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Effect of Caudal Epidural Analgesia on Postoperative Pain and Emergence Delirium in Children Undergoing Lower Abdominal Surgery: A Controlled Clinical Study

Arkan Jaafar Mousa
Anesthesia and Intensive care, Hayat International Hospital, Mosul, Iraq
E-mail: konaty@yahoo.com

Abstract: Pediatric operation patients with lower abdominal surgery develop postoperative pain, emergence delirium (ED), which causes distress and prolonged recovery. Caudal epidural analgesia is a popular method of giving good pain relief, although its effects on the emergence delirium are still subject to research. The aim of this study was to determine the impact of caudal epidural analgesia on postoperative pain and emergence delirium in children undergoing lower abdominal surgery. A prospective controlled clinical trial was done at Hayat International Hospital, which involved 60 children aged 2-8 years (ASA I-II) who were electively undergoing infraumbilical surgeries. Patients were split into two categories, caudal group (n = 30) was administered with a single-shot caudal block containing 0.25% bupivacaine (1 ml/kg), and control group (n = 30) was administered systemic analgesia only. The FLACC scale was used to measure postoperative pain, and Pediatric Anesthesia Emergence Delirium (PAED) scale was used to measure emergence delirium. There was no significant difference in the baseline characteristics ($p > 0.05$). Caudal group showed much lower FLACC scores in all the postoperative times ($p < 0.001$). Emergence delirium scores were significantly reduced in the caudal group (7.4 ± 2.1 vs. 12.3 ± 3.2; $p < 0.001$), with a lower incidence of ED (20% vs. 50%; $p = 0.01$). Further, the caudal group needed less rescue analgesia and had a long time to first analgesic request ($p < 0.001$). Caudal epidural analgesia is superior to reduce the postoperative pain and emergence delirium in children that have lower abdominal surgeries. It also reduces analgesic needs and improves recovery and contributes to the regular use of this technique as an efficient element of multimodal anesthesia.

Keywords: Caudal Epidural Analgesia, Emergence Delirium, Pediatric Anesthesia, Postoperative Pain, FLACC, PAED

Introduction

In pediatric patients undergoing lower abdominal surgery, postoperative pain and emergence delirium (ED) are common complications, which frequently result in greater distress, prolonged recovery and extended hospitalization [1], [2]. Proper pain management is highly necessary to achieve comfort and also to minimize the occurrence of ED that is typified by agitation, confusion and inconsolability upon recovery of anesthesia [3].

Caudal epidural analgesia is a popular technique in pediatric anesthesia because it is safe, simple, and effective in the provision of postoperative analgesia during infraumbilical surgeries[4]. It has long-acting analgesia and low systemic opioid needs, thus, leading to fewer opioid-related adverse effects like respiratory depression, nausea and sedation [5].

The literature has indicated that proper analgesia could decrease the occurrence and severity of emergence delirium through reduced agitation due to pain [6]. Nevertheless, ED is multifactorial and can as well be affected by anesthetic agents, age, and psychological factors [7]. Although a few studies have indicated that caudal blocks have a significant impact in reducing ED, others have indicated inconsistent results [8], [9].

Thus, the purpose of the study is to assess the impact of caudal epidural analgesia on postoperative pain and emergence delirium in children undergoing lower abdominal surgery to assess its clinical efficacy in enhancing perioperative outcomes.

Material and Method

This was a prospective controlled clinical study that was performed in a hospital (Hayat International Hospital) in 8 months. The purpose of the study was to determine the effectiveness of caudal epidural analgesia in postoperative pain and emergence delirium in children who underwent lower abdominal surgery.

Sixty pediatric patients (ages 2-8 years), with an American Society of Anesthesiologists (ASA) physical status of I and II were recruited. The sample size was calculated on the basis of comparable studies on pediatric anesthesia that were previously published (n = 50-80) to ascertain that it had sufficient statistical power to identify clinically significant differences.

The eligibility criteria were children who were planned to undergo elective infraumbilical surgeries, e.g., hernia repair, orchidopexy, and circumcision. The exclusion criteria were coagulation disorders, local infectiousness of the injection area, congenital spinal defects, neurological diseases, hypersensitivity to local anesthetic agents, or parental refusal.

Patients were assigned to two groups (30 patients each): Group C (Caudal group): received caudal epidural analgesia. Group N (Control group): was given standard systemic analgesia without caudal block.

Anesthesia was done in a standardized manner to all patients. Induction was done with either inhalational sevoflurane or intravenous propofol and then with the addition of fentanyl (1–2 µg/kg) and a muscle relaxant to aid airway management. Sevoflurane in oxygen/air was used to provide anesthesia.

