific anesthesia protocol for the administration of intraoperative narcotics in these cases.

This is one of the largest comparative effectiveness studies to rigorously examine early postoperative outcomes in a series of patients undergoing caudal blocks and DPNB for penile procedures. Our results contradict the systematic review that found no difference in the need for rescue or other analgesia in boys receiving caudal blocks versus DPNB for circumcision.[1] We also did not note any cases of motor blockade or urinary retention although it is possible that our study was underpowered to detect such rare outcomes. The strengths of our study include its quantitative approach to the measurement of intra- and postoperative pain control using validated pain scale scores and narcotic administration data. To our knowledge, this is the first study to compare operating room charges and time required for caudal blocks versus DPNB. We used ME's to standardize dosing and analyzed intra- and postoperative variables separately to provide a comprehensive view of perioperative pain control.

Limitations of our study include the lack of information about the reasons for block selection which is typically a shared decision amongst the parents, surgeon and anesthesiologist. Thus, we were not able to control for potential selection bias in the multivariable analysis. Second, we did not control for clustering of similar caudal block techniques by anesthesiologist because of the difficulty in determining which anesthesiologist performed the caudal block. Third, we were not able to compare the requirement for inhaled anesthetics between the two groups.

Fourth, our database contains only data from the Phase 1 of the PACU that may be subject to differential assessment bias given the inter-observer variability in the nurses providing FLACC scale assessments. Finally, cost and charge data was available only in a subset of patients. This could introduce bias if these patients had a

lower pain threshold than patients did not have cost/charge data available. The surgery location is most commonly determined, however, by the availability of block time and surgeon/parental preference for a particular date. Finally, since the study contains only male patients the results may not be generalizable to females.

Conclusions

Caudal blocks appear to provide better regional anesthesia in terms of the likelihood of FLACC scores >3 and the need for intraoperative and PACU narcotics compared to DPNB. DPNB patients had 4.2 times the rate of narcotic use overall compared to caudal patients. Caudal blocks may offer a small but significant advantage in the immediate postoperative period although it is unclear whether they are cost-effective. Although this study does not provide definitive evidence of the "ideal" patient for a caudal vs. DPNB, we have utilized the findings to engage parents in a shared-decision making approach about which type of block they prefer for their children. Future directions include a randomized, prospective study of patients undergoing outpatient surgeries to compare 24-hour outcomes in caudal vs. DPNB patients to track their patient-reported outcomes.

References:

