A Comparison of Three Different Volumes of Levobupivacaine for Caudal Block in Children Undergoing Orchidopexy and Inguinal Hernia Repair

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Significance of the Study

- This study showed that the caudal block using three different volumes of 0.25% levobupivacaine yielded similar quality and duration of intra- and postoperative analgesic effects. Low-volume levobupivacaine is sufficiently effective for analgesia in children undergoing orchidopexy or inguinal hernia repair.

Keywords

Levobupivacaine · Volume · Caudal block · Children

Abstract

Objective: The aim of this study was to compare the efficacy of 3 different volumes of 0.25% levobupivacaine caudally administered on the effect of intra- and postoperative analgesia in children undergoing orchidopexy and inguinal hernia repair. **Subjects and Methods:** Forty children, aged 1–7 years, American Society of Anesthesiologists (ASA) physical status I and II, were randomized into 3 different groups according to the applied volumes of 0.25% levobupivacaine: group 1 ($n = 13$): $0.6 \text{ mL} \cdot \text{kg}^{-1}$; group 2 ($n = 10$): $0.8 \text{ mL} \cdot \text{kg}^{-1}$; and group 3 ($n = 17$): $1.0 \text{ mL} \cdot \text{kg}^{-1}$. The age, weight, duration of anesthesia, onset time of intraoperative analgesic, dos-

age, and addition of intraoperative fentanyl were compared among the groups. The time to first use of the analgesic and the number of patients who required analgesic 24 h after surgery in the time intervals within 6 h, between 6 and 12 h, and between 12 and 24 h postoperatively were evaluated among the groups. Statistical analyses were performed with a Dunnett t test, ANOVA, or Kruskal-Wallis test and χ^2 test. Logistic regression analysis was used in order to examine predictive factors on duration of postoperative analgesia. **Results:** Age, weight, duration of anesthesia, onset time of intraoperative analgesic, dosage, and addition of intraoperative fentanyl were similar among the groups. The time to first analgesic use did not differ among the groups, and logistic regression modelling showed that using the 3 different volumes of levobupivacaine had no predictive influence on duration of postoperative analgesia. The numbers of pa-

tients who required analgesics within 6 h (3/2/3), between 6 and 12 h (3/1/3), and between 12 and 24 h (1/0/2) after surgery were similar among the groups. **Conclusion:** The 3 different volumes of 0.25% levobupivacaine provided the same quality of intra- and postoperative pain relief in pediatric patients undergoing orchidopexy and inguinal hernia repair.

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Introduction

Caudal block is one of the most commonly used pediatric regional anesthetic techniques for postoperative analgesia [1]. Caudal block is easy to perform; extensively safe if used in children, resulting in low pain scores; and when combined with general anesthesia, it reduces the requirement for volatile agents and opioids [2, 3]. Caudal block is performed in children undergoing surgery at the lumbosacral to midthoracic dermatomal levels with anticipated moderate-to-severe perioperative and postoperative pain [4]. The extent of analgesia during epidural blockade with local anesthesia depends on the anatomic spread of solution within the epidural space, which is determined by the injected volume [5]. However, the formula for determining the correct volumes for different cases of local anesthetic (LA) is not yet known, but it has been suggested that only high volumes of 0.7–1.0 mL · kg⁻¹ might be able to achieve an analgesic effect to the level T10 vertebra or above [6]. Certain authors reduced the applied volume to 0.5 mL · kg⁻¹ LA in order to avoid side effects and toxicity [7].

There are several different LA agents available for the regional block [1]. Levobupivacaine, the S-enantiomer of bupivacaine, has been promoted as an alternative to more cardiotoxic racemic bupivacaine [8]. Levobupivacaine is generally a well-tolerated anesthetic and analgesic with a wide range of clinical applications [9]. Due to different data in the literature, further studies are needed to confirm optimal volume of levobupivacaine for caudal block in children. Therefore, the aim of this prospective study was to compare the efficacy of caudal block with 3 different volumes of 0.25% levobupivacaine and the effect of intra- and postoperative analgesia of levobupivacaine in children undergoing orchidopexy and inguinal hernia repair.

Subjects and Methods

The study was approved by the Institutional Ethics Committee of Clinical Centre Nis (No. 2552/12) and the study was performed according to the Declaration of Helsinki. Informed written con-

Table 1. Children's and Infants' Postoperative Pain Scale

Item	Score 0	Score 1	Score 2
Crying	None	Moaning	Screaming
Facial expression	Relaxed smiling	Wry mouth	Grimacing
Posture of the trunk	Neutral	Variable	Rear up
Posture of the legs	Neutral	Kicking	Tightened
Motor restlessness	None	Moderate	Restless

sent was obtained from the parents. Forty patients scheduled for orchidopexy and/or inguinal hernia repair, aged 1–7 years, American Society of Anesthesiologists (ASA) physical status I and II, were included in this prospective randomized study, which was conducted over a period of 6 months from May 2015 to October 2015. Exclusion criteria were local infection; bleeding tendency; congenital spinal anomaly; neurologic diseases; and serious renal, hepatic, lung, and cardiac diseases.

