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Originals

Comparison of 0.2 % Ropivacaine and 0.25 % Bupivacaine in Pediatric Caudal Block : Evaluation of Postoperative Pain and Plasma Concentration of Local Anesthetics

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SUMMARY

The purpose of this study is to assess the effects of pediatric caudal block using 0.2 % ropivacaine or 0.25 % bupivacaine on intraoperative and postoperative analgesia. We also examined plasma concentrations of the local anesthetics after caudal injection. Forty children, who were scheduled for inguinal herniorrhaphy, underwent caudal block with 0.2 % ropivacaine 1 ml/kg (group R, n = 20) or 0.25 % bupivacaine 1 ml/kg (group B, n = 20) after induction of general anesthesia. Anesthesia was maintained using a face mask with 66 % nitrous oxide in oxygen supplemented with sevoflurane. Postoperative pain scores using a pediatric pain scale and plasma concentration of each local anesthetic were measured using gas chromatography. Since two patients in Group R and one patient in Group B required more than 1 % of sevoflurane to prevent their body movement when the surgical procedure was started, they were excluded from this study as the failed block. No patient in Groups R and B required intraoperative analgesics under light general anesthesia and postoperative analgesics. The maximum plasma concentration of ropivacaine and bupivacaine were 0.70 ± 0.28 μg/ml at 45 min and 0.80 ± 0.42 μg/ml at 30 min after the caudal injection, respectively. In conclusion, pediatric caudal block with 0.2 % ropivacaine is an alternative to 0.25 % bupivacaine for intraoperative and postoperative analgesia.

Key Words : Pediatric anesthesia, Caudal block, Ropivacaine, Bupivacaine

INTRODUCTION

Caudal block is a preferable technique for intraoperative and postoperative pain relief in children who undergo surgery below the umbilicus under general anesthesia. We have demonstrated that caudal block with 0.25 % bupivacaine is useful for intraoperative and postoperative analgesia in children who undergo inguinal herniorrhaphy[1]. However, we have to select a safer local anesthetic in pediatric caudal block because a large volume of local anesthetics is necessary to achieve an appropriate level of sensory block. Ropivacaine, a relatively new amino-amide local anesthetic agent with a structure related to bupivacaine, is a long-acting anesthetic. The duration of action of ropivacaine when applied for neuraxial or peripheral nerve block is similar to or shorter than that of bupivacaine[2～6]. Ropivacaine may be more useful in regional anesthesia because of less cardiotoxicity compared with bupivacaine[7～10]. However, little is known about the effects of

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pediatric caudal block with 0.2% ropivacaine and the plasma concentration of ropivacaine after caudal injection.

The aim of this study is to clarify the differential effects of caudal block with 0.2% ropivacaine or 0.25% bupivacaine on intraoperative and postoperative analgesia. We also examined the plasma concentrations of local anesthetics after caudal injection in children who undergo inguinal herniorrhaphy under general anesthesia.

MATERIALS AND METHODS

Forty children weighing 10－20 kg, aged 1 to 5 years, ASA 1, who were scheduled for unilateral inguinal herniorrhaphy were studied after obtaining the approval of the hospital ethics committee and the parents' informed consent. Patients with anemia, hepatic or renal disease were excluded in the study. All caudal blocks were performed by one anesthesiologist, and anesthesia was maintained by two anesthesiologists who were blinded as to the drugs used. A single-blinded investigator measured plasma levels of local anesthetics.

The patients received no preoperative medication. After arriving at the operating room, indirect arterial blood pressure, pulse oximetry, capnography and ECG were monitored. Anesthesia was induced using a face mask by inhalation of progressively higher concentrations of sevoflurane. When the depth of anesthesia was judged adequate, two intravenous cannulas were inserted on the dorsum of the hands, one for fluid infusion at a rate of 5 ml/kg/h, and the other for measurement of plasma concentrations of local anesthetics. The latter cannula was flushed with heparinized saline. The patient was placed in the lateral position with knees drawn up to the stomach, and local anesthetics were injected into the caudal epidural space via the sacral hiatus after confirming negative aspiration of blood or cerebrospinal fluid using a 23 gauge 2.5－cm disposable needle. Then the patients were randomly assigned to two groups : group R (n = 20) received 0.2% ropivacaine 1 ml/kg and group B (n = 20) received 0.25% bupivacaine 1 ml/kg.