[1] Cyna AM, Middleton P. Caudal epidural block versus other methods of postoperative pain relief for circumcision in boys. The Cochrane database of systematic reviews. 2008:CD003005.
[2] Peutrell JM P-RC. Regional analgesia and acute pain managment in children. In: Prys-Roberts C BJB, editor. International Practice of Anaesthesia. 1st ed. Oxford: Butterworth-Heinemann; 1996.
[3] Polaner DM, Taenzer AH, Walker BJ, Bosenberg A, Krane EJ, Suresh S, et al. Pediatric Regional Anesthesia Network (PRAN): a multi-institutional study of the use and incidence of complications of pediatric regional anesthesia. Anesthesia and analgesia. 2012;115:1353-64.
[4] Shah RD, Suresh S. Applications of regional anaesthesia in paediatrics. British journal of anaesthesia. 2013;111 Suppl 1:i114-24.
[5] Metzelder ML, Kuebler JF, Glueer S, Suempelmann R, Ure BM, Petersen C. Penile block is associated with less urinary retention than caudal anesthesia in distal hypospadia repair in children. World journal of urology. 2010;28:87-91.
[6] Suresh S, Long J, Birmingham PK, De Oliveira GS, Jr. Are caudal blocks for pain control safe in children? an analysis of 18,650 caudal blocks from the Pediatric Regional Anesthesia Network (PRAN) database. Anesthesia and analgesia. 2015;120:151-6.
[7] Abaci A, Makay B, Unsal E, Mustafa O, Aktug T. An unusual complication of dorsal penile nerve block for circumcision. Paediatric anaesthesia. 2006;16:1094-5.
[8] Fontaine P, Dittberner D, Scheltema KE. The safety of dorsal penile nerve block for neonatal circumcision. J Fam Pract. 1994;39:243-8.
[9] Najafi N, Veyckemans F, Du Maine C, van de Velde A, de Backer A, Vanderlinden K, et al. Systemic Toxicity Following the Use of 1% Ropivacaine for Pediatric Penile Nerve Block. Reg Anesth Pain Med. 2016;41:549-50.
[10] Snellman LW, Stang HJ. Prospective evaluation of complications of dorsal penile nerve block for neonatal circumcision. Pediatrics. 1995;95:705-8.
[11] Yu RN, Houck CS, Casta A, Blum RH. Institutional Policy Changes to Prevent Cardiac Toxicity Associated With Bupivacaine Penile Blockade in Infants. A A Case Rep. 2016;7:71-5.
[12] Weksler N, Atias I, Klein M, Rosenztsveig V, Ovadia L, Gurman GM. Is penile block better than caudal epidural block for postcircumcision analgesia? Journal of anesthesia. 2005;19:36-9.
[13] Haliloglu AH, Gokce MI, Tangal S, Boga MS, Tapar H, Aladag E. Comparison of postoperative analgesic efficacy of penile block, caudal block and intravenous paracetamol for circumcision: a prospective randomized study. International braz j urol : official journal of the Brazilian Society of Urology. 2013;39:551-7.
[14] Canakci E, Yagan O, Tas N, Mutlu T, Cirakoglu A, Benli E. Comparison of preventive analgesia techniques in circumcision cases: Dorsal penile nerve block, caudal block, or subcutaneous morphine? J Pak Med Assoc. 2017;67:159-65.
[15] Beyaz SG. Comparison of Postoperative Analgesic Efficacy of Caudal Block versus Dorsal Penile Nerve Block with Levobupivacaine for Circumcision in Children. Korean J Pain. 2011;24:31-5.
[16] Kazak Bengisun Z, Ekmekci P, Haliloglu AH. Levobupivacaine for postoperative pain management in circumcision: caudal blocks or dorsal penile nerve block. Agri. 2012;24:180-6.
[17] Gauntlett I. A comparison between local anaesthetic dorsal nerve block and caudal bupivacaine with ketamine for paediatric circumcision. Paediatric anaesthesia. 2003;13:38-42.

[18] Sandeman DJ, Reiner D, Dilley AV, Bennett MH, Kelly KJ. A retrospective audit of three different regional anaesthetic techniques for circumcision in children. Anaesthesia and intensive care. 2010;38:519-24.
[19] Vater M, Wandless J. Caudal or dorsal nerve block? A comparison of two local anaesthetic techniques for postoperative analgesia following day case circumcision. Acta Anaesthesiol Scand. 1985;29:175-9.
[20] Yeoman PM, Cooke R, Hain WR. Penile block for circumcision? A comparison with caudal blockade. Anaesthesia. 1983;38:862-6.
[21] Pediatric Regional Anesthesia Network.
[22] The United States Census Bureau: American Fact Finder. http://factfindercensusgov/faces/nav/jsf/pages/indexxhtml.
[23] Opioid Morphine Equivalent Conversion Factors. Atlanta, Georgia: Centers for Disease Control and Prevention.
[24] Merkel SI, Voepel-Lewis T, Shayevitz JR, Malviya S. The FLACC: a behavioral scale for scoring postoperative pain in young children. Pediatr Nurs. 1997;23:293-7.
[25] Merkel S, Voepel-Lewis T, Malviya S. Pain assessment in infants and young children: the FLACC scale. Am J Nurs. 2002;102:55-8.

