# Duration of Analgesia Following Caudal Block for Day case Paediatric Herniotomy: Effect of Dexmedetomidine as Adjunct to Bupivacaine

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## ABSTRACT

**Background:** Caudal block is often utilized for postoperative pain following paediatric surgical procedures including day-case herniotomy. It is, however, limited by the short duration of action of the one shot caudal bupivacaine commonly utilized, thus necessitating the inclusion of an effective adjuvant for a prolonged action. **Objective:** This study compared the total duration of analgesia between caudal block with bupivacaine combined with dexmedetomidine and bupivacaine alone in paediatric day case inguinal herniotomy. **Methods:** Eighty male children between the age of 3 and 8 years scheduled for day case inguinal herniotomy were enlisted into this double-blind, prospective, randomised-controlled study. The children were randomised into Bupivacaine mixed with dexmedetomidine (BD) Group and Bupivacaine mixed with normal saline (B) Group. All patients had caudal block, after induction of anaesthesia, patients in B Group received 0.5ml/kg of 0.25% plain bupivacaine made up to 20ml with normal saline, while those in BD Group received 0.5ml/kg of 0.25% plain bupivacaine mixed with 1µg/kg of dexmedetomidine made up to 20ml with normal saline. Surgery commenced 15 minutes later and anaesthesia was maintained with halothane. Time to first analgesia request (at pain scores of above 4) and total analgesia consumption were documented. **Results:** The demographic characteristics of the groups were comparable. The time to first analgesic (TFA) request was 10.37 ± 0.97 hr in BD group and 4.62 ± 0.88 hr in B group ($p< 0.001$). Five patients in B group received rescue fentanyl and none in BD group in the PACU. The mean total Paracetamol consumption was 9.41 ± 4.13 ml in BD group compared to 16.47 ± 4.72 ml in B group ($p < 0.001$). **Conclusion:** Dexmedetomidine (1µg/kg) in combination with caudal bupivacaine 0.25% prolongs the duration of analgesia and resulted in a reduction in analgesia consumption in day-case paediatric inguinal herniotomy.


**Keywords:** Dexmedetomidine, bupivacaine, caudal block.

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**Received: 6th December 2025**
**Accepted: 12th March 2026**
**Published online: 30th June 2026**

**Access this article online**

QuickResponse Code

**website:**www.bornomedicaljournal.com

**DOI**: 10.31173/bomj.bomj_2532_23

## Introduction

Paediatric herniotomy is a minor surgical procedure commonly done on a day case basis where the patient gets admitted and returns home on the day of surgery. This is often associated with pain in the post-operative period following hospital discharge.[1] Pain among the paediatric patients remains a major concern worldwide, in which there has been an introduction of new analgesic agents and newer methods of application of old ones. Despite all these measures, pain remains the most frequent complication after day case surgery.[2]

In a study by Faponle and Usang, they reported that 72% of symptoms recorded by parents at home was post-operative pain following paediatric day case surgeries.[3] Thus, a long-lasting postoperative analgesia in day case surgeries is of paramount importance.

Multimodal approach is employed for pain management in the current practice which involves the use of non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol and opioids. In a day-case setting, opioids are usually avoided because of potential side effects such as pruritus, sedation, vomiting, nausea, respiratory depression and reduction in bowel motility leading to ileus which may delay discharge.[4,5] A previous study has shown that postoperative pain management was suboptimal in day-care settings, with 15% of patients contacting the hospital postoperatively reporting pain problems.[6]

Over many years, several regional anaesthetic techniques have gained popularity for intra-operative and post-operative analgesia, especially in day-case surgical procedure. They provide an additional effective and long-lasting postoperative pain relief and also reduction for general anaesthesia requirement.[7, 8] Caudal anaesthesia is the most commonly used technique for providing perioperative analgesia in paediatric patients undergoing surgical procedures below the umbilicus. Caudal block technique is simple, with a failure rate of only 1% reported in children less than 7 years of age compared with 14.7% failure rate in older children.[9]

Caudal anaesthesia for day-case surgery is commonly carried out by the single shot technique with bupivacaine. However, the duration of bupivacaine is 2-4 hours. To prolong the effect of bupivacaine postoperatively when adopted for caudal block, adjuvants such as fentanyl, tramadol and dexamethasone are commonly used. However, fentanyl and tramadol are highly controlled medications, limiting their availability, and tramadol use can be associated with significant post-operative nausea and vomiting (PONV). Dexamethasone cannot be used in patients with impaired glucose tolerance.[10]

Dexmedetomidine is a potent and highly selective $\alpha_2$ adrenergic agonist. It has a sedative, sympatholytic action and has been shown to prolong effect of local anaesthetic agent.[11] A study by Liu *et al*[11] demonstrated its effects in prolonging the duration of analgesia and reduction of total opioid consumption postoperatively when combined with bupivacaine for regional block. The drug dexmedetomidine is however not commonly used as an additive to bupivacaine in sub–Saharan Africa despite its known advantage over other additives. This study therefore seeks to evaluate the effect of dexmedetomidine as adjunct to bupivacaine on the duration of analgesia following caudal block in day-case paediatric inguinal hernia herniotomy.

