Comparison of postoperative analgesic effect of caudal bupivacaine with and without ketamine in Pediatric subumbilical surgeries

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Abstract

Background and Aims: Management and assessment of postoperative pain in children is often a tough task as they cannot effectively communicate their discomfort. Caudal block is an excellent means of providing postoperative analgesia. In this study, we compared the postoperative analgesic effect of bupivacaine with and without ketamine when given caudally in children undergoing subumbilical surgeries.

Material and Methods: Fifty-eight American Society of Anesthesiologists grades I and II children of either gender undergoing subumbilical surgeries were randomly allocated into two groups B and BK of 29 each. Group B received 0.75 ml/kg 0.25% bupivacaine and Group BK received 0.75 ml/kg 0.25% bupivacaine plus ketamine 0.5 mg/kg. A standardized anesthetic protocol was used. The duration of postoperative analgesia, motor block, sedation score, and hemodynamic parameters were assessed. Statistical analysis was performed using Mann–Whitney U test, independent-samples t-test, and Chi-square test.

Results: The hemodynamic parameters and motor block were comparable between the groups. Duration of analgesia was prolonged in Group BK compared to Group B 11.3 ± 2.2, vs. 7.0 ± 2.3 hours, \( p < 0.001 \). However, sedation score was found to be higher in BK group compared to B Group (\( P < 0.001 \)).

Conclusion: Ketamine as an adjuvant to bupivacaine in caudal block is associated with a significant prolongation of postoperative analgesia.

Keywords: Adjuvant, caudal block, ketamine, sedation

Introduction

In 1933, Campell first described the use of caudal anesthesia for pediatric urological surgeries. Since then, this technique has become widely popular and is the most frequently used pediatric regional anesthetic technique.\(^{[1-5]}\) The technique offers superior pain relief compared to other modes of analgesia, but its major limitation is the short duration of analgesia associated with the single injection technique.\(^{[6-8]}\)

Bupivacaine is one of the most commonly used local anesthetic in caudal anesthesia. It is used for lower abdominal, lower limb, and perineal surgeries in the pediatric age group.\(^{[9]}\) However, it is found that analgesia is often short lived, only for approximately 4–6 hours.\(^{[7,8,10]}\) It is possible to prolong the duration of analgesia by adding a number of adjuvants such as opioids and nonopioids such as clonidine, ketamine, midazolam, and neostigmine.\(^{[11-13]}\)

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Ketamine, a phencyclidine derivative, had fallen out of popularity because of its unpropitious psychological effect and abuse potential.\(^{[16,17]}\) However, recently there has been a revival of interest in the use of subanesthetic doses of ketamine as an adjunct to local anesthetic as it increases the efficacy of caudal block in children.\(^{[16,18]}\) There are a subset of glutamate receptors which are stimulated by the excitatory amine N-methyl D–aspartate (NMDA). These receptors are located in the central nervous system as well as the substantia gelatinosa of the spinal cord. They play a critical role in central pain processing in the spinal cord. Ketamine binds noncompetitively to these NMDA receptors and blocks them. Blockade of these receptors leads to decrease in the activation of dorsal horn neurons.\(^{[19,20]}\) In this study, we compared the efficacy of adding ketamine to bupivacaine in prolonging the duration of analgesia.

**Material and Methods**

After obtaining approval from the Ethics Committee, 58 American Society of Anesthesiologists physical status I and II children aged between 1 and 12 years undergoing subumbilical surgeries were selected for the study. The study was undertaken over a period of 2 years. Patients with active infections, bleeding diathesis, central nervous system diseases, neurological disorders, anticoagulant therapy, abnormalities of the sacrum, vertebral column and spinal cord, raised intracranial tension, failed block, and those who refused the procedure were excluded from the study.

Patients were recruited randomly into two groups B and BK by drawing lots from 58 folded paper strips in which B and BK were inscribed in 29 each. Group B (bupivacaine) 0.25% plain bupivacaine 0.75 ml/kg. Group BK (bupivacaine plus ketamine) 0.25% bupivacaine 0.75 ml/kg with preservative-free ketamine 0.5 mg/kg. Preanesthetic check-up was done and informed consent was obtained from the parents. Intravenous access was secured and standard monitors to record pulse rate, oxygen saturation (Sp\(_{\text{O}}\)), noninvasive blood pressure, electrocardiogram, and endtidal carbon dioxide were established. All patients were given general anesthesia. They were given atropine 20 μg/kg, ondansetron 0.1 mg/kg, fentanyl 2 μg/kg, and midazolam 0.05 mg/kg intravenously. Anesthesia was induced with propofol 2–4 mg/kg till loss of verbal communication followed by the placement of a laryngeal mask airway of appropriate size.\(^{[21,22]}\) After induction, patients were placed in a lateral position with the knees drawn up, the upper knee being flexed more than the lower knee (Simm’s position). After ensuring complete asepsis and adequate draping, the sacral hiatus was palpated and a short bevelled scalp vein set of 22-G was introduced at an angle of 45° to the skin aiming cephalad. The sacral canal was entered with a distinct “pop” after piercing the sacrococcygeal ligament. After ensuring negative aspiration for blood, bone marrow, and cerebrospinal fluid (CSF), the prepared local anesthetic solution was injected. Patients were then repositioned. Paracetamol suppository 20 mg/kg was given to all children after repositioning them in a supine position. Routine intraoperative monitoring was done. Heart rate (HR), blood pressure (BP), Sp\(_{\text{O}}\), respiratory rate (RR), and degree of sedation values were recorded from the time the child arrived in the recovery room and then at 30 min, 1, 2, 4, 6, 8, 10, 12, 18, and 24 h. The efficacy of analgesia was documented using the modified objective pain score (OPS). This score uses five criteria — crying, agitation, movement, posture, and localization of pain. Each criterion scores from 0 to 2 to give a total score of 0–10.\(^{[23]}\) The OPS was documented by an anesthetist and nurse who were blinded to the given drugs. Duration of analgesia was taken as the time from the initiation of caudal block to the first administration of postoperative analgesia. Analgesia was given to patients when their OPS reached 4 or more. It was given in the form of syrup ibuprofen 5 mg/kg. The degree of sedation was assessed using an objective score based on eye opening (eyes open spontaneously – 0; eyes open in response to verbal – 1; eyes open in response to physical stimuli – 2).\(^{[24]}\) Patients were shifted to the postoperative ward after 2 h where monitoring was continued. They were discharged after 24 hours.