Table 1: Bivariate analysis of the association of block type with demographic and procedure characteristics

Variable	N	Caudal (N=547)	*DPNB (N=191)	p-value
Mean age (Years) (Overall Age: 2.1 ± 2.2)	738	1.6 ± 1.6	3.5 ± 2.9	**<0.0001**
**Age Categories - infant - early childhood - late childhood	738	 253 (46.3%) 263 (48.1%) 31 (5.7%)	 50 (26.2%) 86 (45.0%) 55 (28.8%)	**<0.0001**
Race - Caucasian - African-American - Other - Refused/Unknown	738	 397 (72.6%) 103 (18.8%) 11 (2.0%) 36 (6.6%)	 124 (64.9%) 45 (23.6%) 13 (6.8%) 9 (4.7%)	**0.004**
Insurance - Private - Public - Self-Pay - Missing	738	 201 (36.7%) 275 (50.3%) 8 (1.5%) 63 (11.5%)	 52 (27.2%) 118 (61.8%) 3 (1.6%) 18 (9.4%)	**0.04**
**Median Income (IQR)	738	$45,594 (37,124, 57,859)	$43,638 (35,126, 55,601)	**0.03**
Procedure Chordee/buried penis repair (n=359) Circumcision/circumcision revision (n=379)	738	 330 (60.3%) 217 (39.7%)	 29 (15.2%) 162 (84.8%)	**<0.0001**

*DPNB=dorsal penile nerve block

**Age categories: infant (< 1 year), early childhood (1-4 years), late childhood (5-9 years)

***Median income by zip code using 2014 U.S. Census data for the state of Indiana

Table 2: Bivariate analysis of the association of block type with pain scores, narcotic administration, pre-incision anesthesia time and adjusted operating room charges

Variable	N	Caudal (N=547)	*DPNB (N=191)	p-value
Adjusted operating room charges*	171	$12760 ± $4077	$9402 ± $3741	**<0.0001**
Cumulative narcotics (yes/no)**	738	51 (9.3%)	75 (39.3%)	**<0.0001**
Cumulative morphine equivalents (mg/kg)	122	0.29 (0.19,0.36)	0.10 (0.05, 0.25)	**<0.0001**
Intraoperative data				
Pre-incision anesthesia time (min)***	738	27.9 ± 7.4	19.5 ± 6.6	**<0.0001**
Intraoperative narcotics	738	16 (2.9%)	63 (33.0%)	**<0.0001**
Intraoperative morphine equivalents (mg/kg)	77	0.04 (0.03, 0.08)	0.05 (0.04, 0.08)	0.3
Intraoperative anti-emetics	738	206 (37.7%)	117 (61.3%)	**<0.0001**
PACU data				
PACU time (min)****	738	32.9 ± 15.5	36.2 ± 16.4	**0.01**
Maximum pain score	734	0 (0, 1)	0 (0, 3)	**<0.0001**
Maximum pain score > 3	734	44 (8.1%)	37 (19.5%)	**<0.0001**
PACU narcotics	738	41 (7.5%)	30 (15.7%)	**0.0009**
PACU morphine equivalents (mg/kg)	67	0.31 (0.23, 0.40)	0.25 (0.12, 0.36)	0.09
PACU anti-emetics	738	4 (0.7%)	2 (1.0%)	0.7

*DPNB=dorsal penile nerve block

Table 3: Multivariable linear regression, controlling for clustering by surgeon, examining the association between block type, age, procedure type, and pre-incision anesthesia time (in minutes)*

Characteristic	Mean ± SD (min)	95% CI	p-value
Block type			
DPNB	19.5 ± 6.6	(18.6, 20.5)	**<0.0001**
Caudal	27.9 ± 7.4	(27.3, 28.5)	
****Age, y**			
Infant	27.6 ± 8.4	(26.6, 28.5)	**0.002**
Early childhood	25.0 ± 6.7	(24.3, 25.7)	
Late childhood	22.2 ± 10.1	(20.0, 24.3)	
Procedure Type			
Chordee/buried penis repair	28.3 ± 8.1	(27.5, 29.2)	**0.004**
Circumcision/circumcision revision	23.3 ± 7.2	(22.6, 24.0)	

DPNB=dorsal penile nerve block

*Pre-incision anesthesia time is defined as the time (in minutes) from when the patient enters the room to the time of the surgical incision and is inclusive of the time spent performing a caudal block

