ORIGINAL ARTICLE

Caudal epidural blockade for major orthopedic hip surgery in adolescents

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ABSTRACT

Background: There continues to be a significant focus on the value of regional and neuraxial anesthesia techniques for adjunctive use when combined with general anesthesia. The reported advantages include decreased patient opiate exposure, decreased medication-related adverse effects, decreased postanesthesia recovery room time and hospital stay, and increased patient satisfaction. **Materials and Methods:** The authors present a case-controlled series evaluating the use of a single caudal epidural injection prior to incision as an adjunct to general anesthesia for the open repair of slipped capital femoral epiphysis. Opiate consumption, pain scores, and hospital stay were compared between the two cohorts of 16 adolescent patients. All patients received a demand-only patient-controlled opiate delivery system. **Results:** Although the failed block rate was high (31%), there was decreased opioid use in the perioperative arena as well as during the first 24 postoperative hours in patients who had a successful caudal epidural block. Furthermore, discharge home was possible in 27% of patients who received a caudal epidural block compared to 0% of patients who did not receive a caudal block. **Conclusion:** The potential utility of caudal epidural block as an adjunct to general anesthesia during major hip surgery in adolescents is presented. Factors resulting in a failed block in this patient population as well as the use of the ultrasound as an added modality to increase block success are reviewed.

Key words: *Adolescents, adults, caudal epidural*

INTRODUCTION

The caudal epidural block, first described in 1933, is one of the most common regional techniques performed in pediatric anesthesia.[1] The block is performed by inserting a needle through the sacrococcygeal ligament at the base of the sacrum and into the epidural space. In infants and young children, sacral landmarks are easily palpated, likely contributing to the popularity of the technique in this age group. Effective analgesia can be obtained at the umbilicus and below when using 1 mL/kg (maximum 30 mL) of dilute local anesthetic solution such as 0.2% ropivacaine or 0.125-0.25% bupivacaine. Contrary to its frequent use in infants and young children, caudal epidural blockade is far less commonly used in adolescents and teenagers with many anesthesia providers believing that age is a restrictive factor to the use of this technique. While no specific issues preclude its use in older age groups, anatomic changes can make accessing the caudal epidural space more difficult. Despite these issues, there has been recent and ongoing interest regarding the use of caudal epidural blockade to provide postoperative analgesia in adults.[2-5]

Although the indications for major hip surgery are relatively limited in the adolescent population, open approach for operative repair of severe slipped capital femoral epiphysis (SCFE) is commonly employed. Such procedures can be associated with significant postoperative pain despite the use of systemic opioids. While caudal epidural blockade is more difficult to perform in this population, our clinical experience suggests that these patients may benefit from neuraxial analgesia. In this report, we retrospectively reviewed our experience with caudal epidural blockade in a cohort of adolescents undergoing open SCFE repair and compared their intraoperative and postoperative course to a group that received intravenous opioid analgesia. The benefits and shortcomings of this approach in teenagers are discussed.

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MATERIALS AND METHODS

This study was conducted at Nationwide Children's Hospital, a tertiary care children's hospital in Columbus, Ohio. After approval from the Institutional Review Board of Nationwide Children's Hospital, a retrospective chart review was conducted identifying all patients with SCFE requiring surgical hip dislocation with subcapital osteotomy over a 2-year period (January 2012 to January 2014). Patients who received a caudal epidural block were included for analysis. A control group of the same size was then randomly selected from the same time period. The anesthetic records including the preoperative evaluation, intraoperative record, and postanesthesia care unit (PACU) record were retrieved from the electronic anesthesia information management system (PICIS, 11000 Optum Circle, Eden Prairie, MN 55344). The electronic hospital information management system (EPIC, 1979 Milky Way Verona, Wisconsin 53593) was used to view the records during their postoperative inpatient admission.

Although the anesthetic management was at the discretion of the attending anesthesiologist, the anesthetic techniques were comparable in all patients given similarities in local practice. Patients were premedicated with intravenous or oral midazolam. Either an inhalational induction with sevoflurane or an intravenous induction with propofol was performed. Depending on the anesthetic induction technique, intravenous access was secured prior to or immediately after anesthetic induction. Either an endotracheal tube or laryngeal mask airway (LMA) was used to secure the airway after the induction of general anesthesia. Caudal epidural blockade was performed after the induction of anesthesia and before surgical incision with surgical assistance for proper positioning prior to block placement. A 22 gauge styletted spinal needle (1.5 or 3.5 inches in length) was used in a sterile fashion to access the caudal epidural space after preparation of the site with chlorhexidine. Dosing included 1 mL/kg (maximum 30 mL) of either bupivacaine 0.25% or ropivacaine 0.2% with epinephrine 1:200,000 with the addition of 1 μg/kg of clonidine. Anesthesia was maintained with an inhalational anesthetic agent and supplemented with intravenous opioids as needed to maintain hemodynamic stability. At the end of the procedure, the airway device (LMA or endotracheal tube) was removed, and the patient was transferred to the PACU. All patients received a demand-only, patient-controlled analgesia (PCA) device postoperatively. The following information was recorded from their PACU stay: Postoperative pain scores using a self-report visual analog score ranging from 0 to 10 (0 indicating no pain), total dose of opioids required (reported in morphine equivalents), and total doses of rescue antiemetics. Data collected during an inpatient admission included pain scores and opioid use for 24 h postoperatively, as well as total length of hospital stay. A failed caudal block was defined as the need for rescue opioids in the immediate postoperative period. In the caudal group, those who were judged to have a working block were included for analysis and compared to the control group who did not receive a caudal epidural block.