All data were collected, coded, and entered onto a Microsoft Excel sheet and analyzed using Statistical Package for Social Sciences (SPSS 16.0, SPSS Inc., Chicago, IL, USA). Comparison of demographic characteristics were done using the Chi-square test for categorical data and independent t-test for continuous data such as HR, BP, and RR. The results were described as mean ± standard deviation. A P value of ≤0.05 was considered significant.

**Results**

Both groups were comparable with respect to age, weight, and duration of surgery [Table 1]. There were no differences in the baseline hemodynamic parameters like such as HR, BP, respiratory rate and Sp\(_{\text{O}}\). The types of sub umbilical surgeries included in our study were herniotomy, orchidopexy, and hypospadias.

| Table 1: Demographic data | Parameters | Group B (n=29) | Group BK (n=29) | P  |
|---------------------------|------------|---------------|----------------|----|
| Age (Years)               | 4.2 (3.0)  | 4.6 (3.2)     | 0.72           |
| Weight (kg)               | 14.6 (6.9) | 16.8 (6.7)    | 0.145          |
| Duration of surgery (h)   | 1.3 (0.4)  | 1.22 (0.60)   | 0.379          |
The results are depicted as mean ± SD. The mean duration of analgesia was indicated by the time to first dose of analgesia. It was significantly prolonged when ketamine was added to bupivacaine (11.3 ± 2.2) than when bupivacaine was used alone (7.0 ± 2.3) ($P < 0.001$).

There was significant difference in the sedation score between the two groups. Patients in the BK had higher sedation scores in the initial 30 min after surgery than group B [Figure 1]. However, all children were fully awake at the end of 1 h.

None of the patients in either group had motor blockade or urinary retention.

**Discussion**

Regardless of the development of newer standards of pain management, postoperative pain continues to be undertreated.[23] This concept gains even more significance when these patients are children as they cannot express their agony. Caudal block is an efficient method of providing satisfactory pain relief in children. However, the duration of analgesia with single shot caudal bupivacaine is of a very limited duration of approximately 4–6 h. A number of opioid as well as nonopioid additives have been suggested for use in caudal block with the view of enhancing the duration and quality of pain relief. Ketamine is an NMDA receptor antagonist. NMDA receptors are involved in nociceptive modulation, the wind-up phenomenon, peripheral receptive fields expansion, primary and secondary hyperalgesia, and neuronal plasticity. Ketamine also exerts its effect on the opioid receptors, primarily the mu opioid receptor. Even subanesthetic doses of ketamine have been found to have potent analgesic effect.[26]

Intravenous ketamine was not found to offer a better analgesia compared to plain bupivacaine or ketamine administered caudally, as evidenced by the study conducted by Martindale et al.[27] This indicates that ketamine brings forth its analgesic effect by its local action on the neuraxis and this property can be exploited to offer superior pain relief to postoperative patients. Previous several investigators have affirmed that ketamine when administered extradurally has a modulatory influence on the pain pathway involved in postoperative pain. Several different doses of ketamine (0.25–1 mg/kg) have been tried along with local anaesthetics for prolonging the duration of analgesia. However, when higher doses were used, behavioral side effects such as restlessness, hallucinations, and agitation were reported. In our study, we used ketamine at a dose of 0.5 mg/kg and could document no adverse neurobehavioral side effects.

In our study, we found no difference in the hemodynamic parameters such as HR, BP, SpO₂, and respiratory rate between the two groups. This finding reiterates the fact that caudally administered ketamine has a local action on the spinal cord with very little systemic effects.

We found a significant difference in the sedation score between the two groups up to 30 min after arrival in the recovery room. This finding is supported by another study performed by Ahuja et al.[28] where they compared the effect of fentanyl and ketamine in combination with bupivacaine in caudal blockade. However, this increase in sedation did not prolong the stay of children in recovery room and all children in the bupivacaine plus ketamine group were fully awake at the end of 1 h. Children in the bupivacaine plus ketamine group were sleeping and less restless in the immediate postoperative period when compared to the plain bupivacaine group. Our study could document no immediate adverse side effects such as motor blockade when ketamine was used in caudal block.[29,30]

In conclusion, our observations show that caudal administration of ketamine 0.5 mg/kg along with 0.75 ml/kg 0.25% bupivacaine significantly prolongs the duration of postoperative analgesia in children undergoing subumbilical surgeries more than plain bupivacaine without any significant adverse reactions.

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**Conflicts of interest**

There are no conflicts of interest.

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