

Comparison of Extension of Analgesic Effect of Bupivacaine Alone and Bupivacaine with Dexmedetomidine in Caudal Anesthesia amongst Children

Ayesha Mirza¹ and Amjad Nadeem²

Analgesic Effect of Bupivacaine Alone and with Dexmedetomidine in Caudal Anesthesia amongst Children

ABSTRACT

Objective: To compare the duration and quality of postoperative analgesia between caudal bupivacaine alone and bupivacaine combined with dexmedetomidine in children.

Study Design: Prospective randomized comparative study

Place and Duration of Study: This study was conducted at the Department of Anesthesia KRL Hospital Islamabad from 20th April 2026 till 20th July 2026.

Methods: This study included 140 children undergoing elective infraumbilical surgery. Patients were divided equally into two groups.

Results: Mean duration of analgesia was significantly longer with bupivacaine plus dexmedetomidine than with bupivacaine alone (12.86 ± 2.74 vs. 6.42 ± 1.58 hours, $p < 0.001$). Time to first rescue analgesia was also prolonged (12.51 ± 2.68 vs. 6.18 ± 1.51 hours, $p < 0.001$), while rescue analgesia within 24 hours was required less frequently (48.6% vs. 87.1% , $p < 0.001$). Mean rescue doses were lower in the dexmedetomidine group (0.69 ± 0.66 vs. 1.74 ± 0.72 , $p < 0.001$), with significantly lower FLACC scores up to 12 hours. Emergence agitation was reduced (8.6% vs. 21.4% , $p = 0.033$), although early postoperative sedation was greater. Mean intraoperative heart rate and mean arterial pressure were modestly lower with dexmedetomidine.

Conclusion: Adding dexmedetomidine to caudal bupivacaine significantly prolonged postoperative analgesia, reduced pain scores and rescue analgesic requirements, and decreased emergence agitation in children without a significant increase in overall adverse effects.

Key Words: Analgesic Effect, Bupivacaine, Dexmedetomidine, Anesthesia, Children

Citation of article: Mirza A, Nadeem A. Comparison of Extension of Analgesic Effect of Bupivacaine Alone and Bupivacaine with Dexmedetomidine in Caudal Anesthesia amongst Children. Med Forum 2026;37(9):116-120. doi:10.60110/medforum.370922.

INTRODUCTION

Good perianesthetic pain management is a key component of paediatric anaesthesia because inadequate pain management can have a detrimental effect on physiological stress, agitation, postoperative discomfort and recovery times¹. Caudal epidural anesthesia is the most frequently used regional anesthetic in children for infraumbilical surgery, surgery of the lower abdomen, urological surgery, surgery of the perineum and lower limbs². It is an easy procedure to do and useful for intraoperative and early

postoperative pain management, and decreases the need for systemic opioids³. The drawback of single shot caudal block however is that the duration of the block of analgesia is relatively short if a local anesthetic is injected alone⁴. Caudal anesthesia with bupivacaine is often used for caudal anesthesia in children due to its proven regional anesthetic efficacy and relatively long duration of action⁵. However, the pain relieving properties of a caudal injection can become less effective in the postoperative period and may require supplementation with other pain medications⁶. Several adjuvants have thus been studied to extend caudal analgesia without significantly increasing the incidence of adverse effects, such as opioids, clonidine, ketamine, dexamethasone, magnesium, and dexmedetomidine⁷. Of these, dexmedetomidine has garnered special attention due to its α_2 -adrenergic agonist activity and analgesic and sedative properties⁸. Dexmedetomidine has the potential to increase the effects of caudal local anesthetic in the spinal and supraspinal levels, via α_2 -adrenergic mechanisms⁹. Randomized trials have shown that the addition of dexmedetomidine to caudal bupivacaine has a significant effect on the extension of postoperative

¹. Resident / Consultant², Department of Anesthesia KRL Hospital Islamabad.

