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Research Article

CAUDAL EPIDURAL ANAESTHESIA IN CHILDREN: A COMPARATIVE STUDY OF THREE DIFFERENT CONCENTRATIONS OF LEVOBUPIVACAINE

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ABSTRACT

This study was undertaken to investigate three different concentrations of levobupivacaine (0.125%, 0.20%, and 0.25%; n = 30 in each group) in children for caudal blockade in a prospective, randomized, blinded fashion in the age group of 1–7 yrs undergoing surgery below umbilicus. The total duration of analgesia was assessed as the time to first administration of supplemental analgesia (based on a Childrens and Infants Postoperative Pain Scale score of ≥4), and the degree of immediate postoperative motor blockade was determined by using a 3-point scale. A relationship of dose-response was observed both with regard to median duration of postoperative analgesia (0.125%, 60 min; 0.20%, 118 min; 0.25%, 158 min) and the number of patients with evidence of early postoperative motor blockade (0.125%, 0; 0.20%, 4; 0.25%, 8). A significantly delayed motor blockade was observed with 0.125% concentration ($P = 0.003$) but was found to result in a significantly shorter duration of postoperative analgesia ($P < 0.05$). All patients were haemodynamically stable intra and postoperatively.

From the above observations, it was evident that the use of 0.20% levobupivacaine might represent the best clinical option if a plain levobupivacaine solution is to be used for caudal blockade in children.

Key Words: *Caudal, Levobupivacaine, Three Concentrations, Postoperative Analgesia*

INTRODUCTION

In all areas of anesthesia, safety and efficiency are valued goals and in developing countries additional challenges due to shortages of anesthetic drugs, supplies and monitoring equipment may be present. Caudal epidural anesthesia in developing countries, can in combination with general anesthesia or alone provide safe, reliable and efficient analgesia and / or anesthesia for both high risk and general pediatric surgical patients.

These techniques can be easily learnt and may be modified to extend analgesia into the postoperative period (with the addition of opioids or continuous techniques) or replace general anesthesia in circumstances where either the equipment or general anesthetic techniques are not available.

Levobupivacaine, the S(-) enantiomer of bupivacaine, with less cardiovascular and central nervous system toxicity, a slightly longer duration of sensory block, but otherwise similar to its parent. The rationale for using levobupivacaine is to reduce the risk for unwanted motor blockade (McClure, 1996; McLeod and Burke, 2001) and also to provide a wider margin of safety for both central nervous system and cardiac toxicity in comparison with racemic bupivacaine (McClure, 1996; McLeod and Burke, 2001; Santos and DeArmas, 2001).

Ropivacaine has been well documented both in adults and children (McClure, 1996; Lonnqvist *et al.*, 2000; Ivani *et al.*, 1998, 1999; Luz *et al.*, 2000; and Bosenberg *et al.*, 2002). However, fundamental information concerning the use of levobupivacaine in children is still lacking despite an adequate bibliography with regard to adult practice (McLeod and Burke, 2001). Thus, the aim of the current study was to investigate the dose-response relationship of levobupivacaine for caudal blockade in children.

MATERIALS AND METHODS

The study was a prospective, blinded, randomized, comparative type. The sample size was based on the previous studies (Bosenberg *et al.,* 2002; and Ivani et *al.,* 2002). The calculation revealed that 15 subjects per group were needed to detect a difference in the duration of postoperative analgesia as small as 1.5 times the standard deviation with power of 0.8 and significance level of 0.05, the sample size was doubled (30 per group) to account for the skew deviation of the variables in the study.