The surgery was started approximately 15 min after caudal block. When the concentration of sevoflurane was needed more than 1% to prevent high blood pressure, tachycardia or body movement of children at the start of surgical procedure, the patient was considered to exclude from the study as the failed block. Anesthesia was maintained with 66% nitrous oxide in oxygen supplemented with less than 1% of sevoflurane during surgery. Ventilation was assisted using a face mask, and the end-tidal carbon dioxide tension was maintained between 35 and 40 mmHg. Mean arterial pressure (MAP) and heart rate (HR) were recorded before the induction of anesthesia (baseline), 30 min after caudal block, and 30 min after the surgery.

Table 1 Objective pain scale

Observation	Criteria	Points
1. Blood pressure	± 10% Pre-Op	0
	10 to 20% Pre-Op	1
	20 to 30% Pre-Op	2
2. Crying ?	Not crying	0
	Crying but responds to tender loving care	1
	Crying and does not respond to tender loving care	0
3. Moving	None	0
	Restless	1
	Thrashing	2
4. Agitation	Patient asleep or calm	0
	Mild	1
	Hysterical	2
5. Verbal evaluation or body language	Patient asleep or state no pain	0
	Mild pain (cannot localize)	1
	Monderate pain (can localize) verbally or by pointing	2

After surgery, patients stayed for 30 min in the recovery room. They were then transferred to the ward where they were evaluated by their nurse using a pediatric pain scale[11] every 1 h for 24 h after the surgery. The objective measure consisted of 0 to 2 point scoring of five criteria, including blood pressure, crying, moving, agitation, and verbal responses or body language (Table 1). Indirect arterial blood pressure and pulse oximetry were monitored on the ward. Postoperative pain therapy was determined by the patient's pain score, and those patients who underwent rectal acetaminophen 10 to 20 mg/kg for a score ≥ 3. Each parent stayed with their child on the ward, and they asked measurement of a pain score to the nurse in charge when their child was crying and/or agitating.

Table 2 Demographic data. Group R : Patients who received 0.2% ropivacaine 1 ml/kg. Group B : Patients who received 0.25% bupivacaine 1 ml/kg.

Demographic Data		
	Group B (n = 18)	Group R (n = 19)
Age (yrs)	2.8 ± 1.6	2.5 ± 1.3
Gender (male/female)	12/8	10/10
Height (cm)	93 ± 11	91 ± 11
Weight (kg)	14.3 ± 2.8	12.9 ± 2.7
Duration of anesthesia (min)	43 ± 8	45 ± 9
Duration of surgery (min)	26 ± 6	28 ± 11

Table 3 Mean arterial pressure and heart rate. Group R : Patients who received 0.2% ropivacaine 1 ml/kg. Group B : Patients who received 0.25% bupivacaine 1 ml/kg.

Changes in Mean Arterial Pressure			
	Mean Arterial Pressure (mmHg)		
	Baseline	30 min after Caudal Block	30 min after Surgery
Group R (n = 18)	78 ± 16	75 ± 14	76 ± 17
Group B (n = 19)	77 ± 13	76 ± 10	77 ± 19
Changes in Heart Rate			
	Heart Rate (bpm)		
	Baseline	30 min after Caudal Block	30 min after Surgery
Group R (n = 18)	119 ± 24	122 ± 13	123 ± 18
Group B (n = 19)	123 ± 20	124 ± 18	127 ± 13

Approximately 2 ml of blood was obtained from the venous sampling cannula, and plasma concentration of each local anesthetic was measured by gas chromatography at 5, 15, 30, 45, 60, 75, and 90 min after caudal injection of local anesthetics.