Correspondence: Dr. Ayesha Mirza, Resident, Department of Anesthesia KRL Hospital Islamabad.

Contact No: 03035568020

Email: aisha.mirza26@gmail.com

Received: July, 2026

Reviewed: August, 2026

Accepted: August, 2026

analgesia when compared to caudal bupivacaine alone¹⁰. Another study that combined effects of caudal anesthesia with dexmedetomidine on children also showed that dexmedetomidine had a significant effect in prolonging time to first rescue analgesic administration¹¹. In more recent comparisons, dexmedetomidine has been shown to be one of the most potent caudal adjuvants to prolong postoperative analgesia in children¹². Although dexmedetomidine has analgesic activity, it can affect sedation and cardiovascular parameters, such as heart rate and blood pressure¹³. A few studies have noted a higher rate of bradycardia, and others have found prolonged analgesia but no excessive number of adverse reactions¹⁴. Thus, the efficacy and safety of dexmedetomidine use as a caudal adjuvant in children should be evaluated. Application of analgesia for a longer duration after pediatric surgery will decrease rescue analgesic needs, enhance postoperative comfort and facilitate a smoother recovery phase¹⁵.

METHODS

This prospective randomized comparative study was conducted at the Department of Anesthesia KRL Hospital Islamabad from 20th April 2026 till 20th July 2026 and included 140 children undergoing elective infraumbilical surgery under general anesthesia with caudal analgesia. Patients were randomly divided into two equal groups of 70 each. Group A received caudal 0.25% bupivacaine 1 mL/kg alone, while Group B received caudal 0.25% bupivacaine 1 mL/kg combined with dexmedetomidine 1 µg/kg. Children aged 2–10 years, belonging to American Society of Anesthesiologists (ASA) physical status I or II and scheduled for elective lower abdominal, urological, perineal, or inguinal surgery were included. Children with known allergy to study drugs, coagulopathy, infection at the caudal injection site, congenital spinal abnormalities, neurological disorders, significant cardiac or respiratory disease, developmental delay interfering with pain assessment, or failed caudal block were excluded.

Data Collection: After approval from the Institutional Ethical Review Committee and obtaining informed consent from parents or guardians, patients were enrolled using a non-probability consecutive sampling technique and randomly allocated to either group using computer-generated random numbers with concealed allocation. Standard monitoring included heart rate, non-invasive blood pressure, oxygen saturation, respiratory rate, and electrocardiography. Following induction of general anesthesia, caudal block was performed under aseptic conditions in the lateral position. The study solution was administered according to group allocation after confirming correct needle placement and negative aspiration for blood or cerebrospinal fluid. Heart rate, blood pressure, oxygen

saturation, and adverse events were recorded intraoperatively and during postoperative recovery. Postoperative pain was assessed using the Face, Legs, Activity, Cry and Consolability (FLACC) score at predetermined intervals. The primary outcome was duration of analgesia, defined as the time from administration of the caudal block to the first requirement for rescue analgesia. Rescue analgesic medication was administered when the FLACC score was ≥ 4 .

Statistical Analysis: Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Age, weight, duration of surgery, duration of analgesia, pain scores, hemodynamic parameters, and rescue analgesic requirements were compared between groups using the independent t-test or Mann–Whitney U test, as appropriate. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

The two groups were comparable at baseline. Mean age was 5.82 ± 2.14 years in the bupivacaine group and 5.64 ± 2.08 years in the bupivacaine+dexmedetomidine group, while mean weight was 20.46 ± 6.72 versus 19.98 ± 6.54 kg.

