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Evaluation of The Analgesic Effect of Caudal Anesthesia In Pediatric Lower Extremity Orthopedic Surgery

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ABSTRACT

The aim of this study is to evaluate the preoperative and postoperative effects of caudal analgesia in pediatric orthopedic lower extremity surgery.
A total of 92 children who underwent lower extremity osteotomy under general anesthesia were included in the study retrospectively. For caudal analgesia, 0.5 ml/kg 0.25% levobupivacaine and 20 mcg/ kg morphine were used routinely. The effect of caudal analgesia on hemodynamic parameters (heart rate, mean arterial pressure, oxygen saturation, sevoflurane concentration) and procedural success rates were evaluated using objective pain scale scores (OPS).
The mean age of the patients was 5.6±3.7 (1-13) years, and 54.3% of them were male. The mean operation time was 100±94 minutes. Side effects (nausea-vomiting) were detected in 12% of the cases. Caudal block suppressed the response to the surgical incision, and caused a decrease in heart rate, mean arterial pressure, and sevoflurane values ($p < 0.05$). The OPS's were found to be ≥ 5 in 8.7% of the patients, and in these patients' caudal block was considered to be unsuccessful for achieving a satisfactory analgesic effect. The time to the first analgesic administration to the patients was 526 ± 242 (85-1110) minutes after caudal analgesia. In the first 24 hours, 40.2% of the patients did not need additional analgesics.
Caudal block is an anesthesia technique with high success rate, easy application, and low complication rate. In addition, it can provide long-term analgesia both perioperatively and postoperatively in pediatric patients undergoing subumblical surgery with a single injection technique.

Keywords: Caudal analgesia, pediatric patients, postoperative nausea-vomiting, objective pain scale, total spinal block

Introduction

Caudal anesthesia is an effective method for perioperative and postoperative pain control. Since it provides potent analgesia, it confers significant patient comfort with use of fewer anesthetic agents during the operation and a decrease in analgesic requirement after the operation (1). In addition, it is an easy, simple, and safe anesthesia technique to apply (2-4). Although various local anesthetics are used in the caudal block to increase duration, and quality of the blockade and reduce side effects, bupivacaine is mostly preferred. There are formulas regarding the drug dose that consider the age, weight, height, and desired block level of the patient. All these formulas are based on amount of the drug administered, if they do not exceed the maximum reliable dose of the drug used (5).

Painful stimuli that may occur during surgical intervention or the perioperative period led to some changes in the nervous system, contributing to the increase of postoperative pain. If analgesic treatment is started after onset of painful stimulation, peripheral hypersensitivity and hyperexcitability of the central nervous system may have developed, so there may be difficulties in the management of the postoperative pain in such cases (6). It has been shown that analgesia before surgical trauma can reduce posttraumatic sensitivity and secondary hyperalgesia in the spinal cord. Minimizing the stress response may reduce morbidity, length of hospital stays, and cost (7). Considering that orthopedic lower extremity operations are quite painful, we evaluated the analgesic efficacy of the caudal block in pediatric orthopedic lower extremity interventions.

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Materials and Methods

After receiving the approval of the hospital ethics committee (Decision number: 13-9.1/6, Date: 07/10/2013) the files of pediatric patients who underwent lower extremity surgery under caudal blockade between 2010 and 2013 in the Department of Orthopedics and Traumatology were retrospectively examined. Written informed consent was taken from the parents of all the participants. Exclusion criteria of the study were coagulation disorders, infection at the injection site, patients with anatomic anomalies of the sacral region, and rejection by the parents. Demographic data of the patients (age, gender, and weight), intraoperative and postoperative heart rates (HRs), mean arterial blood pressures (MAPs), oxygen saturations (SpO2), objective pain scale scores (OPSs, Table1), Ramsay Sedation Scores (RSSs, Table 2), intraoperative sevoflurane level (%), the first administration time of analgesics, and relevant complications were recorded.