After Institutional Ethics Committee approval and written informed parental consent, children in the age group of 1–7 years under ASA status I and II, scheduled for elective inguinal surgery, were enrolled in the study. Children with bleeding disorders, neuromuscular disease, bony abnormalities of the spine and infection at the site of caudal analgesia were excluded from the study. 90 children were randomly allocated into three groups of 30 each based on picking lots from a sealed bag to receive a caudal block with one of three different concentrations as follows-

Group I – 0.125% of Levobupivacaine 1 ml/Kg
Group II – 0.20% of Levobupivacaine 1 ml/Kg
Group III – 0.25% of Levobupivacaine 1 ml/Kg

All patients received oral premedication with 0.5 mg/kg of midazolam approximately 30 min before the induction of anesthesia. Anesthesia was induced either with IV propofol (2–3 mg/kg) or with inhaled induction of sevoflurane 8% in oxygen. Airway management was performed by either a face mask or a laryngeal mask airway and anesthesia was subsequently maintained with sevoflurane 1%–3% in oxygen-air using spontaneous ventilation. Heart rate (HR), noninvasive blood pressure (NIBP), respiratory rate, $EtCo_2$, and SpO_2 were monitored throughout the procedure.

After the induction of anesthesia, patients were placed in the lateral decubitus position, and a caudal blockade was performed. After identifying the sacral hiatus, the skin over the caudal area is cleaned with Betadine and alcohol (70%) containing solution, which is allowed to dry. Then, using sterile technique, the caudal epidural space is entered using a short 22-gauge needle. The needle is inserted at a 60-degree angle and the needle is advanced until a "pop" is felt. The needle is then lowered to a 20-degree angle and advanced an additional 2-3 mm to make sure the bevel is in the caudal epidural space. Test aspiration was done gently as vessel walls can easily collapse producing a false negative. If no blood or CSF is aspirated then local anesthetic was injected in small amounts, with repeated aspirations throughout the injection. The preparation of drug was done by one anaesthesiologist and the caudal block was performed by another. The latter also monitored the intraoperative variables and scores.

The surgical incision was made 10 min after caudal placement of the drug and the duration of surgery was noted. An intraoperative successful blockade was defined as a hemodynamic (HR or NIBP) reaction <20% compared with baseline in response to surgical incision. The intraoperative haemodynamic and respiratory parameters were monitored and documented every 5 min till awakening. The duration of anaesthesia was noted in all the three groups. After emergence from anesthesia, the degree of motor blockade was registered using a simple 3-point scale (0 = no movements, 1 = possible to move the legs, and 2 = able to stand) Ivani *et al.,* (2002).

The heart rate, blood pressure, respiratory rate, pain score and sedation score were assessed in the postoperative period for 2 hours. Postoperative analgesia was evaluated by the Childrens and Infants Postoperative Pain Scale (CHIPPS) (10). CHIPPS is a well-validated five-item behavioral scale where each variable (crying, facial expression, posture of the trunk, posture of the legs, and motor restlessness) is given a score of 0–2 with a total score of ≥4 identifying the need for supplemental analgesia (10). The follow-up in ward for FLACC scale was noted separately by the anaesthesiologist and nurse who were blinded.

The time from caudal placement of drug to the first recording of a FLACC scale > 3 was taken as the duration of analgesia. Rescue analgesia was provided with paracetamol suppository 40 mg/kg when ever the pain score was recorded as > 3. The number of rescue analgesics required in first 24 hours was also noted. The sedation score was graded as 0 for awake, 1 for mild (arousable by voice), 2 for moderate

(arousable to pain) and 3 for unarousable. The sedation score was assessed every 15 min. and documented for 2 h in the recovery room.

Data was reported as mean ± SD. The influence of the drug concentration on motor blockade was analyzed by Fisher's exact test. Time to first supplemental analgesic request was compared using the Mann-Whitney U-test. A P value <0.05 was considered statistically significant.

RESULTS

The age, weight and the duration of surgery in the study groups were compared using the independent't' test. The type of surgery was compared between the three groups using the Pearson's chi-square test. The study groups were comparable with respect to age, weight and duration of surgery (Table 1). The type of surgery was similar in all the three groups (Table 2).

