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Original Research Article

Comparison of 0.25% Bupivacaine and Dexmedetomidine Versus 0.25% Bupivacaine in Caudal Epidural Block in Terms of Motor Blockade and Post-Operative Analgesia in Children Undergoing Infraumbilical Surgeries

Pooja[1], Brajesh Kaushal[2], RP Kaushal[3], Palak Sharma[4], Sweyta Shrivastava[5]

[1,4]Resident, Department of Anaesthesiology, Gandhi Medical College and Hamidia Hospital, Bhopal, Madhya Pradesh, India,

[2]Associate Professor, Department of Anaesthesiology, Gandhi Medical College and Hamidia Hospital, Bhopal, Madhya Pradesh, India,

[3]Professor and Head, Department of Anaesthesiology, Gandhi Medical College and Hamidia Hospital, Bhopal, Madhya Pradesh, India,

[5]Assistant Professor, Department of Anaesthesiology, Gandhi Medical College and Hamidia Hospital, Bhopal, Madhya Pradesh, India

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Corresponding author: Dr. Palak Sharma

Conflict of interest: Nil

Abstract:

Background: This hospital-based observational study aimed to assess the impact of adding dexmedetomidine to bupivacaine in caudal epidural block (CEB) on the duration of postoperative analgesia and motor recovery in pediatric patients undergoing infraumbilical surgeries.

Materials and Methods: A total of 60 pediatric patients (2-10 years old) undergoing elective infraumbilical surgeries were randomly assigned to two groups: Group A (n=30) received 0.25% bupivacaine, while Group B (n=30) received 0.25% bupivacaine with dexmedetomidine. The duration of postoperative caudal analgesia was recorded in both groups. Motor recovery time was assessed, and Mann-Whitney U tests were conducted to analyse the data.

Results: The addition of dexmedetomidine significantly prolonged the duration of postoperative caudal analgesia in Group B (8.80 ± 0.92 hours) compared to Group A (4.03 ± 0.85 hours) with a highly significant p-value of 0.001. Moreover, the Mann-Whitney U test revealed a highly significant p-value of 0.0001, indicating a considerable delay in full motor recovery in Group B (4.17 ± 0.64 hours) compared to Group A (2.83 ± 0.68 hours).

Conclusion: This study demonstrates that the addition of dexmedetomidine to bupivacaine in caudal epidural block for pediatric patients undergoing infraumbilical surgeries significantly prolongs postoperative analgesia while delaying motor recovery. These findings offer valuable insights for optimizing anaesthesia techniques in this patient population.

Keywords: Pediatric surgery, Infraumbilical surgeries, Caudal epidural block, Dexmedetomidine, Bupivacaine, Postoperative analgesia, Motor recovery.

Introduction

Pediatric surgical procedures, particularly those involving the infraumbilical region, present unique challenges in anesthesia management. Ensuring adequate pain relief while minimizing motor blockade is of paramount importance to enhance postoperative recovery and patient comfort. [1, 2] Caudal epidural block (CEB) is a widely accepted technique for providing intraoperative and postoperative analgesia in pediatric patients undergoing infraumbilical surgeries.

However, the choice of local anesthetic agents and adjuvants can significantly impact the quality and duration of analgesia and motor blockade. [3, 4] This original research article investigates the comparative efficacy of 0.25% bupivacaine alone versus a combination of 0.25% bupivacaine and dexmedetomidine in CEB for pediatric patients undergoing infraumbilical surgeries. Motor blockade and postoperative analgesia are two critical aspects evaluated in this study to determine the superiority of one technique over the other.

Bupivacaine is a long-acting local anesthetic commonly employed in CEB, providing excellent analgesia but potentially leading to prolonged motor blockade, which may hinder early ambulation and overall patient comfort. [5] Dexmedetomidine, a

highly selective alpha-2 adrenergic agonist, has gained popularity as an adjuvant to local anesthetics in regional blocks due to its potential to prolong analgesia without exacerbating motor blockade. Nevertheless, the precise balance between analgesic efficacy and motor function preservation in pediatric patients remains to be elucidated. [1, 2]

The primary objective of this study is to compare the duration and degree of motor blockade between the two CEB techniques, aiming to identify an optimal approach for maintaining motor function while ensuring effective pain relief in pediatric infraumbilical surgeries. The outcomes of this study will contribute valuable insights into refining anesthesia practices in pediatric infraumbilical surgeries, ultimately improving the overall perioperative experience for these young patients. Understanding the delicate balance between motor blockade and analgesia will aid healthcare providers in tailoring anesthetic techniques to individual patient needs, thus optimizing postoperative recovery and outcomes.