After administration of midazolam (0.5 mg/kg oral) for premedication, all patients were brought into the operating room. Electrocardiogram, peripheral oxygen saturation, non-invasive blood pressure, and temperature were used as standard anesthesia monitoring. After induction of anesthesia with sevoflurane (8%), and intravenous cannulation, atropine (10 μg/kg), fentanyl (1 μg/kg), and rocuronium (0.6 mg/kg) were administered. The patients were placed in the lateral decubitus position after orotracheal intubation, and the caudal block was performed using a 22-gauge hypodermic needle. The 0.25% levobupivacaine plus 20 mcg/kg morphine were prepared for caudal analgesia. The total dose (0.5 mL/kg) was our standard protocol used for all our patients. Sevoflurane (0.5-1.5 MAC) and rocuronium (0.15 mg/kg) were used for the maintenance of anesthesia. Additional analgesics were not used for the patients in the intraoperative period after caudal analgesia. All patients were extubated in the operating room and monitored in the post-anesthesia intensive care unit. If the patients' OPS scores were higher than four, meperidine (0.5 mg/kg iv), paracetamol (10 mg/kg iv), and metamizole sodium (15 mg/kg iv) were administered as rescue analgesia. Patients with Modified Aldrete Scores of ≥ 9 were monitored in the service.

Statistical Analyses: Statistical analysis was performed with Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) 21.0 program. The distribution of variables was measured by the Kolmogorov-Simirnov Test. Means, standard deviation (SD), median (lowest-highest), frequencies, and rates (%) were used in the descriptive statistics of the data. Paired samples t-test was used in the analysis of repetitive measurements. A $p<0.05$ was considered as the level of statistical significance.

Results

Of the 92 pediatric cases included in the study, 54.3% were male. The mean values of the patients for age (5.6 ± 3.7 years), the weight (19.2 ± 9.7 kg) and the operation time (100± 94 min) were as indicated. Demographic data of the patients are given in Table 3.

Mean (± SD) values for baseline heart rate (HR) (130±19 [88-178] bpm), mean arterial blood pressure (MAP) (68±12 [44-101] mmHg) and oxygen saturation (SaO2) (99.7 ± 0.7% [97- 100]) were estimated. There was a statistically insignificant increase in HR values after induction of general anesthesia (p=0.055), but they returned to pre-induction values at the 5th minute after the caudal block. When compared with pre-incision values, lower heart rates were detected at the time of surgical incision (p=0.002), and 2nd (p=0.001), 5th (p<0.001), 15th (p<0.001), 30th (p<0.001), 45th (p<0.001), and 60th (p<0.001) minutes after incision. Heart rates at the postoperative 10th, 30th, 60th, 120th, 180th, 240th, and 300th minute were also lower than the baseline values measured before the induction of anesthesia (p<0.001). Due to surgical incision, instead of an increase in HR values, a significant decrease was detected according to the baseline value (p=0.002) (Figure 1).

Mean arterial pressure decreased after caudal analgesia, and this decrease continued throughout the entire operation. Even during surgical incision, MAP values decreased significantly when compared to baseline values. After extubation, MAP values increased, and this increase continued until the postoperative 180th minute (Figure 1).

After induction of anesthesia, sevoflurane concentration decreased from 2.4±0.7% at 5 minutes after induction to 2.3±0.5% at 5 minutes after caudal block (p=0.001). The decrease in sevoflurane concentrations continued until the end of the operation (p<0.001) (Figure 2).

Table 1. Objective Pain Scale

Scores	0	1	2
Blood pressure	± 10% of preoperative value	Greater than 20% of preoperative value	Greater than 30% of preoperative value
Crying	Not crying	Crying but can be consoled	Crying but cannot be consoled
Movement	None	Restless	Thrashing around
Agitation	Calm and sleeping	Agitated	Excessively agitated
Pain	Asleep and feels no pain	Feels pain but cannot localize it	Feels pain and can localize it

Table 2. Ramsay Sedation Scoring

1	Agitated, tired, restless
2	Cooperative, oriented, calm
3	Asleep, responds to a verbal stimulus
4	Asleep, wakes up with a light touch
5	Asleep, opens eyes to painful stimulus
6	Unable to wake up

Time to first analgesic requirement was 526±242 (85-1110 min) minutes after application of caudal block. In the first 24 hours, 40.2% of the patients did not need additional analgesics. Only paracetamol was given to 35.9% of the patients, and a second analgesic (metamizole sodium or meperidine) was added to paracetamol in 23.9% of the patients. Objective pain scale (OPS) scores >4 at postoperative 10th, 30th, and 60th minutes were found 7% (n=8), 5.5% (n=5), and 2.2% (n=2) of the patients, respectively. After postoperative 60th minute, higher OPS scores were not detected in any patient. Patients with a higher OPS score>4 needed analgesics much earlier (255±247 min vs 552±226 min, p=0.001) and in greater amounts (1.25±0.5 vs 0.8±0.8, p=0.032). The number of agitated-tired or restless (Ramsay Sedation Scale Group 1) patients decreased as time elapsed after the operation [19.6% (n=18) at 10th, 10.9% (n=10) at 30th, and 8.7% (n=8) at 60th minutes]. Nausea and vomiting developed in 12% (n=11) of the cases. In one patient (1.1%), the spinal motor block developed and disappeared 165 minutes after the procedure.