Data are presented as mean ± SD. Comparisons between the different variables (age, sex, height, weight, durations of anesthesia and surgery) in the two groups were performed using Student's t-test. Comparisons between groups were made by Wilcoxon test. Intergroup differences were analyzed by repeated-measures ANOVA with Bonferroni's correction as post hoc testing. The threshold for statistical significance was $p < 0.05$.

RESULTS

When surgical procedure was started, two patients in Group R and one patient in Group B required more than 1% of sevoflurane to prevent their body movement. Therefore, they were excluded from this study. Eighteen patients in Group R and 19 patients in Group B experienced adequate anesthesia during surgery, and no patient required any analgesics under general anesthesia with 66% nitrous oxide in oxygen supplemented with less than 1% of sevoflurane. The patients in both groups were similar in age, sex, height, weight, durations of anesthesia and surgery (Table 2) . MAP and HR did not change significantly before and after surgery (Table 3) .

As shown in Table 4, the pain scores of all patients were presented 0 to 2 within the first 24 h after surgery. Therefore, no patient required analgesics. Two patients in Group R and three patients in Group B complained of nausea after surgery. None of children

Table 4 Pediatric pain score. Group R : Patients who received 0.2% ropivacaine 1 ml/kg. Group B : Patients who received 0.25% bupivacaine 1 ml/kg.

Pediatric Pain Score			
2 hours after the surgery	Pain Score		
	0～2	3～6	7～10
Group R (n = 18)	18	0	0
Group B (n = 19)	19	0	0
6 hours after the surgery	Pain Score		
	0～2	3～6	7～10
Group R (n = 18)	18	0	0
Group B (n = 19)	19	0	0
24 hours after the surgery	Pain Score		
	0～2	3～6	7～10
Group R (n = 18)	18	0	0
Group B (n = 19)	19	0	0

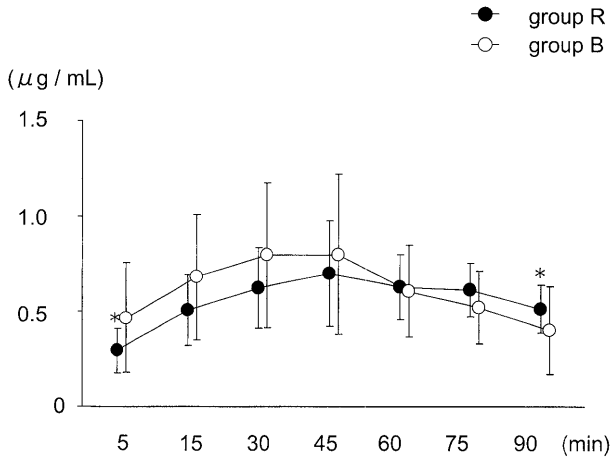

Fig. 1 The mean plasma concentrations of 0.2% ropivacaine 1 ml/kg (Group R) and 0.25% bupivacaine 1 ml/kg (Group B) after caudal injection. *P < 0.05 vs group B

in Groups R and B were found to have respiratory difficulty, pruritus, anuresis, and disturbance of drinking and eating.

The mean maximum concentrations of ropivacaine and bupivacaine in Groups R and B were 0.70 ± 0.28 μg/ml at 45 min and 0.80 ± 0.42 μg/ml at 30 min after the caudal injection, respectively (Fig. 1). The plasma concentration of ropivacaine at 5 min after the caudal injection was significantly lower than that of bupivacaine ($p < 0.05$), and the plasma concentration of ropivacaine at 90 min after the caudal injection was significantly higher than that of bupivacaine ($p < 0.05$). Neither child showed any sign or symptom of local anesthetic toxicity.

DISCUSSION

General anesthesia combined with caudal block is frequently used in pediatric lower abdominal and lower limb operations[12～15]. Light general anesthesia combined with caudal injection of local anesthetics may be the most suitable technique for inguinal herniorrhaphy, since it can be used for intraoperative analgesia and postoperative pain control. Moore et al.[16] reported that a single shot caudal block is preferable to a continuous technique because (1) it is technically less difficult and time-consuming ; (2) the incidence of complications is less ; and (3) the incidence of unsatisfactory anesthesia is less.