All the children fasted and were premedicated with intramuscular midazolam 0.1 mg · kg⁻¹ 30 min before surgery. Peripheral intravenous access with 20–22 G was secured and intravenous induction with propofol 2 mg · kg⁻¹ was administered. If the peripheral intravenous access was missed, sevoflurane was used for anesthesia induction. Anesthesia was maintained with a continuous intravenous propofol infusion of 6 mg · kg⁻¹ · h⁻¹ and the airway was controlled using a facial mask that allowed spontaneous breathing of oxygen and air. Thereafter, a caudal block was performed in the left lateral decubitus position using a 22 or 23-G, sterile, disposable hypodermic needle. Patients were computer randomized to receive levobupivacaine 0.25% (Chirocaine®; Abbott, Latina, Italy) in 3 different total doses: group 1: 0.6 mL · kg⁻¹ (*n* = 13); group 2: 0.8 mL · kg⁻¹ (*n* = 10); and group 3: 1.0 mL · kg⁻¹ (*n* = 17), caudally administered. Levobupivacaine 0.25% was prepared by diluting 0.5% levobupivacaine with normal saline in the ratio of 1:1. If blood or CSF was not aspirated, LA was injected. The patients were positioned for surgery after a delay of at least 15–20 min between caudal blockade and surgical incision. Noninvasive blood pressure, heart rate, and pulse oximetry (SpO₂) were monitored continuously. The propofol infusion was stopped at the beginning of skin suture. After surgery, patients were transferred to the recovery room.

The primary outcome of the study was the clinical efficacy of the caudal block during operation. Caudal block efficacy was estimated by the absence of gross movements, as well as by the significant change (>20%) in pulse rate and/or respiratory rate with the inguinal incision in those undergoing inguinal hernia repair and orchidopexy. In case of change in 2 of these 3 clinical parameters mentioned above, the block was considered clinically ineffective. In case of inadequate analgesia after incision or during operation, a supplementary intravenous bolus of fentanyl was administered.

Secondary outcome measures were the onset time of intraoperative analgesic, duration of postoperative analgesia, and using analgesic after caudal block. The onset time of caudal block was estimated by a mechanical stimulus at the surgical dermatome or at the immediate superior dermatome with a modified Allis clamp 3 min after LA injection [10]. Patients were stimulated every 3 min

Table 2. Demographic and clinical characteristics of the investigated groups with caudal block

Characteristics	Group 1 (0.6 mL · kg ⁻¹)	Group 2 (0.8 mL · kg ⁻¹)	Group 3 (1.0 mL · kg ⁻¹)	<i>p</i>
Age, years	2.69±1.44	3.40±2.53	3.00±1.80	0.58
Weight, kg	13.77±3.52	17.50±6.35	13.65±3.59	0.07
Duration of anesthesia, min	52.69±42.21	47.00±26.48	54.71±26.54	0.61
Intraoperative analgesic onset time, min	13.33±0.58	13.67±1.23	12.80±1.30	0.63
Dosage of fentanyl, µg · kg ⁻¹	1.13±0.25	1.67±0.29	1.20±0.45	0.11
Addition of intraoperative fentanyl	4/13 (30.77)	3/10 (30)	5/17 (29.41)	0.99

Values are presented as *n* (%) or means ± SD.

Table 3. Time to first analgesic requirement of patients that received and did not receive analgesic postoperatively

Analgesic treatment	Group 1 (0.6 mL · kg ⁻¹)	Group 2 (0.8 mL · kg ⁻¹)	Group 3 (1.0 mL · kg ⁻¹)	<i>p</i>
Time to first analgesic, min	888.85±50.72	1,099.00±479.74	877.06±51.40	0.66
Analgesic within 24 h	7/13 (17.5)	3/10 (7.5)	8/17 (20)	0.64
No analgesic within 24 h	6/13 (15)	7/10 (17.5)	9/17 (22.5)	0.83
Analgesic within 6 h	3/13 (7.5)	2/10 (5)	3/17 (7.5)	0.96
Analgesic between 6 and 12 h	3/13 (7.5)	1/10 (2.5)	3/17 (7.5)	0.79
Analgesic between 12 and 24 h	1/13 (2.5)	0/10 (0)	2/17 (5)	0.57