Continuous variables such as age, weight, morphine equivalence, pain score, and length of hospital stay were presented as the median, mean, and standard deviation. Categorical variables like gender and those who achieved a 1-day hospital stay or less were presented with the percentage. Because continuous variables were not normally distributed, Wilcoxon rank-sum test was used for comparison. Categorical variables were compared using Pearson's Chi-square test or Fisher's exact test as appropriate. Morphine equivalence and pain score which were repeatedly measured over time were analyzed using repeated measure ANOVA assuming unstructured variance-covariance structure within each individual. $P < 0.05$ was considered significant. All P values were two-sided. The statistical analyses were done using SAS 9.3 (SAS institute 100 SAS Campus Drive Cary, NC 27513-2414, USA).

RESULTS

Of the 16 patients in the caudal experimental group, five patients were determined to have a failed caudal block (31%). Therefore, 11 subjects remained in the caudal epidural block group and 16 in the control group for further analysis. Patient demographics are provided in Table 1. There were no significant differences between the groups with respect to age, weight, or gender. Opioid consumption in the operating room, in the PACU, and for the first 24 h of the inpatient hospital stay are outlined in Table 2 and Figure 1. The repeated measure ANOVA demonstrated that the difference in morphine equivalents between groups remained statistically constant over time and is, therefore, reported as one single point estimate. The opioid needs of the control group were 2.94 mg (morphine equivalents) higher than the caudal epidural group [95% confidence interval of 1.53-4.35 with $P = 0.0003$, Table 3]. The pain scores measured in the PACU and at 6, 12, and 24 h of inpatient stay are outlined in Table 4 and Figure 2.

Table 1: Demographic data of the two patient groups

Demographic	Caudal epidural block ($n = 11$)	Control ($n = 16$)	P
Age (years)	13.3±1.9	13.9±3.1	0.87
Weight (kg)	59.9±18.1	77.2±31.2	0.08
Males (%)	54.5	53.3	0.95

The repeated measure ANOVA demonstrated that the pain scores between groups changed over time. Therefore, point differences are reported at each time point. Although the pain scores were lower in the PACU and at 6 and 12 postoperative hours, this did not achieve statistical significance at any time point. The average hospital stay was 2.1 days ±0.98 for the experimental group and 2.5 days ± 0.63 for the control group (P = NS). The percentage of patients discharged home at 1 day was 27% for the experimental group and 0% for the control (P = 0.06). There were no complications noted in the experimental group as a result of the caudal epidural block.

DISCUSSION

While caudal epidural blockade is well-described in young children and infants, there remains a paucity of literature regarding its use in teenagers and adolescents. As noted, previously many anesthesia providers believe that caudal epidural block is not feasible or indicated beyond the infant and toddler age groups. As noted from our experience and that from the adult population, there are no anatomical issues which preclude its use in the older population. Our retrospective data suggest that there may be significant benefits in the adolescent undergoing major hip surgery including decreased opioid use intraoperatively, in the PACU, and during the first 24 postoperative hours. As we saw no difference in pain scores, we would speculate that the use of appropriately dosed PCA's allowed the patients who did not receive a caudal epidural block to attain adequate pain control albeit with greater opioid use. Although pain scores were lower in the PACU and at 6 and 12 postoperative hours, there was an increase in pain scores at 24 h in the group that received caudal epidural analgesia. However, this was not statistically different from the group that had not received a caudal epidural block. This increase occurred while the control group's scores showed a relative decrease. The dissipation of the analgesic

Table 2: Opioid consumption (morphine equivalents reported in total milligrams)

Category	Caudal epidural block	Control
Intraoperative	4.6±2.1	9.9±4.7
	3.1 (0-7.7)	7.7 (4-22)
PACU	0	4.94±3.95
	0 (0-0)	0 (0-8)
Inpatient 24 h total	21.5±25.1	52.8±49.4
	20 (0-109)	34 (1-196)

The data are presented as the mean±SD with median (maximum, minimum) range. SD: Standard deviation, PACU: Postanesthesia care unit

Table 3: Estimated difference in morphine equivalents between groups

Category	Point estimate	*P*	95% CI (lower)	95% CI (upper)
Caudal epidural block versus control	2.94	0.0003	1.52	4.34

CI: Confidence interval

Table 4a: Average pain scores

Pain score	Caudal epidural block	Control
PACU	1.45±2.18	2.51±2.52
6 h pain score	0.55±1.29	2.26±2.93
12 h pain score	0.99±1.8	2.3±2.6
24 h pain score	3.5±2.9	1.8±2.5