**Age categories: infant (< 1 year), early childhood (1-4 years), late childhood (5-9 years)

Table 4: Multivariable linear regression, controlling for clustering by surgeon, examining the association between block type, procedure, and adjusted operating room charges (in US dollars)

Characteristic	Mean ± SD	95% CI	p-value
Block type			
DPNB	$9,402 ± $3,741	($8,381, $10,423)	**0.01**
Caudal	$12,760 ± $4,077	($12,014, $13,507)	
Procedure			
Chordee/buried penis repair	$13,754 ± $3,867	($12,920, $14,588)	**<0.0001**
Circumcision/circumcision revision	$9,670 ± $3,625	($8,893, $10,447)	

DNPB=dorsal penile nerve block

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The benefits of regional anesthesia are legion and far exceed the well-documented improvement in analgesia over systemic analgesic strategies[1]. In striving to achieve these benefits for our patients, we are careful to minimize the risks that may be associated with the regional anesthetic technique selected. Omitting regional anesthesia is not a no-risk solution, knowing that there are higher rates of adverse events associated with the systemic administration of opioids that likely would be necessary for adequate postoperative analgesia, compared with using modern regional anesthetic techniques to

achieve pain control and minimize or eliminate opioids. Consequently, we seek to establish equivalency of analgesia and to accurately define the true risk profile of regional anesthetic techniques.

The injection of local anesthesia into the caudal epidural space for pediatric urological procedures was first described in 1933[2]. Accessing the central neuraxis, with its associated provocative list of potentially catastrophic complications, might seem excessively invasive for minor procedures, but in reality is remarkably safe, and has stood the test of time[3]. However, if less invasive techniques (i.e. peripheral nerve blocks) offer indistinguishable analgesia and avoid the (albeit rare) complications, then practice should change. The Pediatric Regional Anesthesia Network is providing up-to-date denominator data that allows us to describe incidence and nature of complications without having to rely on historical data or extrapolate from adult data[4]. Systematic reviews and meta-analyses have shown that caudal blocks are not superior to alternative analgesic strategies in pediatric penile surgery[5] and hernia surgery[6].

In this paper, XX et al describe their retrospective observational cohort study comparing caudal epidural blockade to dorsal penile nerve block (DPNB) for pediatric penile surgery (excluding hypospadias repair)[x]. Their data suggest that at their institution, cases using a DPNB are 26% cheaper and 30% quicker ready-for-incision than cases involving caudal blocks, but are significantly less efficacious at conferring adequate intra- and postoperative analgesia, as measured by pain scores and narcotic consumption. The authors describe some interesting associations, some of which are consistent with current literature, some not. While the paper adds some important points to the discourse and an incremental advancement of the field, readers will recognize how the paper also epitomizes some of the challenges intrinsic to retrospective observational study design. Measured and unmeasured confounding variables distort the apparent associations reported. The caudal techniques are performed prior to the surgical incision by the anesthesiologist, thus providing analgesia intraoperatively. In an era of “value”, longer pre-incision time is an outcome measure. This translates to potentially higher cost but with the balancing measure of a lower intraoperative and potentially postoperative opioid requirement.

The DPNBs were performed at the end of surgery, by a surgeon, and would not be reaching maximum effectiveness until after arrival to the post-anesthesia care unit. As the DPNB would provide no intraoperative analgesia, the anesthesiologist would in most cases opt for the elective provision of alternate systemic analgesia. Unsurprisingly, the ready-time is quicker, the cost lower, pain scores higher (until the block has fully evolved) and opioid consumption higher, for predictable logistical reasons, none of which are related to the efficacy of the DPNB in providing analgesia for penile surgery. An alternative (perhaps provocative) interpretation of these data is that regional anesthesia provided by an anesthesiologist is more efficacious (and costly of time and money) than regional anesthesia provided by the operating surgeon. What wasn't investigated as an active comparator, was the provision of a DPNB prior to the incision.

