Caudal block and emergence delirium in pediatric patients: Is it analgesia or sedation?

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ABSTRACT

Background: Emergence delirium (ED) although a short-lived and self-limiting phenomenon, makes a child prone to injury in the immediate postoperative period and hence is a cause of concern not only to the pediatric anesthesiologist, surgeons, and post anesthesia care unit staff but also amongst parents. Additional medication to quieten the child offsets the potential benefits of rapid emergence and delays recovery in day care settings. There is conflicting evidence of influence of analgesia and sedation following anesthesia on emergence agitation. We hypothesized that an anesthetic technique which improves analgesia and prolongs emergence time will reduce the incidence of ED. We selected ketamine as adjuvant to caudal block for this purpose. **Methods:** This randomized, double blind prospective study was performed in 150 premedicated children ASA I, II, aged 2 to 8 years who were randomly assigned to either group B (caudal with bupivacaine), BK (bupivacaine and ketamine), or NC (no caudal), soon after LMA placement. Recovery characteristics and complications were recorded. **Results:** Emergence time, duration of pain relief, and Pediatric Anesthesia Emergence Delirium (PAED) scores were significantly higher in the NC group ($P<0.05$). Duration of analgesia and emergence time were significantly more in group BK than groups B and NC. However, the discharge readiness was comparable between all groups. No patient in BK group required to be given any medication to treat ED. **Conclusion:** Emergence time as well as duration of analgesia have significant influence on incidence of emergence delirium. Ketamine, as caudal adjuvant is a promising agent to protect against ED in children, following sevoflurane anesthesia.

Key words: Caudal, delerium, emeregence, ketamine, pediatric

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INTRODUCTION

Emergence agitation (EA), also called emergence delirium (ED) has been a common problem faced by pediatric anesthesiologists worldwide. Described as a mental disturbance during recovery from general anesthesia, it is characterized by hallucinations, delusions, and confusion, which manifest as moaning, restlessness, and involuntary physical activity. Though this entity was described in 1960s the problem remained attenuated during the era of halothane but has resurfaced with introduction of sevoflurane and desflurane in pediatric practice. These

newer, less soluble, inhaled anesthetics are more often associated with postanesthesia agitation than with other volatile agents, possibly because of rapid awakening associated with their use which may initiate EA/ED by worsening a child's underlying sense of apprehension when finding him/her in an unfamiliar environment on awakening.[1-4]

Several investigators have compared different anesthetic techniques to assess their influence on incidence and severity of emergence delirium. Caudal block has been shown to protect against ED by improving analgesia, but it has also been shown to produce deafferentation that is reducing or blocking the sensory input and increased sleepiness.[4,5]

In our practice, in the process of using ketamine as adjuvant to bupivacaine for caudal block we observed that these patients exhibited increased sleepiness and minimal incidence of agitation. We hypothesized that caudal epidural block can have effect on ED by not just improving analgesia but prolonging emergence time as well at the

same time. We used ketamine as adjuvant to bupivacaine for caudal epidural to study the effect of emergence time together with analgesia on incidence and occurrence of ED.

This randomized, double blind, prospective study was designed to assess the effects of emergence time together with analgesia on ED.We used ketamine as adjuvant to test the same.

METHODS

After obtaining approval of the hospital ethics committee, written informed consent was taken from parents of children who were selected for the study. One hundred and fifty children of age 2 to 8 years, ASA physical status I and II who were to undergo elective subumbilical surgery under general anesthesia were selected. They were randomized to group B (bupivacaine), group BK (bupivacaine ketamine), and NC or no caudal group by using computer-generated numbers. NC group was taken as the control group.

All children were kept fasting for 4 h and were premedicated with oral midazolam 0.5 mg/kg. Patients with any contraindication to caudal block, risk of pulmonary aspiration, history of gastro esophageal reflux, symptoms of upper respiratory tract infection, cognitive impairment, or potential difficult airway were excluded from the study. Anesthesia was induced and maintained with sevoflurane in oxygen and 66% nitrous oxide. An appropriately sized LMA was inserted after adequate depth of anesthesia was achieved. Penlon AV800 circle ventilator with sodalime was used with fresh gas flow of 1.5 l/min, sevoflurane 1.5 MAC, FiO_2 0.4 with spontaneous, or assisted ventilation. Monitors included precordial stethoscope, pulse oximeter, electrocardiograph (ECG), automated non-invasive blood pressure (NIBP), capnometer, gas analyzer, and nasopharyngeal temperature.

Analgesia was achieved by giving fentanyl citrate 2 ug/ kg in NC group, caudal epidural block using bupivacaine 0.25% (0.5 ml/kg) in group B while group BK bupivacaine received 0.25% (0.5 ml/kg) with preservative free ketamine 0.5 mg/kg. All patients were positioned for caudal block patients including the NC group, and the anesthetist making observations was made to wait outside the operation room for period sufficient for achieving the block. However, the patients of NC group received only intravenous fentanyl 2 ug/kg, but caudal time was recorded for all patients. In the NC group the caudal time reflects the period for which patient was positioned for the block without actually giving it. The adequacy of analgesia was tested at skin incision, a rise of more than 20% in heart rate was considered inadequate analgesia and these children were excluded from the study.

