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CLINICAL REPORT

Caudal bupivacaine and morphine provides effective postoperative analgesia but does not prevent hemodynamic response to pneumoperitoneum for major laparoscopic surgeries in children

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Abstract The use of a caudal block in laparoscopic surgery in children is limited to minor procedures like inguinal hernia repair, and intravenous opioids remain the analgesic modality of choice in major laparoscopic surgery. However, a caudal block is frequently performed at our institute even for laparoscopic surgery. Therefore, we planned to evaluate the analgesic efficacy of caudal bupivacaine and morphine in major laparoscopic surgery as compared to intravenous opioids. Our hypothesis was that a single-shot caudal block would increase the duration of analgesia and minimize the hemodynamic response to pneumoperitoneum. After institutional ethics committee clearance, data were collected for 65 ASA I–II children aged 6 months to 12 years who underwent laparoscopic surgery in the last 14 months. Demographic, surgical, and perioperative anesthetic and analgesic data were noted and analyzed. Twenty-four children received a caudal block with 0.25 % bupivacaine (1–1.25 ml/kg) with morphine (30–50 mcg/kg). In the caudal group, the time to first analgesic request was increased (165 vs. 45 min; $p = 0.00$) and tachycardia response to port site incision was less observed (33 vs. 63 % children; $p = 0.019$). Hemodynamic response to pneumoperitoneum was equal in both of the groups. Single-shot caudal injection of local anesthetic with morphine reduces port site skin incision response and increases the duration of postoperative analgesia but fails to prevent hemodynamic response to pneumoperitoneum.

Keywords Caudal block · Laparoscopy · Children · Morphine

Introduction

Laparoscopic surgery in children was first reported in 1971 and since then an increasing trend has been observed [1]. Although less painful than an open surgical technique, laparoscopic surgeries are not pain free [2]. Pain following laparoscopy is multifactorial and use of minimal abdominal insufflation pressure and meticulous removal of residual gas may help in minimizing pain. Inadequate pain relief can lead to adverse physiological, emotional, and developmental consequences in children [3].

Different analgesic modalities like parenteral opioids, local anesthetic infiltration of port site, non-steroidal anti-inflammatory drugs (NSAIDs), and acetaminophen have been used as part of a multimodal analgesic regimen with varying success in pediatric laparoscopic surgeries [4].

Caudal analgesia, due to its safety and technical simplicity, is the most commonly used regional anesthetic technique for lower abdominal and lower limb surgeries in children [5]. Caudal block may provide effective perioperative analgesia for port-site incisions and peritoneal stretching caused by laparoscopic abdominal surgeries. Available literature on the efficacy of caudal block in laparoscopic surgeries in children is limited and mainly found in the setting of inguinal hernia repair [6–8], which shows that caudal blockade is at least equally or more effective than port-site

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Table 1 Demographic and baseline characteristics of the children

	Group C ($n = 24$)	Group P ($n = 41$)	p value
Age (years)	6.5 [1–12]	8 [1–15]	0.138[a]
Sex (male/female)	19/5	34/7	0.706[c]
Body weight (kg)	19 [8–30]	21 [8–43]	0.102[a]
ASA PS I/II	23/1	39/2	0.895[c]
Type of surgery (orchidopexy/nephrectomy/appendectomy/cholecystectomy)	9/7/5/3	18/14/6/3	0.804[¢]
Intra-abdominal pressure (mmHg)	19.5 (2.8)	18.9 (1.6)	0.405[b]
Duration of surgery (in min)	120 [60–420]	97.5 [30–200]	0.261[a]
Duration of anesthesia (min)	150 [90–450]	132.5 [45–235]	0.235[a]

Data expressed as mean (SD), median [range] or proportion

[a] Mann–Whitney *U* test

[b] Independent sample *t* test

[c] Chi-square test

[¢] Fisher exact test

infiltration or acetaminophen suppositories [6, 7]. However, analgesic efficacy of single-shot caudal local anesthetic with morphine has been observed in open upper abdominal, urological, and cardiac surgeries in children [9, 10]. Therefore, caudal block may have a significant role in perioperative pain management in laparoscopic major abdominal surgeries. Hence, we designed this retrospective study to identify the efficacy of preoperative single injection caudal block in providing perioperative analgesia for major laparoscopic surgeries in children.