In our experience, a surgeon's recognition of the value of a well-placed regional anesthetic block is variable and its success is also dependent on the skill and expertise of the anesthesiologist. It may be that the DPNBs did not all involve injections in the correct anatomical plane. We know that without ultrasound guidance, pediatric anesthesiologists only hit the right plane in the minority of occasions, so "blind" sticks are not ideal[7]. A commonly cited block success rate using "blind" surface landmark plus fascial-click techniques is 70%[8]. As the authors of the current study observe, in order to draw reliable conclusions about relative efficacy of the techniques, prospective, randomized controlled methodology is required. Both blocks should be performed pre-emptively, before the incision, by an experienced core of anesthesiologists, and with ultrasound guidance to ensure the peripheral nerve block is actually deposited in the correct tissue plane. Our suspicion is that this methodology would reduce in magnitude or even eliminate the associations reported by the authors. In the field of pediatric regional anesthesia for urology, there is current interest in the ultrasound-guided pudendal nerve block as an alternative to caudal for pediatric penile surgeries, including hypospadias repair[9-11]. We look forward to clinical trials comparing these regional anesthetic techniques.

1. Bosenberg A: Benefits of regional anesthesia in children. Pediatric Anesthesia 2012; 22: 10-18

2. Campbell MF: Caudal Anesthesia in Children. The Journal of Urology 1933; 30: 245-250

3. Suresh S, Long J, Birmingham PK, De Oliveira Jr GS: Are caudal blocks for pain control safe in children? An analysis of 18,650 caudal blocks from the Pediatric Regional Anesthesia Network (PRAN) database. Anesthesia & Analgesia 2015; 120: 151-156

4. Polaner DM, Martin LD: Quality assurance and improvement: the pediatric regional anesthesia network. Pediatric Anesthesia 2012; 22: 115-119

5. Cyna AM, Middleton P: Caudal epidural block versus other methods of postoperative pain relief for circumcision in boys. The Cochrane Library 2008

6. Baird R, Guilbault M-P, Tessier R, Ansermino JM: A systematic review and meta-analysis of caudal blockade versus alternative analgesic strategies for pediatric inguinal hernia repair. Journal of pediatric surgery 2013; 48: 1077-1085

7. Weintraud M, Marhofer P, Bösenberg A, Kapral S, Willschke H, Felfernig M, Kettner S: Ilioinguinal/iliohypogastric blocks in children: where do we administer the local anesthetic without direct visualization? Anesthesia & Analgesia 2008; 106: 89-93

8. Lim SL, Sb AN, Tan GM: Ilioinguinal and iliohypogastric nerve block revisited: single shot versus double shot technique for hernia repair in children. Pediatric Anesthesia 2002; 12: 255-260

9. Initial Experience with Ultrasound-Guided Pudendal Block in Children Undergoing Hypospadias Surgery: A Single Surgeon Experience Comparing Pudendal Block to Caudal Block

Hecht S, Piñeda J, Bayne A. Society For Pediatric Urology Annual Meeting 2017, Boston, Ma, USA

10. Parras T, Blanco R, Madhavan B (2016) Anterior Approach for Ultrasound-Guided Pudendal Block. J Pain Relief 5:230

11. Bendtsen TF1, Parras T, Moriggl B et al. Ultrasound-Guided Pudendal Nerve Block at the Entrance of the Pudendal (Alcock) Canal: Description of Anatomy and Clinical Technique. Reg Anesth Pain Med. 2016 Mar-Apr;41(2):140-5

Is my block better than your block?

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We agree that it would be interesting to compare the efficacy of a pre-incision dorsal penile nerve block (DPNB) to a pre-incision caudal block. A prospective, randomized trial including a protocol for intraoperative narcotic administration would be ideal. The performance of DPNB by anesthesiologists using ultrasound guidance, however, may not reflect current clinical practice in the majority of pediatric centers. This is a classic example of efficacy (the performance of an intervention under ideal and controlled circumstances) versus effectiveness (its performance under "real-world" conditions). [1]

REFERENCES

1. Singal, A. G., Higgins, P. D., Waljee, A. K.: A primer on effectiveness and efficacy trials. Clin Transl Gastroenterol, **5:** e45, 2014