**Methods**

This prospective, double-blind, randomized study was carried out at Aminu Kano Teaching Hospital, a tertiary institution in northwest Nigeria. Following Institutional Ethical Committee approval, 80 patients aged between 3-8 years scheduled for elective day-case hernia surgeries, and belonging to American Society of Anesthesiologists' (ASA) physical status classification I or II and whose guardian/ parent had consented in written were enrolled. Exclusion criteria included patients with known hypersensitivity to the study drugs, coagulation abnormalities, sepsis or infection at the site of caudal injection, spinal deformity, children with respiratory disorders, neurological disorders, cardiac disorders, and gastrointestinal disorders, renal or hepatic impairments.

A detailed history from parent or guardian was obtained and physical examination performed on the day of surgery. Investigations reviewed included full blood count and differentials (FBC), electrolyte, urea and creatinine (EUCr), and urinalysis. Preoperative routine fasting guidelines of 2 hours for clear fluids and 6 hours for solids foods was ensured before surgery. The patients were randomly allotted to either B group (bupivacaine mixed with saline) or BD group (bupivacaine mixed with dexmedetomidine) after either the guardian or parent was asked to pick a uniformly sized sheet of paper from a large box representing either of the two study groups. Both the patient and the investigator were blinded to the allocated group. All patients were weighed preoperatively.

The study agents were then prepared under aseptic condition by a research assistant (resident doctor) who was not involved in data collection. A cockpit drill was carried out in the operating suite ensuring oxygen supply, availability of necessary basic resuscitative and airway materials. Baseline vital signs including respiratory rate, heart rate, blood pressure, and pulse oximetry for arterial oxygen saturation were obtained and recorded using a multi parameter monitor. Induction of anaesthesia was achieved using a step-by-step increment of

halothane from 0.5% up to 5% in 100% oxygen every 60 seconds, the patient was breathing via a Jackson Rees' modified Ayre's T-piece breathing system for patients < 25 kg or Bain Circuit for patients > 25 kg with appropriately sized face mask until consciousness was lost. Intravenous access with a 22-guage cannula on the dorsum of the hand was secured after achieving an adequate depth of anaesthesia. Dextrose 4.3% in 0.19 saline solution was then set-up to correct fluid deficit and maintenance, airway control was then achieved with an appropriately sized i-gel based on patient weight, maintenance of general anaesthesia continued with halothane. The investigator performed caudal block in all patients, in which he was blinded to the study drugs. Patients in B Group (Bupivacaine alone) received 0.5ml/kg of 0.25% plain bupivacaine in a 20ml syringe made up 20ml with normal saline, while those in BD Group (Bupivacaine plus Dexmedetomidine) received 0.5ml/kg of 0.25% plain bupivacaine mixed with 1µg/kg of dexmedetomidine in 20ml syringe made up to 20ml with normal saline for caudal block. The investigator performed the caudal block by placing each patient in the lateral decubitus position with knees drawn towards the chest. The sacral hiatus was identified as the apex of an equilateral triangle facing inferiorly with a line joining the posterior superior iliac spine as the base. The finger palpating the space was directed caudally from the midpoint of the line joining the posterior superior iliac spines or cranially from the coccyx until a depression was felt after cleaning and draping in a sterile manner. At 45 degrees to the skin a 22g cannula was inserted into the sacral hiatus until a click was felt then it was angulated at 30 degrees with the spine. A 2 ml syringe filled with normal saline as test dose was then used to exclude subcutaneous placement before the local anaesthetic agent bupivacaine in group B or bupivacaine with dexmedetomidine in group BD was injected after a negative aspiration test. Time of administration of study drug was noted and documented. Then patients were placed in a supine position, and surgery was allowed to start 15-20 minutes later while the patients were breathing spontaneously via the i-gel device.