Ropivacaine has recently been used in clinical practice because it is less toxic to the cardiovascular and central nervous systems than bupivacaine[9, 10] . Ropivacaine also has a quicker onset of action and less motor block than bupivacaine. Therefore, ropivacaine may be preferable for pediatric caudal block. To date, no single study has compared the efficacy of caudal block with 0.2% ropivacaine or 0.25% bupivacaine for perioperative pain management except for the influence of general anesthesia in children. From this study, caudal block with 0.2% ropivacaine 1 ml/kg was appropriate for intraoperative and postoperative pain relief in children who undergo inguinal herniorrhaphy under light general anesthesia. None of children required any analgesics in the intraoperative and postoperative period. However, two out of 20 patients in Group R and one out of 20 patients in Group B required more than 1% of sevoflurane to prevent their body movement when the surgical procedure was started approximately 15 min after caudal block. We excluded them from the study as the technical failure.

The maximum plasma concentrations of ropivacaine and bupivacaine were 0.70 ± 0.28 μg/ml and 0.80 ± 0.42 μg/ml, and attained at 45 min and 30 min after caudal injection of each local anesthetic, respectively. Those values were below the threshold, 2.2 μg/ml and

2.1 μg/ml for ropivacaine and bupivacaine, respectively, that produced symptoms and signs of toxicity of the central nervous system after intravenous injection in healthy volunteers[17]. Of particular interest was the observation that the plasma concentration of ropivacaine at 5 min after caudal injection was significantly lower than that of bupivacaine, and the plasma concentration of ropivacaine at 90 min after caudal injection was significantly higher than that of bupivacaine. Furthermore, the plasma concentrations of ropivacaine were lower from 5 to 45 min after caudal injection and higher from 60 to 90 min compared with those of bupivacaine. A vosoconstrictive property of ropivacaine may produce such results because of slower vascular uptake of the local anesthetic from the caudal epidural space[18].

There are some pain scales on evaluation of postoperative pain scores after pediatric caudal block. Luz et al.[19] measured pain scores after caudal block using an objective pain scale (0 – 10 points) for children younger than 5 years. They also used a visual analogue scale (VAS) for children older than 5 years. Koinig et al.[20] used an observational pain-discomfort scale (OPS), which gave a cumulative score from 5 to 15 to estimate the quality of analgesia by assessment of behavioral objective parameters (crying, facial expression, position of the torso, position of the legs, and motor restlessness). Karmakar et al.[18] used a four-point behavior observer scale (1 = no sign of pain or uneasiness, 2 = uneasy but does not seem to be in pain, 3 = moderate pain, and 4 = severe pain) to assess pain scores after pediatric caudal block. In the present study, we used a pediatric pain scale including blood pressure, crying, moving, agitation, and verbal responses or body movement[11]. This scale consists of physical response and behavior to pain after surgery. There is no reliable measurement of pediatric pain scores. We believe, however, that the scale in this study is acceptable for the evaluation of postoperative pain scores in children.

With regard to concentrations of ropivacaine, Luz et al.[19] compared analgesic efficacy induced by 0.1 % and 0.2 % ropivacaine after caudal anesthesia in children. Single-shot caudal block with 0.1 % ropivacaine was less effective for intraoperative and postoperative pain relief than that of 0.2 % ropivacaine. They have pointed out that the duration of pediatric caudal analgesia with 0.2 % ropivacaine is approximately 4.5 h, which are similar to that of 0.375 % ropivacaine. Koinig et al.[20] demonstrated that the most effective analgesia produced by pediatric caudal block was achieved by 0.5 % ropivacaine. However, it was accompanied by a longer and more pronounced motor block. Children feel extremely uncomfortable in the postoperative period when they experience residual motor block. From our and previous studies, 0.2 % ropivacaine is recommended for caudal block in children who undergo surgery below the umbilicus under general anesthesia.

In conclusion, pediatric caudal block with 0.2 % ropivacaine 1 ml/kg is effective for intraoperative analgesia, postoperative pain control, and reducing toxicity of local anesthetics in children undergoing inguinal herniorrhaphy.

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