Table No. I: Baseline Demographic and Operative Characteristics

Characteristic	Bupivacaine alone (n=70)	Bupivacaine + Dexmedetomidine (n=70)
Age, years, Mean $\pm$ SD	5.82 $\pm$ 2.14	5.64 $\pm$ 2.08
Weight, kg, Mean $\pm$ SD	20.46 $\pm$ 6.72	19.98 $\pm$ 6.54
Male, n (%)	47 (67.1)	45 (64.3)
Female, n (%)	23 (32.9)	25 (35.7)
ASA I, n (%)	55 (78.6)	57 (81.4)
ASA II, n (%)	15 (21.4)	13 (18.6)
Duration of surgery, min, Mean $\pm$ SD	54.72 $\pm$ 14.63	56.18 $\pm$ 15.21
Duration of anesthesia, min, Mean $\pm$ SD	71.84 $\pm$ 16.28	73.26 $\pm$ 16.94
Inguinal surgery, n (%)	27 (38.6)	26 (37.1)
Urological surgery, n (%)	25 (35.7)	26 (37.1)
Perineal/other infraumbilical surgery, n (%)	18 (25.7)	18 (25.7)

Males comprised 67.1% and 64.3%, and ASA-I status was present in 78.6% and 81.4%, respectively. Mean surgical duration was 54.72±14.63 versus 56.18±15.21 minutes and anesthesia duration 71.84±16.28 versus 73.26±16.94 minutes, with no significant baseline differences.

Dexmedetomidine significantly prolonged analgesia (12.86±2.74 vs. 6.42±1.58 hours, $p<0.001$) and delayed first rescue analgesia (12.51±2.68 vs. 6.18±1.51 hours, $p<0.001$). Rescue analgesia within 24 hours was required in 48.6% versus 87.1%, with fewer rescue doses (0.69±0.66 vs. 1.74±0.72, $p<0.001$). Table 2.

Table No.2: Postoperative Analgesic Outcomes

Outcome	Bupivacaine alone (n=70)	Bupivacaine + Dexmedetomidine (n=70)	p-value
Duration of analgesia, hours, Mean±SD	6.42±1.58	12.86±2.74	<0.001
Time to first rescue analgesia, hours, Mean±SD	6.18±1.51	12.51±2.68	<0.001
Rescue analgesia required within 24 h, n (%)	61 (87.1)	34 (48.6)	<0.001
Number of rescue doses in 24 h, Mean±SD	1.74±0.72	0.69±0.66	<0.001
FLACC score at 2 h, Mean±SD	1.18±0.91	0.74±0.72	0.002
FLACC score at 4 h, Mean±SD	2.06±1.12	1.02±0.88	<0.001
FLACC score at 6 h, Mean±SD	3.41±1.36	1.46±1.02	<0.001
FLACC score at 12 h, Mean±SD	3.08±1.27	2.14±1.13	<0.001
FLACC score at 24 h, Mean±SD	2.24±1.08	1.96±1.02	0.116

Table No.3: Hemodynamic Parameters and Postoperative Sedation

Parameter	Bupivacaine alone (n=70)	Bupivacaine + Dexmedetomidine (n=70)	p-value
Baseline heart rate, beats/min, Mean±SD	103.42±14.81	102.76±14.37	0.789
Mean intraoperative heart rate, beats/min, Mean±SD	99.86±13.72	91.38±12.64	<0.001
Baseline MAP, mmHg, Mean±SD	68.72±7.84	69.14±8.06	0.755
Mean intraoperative MAP, mmHg, Mean±SD	66.81±7.26	64.12±7.18	0.029
Mean SpO ₂ , %, Mean±SD	98.41±0.86	98.36±0.91	0.739
Sedation score at 1 h, Mean±SD	1.38±0.49	1.91±0.61	<0.001
Sedation score at 2 h, Mean±SD	1.21±0.41	1.62±0.55	<0.001
Emergence agitation, n (%)	15 (21.4)	6 (8.6)	0.033