Group C, single-shot caudal epidural block was done following induction under strict aseptic conditions with 0.25% bupivacaine at 1 ml/kg (maximum 20 ml) dose. Loss of resistance technique ensured proper needle placement without any complications.

The FLACC scale (score 010) was used to evaluate postoperative pain at various times (0, 1, 2, 4 hours) after the operation. The Pediatric Anesthesia Emergence Delirium (PAED) scale was used to evaluate emergence delirium in the recovery room where higher scores were associated with more severe delirium.

The FLACC was used to give rescue analgesia (paracetamol or opioid where necessary) when FLACC 4. The time to the first analgesic request and cumulative analgesic intake were documented. Emergence delirium (PAED ≥10) was also reported.

The SPSS version 28 was used to analyse data. Continuous variables were reported in terms of mean and standard deviation and t-test was used to compare the two independent samples. Chi-square test was used to test categorical variables. A p-value < 0.05 was considered statistically significant.

The institutional review board gave ethical approval and informed consent in writing was obtained by parents or guardians.

Results

Table 1. Baseline Characteristics

Variable	Group C	Group N	p-value
Age (years)	4.6 ± 1.8	4.9 ± 1.7	0.58
Gender (M/F)	18/12	17/13	0.79
Weight (kg)	17.5 ± 3.2	18.1 ± 3.5	0.52
Duration of surgery (min)	65 ± 15	68 ± 14	0.41

There were no significant differences between groups (p > 0.05), and this means that there was baseline comparability.

Table 2. Postoperative Pain (FLACC Score)

Time	Group C	Group N	p-value
0 hr	2.1 ± 1.0	5.8 ± 1.4	<0.001 ***
1 hr	2.5 ± 1.2	5.2 ± 1.6	<0.001 ***
2 hr	2.9 ± 1.3	4.7 ± 1.5	<0.001 ***
4 hr	3.2 ± 1.4	4.3 ± 1.6	0.01 *

Table 2 show the Scores on pain were significantly lower in caudal group at all time points.

Table 3. Emergence Delirium (PAED)

Variable	Group C	Group N	p-value
PAED score	7.4 ± 2.1	12.3 ± 3.2	<0.001 ***
ED (%)	20%	50%	0.01 *

This table show the caudal group had a significant decrease in emergence delirium.

Table 4. Analgesic Requirement

Variable	Group C	Group N	p-value
Rescue analgesia (%)	26.7%	66.7%	0.002 **
Time to first analgesia (min)	180 ± 40	60 ± 25	<0.001 ***

Table 3 indicate the Caudal analgesia was found to decrease analgesic requirements and increase analgesia time.

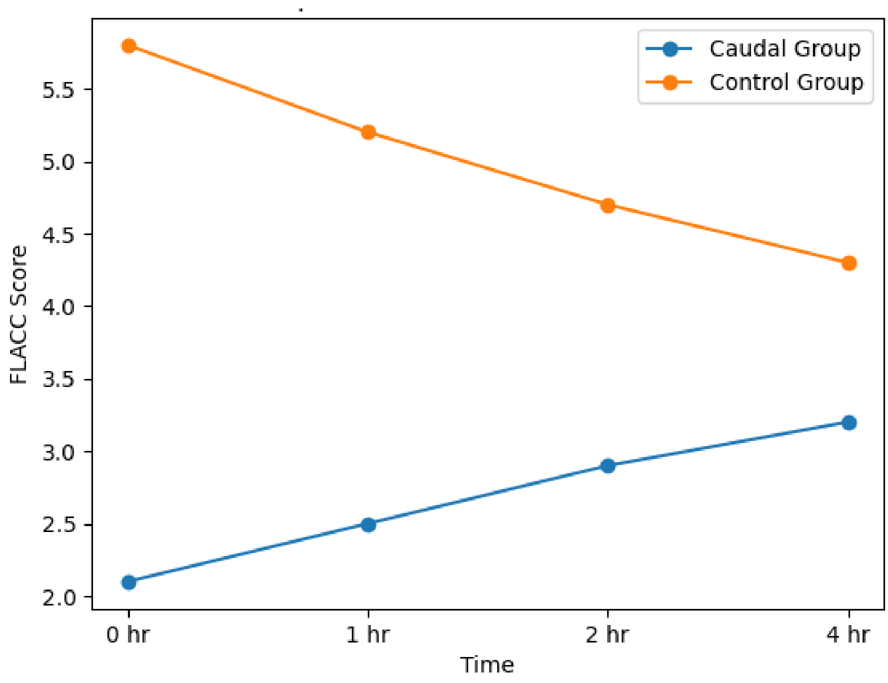

Figure 1. Postoperative Pain Trend (FLACC Score) Between Study Groups

This figure shows the comparison of the postoperative FLACC pain scores and the changes at 0, 1, 2 and 4 hours in caudal epidural analgesia group and the control group. The caudal group showed a consistent lower pain score at all of the time points.