Monitoring and observation of vital signs continued at intervals of five-minutes until the end of surgery. Maintenance of anaesthesia was with halothane 0.5-1%, adequate anaesthesia was judged by stable vital signs within the baseline values and lack of movement following skin incision. For patients that had failed caudal block, anaesthesia was deepened with increased concentration of halothane and intravenous fentanyl 1 to 2 µg/kg was given. Failed caudal block was judged by a > 20% increase in heart rate compared to baseline values, and movement of the limbs to surgical incision. Patients with failed block were excluded from the study. At the end of surgery, i-gel was removed immediately after halothane was discontinued and oxygen was administered until after emergence from anaesthesia. Patients were managed in the recovery room (PACU) by a recovery nurse that is unaware of group allocation.

Nurses in the PACU and the ward had been taught the use of the Objective Pain Scale (OPS) for pain assessment as it relates to the study, parameters assessed in the OPS include crying, movement, complain of pain, systolic blood pressure, and agitation. Children who could talk and understand were taught how to report pain or discomfort. Others had their pain score reported by the PACU nurse. Postoperative pain was assessed on arrival at PACU, then at the $30^{th}$ and $60^{th}$ minute, this continued in the ward at the $120^{th}$, $180^{th}$ and $240^{th}$minutes using the OPS. Patients with an OPS score of 4 and above had rescue analgesic of intravenous 0.5 µg/kg fentanyl given. The duration of analgesia requirement was noted and documented; this was the duration from time of administration of study drugs to time of first request for analgesic.

Patients with a satisfied Aldrete score value ≥ 9 which is assessed using different criteria including patient activity, respiration, circulation, consciousness level and colour were discharged to the ward from the PACU after 1 hour according to hospital protocol.

Patients who satisfy the Post Anaesthesia Discharge Scoring System (PADSS) value ≥ 9, that is assessed using different criteria including vital signs, activity and mental status; pain, nausea and vomiting; surgical bleeding; intake and output, were discharged home from the ward on oral paracetamol at 20 mg/kg.

After discharge, information regarding the pain intensity (using NRS), time to first oral analgesic (paracetamol 20 mg/kg) and any other complications such as vomiting, irritability was obtained from parents via a phone call. Parents/guardians had been taught the use of the Numeric Rating Pain Scores (NRS ranging from 0 = no pain to 10 = the worst imaginable pain) so that they were able to assess pain after

discharge. Pain was assessed at home 4 hourly, for a period of twenty-four hours after the surgery. An NRS ≥ 4 was regarded as time to first oral analgesic request/duration of analgesia, this was documented. Total analgesic consumption was then calculated and documented.

Data Analysis

Statistical package for the social sciences (SPSS) version 25 (International Business Machines, IBM, New York, United States of America) was used to process the data. Quantitative data (age, weight, time to first analgesia request, total analgesic consumption) were summarized using means and standard deviation. Ordinal data (ASA classification) was summarized using percentage. Student t test was used to test for association for continuous data and for ordinal data, chi test was used. A *p*- value ≤ 0.05 was considered statistically significant in all tests.

**Results**

Eighty patients were recruited for this study; however, three patients were excluded, they include two from B group and one from BD group because of failed caudal block. The age and weight of patients in the two groups were not significantly different as represented in Table I. The mean duration of surgery was not different across the groups [BD, (35.18 ± 4.03) versus B, (38.51 ± 8.96) min (p = 0.514)].

Table II shows the Duration of analgesia and total consumption of analgesia in 24hrs in BD and B group. It was 10.37 ± 0.97 and 4.62 ± 0.88 hour respectively for BD and B groups, the difference was statistically significant (*p* <0.001).

Total oral paracetamol (20 mg/ml) consumed between the 2 groups was also significantly different. Patients in BD group had a value of 9.41 ± 4.13 ml, compared with B group that had a mean of 16.47 ± 4.72 ml, p< 0.001 (Paracetamol 20mg/ml).

**Table I: Demographic characteristics of the study groups.**

| Variables | BD Group (n=39) | B Group (n=38) | *p*-value |
|---|---|---|---|
| **Age (years) Mean± SD** | 5.28±1.47 | 5.39±1.69 | 0.756 |
| **Weight (kg) Mean ± SD** | 19.85±5.70 | 20.63±4.00 | 0.487 |
| **ASA (%)** | | | |
| **I** | 35 (89.7) | 32 (84.2) | 0.517 |
| **II** | 4 (10.3) | 6 (15.8) | |