Methodology

After obtaining the institute's ethical committee permission, children aged between 6 months and 12 years who underwent laparoscopy surgery at our institute between January 2013 and May 2014 were eligible to be included in this retrospective study.

Data collection

Anesthetic charts, case records, and nurses chart of the patients were obtained from the medical record section of the institute. A detailed review of all records was done to extract the necessary data. The data which were noted from anesthesia case record have been provided in the Online Supplementary Material. All the data obtained were tabulated in a Microsoft Excel data sheet. The following patients were planned to be excluded from the analysis:

(1) Insufficient availability of data.
(2) Conversion to open surgery.

Analysis of data

Statistical analysis was done by IBM SPSS Statistics Software for MAC version 21.0. Independent sample *t* test, Mann–Whitney *U* test and Chi-square test were used as applicable. A p value <0.05 was considered statistically significant.

Results

Sixty-five patients were included in this study. Baseline demographic characteristics, type of surgery, duration of surgery, and anesthesia were similar between patients who received caudal block or not (Table 1). Twenty-four patients received preoperative caudal block and the remaining 41 did not.

Anesthesia protocol

In the OR, anesthesia was induced by gradually increasing the concentration of sevoflurane in oxygen. After intravenous cannulation, an injection of fentanyl was given at a dose of 2 mcg/kg. In children who had an intravenous cannula in situ, anesthesia was induced by 2–4 mg/kg propofol or 4–5 mg/kg of thiopentone sodium. Muscle relaxation was achieved by injection of atracurium 0.5 mg/kg and endotracheal intubation was done in all patients. Anesthesia was maintained by isoflurane in air-oxygen and intermittent boluses of atracurium and fentanyl as clinically judged. Intravenous paracetamol was given at a dose of 15 mg/kg 30 min before completion of surgery.

In the postoperative period, all children received intravenous paracetamol every 8 h and rescue analgesia was provided by injection of fentanyl at 0.5 mcg/kg.

Table 2 Analgesic efficacy of caudal block

	Group C ($n = 24$)	Group P ($n = 41$)	p value
Time to first rescue analgesia (min)	165 [45–480]	45 [30–120]	***p < 0.0001***[a]
Total fentanyl consumption in 24 h (mcg/kg)	1.04 (0.29)	2.29 (0.56)	***p < 0.0001***[b]
Tachycardia at skin incision (yes/no)	8/16	26/15	***0.019***[c]
Tachycardia at pneumoperitoneum (yes/no)	18/6	36/5	0.184[c]
Hypertension at pneumoperitoneum (yes/no)	17/7	35/6	0.157[c]
Intraoperative fentanyl consumption (mcg/kg)	5.5 (1.5)	5.8 (1.7)	0.463[b]
Time to discharge from PACU (min)	60 [30–90]	45 [30–90]	0.054[a]
Time to hospital discharge (days)	6 [1–8]	4 [2–9]	0.070[a]

Data expressed as mean (SD), median [range] or proportion

Bold values indicate statistical significance at $p < 0.05$

[a] Mann–Whitney U test

[b] Independent sample t test

[c] Chi-square test

Characteristics of caudal block

A resident who had at least 1 year of experience performed caudal block. In all patients, 0.25 % preservative-free bupivacaine was used. Median (range) dose of the local anesthetic was 1.0 (0.75–1.25) ml/kg. Morphine was added with local anesthetic in caudal block with a median (range) dose of 50 mcg/kg (30–50 mcg/kg).

Analgesic efficacy

Time to ask for first analgesia in the postoperative period was significantly longer in patients who received caudal analgesia (median difference by Hodges–Lehmann method 105 min, 95 % CI 80–135 min). Incidence of hypertension and tachycardia at the time of creation of pneumoperitoneum was found to be similar in patients who received caudal block and those who did not. Tachycardia at the time of port-site skin incision was significantly less in patients who received caudal block (Table 2). However, intraoperative fentanyl consumption was similar in both of the groups.

Complications

None of our patients in any group had postoperative vomiting, pruritus, or respiratory depression. The incidence of urinary retention could not be assessed, as most of our children underwent urological surgeries and hence they were kept catheterized for 24–72 h after surgery. Time to discharge from PACU and time to discharge from hospital was similar in between children who received caudal block and who did not.