At the end of the procedure the LMA was removed in

the operating room when swallowing appeared. They were shifted to post anesthesia care unit (PACU or phase I recovery area) with oxygen. In the PACU, they were reunited with one of the parents. Emergence time was calculated from time of removal of LMA to eye opening in response to gentle glabellar tap in the recovery (glabellar tap was done every 5 min in the PACU). This was taken as emergence time or stay in phase I recovery. After eye opening, they were shifted to ambulatory surgery unit or phase II recovery. Behavioral assessment and Objective Pain Scoring (OPS)[5] was done on arrival and continuously thereafter for entire stay in PACU by a trained anesthesia resident. The OPS was used to assess the duration of analgesia which is an observational scoring system which uses five criteria: crying, agitation, movement, posture, and localization of pain, each uses scores from 0 to 2 to give a total score of $0 - 10$. Duration of analgesia was defined as time between administration of intraoperative and postoperative analgesia. Patients with OPS >4 were given fentanyl 1 ug/kg as the supplemental dose. All intraoperative and postoperative records were done by experienced anesthetist not involved in study.

Level of agitation was described using the recently published PAED scoring, as described in reference 5 and Table 1. Any score of >10 was taken as ED. Modified Aldrete scoring was done for all patients to assess discharge readiness. Any untoward events including any pharmacologic interventions during postoperative period were recorded. Time to discharge was recorded from time of arrival in phase I recovery to discharge readiness. The patients were followed up for pain and agitation upto 24 h and parents were requested to report us telephonically about any event thereafter.

Statistics

The data were analyzed using SPSS software (12.0 version; SPSS Inc., Chicago, IL, USA). Kolmogorov–Smirnov test indicated that the data were not normally distributed, hence, nonparametric test (i.e., Chi-squared test, Mann–Whitney

Table 1: The Pediatric Anesthesia Emergence Delirium Scale[6]

Clinical presentation	Scores
The child makes eye contact with the caregiver	0:extremely
The child's actions are purposeful	1:very much
The child is aware of his or her surroundings	2:quite a bit
	3:just a little
	4:not at all
The child is restless	0: not at all
The child is inconsolable	1:just a little
	2:quite a bit
	3:very much
	4:extremely

U-test, and Wilcoxan W-test) were applied. *P*<0.05 was considered significant. From preliminary data, we calculated with alpha-set at 0.05 that 50 patients in each group would give a statistical power of 87% to detect a 25% of difference in PAED scores between groups.

RESULTS

All the three groups were comparable with respect to age, weight, and gender distribution [Table 2] and duration of anesthesia (in minutes).

The hemodynamic variables remained within normal limits for all patients in the study groups. These parameters were also comparable between all groups.

The emergence time (minutes) was 11±3.2 in NC, 14.5±1.5 in group B, and 24±2.5 in group BK, (*P*<0.05).

The patients who did not receive caudal block (NC) exhibited significantly higher PAED scores as compared to patients in group B and BK. Number of patients exhibiting ED was 15/50 in NC, 7/50 in B, and none in BK (*P*<0.05).

Duration of analgesia was found to be significantly more in group BK i.e., 7.43±3.9 h as compared to group B where it was 4.11±0.67 h, and 1.24±0.30 h in NC groups. Duration of stay (in minutes) in phase I recovery was 11±3.2 in NC, 12.2±4 in B, 25.7±5.95 in BK, this difference was significant between groups (*P*<0.05).

However, the discharge readiness or phase II recovery was comparable between all the three groups. The perioperative anesthetic variables have been cited in Table 2 and the recovery characteristics in Table 3.

DISCUSSION

Emergence delirium (ED) is "disturbance in a child's awareness of and attention to his/her environment with disorientation and perceptual alterations in postanesthesia period" as defined by Sikich N, Lerman as.[6] Several studies have shown that ED usually occurs within the first 30 min of recovery from anesthesia, is self-limited (5-15 min), and often resolves spontaneously,[7,8] rare instance, where agitation and regressive behavior has lasted up to 2 days has also been described.[9] In this study no instance of ED was witnessed after 30 min of arrival to PACU.

The incidence of ED/EA largely depends on definition, age, anesthetic technique, surgical procedure, and application of adjunct medication. Generally, it ranges from 10 to 50%,[8,10-16] but may be as high as 80%. Studies that have evaluated ED so far lack uniformity in protocol, and therefore it is difficult to compare and interpret their results with certainty. In this study we found that it varied from 0% in patients who received ketamine as adjuvant to 10% in patients who did not receive any caudal block.

Aono *et al.* observed that[12] ED is experienced more often in preschoolers. Older children and adults usually become oriented rapidly, whereas preschool-aged children,[11,16] who are less able to cope with environmental stresses, tend to become agitated and delirious. We analyzed patient of same age group. One limitation of our study was that age-wise analysis was not performed.