Materials and Methods

This observational, hospital-based study included a total of 60 patients, all of whom underwent infraumbilical surgeries and met specific inclusion criteria. These criteria encompassed patients classified under American Society of Anaesthesiologists (ASA) physical status I and II, aged between 2 to 10 years.

The surgical procedures targeted were elective, infraumbilical surgeries such as herniotomy, orchidopexy, or hypospadias repair. Exclusion criteria were applied, which included cases where parental consent was not provided, inpatient status at the time of surgery, patients falling into ASA grades III, IV, V, or E, those with a history or evidence of back infection, known allergies to bupivacaine, congenital malformations of the back, or pre-existing neurological or spinal diseases.

In this observational study, informed and written consent was obtained from all 60 patients before their participation. The allocation of the type of caudal block to be administered was done using a randomization technique, ensuring unbiased group assignments.

The methodology involved securing an intravenous line and initiating Isolyte P. Standard monitoring was employed, including an electrocardiogram, pulse oximeter, and non-invasive blood pressure measurement. Intravenous premedication was administered, consisting of Glycopyrrolate at 0.04 mg/kg and Emeset at 0.1 mg/kg. Induction of anesthesia was accomplished with ketamine at a dose of 1 mg/kg. Subsequently, a caudal block was performed under strict aseptic conditions, with patients placed in the left lateral position.

Table 1: Face, Legs, Activity, Cry, Consolability Pain Scale

Categories	0	1	2
Face	Smile or no particular expression	Occasional grimace, frown, withdrawn, disinterested	Frequent to constant frown, clenched jaw, quivering chin
Legs	Normal position or relaxed	Uneasy or restless	Kicking legs or drawn up
Activity	Lying quietly, normal position moves easily	Squirming, shifting back and forth, tense	Arched, rigid or jerking
Cry	No cry (awake or asleep)	Moans or whimpers, occasional complaints	Crying steadily, screams or sobs, frequent complaints
Consolability	Content or relaxed	Reassured by occasional hugging, touching, talking, distractable	Difficult to console

Table 2: Motor Power Scale

Muscle Tone	Flaccid (0)	Hypotonia (1)	Normal (2)
Muscle power(Flexion)	Unable	Partial	Normal
Ankle	0	1	2
Knee	0	1	2
Thigh	0	1	2
Ability to stand	0	1	2

Patients were randomly assigned to one of two groups based on the drug administered: Group A (n=30) received (0.25%) bupivacaine at 1 ml/kg plus normal saline (NS) at 1 ml.

Group B (n=30) received (0.25%) bupivacaine at 1 ml/kg plus dexmedetomidine at 1 µg/kg, diluted in 1 ml of NS.

After the block administration, the injection site was dressed, and patients were carefully turned to a supine position. Anesthesia maintenance was achieved using a combination of O2, N2O, and sevoflurane.

In the postoperative phase, patients were monitored for pain using the Face, Legs, Activity, Cry,

Consolability (FLACC) pain scale for a duration of 12 hours.

Statistical Analysis: The statistical analysis plan encompassed recording the duration of analgesia, defined as the time elapsed from the caudal block to the administration of the first rescue analgesic. Postoperative rescue analgesia was delivered in the form of Paracetamol at 10 mg/kg as a suppository. The timing of the first rescue analgesia was meticulously documented for both groups. All observations were subjected to statistical analysis, with results being presented as mean ± standard deviation. A significance level of $P < 0.05$ was established as the threshold for statistical significance.

Results

Table 3: Demographic Data

Variables	Group A	Group B
Age (yrs)*	6.13 (2.65)	5.26 (2.16)
Weight(kg)*	18.53 (1.04)	16.08 (5.38)
Sex ratio(M:F)	19:11	16:14

*Data presented as Mean (SD)

Table 4: Mean Duration of Caudal Analgesia

	Group A Mean(SD)	Group B Mean(SD)
Mean duration of analgesia(SD)	3.73(0.74)	8.8(0.92)

The mean duration of postoperative caudal analgesia in Group A patients was 4.03 ± 0.85 hours while in patients of Group B this duration was 8.80 ± 0.92 hours. This shows the duration was significantly prolonged by the addition of dexmedetomidine to bupivacaine. Mann – Whitney U Test p – value = 0.001 highly significant.

Table 5: Face, Legs, Activity, Cry, Consolability Pain Score Distribution amongst Study Participants

Post-operative time period	Group A (Mean ± SD)	Group B (Mean ± SD)
2 hours	5.26(0.78)	4.1(0.84)
4 hours	7.06(0.82)	5.9(0.8)
6 hours	8.1(0.75)	7.06(0.94)
8 hours	9.03(0.71)	7.46(0.73)
10 hours	9.46(0.5)	8.06(0.71)
12 hours	9.63(0.49)	8.56(0.5)
Mean score	**8.09(1.68)**	**6.86(1.62)**

Independent-t test with 95% CI applied to compare the mean FLACC score of both groups p-value = 0.005(i.e. <0.05) which shows statistical significance. The mean FLACC pain score was less in patients belonging to Group B throughout the initial 12 h of postoperative period. The mean FLACC score of Group A points was 8.09 ± 1.68 while that of Group B was 6.86 ± 1.62.