Discussion

This study showed that in pediatric lower extremity surgery, the application of preoperative caudal analgesia had a positive effect on intraoperative and postoperative hemodynamics.

The caudal analgesia is performed preoperatively or postoperatively period. However, preoperative application provides a reduction in anesthetic and analgesic use. Due to the use of local anesthetics and adjuvants in high volumes and concentrations, the incidence of major complications such as systemic toxic reaction, total spinal block, hypotension, and neurological sequelae increase (2-8). In 750 pediatric patients, Dalens et al. (9) detected caudal block failure in only 1% of children less than 7 years and 14.5% of older children. Other studies reported the average caudal block failure of 1.9-7.4% in lower extremity operations. The most common complications in caudal anesthesia were block failure, blood aspiration, and intravascular injection (4,10,11).

According to our assessments, analgesia was inadequate in 8.7% of the patients since the OPS scores of these patients were >4 in the postoperative period. Block failure was attributed to misinterpretation of resistance loss and subcutaneous injection of the drug due to the softness of the tissues. One patient developed a motor block that disappeared completely 165 minutes after the procedure. Since the patient was under general anesthesia, the spinal motor block could not discern early.

The analgesic synergistic effects of epidural opioids and local anesthetics are well known, and the combination of these drugs more widely use than their applications per se. The addition of

Table 3. Demographic and Operative Data of The Patients

	Mean ±standard deviation, median (lowest-highest)
Age (year)	5.6±3.7, 4.5 (0.5-13)
Gender (male) (n, %)	50 (54.3)
Weight (kg)	19.2±9.7, 18 (7.5-50)
Duration of operation (min)	100±94, 90 (15-210)
Side effect (nausea-vomiting) (n, %)	11 (12)
First analgesic after operation (min)	434±228, 480 (20-1020)
First analgesic after caudal block (min)	526±242, 537 (85-1110)

Data are given as mean ± standard deviation, median (lowest-highest), number (n), and percentage (%).

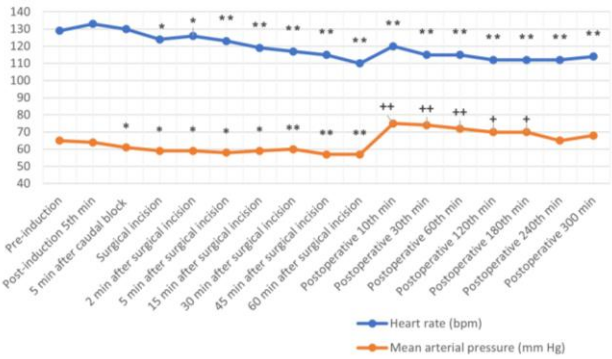

Fig. 1. Heart rate (HR) and mean arterial pressures (MAP) of the patients before and after caudal analgesia.
*p<0.05, **p<0.001 (Heart rates decreased significantly compared to pre-induction values)
*p<0.05, **p<0.001 (Mean arterial pressures decreased significantly compared to pre- induction values)
+p<0.05, ++p<0.001 (Mean arterial pressures increased compared to pre-induction values)

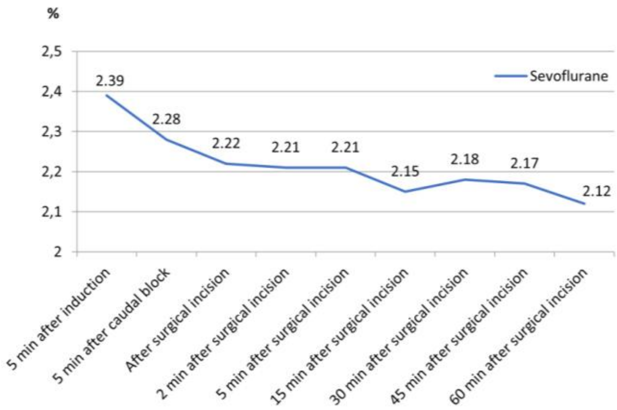

Fig. 2. Change of sevoflurane (Sev) over time (min) in patients who underwent caudal block. At all-time points, the sevofluran concentration (%) was significantly lower than the baseline (5th minute of induction) value (p<0.001).