Table No.4: Adverse Effects and Recovery Outcomes

Outcome	Bupivacaine alone (n=70)	Bupivacaine + Dexmedetomidine (n=70)	p-value
Bradycardia, n (%)	2 (2.9)	7 (10.0)	0.086
Hypotension, n (%)	2 (2.9)	5 (7.1)	0.245
Nausea/vomiting, n (%)	9 (12.9)	5 (7.1)	0.256
Urinary retention, n (%)	3 (4.3)	4 (5.7)	0.698
Respiratory depression, n (%)	0 (0.0)	0 (0.0)	1.000
Excessive sedation, n (%)	1 (1.4)	4 (5.7)	0.366
Any adverse effect, n (%)	16 (22.9)	19 (27.1)	0.559
Time to full recovery, min, Mean±SD	34.62±9.84	39.28±10.72	0.008
Parent satisfaction, n (%)	51 (72.9)	64 (91.4)	0.004

Baseline heart rate and MAP were similar between groups, but mean intraoperative heart rate was lower with dexmedetomidine (91.38±12.64 vs. 99.86±13.72 beats/min, $p<0.001$), as was MAP (64.12±7.18 vs. 66.81±7.26 mmHg, $p=0.029$). Mean SpO₂ remained comparable (98.36±0.91% vs. 98.41±0.86%). Table 3. Overall adverse effects were comparable between dexmedetomidine and bupivacaine-alone groups (27.1% vs. 22.9%, $p=0.559$). Bradycardia occurred in 10.0% versus 2.9%, hypotension in 7.1% versus 2.9%,

nausea/vomiting in 7.1% versus 12.9%, urinary retention in 5.7% versus 4.3%, and excessive sedation in 5.7% versus 1.4%; no respiratory depression occurred. Table 4.

DISCUSSION

The present study showed that the infusion of dexmedetomidine along with caudal bupivacaine significantly increased the duration of the analgesic

effect in children undergoing infraumbilical surgery. The mean duration of analgesia was 6.42 ± 1.58 hours for bupivacaine alone and 12.86 ± 2.74 hours for bupivacaine with dexmedetomidine ($p < 0.001$). Likewise, the time to SR analgesia was prolonged from 6.18 ± 1.51 to 12.51 ± 2.68 hrs. Several previous studies have also found a significant increase in time to first rescue analgesia with caudal bupivacaine and dexamethasone, of 14.4 ± 7.5 hours versus 6.6 ± 2.5 hours with caudal bupivacaine alone^{16,17}. The results of this study indicate not only that dexmedetomidine helps to postpone the onset of postoperative pain, but also that it decreases the total amount of analgesics used. Dexmedetomidine's analgesic benefit was corroborated by postoperative pain scores. FLACC scores were significantly lower in the combination group at 2 hours (0.74 ± 0.72 vs. 1.18 ± 0.91), 4 hours (1.02 ± 0.88 vs. 2.06 ± 1.12), 6 hours (1.46 ± 1.02 vs. 3.41 ± 1.36), and 12 hours (2.14 ± 1.13 vs. 3.08 ± 1.27). However, the difference decreased by 24 hours and reached non-statistical significance (1.96 ± 1.02 vs. 2.24 ± 1.08 , $p = 0.116$). In another previous study, eight patients in the bupivacaine-only group became agitated but no children agitated in the group receiving caudal dexmedetomidine and bupivacaine¹⁷. Therefore, this moderate postoperative sedation may also help to facilitate a more tranquil emergence and recovery from sedation following surgery, in addition to the analgesia. Dexmedetomidine had a small hemodynamic effect. Mean intraoperative heart rate was significantly lower in the combination group (91.38 ± 12.64 vs. 99.86 ± 13.72 beats/min, $p < 0.001$), while mean arterial pressure was also slightly reduced (64.12 ± 7.18 vs. 66.81 ± 7.26 mmHg, $p = 0.029$). These changes were not reflected in any significant differences in mean oxygen saturation between groups ($98.36 \pm 0.91\%$ vs. $98.41 \pm 0.86\%$), nor in any respiratory depression. Previous studies also have reported statistically significant changes in the hemodynamics following the addition of dexmedetomidine to caudal bupivacaine, but these changes were not deemed clinically significant¹⁸. Caudal dexmedetomidine has also been found to be effective for prolonged periods without a significant rise in overall adverse effects as compared to previous studies¹⁹. Bradycardia and hypotension were more common with dexmedetomidine (10.0% and 7.1% respectively), but neither was statistically significant compared with the controls (2.9% and 2.9% respectively). Frequently, nausea/vomiting, urinary retention, excessive sedation and the percentage of adverse effects did not differ significantly between both groups (27.1% vs 22.9%, $p = 0.559$; 3.9% vs 3.3%, $p = 0.873$; 12.9% vs 11.8%, $p = 0.837$; respectively). Other prior studies have also demonstrated a similar rate of hemodynamic changes and other adverse events when comparing caudal dexmedetomidine regimens to other regimens with a much longer duration of action