Table 6: Mean Time for Full Motor Recovery In Group A And Group B

	Group A mean(SD)	Group B mean(SD)
Full motor recovery time (Hours)	**2.83(0.68)**	**4.17(0.64)**

Mann- Whitney U test p-value = 0.0001 highly significant. Time for full motor recovery was prolonged in group B i.e. 4.17(0.64) hours. While in group A it was 2.83 (0.68) hours.

Discussion

Caudal epidural analgesia is one of the most popular and commonly performed regional blocks in pediatric anesthesia. It is a reliable and safe technique that can be used with general anesthesia for intra and postoperative analgesia in patients undergoing abdominal and lower limb surgeries. [1] The main disadvantage of caudal anesthesia is the short duration of action after a single injection of local anesthetic solution. The use of caudal catheters to administer repeated doses or infusions of local anesthetics is not popular because of the risk of infection. [2] The results of this observational study shed light on the potential advantages and considerations of incorporating dexmedetomidine as an adjuvant to bupivacaine in caudal epidural block (CEB) for pediatric patients undergoing infraumbilical surgeries. Our primary objectives were to investigate the effects of this combination on the duration of postoperative analgesia and motor recovery, comparing two groups: Group A, administered with 0.25% bupivacaine alone, and Group B, given 0.25% bupivacaine combined with dexmedetomidine. Sharpe et al. speculated that small volume of bupivacaine (0.5 ml/kg) may not be enough to deliver clonidine up to the spinal cord leaving only direct action on the nerve routes in the caudal area. Hence, we chose a standard dose of 1 ml/kg 0.25% bupivacaine in both the groups. We chose a dose of 1 µg/kg of dexmedetomidine in our study as there were similar studies done with clonidine showing that increasing the dose from 1 µg/kg to 2 µg/kg did not enhance the analgesic effect

of clonidine but increased the incidence of side effects such as respiratory depression, bradycardia, and hypotension with increasing dose. We chose the FLACC pain scale to evaluate postoperative pain as it is easy to use, is validated and gives an objective evaluation.

The significant extension of postoperative caudal analgesia observed in Group B (8.80 ± 0.92 hours) compared to Group A (4.03 ± 0.85 hours) aligns with findings from previous studies. Salgado et al. (2006) reported similar results, illustrating that intravenous dexmedetomidine can significantly prolong the duration of spinal anesthesia when combined with bupivacaine, underscoring its utility as an adjuvant. [2] This extension of analgesic duration has significant clinical implications, as it may lead to improved patient comfort, reduced opioid requirements, and enhanced overall postoperative recovery. [4]

However, the advantage of prolonged analgesia in Group B was juxtaposed with a delay in motor recovery. Group B exhibited a mean time for full motor recovery of 4.17 ± 0.64 hours, while Group A achieved full motor recovery in 2.83 ± 0.68 hours. This delay in motor recovery, evidenced by the highly significant Mann-Whitney U test p-value of 0.0001, invites critical consideration.

The findings regarding motor recovery echo those of Kim et al. (2012), who explored the addition of dexmedetomidine to Ropivacaine in femoral nerve blocks and found that it did not enhance postoperative analgesia but potentially impacted motor recovery. [3] This delay may affect patient ambulation and discharge times, particularly relevant in pediatric cases where patients are often eager to return to normal activities post-surgery. [6-8] Individualized anesthesia plans and close monitoring become imperative when striking a balance between the advantages of extended analgesia and potential motor recovery delays. [9, 10] While our study provides valuable insights, certain limitations must be acknowledged. The observational design, relatively modest sample size, and the focus on a specific age group (2-10 years) and surgical procedures may limit the generalizability of our findings. Future research should encompass larger, more diverse cohorts to offer a more comprehensive understanding of the clinical implications of dexmedetomidine as a caudal adjuvant in pediatric anesthesia.

Conclusion

In conclusion, the addition of dexmedetomidine to bupivacaine in CEB significantly prolongs postoperative analgesia in pediatric patients undergoing infraumbilical surgeries. However, this benefit is counterbalanced by a delay in motor recovery. Clinicians must weigh these findings when selecting anesthesia techniques for pediatric patients, carefully considering the advantages of extended pain relief against potential motor function delays.

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