morphine to local anesthetics improves both the quality and duration of the postoperative analgesic effect (2,12). Nausea and vomiting, itching, urinary retention, and hypoventilation may develop associated with the administration of caudal-epidural opioids. Delayed respiratory depression may develop in 8% of pediatric patients due to epidural morphine.

Respiratory depression occurs within the first 12 hours of caudal administration of morphine (3.8 hours average) (13). In 40 pediatric patients undergoing lower extremity osteotomy under caudal analgesia, Sertoz et al. (2) compared caudal administration of 0.5 ml/kg 0.25% levobupivacaine+20 µg/kg morphine (Group I) with caudal injection of 0.5 ml/kg 0.25% levobupivacaine + intravenous 0.1 mg/kg morphine (Group II). There were not statistically significant between the groups in terms of the intraoperative and postoperative hemodynamic parameters; they found that the first analgesic requirement was longer in Group I (644± 160 min vs 542± 98 min, p=0.02). The authors stated that morphine added to the caudal levobupivacaine provided longer postoperative analgesic effect without causing perioperative hemodynamic changes and side effects. Marjanovic et al. (14) compared three different doses of levobupivacaine in pediatric patients who underwent orchiopexy and inguinal hernia repair. The mean time to the first analgesic requirement in 40 patients was 936 ± 497 minutes, there was no difference between three different 0.25% levobupivacaine doses (0.6 mL/kg, 0.8 mL/kg, and 1 mL/kg) in terms of requirement for additional analgesia. Twenty-two (55%) patients did not need analgesics during the postoperative period, while additional analgesics were required within the first 6 hrs in 20%, 6-12 hrs in 17.5%, and 12-24 hrs in 7.5% of the patients. The fentanyl dose used in all three groups was similar (p = 0.99).

In our patients, the mean time interval to the administration of the first analgesic was 526±242 (85-1110) minutes and 40.2% of the patients did not need additional analgesics within the first 24 hours. In 35.9% of the patients, paracetamol provided adequate pain control, and none of the patients experienced a high OPS (score > 4) after the 60th minute following the surgery. Nausea-vomiting (12%) was the most common side effects in the postoperative period due to opioid use, while respiratory depression or urinary retention requiring urinary catheterization did not observe.

Kim et al. (11) reported that the pre-empitive caudal block reduced the use of sevoflurane by 36% compared to those administered general anesthesia alone. There was a decrease in heart rate and mean arterial pressure after the procedure in patients who underwent caudal blocks. Reinoso-Barbero et al. (15) reported that sevoflurane concentration decreased 20 minutes after the caudal block which also reduced sevoflurane use by 46%, without any notable change in the patients' hemodynamic values. Raux et al. (16) reported that after caudal block mean arterial pressure significantly decreased by 14% and systemic vascular resistance decreased by 24%, while the heart rate increased by 20%.

In our study, HR and MAP decreased after the caudal block and remained at low levels throughout the operation. After the operation, MAP levels increased but HR values remained low. Sevoflurane rate was significantly lower until the end of the operation.

Our study has some limitations: Firstly, this is a retrospectively designed study, and we aimed to present our clinical experiences. Its results must be supported by randomized controlled trials. Secondly, although the caudal block had a positive effect on intraoperative sevoflurane levels, Bi-Spectral Index (BIS) was not applied to monitor the sedation levels of the patients.

In conclusion, in pediatric lower extremity surgery, the caudal block is a highly successfully applicable analgesia method (91.3%). Pre-emptive administration of caudal analgesia reduced the use of intraoperative anesthetics and had positive effects on the hemodynamic status of the patients. The addition of morphine to levobupivacaine prolonged the duration of analgesic action, causing an increase in nausea-vomiting rates (12%). Therefore, the patients should closely monitor for complications such as nausea-vomiting, respiratory depression, and total spinal block that may develop during the postoperative period.

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