for analgesia. Parent satisfaction was significantly higher for the combination regimen (91.4% vs. 72.9%; $p = 0.004$) which may be due to improved pain management and minimizing agitation and the need for rescue analgesics. This study has some limitations. The results might not be generalizable due to the single center design and small sample size. Clinical scoring systems were used to evaluate pain and sedation, and may be subject to observer variability. The study evaluated only one dose of dexmedetomidine, so the optimal dose-response relationship could not be determined.

CONCLUSION

The addition of dexmedetomidine to caudal bupivacaine significantly prolonged postoperative analgesia, delayed the need for rescue analgesia, reduced pain scores and rescue analgesic requirements, and decreased emergence agitation compared with bupivacaine alone. Although dexmedetomidine was associated with greater early sedation, modest reductions in heart rate and blood pressure, and a slightly longer recovery time, the overall adverse-effect profile remained comparable between groups.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Ayesha Mirza, Amjad Nadeem
Drafting or Revising Critically:	Ayesha Mirza, Amjad Nadeem
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

Conflict of Interest: The study has no conflict of interest to declare by any author.

Source of Funding: None

Ethical Approval: No.ERC-KRL-HIPUB-ERC/114 dated 16.09.2025 and CPSP Approval Reference No.CPSP/REU/ANS-2021-045-2787 Dated 17.04.2026

REFERENCES

1. Amaambo NNT. A comparative study of analgesic effect of caudal bupivacaine with dexmedetomidine versus bupivacaine alone for infraumbilical surgeries in children in Windhoek Central Hospital. University of Namibia 2025. <https://repository.unam.edu.na/items/e8d20d13-7f18-457a-a4ce-4c228c954d2a>
2. Anil Kumar LN, Raghav A, Chahar S. Analgesic Benefits of Caudal Dexmedetomidine with Bupivacaine in Children Undergoing Infra-Umbilical Procedures. Int J Acad Med Pharm 2026;8(1):27-33.