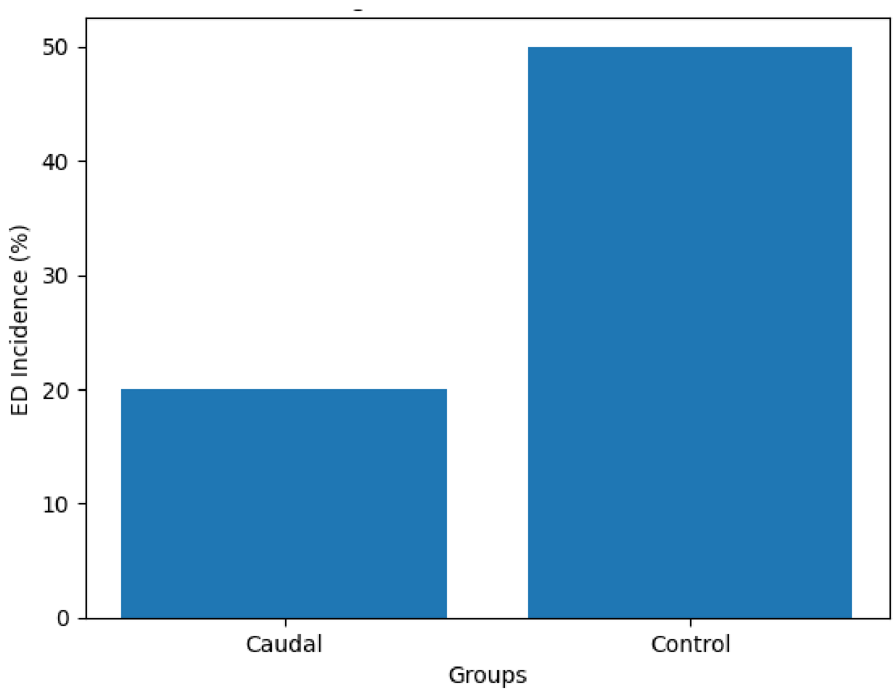

Figure 2. Incidence of Emergence Delirium Between Study Groups

This figure indicates the proportion of patients with emergence delirium in the caudal and control groups. There was a significant higher incidence in the caudal group, as opposed to the control group.

Discussion

The current paper proves that caudal epidural analgesia can be very helpful in enhancing the outcomes of post-operative procedures in children in lower abdominal surgery, especially in regards to pain management and minimization of emergence delirium.

The drastic fall in the FLACC scores in the postoperative period among the caudal group participants supports the proven analgesic property of caudal blocks in pediatric anesthesia [10]. Segmental blockade is achieved by caudal epidural analgesia leading to better pain relief in infraumbilical surgery. The results can be attributed to the prior literature that has found better analgesia and lower pain scores in children undergoing caudal blocks vs those undergoing systemic analgesia alone [11], [12].

One important result of this research is that there was a significant decrease in emergence delirium in the caudal group. One of the most frequent postoperative complications in children, especially after undergoing sevoflurane anesthesia, is emergence delirium, which is linked to agitation and slow recovery [13]. This is because the lower scores of PAED in the study indicate that pain control is a significant factor in ED reduction. Distress that is associated with pain is regarded as one of the main causes of the emergence agitation, and the analgesia can help to reduce such reaction to a great extent [14], [15].

Moreover, the decreased requirement in rescue analgesia and increased duration of first analgesic request in the caudal group demonstrates the opioid-sparing outcome of regional anesthesia [16]. This especially helps in pediatric groups, where the risk of respiratory depression and other negative effects is minimized by limiting the exposure to opioids. Other researchers have also reported similar results, that show reduced postoperative analgesic needs with caudal epidural analgesia [17], [18].

Even though caudal analgesia played a huge role in reducing ED in this study, it should be noted that emergence delirium is multifactorial. It can also be caused by factors like rapid development due to inhalational anesthesia, being younger in age, anxiety before surgery and environmental factors [19]. Hence, caudal analgesia must be viewed in the framework of a multimodal approach to perioperative care.

On the whole, the results of this research are in line with the current literature that confirms the effectiveness of caudal epidural analgesia to enhance postoperative outcomes among children [20], [21]. Nevertheless, the findings are to be viewed in the light of some limitations, such as the small sample size and single center design. Additional major, multicentric studies are suggested to confirm these results.

Conclusion

Caudal epidural analgesia is a more effective method of reducing postoperative pain and emergence delirium in children undergoing lower abdominal surgery. It also reduces analgesic needs and enhances recovery rates, which justifies its common application as a component of multimodal pediatric anesthesia.

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