Table 1: Demographic Data in different group of patients (mean ± SD)

Sr. No.	Demographic Data	Number of patients		
		Group A	Group B	Group C
1	Age (years)	3.62 ± 1.51	3.86 ± 1.68	3.77 ± 1.30
2	Weight (Kg)	12.33 ± 2.65	13.6 ± 2.93	13.31 ± 2.66
3	Gender (M:F)	29/1	30/0	29/1
4	Duration of surgery (min)	32.7 ± 9.21	37.12 ± 10.54	33.76 ± 9.87

Table 2: Surgical procedures performed in groups

Sr. No	Operative procedure	Number of patients		
		Group A	Group B	Group C
1	Inguinal hernia repair	12	13	16
2	Hydrocele repair	08	09	08
3	Orchidopexy	03	05	02
4	Phimosis	07	03	04

Table 3: Degree of Motor blockade during first postoperative hour in different groups

Sr. No.	Motor score	Number of patients		
		Group A	Group B	Group C
1	0	00	00	00
2	1	00	06	12
3	2	30	24	18

Measured with simple 3-point scale (0 = no movements, 1 = possible to move the legs, and 2 = able to stand)

Table 4: Pain score >3 at different time intervals prior to rescue medication

Sr. No.	Number of patients with pain score>3 at	Number of patients		
		Group A	Group B	Group C
1	1h	17	08	00
2	2h	13	16	09
3	4 h	00	06	14
4	8h	00	02	06
5	12h	00	00	01

No signs of motor blockade could be observed after the first postoperative hour in any of the patients. However, during the first postoperative hour, six children in Group II and twelve children in Group III had a motor blockade score of 1, whereas all patients in Group I were without any signs of motor

blockade during the first postoperative hour. This difference in motor blockade during the first postoperative hour was statistically significant between Group I and Group III (P = 0.003; Group I versus Group II, P = 0.106; Group II versus Group III, P = 0.301).

Rescue analgesia (caused by a FLACC score of > 3) was administered to eleven patients (35%) in Group I, 10 patients (35%) in Group II, and nine patients in Group III (30%) (P = ns). The highest FLACC score registered for each individual patient during the first 4 postoperative hours is displayed in Table 4. The pain score was compared using the Pearson's chi square test. There was a significant difference in the pain score of children in Group I, II and III. 17 children required rescue analgesic within first hour of postoperative period in group I as compared to 8 children in group II. 13 children in group I required rescue analgesia within 2 hours as compared to 16 children in group II and 9 children in group III. Where as 6 children in group II and 14 children in group III required analgesia within next 4 hours. Maximum 6 children required analgesia within 8 hours in group III as compared to 2 children in group II. And 1 child in group III required analgesia within 12 hours of postoperative period. The requirement of rescue medications was compared to groups using Pearson's chi square test and it was found to be significant when Group I was compared to group II and Group III (group I versus group II, $p < 0.037$; Group I versus Group III, $p < 0.053$; Group II versus Group III, $p < 0.52$). No nausea or vomiting were noted in any of the patients during the observation period.

DISCUSSION

The present study found a clear dose-response relationship for levobupivacaine within the concentration range of 0.125%–0.25% with regard to both early postoperative motor blockade and the time to first administration of supplemental postoperative analgesia after caudal anesthesia in children.

No differences were observed between the intraoperative efficacies of the various concentrations of levobupivacaine used in the study. However, during the early postoperative phase, an obvious dose-response effect was seen with regard to motor blockade. Only patients receiving 0.125% levobupivacaine were free of postoperative motor blockade, whereas the number of patients with residual motor blockade increased with increasing concentrations of levobupivacaine. In the group treated with 0.25% levobupivacaine, as many as 40% of the patients' experienced residual motor blockade during the first postoperative hour. This finding is similar to what has been reported for use of ropivacaine in children. Thus, using ropivacaine concentrations in excess of 0.2% for caudal blockade in children is also associated with an increased incidence of early motor blockade (Da Conceicao *et al.,* 1998; 1999). The use of ropivacaine 0.2% for caudal blockade rarely causes and effects on early motor function (McClure, 1996; Lonnqvist *et al.,* 2000; Ivani *et al.,* 1998, 1999; Luz *et al.,* 2000) and Bosenberg *et al.,* (2002) a finding that somewhat contrasts with the 20% incidence of residual motor blockade found in the 0.2% levobupivacaine group. However, the equipotency between ropivacaine and levobupivacaine has been disputed, and the minimum effective local anesthetic concentration studies have found the potency of ropivacaine to be only 60% of racemic bupivacaine (D'Angelo, 1999). Thus, the difference with regard to early postoperative motor function between 0.2% ropivacaine and 0.2% levobupivacaine could only be a reflection of a potency difference between the two drugs.