* p value of ≤ 0.05 is statistically significant

**Table II: Duration of analgesia and 24 hr Analgesic consumption**

| Variables | BD Group (n=39) | B Group (n=38) | *p*-value |
|---|---|---|---|
| **TFA (hrs) Mean ±SD** | 10.37±0.97 | 4.62±0.88 | <0.001* |
| **Total Analgesic (pcm) consumption in24hrs (ml)** | 9.41±4.13 | 16.47±4.72 | <0.001* |

* p value of ≤ 0.05 is statistically significant.
pcm- Paracetamol

**Discussion**

This study has shown that 1µg/kg of dexmedetomidine when used as an adjunct to 0.5ml/kg of 0.25% bupivacaine and given for caudal epidural would prolong the duration of analgesia and decrease the post-operative consumption of analgesia when compared with bupivacaine (0.25%) alone.

There was a significantly longer duration of analgesia in the dexmedetomidine group (10.37 ± 0.97 hr) compared to the control group (4.62 ± 0.88 hr), p< 0.001. Our finding was similar to the one obtained by Saadawy and colleagues,[12] who investigated the effect of dexmedetomidine when combined with bupivacaine for caudal block in children who had unilateral inguinal hernia repairs or orchidopexy. In their study, the duration of analgesia was significantly longer in their BD group (18.5 ± 2.8 hr) compared to bupivacaine group (6.2 ± 2.8 hr) (P< 0.001). The duration of analgesia in both groups in their study was however longer compared to what was observed in this present study. This might be due to the higher volume of bupivacaine (1ml/kg of 0.25%) they used in their study as compared to 0.5ml/kg of 0.25% bupivacaine used in the present study.

Dexmedetomidine has also been found to have a superior effect with prolonged duration of analgesia when compared with other adjuvants to bupivacaine. Oruobu-Nwogu *et al*[13] reported a significant prolongation of the mean duration of analgesia in their patients that received 1.5µg/kg dexmedetomidine versus those that received 50µg/kg midazolam combined with 0.20% bupivacaine (14.4±2.36 hr versus 12.0±3.69 hr respectively) (p=0.01) for caudal block.

Dexmedetomidine has also been found to prolong the analgesic effect of other local anaesthetic agents, similar to what was observed with bupivacaine in this present study. Nasreen *et al*[14] reported a significant prolongation of mean duration of analgesia in patients that received 0.75 ml/kg of 0.125% levobupivacaine combined with 1 µg/kg dexmedetomidine compared to patients that received 0.75 ml/kg of 0.25% levobupivacaine alone (21.65 ± 2.4 hr vs. 5.8 ± 0.6 hr respectively) (p < 0.05).The levobupivacaine dexmedetomidine combination in their study produced a longer duration of analgesia compared to the bupivacaine dexmedetomidine combination in this present study). The time to first analgesia request following caudal block with dexmedetomidine combined with ropivacaine (11.96 ± 1.67 hr) in another study by Usha and Suhas[13]was similar to what was obtained with dexmedetomidine bupivacaine in this index study (10.37 ± 0.97 hr).

The mean oral paracetamol dose given by parents at home was less in BD group, 9.81 ± 4.13 ml compared with 16.47 ± 4.72 ml in B group, p< 0.001 (paracetamol 20 mg ml-1), which is in keeping with some studies that shows low post operative pain score results, and less analgesic consumption. [13,16]

In a study on the assessment, attitude, and post-operative management by the parents at home, with regards to pain in paediatric, inadequate doses of postoperative analgesics given by parents was demostrated.[17] Misconceptions regarding the safety and used of the analgesia were the reasons why most of the parents provided under doses of analgesics at home. Kankkunen et al[18] also observed that pain assessment by parents was accurate most times but their perception misled them to decrease the dose of postoperative pain medication for their children.

**Limitations**

1. Relying on parental competence for effective pain evaluation at home may not guarantee objectivity and the absence of bias in this regard.
2. Erroneous pain assessment by parents may also influenced total analgesic consumption

**Conclusion**

This study demonstrates that1µg/kg dexmedetomidine when used in combination with 0.25% bupivacaine for caudal block prolongs the duration of analgesia and results in a reduction of analgesia consumption in day-case paediatric inguinal herniotomy.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

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**Cite this Article as**: Mohammed A, Salahu D, Abdurrahman A, Adesope S, Atiku M, Ibrahim N, Ahmed AI Abubakar Y. Duration of Analgesia Following Caudal Block for Daycase Paediatric Herniotomy: Effect of Dexmedetomidine as Adjunct to Bupivacaine. **Bo Med J** 2026; 23 (1): 45-51 **Source of Support**: Nil, **Conflict of Interest**: None declared