Discussion

Available data on caudal block in laparoscopic surgeries in children are mostly limited to minor laparoscopic procedures and studies aiming to compare caudal block with local infiltration or paracetamol or NSAIDs [4, 7, 8, 11]. On the contrary, we included children for major laparoscopic surgery since they are the population who might be maximally befitted from caudal analgesia. Moreover, we included a relatively larger number of children compared to previous studies. Intravenous opioids are otherwise routinely used in these surgeries and the benefit of caudal blockade was reflected in increased time to first analgesic request and reduced 24-h opioid consumption in the present study. However, intraoperative opioid consumption, time to PACU discharge, and time to hospital discharge were not affected.

Our patients received bupivacaine 0.25 % 1 ml/kg for caudal block. Previous studies show wide variation in drug dosage. Golladay et al. [6] found better pain control with caudal bupivacaine 0.6 ml/kg than with high-dose acetaminophen suppositories in laparoscopic inguinal procedures. However, this included a limited number of subjects with heterogeneous study population including neonates as well. Tobias et al. [7] observed that caudal 0.25 % bupivacaine 1.2 ml/kg was more effective than local infiltration combined with ilioinguinal/iliohypogastric block for analgesia after inguinal herniorrhaphy with laparoscopic inspection of the peritoneum. Borkar et al. [11] found that caudal bupivacaine 0.2 % 1 ml/kg was equally efficacious as compared to the combination of diclofenac suppository 3 mg/kg and port site infiltration after laparoscopy in children. However, the use of adjuvant was the main difference in our study. Morphine is the most often used additive in caudal block and we used caudal morphine 30–50 mcg/kg in view of major laparoscopic surgery. None of the previous studies used any adjuvant with local anesthetics, which may be a reason for a questionable benefit of caudal block after laparoscopy. The reduced requirement of postoperative intravenous opioid could be attributed to caudal morphine.

We found that caudal analgesia prevented hemodynamic response of skin incision but failed to prevent hemodynamic responses to pneumoperitoneum. The pneumoperitoneum response is predominantly a sympathetic system-mediated response and caudal local anesthetic block by its sympatholytic property should prevent it. However, failure to prevent this response by caudal blockade emphasizes the possible involvement of the rennin–angiotensin

and vasopressin system along with the role of circulating catecholamines [12]. Moreover, the presence of hemodynamic response to pneumoperitoneum in both of the groups mandated the use of further fentanyl in both of the groups negating any advantage caudal blockade could otherwise provide in intraoperative analgesic requirement. Abdominal insufflation pressure may be an important determinant of ongoing pneumoperitoneum response [11] and it was similar in both the groups. As the height of sensory block with even a 1–1.2 ml/kg dose of local anesthetic in caudal space might not reach mid-thoracic level in all cases [13, 14], inadequate sensory block may be a reason why pneumoperitoneum response was not prevented. Though rostral spread of caudal morphine has been reported, and it has been found to be effective for even the cardiac surgical population [15], spread is delayed [16]. We have not been able to control the time between caudal block and pneumoperitoneum, so it is not possible to determine whether sufficient time could have decreased sympathetic stimulation.

As most of the children in our study undergoing major laparoscopy surgery and laparoscopic urological surgeries were catheterized for 24–48 h, the incidence of urinary retention could not be assessed. It is worth mentioning that none of our children had respiratory depression or sedation. It is also worth mentioning that respiratory depression from epidural opioid is delayed, hence monitoring for 12 h postoperatively is desirable.

The most important limitation of our study is the retrospective design and inclusion of a variety of laparoscopic surgical procedures. Nurses administered postoperative rescue analgesics but they were not objectively assessed on specified time intervals or documented properly. As our study is a retrospective one, adverse effects such as nausea and vomiting may be under-reported. Moreover, children, particularly infants, also might not be able to express nausea.

Preoperative single-injection caudal local anesthetic along with morphine provides significant postoperative analgesia following major laparoscopic surgery in children. It may also prevent hemodynamic responses to skin incision but not to pneumoperitoneum. Prospective randomized trials are required to confirm the benefit of caudal analgesia for pediatric surgeries.

Conflict of interest None.

Ethics approval Institutional ethics committee approval was obtained before starting the study.

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