PACU: Postanesthesia care unit

Table 4b: Hospital stay

Category	Caudal epidural block	Control	*P*
Length of stay (days)	2.18±0.98	2.53±6.3	0.3
One day hospital stay %	27 (3 of 11)	0 (0 of 16)	0.06

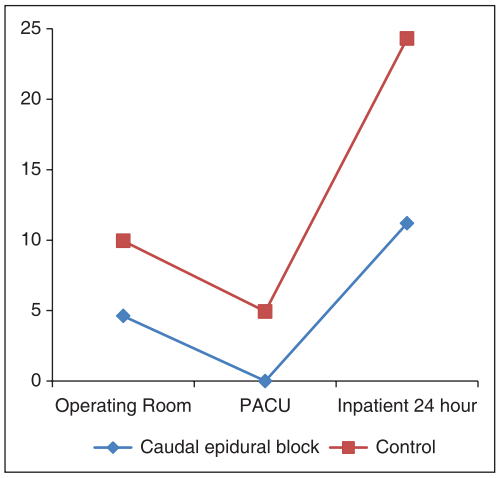

Figure 1: Opioid consumption (reported in morphine equivalents in milligrams) over time. The difference between the two groups is significant at each time point and reported as a single point estimate [Table 3]

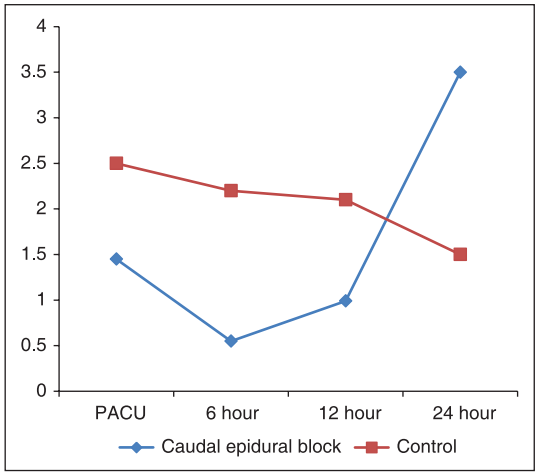

Figure 2: Average pain scores plotted over time

effects of the caudal epidural block at a time when opioid plasma concentrations were lower (given the decreased use of PCA-opioids over the previous 24 h) may explain the increased pain scores. In addition, with effective caudal epidural block, we noted that analgesia was effective enough to eliminate the need for rescue analgesia in the PACU as well as facilitate discharge home within the first 24 h, an effect not seen without the use of caudal epidural block. Three patients in the caudal epidural group were discharged home within 24 h of surgery compared to none of the patients in the control group.

Other studies have shown caudal epidural blockade to be effective in adult patients. A prospective study of 51 adults undergoing lumbosacral surgery showed significantly lower pain scores and shorter time to ambulation for those who received caudal epidural blocks.[2] Another study by Kita *et al.* compared lumbar epidural anesthesia with caudal epidural anesthesia and general anesthesia for hip arthroplasty in adults.[3] The epidural anesthesia groups had lower pain scores and opiate consumption compared with the general anesthesia group. Interestingly, the authors noted ease of caudal placement when compared with lumbar placement of the epidural block. In accordance with this finding, a separate study by Wong *et al.* reports a landmark-based caudal epidural block success rate of 95.9% in a cohort if 172 adult females undergoing gynecologic surgery.[4]

The failure rate in our population was higher compared with that of the previously mentioned study group and greater than what we note in our usual clinical practice in infants and young children.[5] Although the failure rate was higher than expected based on previous literature, the patients in the current study were more likely to be obese than their age-matched counterparts, potentially increasing the difficulty of caudal epidural placement based on landmarks alone. Previous studies have demonstrated a correlation between elevated body mass index (BMI) and the incidence of SCFE with 81% of the patients with SCFE having a BMI greater than the 95th percentile versus 41% of control patients.[6] Given these concerns and its routine use for regional anesthesia of other types, it may be that ultrasound can be used to increase the accuracy of caudal epidural placement in this population. Chen *et al.* demonstrated that the success rate of ultrasound guidance when used to guide caudal epidural needle placement in real time was 100% as confirmed with contrast dye fluoroscopy.[7] Wang *et al.* randomized children to a landmark-based or ultrasound-guided caudal epidural block for inguinal hernia repairs.[8] Although the success rate between the two groups was very similar, the first puncture success rate was higher in the ultrasound group (92.8% vs. 60%).[8]

CONCLUSION

The successful use of caudal epidural block as an adjunct to general anesthesia for the open repair of SCFE in adolescents not only decreases opioid needs during the first 24 h, but may also result in a shorter hospital stay and an increased chance of early discharge within the 1st postoperative day. Although there was a higher failed block rate in this series as compared to others, the patient population's inherent increased BMI may present added difficulties in placement of the block with a landmark-based approach highlighting the potential added utility of ultrasound guidance. The success of our preliminary experience with this technique suggests the need to further investigate the efficacy of caudal epidural block in providing analgesia following major surgical procedures in adolescents and older patients.

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