In patients developing a CHIPPS score of ≥4 during the postoperative period, a clear relationship between the concentration of levobupivacaine and duration of analgesia was seen. This somewhat contrasts the previous findings by Wolf *et al.,* (1998) who were unable to find such a correlation between bupivacaine concentration used and the duration of analgesia. The exclusion of epinephrine as an additive to the local anesthetic in the present study might explain this difference in outcome of the two studies. The use of 0.2% or 0.25% levobupivacaine was associated with a two-fold and 2.6-fold increase in the duration of the block, respectively, compared with the 0.125% solution. However, these results must be interpreted with a certain degree of caution because a similar number of patients in each group had appropriate analgesia (CHIPPS score <4) throughout the 24-hour observation period and thus did not require the administration of supplemental analgesics. In line with the studies by Wolf *et al.,* (1998) and Gunter *et*

al., (1991) a considerable number of patients in the present study underwent surgical corrections of inguinal hernia or hydrocele. Although this group of patients represents a significant part of the pediatric surgical population, these patients might be suboptimal for the study of postoperative analgesia because a large proportion does not experience pain to the extent that supplemental analgesia is required. Thus, despite the problem with patient recruitment, further studies in this field should perhaps be performed on a patient population with more pronounced problems with postoperative pain relief, e.g., orchidopexy. Furthermore, Verghese *et al.,* (2001) have shown that efficacy of a caudal block for orchidopexy patients is not only related to the concentrations of the local anesthetic but also to the volume injected. Because the injected volume of local anesthetic was fixed (1 mL/kg), no conclusions in this regard can be drawn for the present study.

Although a moderate degree of residual motor blockade during the first postoperative hour might not be considered a major problem, such an effect can be quite distressing for the child during emergence from anesthesia and could potentially contribute to postoperative agitation and confusion. Therefore, the use of 0.125% levobupivacaine may have a clinical advantage. On the other hand, the use of the 0.125% solution was associated with a quite limited duration of postoperative analgesia in certain patients, and thus, maybe 0.2% levobupivacaine would represent a better clinical compromise between postoperative analgesia and degree of residual motor blockade.

Only limited information has been available regarding the pediatric use of levobupivacaine, (Ivani *et al.,* 2002; Gunter *et al.,*1999; De Negri *et al.,* 2002; Lerman *et al.,* 2002; Taylor *et al.,* 2002) and no information has been published with regard to the use of different concentrations of levobupivacaine for caudal blockade in children.

The rationale for choosing the concentrations of levobupivacaine used in the present study was based on the following: First, because racemic bupivacaine and levobupivacaine are considered to be equipotent, (McLeod *et al.,* 2001) we decided to use the concentrations 0.125% and 0.25%, which previously have been investigated with regard to the optimum concentration of racemic bupivacaine for caudal blockade in children (Wolf *et al.,* 1988 and Gunter *et al.,* 1999). Second, there is a relatively large number of studies and data were present with regard to the use of 0.2% ropivacaine in the setting of pediatric caudal blockade (Lonnqvist *et al.,* 2000; Ivani *et al.,* 1998 and 1999; Luz *et al.,* 2000; Bosenburg *et al.,* 2002). Because of the current discussion relating to the potency of ropivacaine versus levobupivacaine, we decided to include 0.2% levobupivacaine to allow a comparison with previously reported data for ropivacaine.

In conclusion, a dose-response relationship for levobupivacaine was observed both with regard to duration of postoperative analgesia and early postoperative motor blockade. The 0.125% concentration was associated with less early motor blockade but resulted in a shorter duration of postoperative analgesia. Based on the current results, the use of 0.20% levobupivacaine might represent the best clinical option if a plain levobupivacaine solution is to be used for caudal blockade in children.

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