Values are presented as *n* (%) or means ± SD.

after the caudal block until the block proved to be effective during the maximum of 15 min after caudal injection (5 stimuli). Any related movement or significant change in the heart rate or respiratory rate led to the discontinuation of the stimulus. A physiological response or movement at 15 min was analyzed as prolonged LA onset. Data from patients who responded with movements or physiological changes to the fifth stimulus but did not respond to the first surgical stimulus were assigned an onset time equivalent to the time between caudal block and surgical incision. The duration of postoperative analgesia was the time from caudal injection to the time of first analgesic requirement. The postoperative pain relief was evaluated using the Children's and Infants' Postoperative Pain Scale (CHIPPS) at 6, 12, and 24 h during recovery from anesthesia (Table 1). A total score of ≥4 identified the need for supplemental analgesia [11]. In the case of a CHIPPS score of 4 or more, paracetamol 15 mg · kg⁻¹ was administered rectally. Postoperative assessments were made by nursing staff unaware of group allocation for at least 24 h.

Demographic data (age, weight, duration of anesthesia); onset time of caudal block; dosage of fentanyl; addition of intraoperative fentanyl; time to first analgesic requirement; number of patients who required and did not require an analgesic in postoperative period; and using an analgesic within 6 h, between 6 and 12 h, and between 12 and 24 h in the postoperative period was evaluated.

Statistical Analysis

R Statistics Software Version 3.1.3. (R Foundation for Statistical Computing, Vienna, Austria) was used for the statistical analysis. The data are presented as the mean ± SD. For comparison of patient characteristics and differences between the groups, an ANOVA or Kruskal-Wallis test was used as appropriate. Testing for normal distribution of the data was performed by a Dunnett *t* test. A χ^2 test was used to compare nonparametric data. Multivariate logistic regression modelling was used for determining the variables that could predict duration of postoperative analgesia. A value of *p* < 0.05 was considered significant.

Results

The caudal block performed in 40 children who underwent orchidopexy and inguinal hernia repair was successful in all patients. Comparison of age, weight, duration of anesthesia, intraoperative analgesic onset time, dosage of fentanyl, and addition of intraoperative fentanyl between the investigated groups are shown in

Table 4. Model regression and predictors such as: age, weight, duration of anesthesia, and volumes of levobupivacaine (0.6, 0.8 and 1 mL·kg⁻¹) in predicting the time to first analgesic therapy

	<i>R</i>	<i>R</i> ²	Adjusted <i>R</i> ²	SE of the estimate	<i>F</i>	<i>p</i>		
Model 2	0.39	0.15	0.08	475.68	2.19	0.11		
		Unstandardized coefficient <i>B</i>	SE	Standardized coefficient β	<i>t</i>	<i>p</i>	95% CI for <i>B</i>	
							lower	upper
Model 2	(Constant)	1,293.48	317.43		4.08	0.00	649.70	1,937.26
	Levobupivacaine groups	194.64	102.82	0.32	1.89	0.07	-13.90	403.17
	Weight	-86.36	37.28	0.80	-2.32	0.03	-161.96	-10.76
	Age	178.33	86.38	0.68	2.06	0.05	3.14	353.52

Table 2. There were no significant differences between the groups regarding age (ANOVA, Kruskal-Wallis test: $p = 0.58$), weight (Dunnnett t test: $p = 0.07$), sex (χ^2 analysis: $p = 0.52$), and duration of anesthesia (ANOVA, Kruskal-Wallis test: $p = 0.61$). The mean analgesic onset time was 13.33 ± 0.58 min in group 1, 13.67 ± 1.23 min in group 2, and 12.8 ± 1.30 min in group 3, without a significant difference between the groups (Dunnnett t test: $p = 0.63$). The additional dose of fentanyl was in the range of $1.13\text{--}1.67 \mu\text{g} \cdot \text{kg}^{-1}$ in all the groups, and there was no significant difference in the required dose of fentanyl among the investigated groups (χ^2 analysis: $p = 0.11$). Of the 40 patients, fentanyl was added intraoperatively in 12 (30%): 4 (30.77%) in group 1, 3 (30%) in group 2, and 5 (29.41%) in group 3, without significant differences ($p = 0.99$).