In most of the previous studies self-developed scales have been used, some of which have not been validated. We compared our observations based on PAED scale, as described by Sikich and Lerman. As this consists of five psychometric items, three of which have been described as important parts of delirium and hence help to distinguish

Table 2: Patient demographics and preoperative hemodynamic variables

	Group NC	Group B (Bupivacaine)	Group BK (Bupivacaine ketamine)
Age (years)	2.85±0.95	2.88±1.48	3.18±1.66
Weight (kg)	12.2±2.4	12.54±2.12	13.00±3.26
M/F	51/9	52/8	49/11
Pulse (beats/min)	122±9	128.8±11.5	120.43±12.0
MAP(mmHg)	64±5.5	69.84±4.6	70.23±6.5
Intraop pulse (beats/min)	110±10.2	110±11.95	112.3±11.45
Intraop BP (mmHg)	54±4	56.43±4.24	59.08±3.76
SpO$_2$ (%)	100	100	100
Anesthesia Duration (minutes)	66±4.5	66.0±8.5	58.6±7.4

Values are expressed as mean±SD. NC – No caudal; B – Bupivacaine; BK – Bupivacaine+Ketamine

Table 3: Recovery characteristics

	Emergence time (minutes)	OPS>4 (Phase I)	Duration of analgesia (hours)	PAED score	Phase-II (hours)
No Caudal (NC)	15±3.2	14/50 (28%)	1.24±0.30	7.4±4.5	3.35±0.5
Bupivacaine (B)	14.5±1.5	5/50 (10%)	4.11±0.67	6.6±1.7	4.1±0.7
Bupivacaine Ketamine (BK)	24±2.5	0/50 (0)	7.43±3.9	5.4±0.87	4.26±0.62
P value	0.001	*P*<0.05	0.001	0.001	>0.05

Values are expressed as mean±SD. *P*>0.05 is considered not-significant, *P*<0.01 is highly significant

it from pain.[6,17] The results showed a strong association between occurrence of ED and usage of caudal block. In the PAED scale scores higher than 10 signify EA. In the present study there were about 5 out of 50 that are 10% patients who showed PAED score of more than 10 in the group which did not receive caudal and 2 out of 50 (i.e., 4 %) in bupivacaine group and none in group where ketamine was used as adjuvant.

The duration of analgesia was significantly prolonged in groups B and BK as compared to NC, the same groups of patients showed lesser number of patients with agitation. The none of the patients in the study developed ED in the phase II of recovery. No study however compares severity of ED or provides a validated threshold value for measuring the same. This remains a limitation of the scales and of our study.

Rapid emergence from anesthesia has been postulated as contributory to ED. However, recovery from propofol anesthesia, which is also rapid, is smooth and pleasant but is associated with much lesser ED than sevoflurane anesthesia which is also rapid.[18-21] Similar results were obtained when desflurane/nitrous oxide anesthesia was compared with propofol/remifentanil anesthesia.[22] Oh et al. demonstrated that delaying emergence by a slow, stepwise decrease in the concentration of inspired sevoflurane at the end of surgery did not reduce the incidence of ED; this questions the role of abrupt awakening in the development of ED.[23] In our study even though we used sevoflurane for induction as well as maintenance of anesthesia, ED was seen to occur in all groups.

In accordance with Sikich and Lerman study, we also found negative correlation between PAED score and time to awakening, however no correlation could be found between age and PAED scores. Furthermore, Cole et al.[12] found a similar incidence of ED among children who entered the post anesthesia care unit (PACU) still asleep and those who entered awake. In our study all patients were brought to PACU while asleep and were shifted to phase II when they achieved Aldrette score of 7 but had significant difference in their PAED scores.

Even though time to awakening was significantly different between the groups, this did not affect the discharge readiness. Many investigators have found pain to be a major contributory factor to ED,[1,8,24,25] however it has also been demonstrated even in pain free states,[1,8,18,26] which suggests that analgesics cannot completely attenuate this phenomenon. On the other hand, various agents with different degree of analgesia have been tried with varying results.[14,27-30] This suggests a strong association between pain and ED.

In this study the requirement of analgesics in postoperative period, emergence time as well as incidence of agitation, was significantly different between the groups. The OPS as well as the incidence of ED was maximum in NC and least in BK group. No patient in BK group had ED which needed treatment, could better pain relief or prolonged emergence be held responsible or possibly a combination of both. Aouad et al. showed that pain control with preoperative caudal block significantly reduced ED and pain scores as compared to intravenous fentanyl.[31] However, authors do not discuss the effects of deafferentation produced by the caudal block.[32] None of these studies have calculated the level of sedation or emergence time. In a recent study by Shobha Malviya reduced ED has been shown to have strong association with increased sleepiness after intravenous Clonidine but under adequate analgesic cover.[33] How much does degree of pain relief and the emergence time contribute to ED remains a question still unanswered.

CONCLUSION

Ketamine as caudal additive, possibly due to prolonging emergence as well as duration of analgesia, can to be a promising agent to protect against EA in children. An anesthetic technique which not just prolongs duration and quality of analgesia but also slows emergence would probably tackle the concerns of EA following sevoflurane anesthesia.

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