

Case Series

Intra-operative and post-operative caudal analgesia with 0.125% bupivacaine and dexmedetomidine using single shot 20G IV cannula technique

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ABSTRACT

Optimal perioperative analgesia is essential in paediatric anaesthesia, particularly for acute postoperative pain following lower thoracic, abdominal, and urological surgery. This prospective observational study evaluated the efficacy and adverse effects of single-shot caudal epidural analgesia using 0.125% bupivacaine combined with dexmedetomidine in children undergoing elective urological surgery. Sixteen paediatric patients aged 3–15 years (mean age 7.5±4.1 years) with ASA physical status I–IV were included. Following induction of general anaesthesia, a caudal block was performed using a 20G intravenous cannula, with 0.125% bupivacaine and dexmedetomidine at 1 µg/kg administered at a volume of 1 ml/kg. Descriptive statistics and Student's t-test were used for data analysis, with p<0.05 considered statistically significant. The study included 13 male and 3 female patients, and the mean duration of analgesia was 513.7±162 minutes. No significant difference in analgesic duration was observed according to sex or type of surgical incision. Haemodynamic parameters remained stable throughout the perioperative period, and no clinically significant bradycardia or hypotension was observed. One patient experienced a transient event that resolved spontaneously. Single-shot caudal epidural analgesia using 0.125% bupivacaine combined with dexmedetomidine through a 20G intravenous cannula provided prolonged perioperative analgesia with a favourable safety profile in children undergoing elective urological surgery.

Keywords: Caudal epidural analgesia, Pediatric anesthesia, Dexmedetomidine, Bupivacaine, Urological surgery, Regional anesthesia, Postoperative pain

INTRODUCTION

Perioperative pain management is a principal phenomenon for successful pediatric anesthesia especially when applied on children having lower abdominal and urological surgeries. Inadequate postoperative pain management can lead to greater physiological stress, delay recovery and hospitalisation time, and decrease patient/parent satisfaction. Consequently, pain control optimization has

become one of the main objectives of contemporary pediatric anesthetic practice.¹

The caudal epidural block is the workhorse regional anesthetic technique for most infraumbilical surgical procedures in children, largely because of its ease of use and high success rate. It yields short-term intra-operative anesthesia and long-lasting postoperative analgesia for urological, inguinal, anorectal and lower abdominal surgical interventions.² The anatomical characteristics of

the bone skeleton in children features an incompletely ossified sacrum, as well as a prominent sacral hiatus which make the caudal epidural space quickly and reliably accessible by regional technique.³

Bupivacaine is a commonly used local anaesthetic for caudal analgesia due to its long duration of action and relatively safe profile. Although its analgesic effect is limited when applied alone, which leads to the use of associate postoperative analgesics. In order to prolong the analgesic duration and improve the analgesia quality, many adjuvants have been explored.³

Dexmedetomidine is an alpha 2 adrenergic receptor agonist and extensively selective, used as a potential or adjuvant in paediatric caudal blocks. It augments analgesia through spinal α_2 receptor action, prolongs sensory blockade, decreases postoperative analgesic requirement and provides sedation without clinically significant respiratory depression. It has previously been shown that the addition of dexmedetomidine a potent sedative and analgesic drug improve postoperative pain control with stable hemodynamic parameters when added to bupivacaine.⁴

The principles guiding the access of caudal epidural space also play a role in procedural safety and feasibility. Even though a conventional caudal needle is frequently performed, a 20G IV cannula represents an available, inexpensive and possibly less traumatic cannulation alternative after needle withdrawal. Even though these may have some advantages, there is little clinical evidence with respect to its use in pediatric caudal anesthesia. Although these might be beneficial, there is insufficient clinical evidence regarding its use in pediatric caudal anesthetic.⁵ Many patients undergoing paediatric urological surgeries experience moderate to severe pain in the early postoperative phase therefore effective regional analgesia is particularly challenging but important. Analgesia that is sufficient allows for early rehabilitation, limits the use of opioids in most cases and reduces pain therefore bettering surgical outcome.⁶

Therefore, the present case series was undertaken to evaluate the efficacy and safety of single-shot caudal epidural analgesia with 0.125% bupivacaine with dexmedetomidine administered through 20G IV cannula in children undergoing elective urological surgery.⁷ The case series evaluated the duration and quality of analgesia, hemodynamic stability, and complications related to this procedure in order to establish its usefulness in a clinical perspective.