The time to the first postoperative analgesic administration; patients who did or did not require analgesic supplementation in the postoperative period; and the use of first analgesic administration in patients within 6 h, between 6 and 12 h, and between 12 and 24 h in the postoperative period are given in Table 3. The mean postoperative duration of caudal block was 936.38 ± 496.91 min in all 40 patients and there was no statistical difference among the groups: 888.85 ± 505.72 min for group 1, $1,099 \pm 479.74$ min for group 2, and 877.06 ± 508.40 min for group 3 (ANOVA, Kruskal-Wallis test: $p = 0.66$). The shortest duration of postoperative analgesia was 300 min. In addition, no statistical difference was found among the 3 groups regarding postoperative analgesic administration (ANOVA, Kruskal-Wallis test: $p = 0.64$) (Table 3). Of the 40 patients, 8 (20%) patients required analgesics within 6 h, 7 (17.5%) patients required analge-

sics between 6 and 12 h, and 3 (7.5%) patients required analgesics between 12 and 24 h. There was no statistical difference between the 3 groups in terms of receiving analgesic within 6 h (χ^2 analysis: $p = 0.96$), between 6 and 12 h (χ^2 analysis: $p = 0.79$), and between 12 and 24 h (χ^2 analysis: $p = 0.57$) (Table 3). Of the 40 patients, 22 (55%) did not require any analgesic in the postoperative period. Model regression analysis showed that variables such as age, weight, duration of anesthesia, and volumes of levobupivacaine (0.6, 0.8, and 1 mL·kg⁻¹) did not have any impact on the duration of postoperative analgesia (time to first analgesic; $F = 2.186$, $p = 0.107$) (Table 4).

Discussion

In this study, 3 different volumes (0.6, 0.8, and 1 mL·kg⁻¹) of 0.25% levobupivacaine for caudal block provided similar quality and duration of intraoperative and postoperative pain relief in the pediatric patients undergoing orchidopexy and inguinal hernia repair. The 3 most important variables that determined the quality and level of caudal block were dose, volume, and concentration of the solution used as previously reported [1, 12]. Increasing the injected volume of LA between 0.5 and 1.0 resulted in a modest increase of the caudal spread of the injected solution. However, in practice, 1 mL·kg⁻¹ is a generally suitable volume of LA for pediatric surgeries below T10-level analgesia [13–15]. The finding that 3 different volumes of 0.25% levobupivacaine, 3 different doses of LA, 1.5, 2.0 and 2.5 mg·kg⁻¹, provided similar analgesic effects could indicate that lower volumes provided equal analgesic effects as well as higher volumes of levobupiva-

caine. Analgesic effects of lower doses of LA obtained within the first group of patients were similar to those reported by Yao et al. [16] who used the same clinical dose of levobupivacaine ($1.5 \text{ mg} \cdot \text{kg}^{-1}$) as an optimal clinical dose for inguinal hernia repair. However, other studies [1, 17] indicated that caudal blocks with high volume/low concentration of LA, or vice versa, were more effective in blocking spermatic cord traction response during orchidopexy, but the investigated dose in both cases ($2 \text{ mg} \cdot \text{kg}^{-1}$) was higher than the dose administered in our first group ($1.5 \text{ mg} \cdot \text{kg}^{-1}$). Because pediatric patients were involved in this study, the doses of LA used were reduced and thereby toxicity of LA was avoided similar to other studies [7, 18–20] that did not report adverse events of LA when the recommended dose of $2.5 \text{ mg} \cdot \text{kg}^{-1}$ was used. However, adequate care should be taken regarding pediatric patients as recommended previously [21, 22].

The intraoperative analgesic onset time was 12.8–13.67 min in our study, which was consistent with 11.4 min found in the study of Breschan et al. [23]. Between the groups of patients, the duration of postoperative analgesia was similar regardless of the volumes of levobupivacaine used, $0.6\text{--}1 \text{ mL} \cdot \text{kg}^{-1}$, which is similar to the study of Schrock and Jones [24] who used volumes of $0.7\text{--}1.3 \text{ mL} \cdot \text{kg}^{-1}$ (0.175% of bupivacaine), which resulted in a similar duration of postoperative analgesia. However, the

duration of postoperative analgesia could not be compared because of different clinical doses used. This finding was confirmed by the logistic regression model, which showed that the 3 different volumes of levobupivacaine had no significant influence on the duration of postoperative analgesia. In our study, 45% of the patients required rescue analgesia postoperatively, while in the studies of Laiq et al. [25], Girwalkar-Bagle et al. [26], and Breschan et al. [23], the percentages of patients requiring postoperative rescue analgesia within 24 h were 30, 52, and 60%, respectively. It should be noted that designs of their studies were different from our study.

Conclusion

In this study, the 3 different volumes of 0.25% levobupivacaine used for single-shot caudal anesthesia in children who underwent orchidopexy and inguinal hernia repair provided effective, adequate, and similar analgesic effects in the intraoperative and postoperative period.

Disclosure Statement

The authors report no conflicts of interest.

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