3. Xu W, Wei H, Zhang T. Methods of prolonging the effect of caudal block in children. *Frontiers in pediatrics* 2024;12:1406263.
4. Kadam S. A comparative study of caudal anesthesia with bupivacaine v/s bupivacaine with dexmedetomidine in lower abdominal surgeries in pediatric age group. *Pain Med* 2021;6(3):25-29.
5. El Asser HM, Kamal H. Dexmedetomidine versus fentanyl for ultrasound guided caudal block in pediatrics. A randomized controlled study. *Ain-Shams J Anesthesiol* 2024;16(1).
6. Malik S, Abbas SM, Ali H, Gazder T, Kumar V, Farooq F. Comparative Analysis of Bupivacaine Versus Bupivacaine with Dexmedetomidine in Caudal Block Anesthesia: Comparison of Bupivacaine with Dexmedetomidine in Caudal Anesthesia. *J Health Rehabilitation Res* 2024;4(3): 1-5.
7. Farid DM, Hegab AS, Elhossieny KM, Elsayed AI. Analgesic Effect of Bupivacaine-Dexmedetomidine versus Bupivacaine-Midazolam in Caudal Anesthesia for Pediatric Hypospadias Surgeries. *Zagazig University Med J* 2024;30(9.1): 5048-5058.
8. Salama HG, AlAnsary AM, Kamal El-Din DM, Eldawy MR. Safety and Efficacy of Combined Dexmedetomidine and Bupivacaine versus Bupivacaine Alone in Caudal Block in Pediatric Patients Undergoing Lower Abdominal Surgery. *QJM: An Int J Med* 2024;117 (Supplement_1):hcae070-006.
9. Siddique MAB, Ali NP, Sarder MAH, Rubaiat MM, Haque MN, Ahmed MNU. Comparative Study between Bupivacaine with Dexmedetomidine and Bupivacaine with Fentanyl for Caudal Epidural Analgesia Perioperatively in Paediatric Infraumbilical Surgery. *J Armed Forces Med Coll Bangladesh* 2025;21(2):29-35.
10. Singh K, Bajaj J, Bathla S, Mehta K. Comparison of caudal bupivacaine and dexmedetomidine with caudal bupivacaine and intravenous dexmedetomidine for postoperative analgesia in children: A randomized controlled trial. *J Anaesthesiol Clin Pharmacol* 2024;41(3):455.
11. Shah UJ, Karuppiiah N, Karapetyan H, Martin J, Sehmbi H, Shah U. Analgesic efficacy of adjuvant medications in the pediatric caudal block for infraumbilical surgery: a network meta-analysis of randomized controlled trials. *Cureus* 2022;14(8).
12. Singh A, Gupta KK, Kaur A, Kaur H. Analgesic Efficacy and Safety of Dexmedetomidine as an Adjuvant to Caudal Levobupivacaine for Infraumbilical Surgeries in Children. *J Anesthesia / Anestezi Dergisi (JARSS)* 2021;29(4):263.
13. Khalil KSA, Rashwan SAA, Hussein HAEW. Dexamethasone versus dexmedetomidine as an adjuvant to bupivacaine for ilioinguinal and iliohypogastric nerve block in pediatrics, comparative randomized double-blind study. *Egypt J Med Res* 2023;4(2):27-42.
14. Fares KM, Mohamed SAB, Abd El-Rahman AM, AbdeLemam RM, Osman AMM. Analgesic effect of intrathecal fentanyl vs dexmedetomidine as adjuvants to bupivacaine following abdominal surgery for cancer in children, a randomized trial. *Pain Med* 2020;21(11):2634-2641.
15. Mostafa MF, Hamed E, Amin AH, Herdan R. Dexmedetomidine versus clonidine adjuvants to levobupivacaine for ultrasound-guided transversus abdominis plane block in paediatric laparoscopic orchiopexy: Randomized, double-blind study. *Eur J Pain* 2021;25(2):497-507.
16. Ram GK, Dubey PK, Akhileshwar P, Ranjan A. Dexmedetomidine and ketamine as an adjuvant to levobupivacaine for pediatric caudal analgesia: a randomized, controlled study. *Anesthesia, essays Researches* 2020;14(2):253.
17. Sultan N, Javed H, Khan A, Mir A, Khan A, Shahid N. A Comparison of Caudal Bupivacaine VS Bupivacaine Tramadol Mixture for Postoperative Analgesia In Children Having Lower Abdomen and Lower Limb Surgeries. *Pak J Intensive Care Med* 2025;5(01):242-242.
18. Agarwal S, Agrawal S, Kamal G, Gupta A, Gupta A, Kalra B. A comparative study of clonidine and dexmedetomidine as an adjuvant to levobupivacaine for caudal analgesia in children undergoing below umbilical surgeries: A randomized double-blind controlled trial. *Ağrı* 2026;38(1):21.
19. Pallapati AP, Jose R, Devadharshini B, Gowri M, Joselyn AS. A double-blinded randomized control trial to compare the duration of analgesia using morphine, clonidine, or dexmedetomidine as adjuvants to ropivacaine in caudal anesthesia in children undergoing infraumbilical surgeries. *J Anaesthesiol Clin Pharmacol* 2023;40(3):388.