The objectives of the study were to evaluate intra-operative and postoperative hemodynamic stability, assess procedure-related complications, including hypotension, bradycardia, transient motor blockade, and failed block, compare the duration of analgesia according to patient sex and surgical incision type, and evaluate the feasibility and

safety of using a 20G intravenous cannula for caudal epidural block in pediatric patients.

CASE SERIES

The objective of this case series was to assess the efficacy and safety of single-shot caudal epidural analgesia (CEA) with 0.125% bupivacaine with dexmedetomidine for postoperative pain relief in pediatric patients undergoing elective urological surgery. The case series assessed the duration and quality of intra-operative and postoperative analgesia, perioperative hemodynamic stability, and procedure-related complications in patients undergone two site-specific blocks using caudal block were primary endpoints.

The case series was conducted in the Department of anaesthesiology among all the pediatric patients in a tertiary care hospital scheduled to undergo routine elective urological procedures under general anesthesia.

Table 1: A total of 16 pediatric patients undergoing elective urological surgery were included in the case series.

Age group		Gender distribution	
Children aged	3–15 years	Male	13
Mean age	7.5±4.1 years	Female	3

As a physical status

Patients belonging to ASA Grade I–IV were included.

Inclusion criteria

Patients fulfilling all the following criteria were included in the case series: Children aged 3–15 years; Either gender; ASA physical status I–IV; Scheduled for elective urological surgery; General anesthesia with planned caudal epidural analgesia. Written informed consent obtained from parents or legal guardians

Exclusion criteria

Patients with any of the following conditions were excluded from the case series: Refusal of parental consent; Local infection at the sacral region; Bleeding or coagulation disorders; Known allergy to bupivacaine or dexmedetomidine; Congenital spinal abnormalities; Raised intracranial pressure; Neurological disorders affecting lower limbs; Severe cardiovascular instability

Pre-operative assessment

Each patient underwent a full pre-anaesthetic evaluation including detailed medical history, physical examination, airway assessment, routine laboratory investigations as

well as American Society of Anesthesiologists (ASA) physical status grading. All of the patients adhered to standard preoperative fasting guidelines prior to surgery.

Anaesthetic technique

A standard monitoring including the following was performed after arrival to the operating room; Electrocardiography (ECG); Non-invasive blood pressure (NIBP); Pulse oximetry (SpO₂) anaesthesia was induced according to institutional protocol, with all patients subsequently endotracheal intubated. After induction, patients were placed in left lateral decubitus position and caudal block was given under aseptic precautions.

Caudal block technique

The patient was positioned appropriately, and the sutural hiatus reached its identification through standard anatomical landmarks under sterile conditions. A 20-gauge intravenous (IV) cannula was then carefully inserted in the caudal epidural space, rather than through a standard caudal needle. Placement of the cannula was clinically confirmed by loss of resistance and aspiration yielding neither blood nor cerebrospinal fluid.

Once confirmed the position was (metal) needle withdrawn whilst the plastic cannula remained in place. It has the potential advantage of minimal tissue trauma, decreased risk of dislodgement or misplacement of the needle during drug delivery, and permits a local anesthetic solution to be injected safely into the caudal epidural space.

Drug preparation

The caudal solution was 0.125% bupivacaine with dexmedetomidine (1 µg/kg). The drug solution was given as a single caudal bolus through the 20G IV cannula into the caudal epidural space at a dose of 1 ml/kg body weight.

Outcome measures

The main outcome assessed in the case series was the pain-free interval post postoperative analgesia as decided by patient report. Secondary outcomes were the quality of analgesia, stable hemodynamics, rescue analgesic requirement, and adverse events.

Assessment of analgesia

The duration of analgesia was measured clinical parameters evaluated for postoperative analgesia were based on reflex response (resisting), limb movement, localization of pain and time to the first complaint of pain. The time of analgesia was measured as the interval between cessation of caudal injection and the first sign for rescue analgesia.

Assessment of safety

Adverse events were monitored in all patients, including hypotension, bradycardia, motor blockade, failed caudal block, respiratory complications and any neural deficit. Intraoperative and post-operative hemodynamic parameters were monitored continuously.

Statistical analysis

The data collected were recorded using Microsoft Excel and analysed applying the standard statistical software. Continuous variables were reported as mean ± standard deviation (SD), and categorical variables were summarized as frequency (n) and percentage (%).

Data were analysed mainly using descriptive statistics to describe patient demographics, amount of analgesia time and hemodynamic parameters concerning complications related to the procedure. No formal inferential statistical comparisons were made due to the small sample sizes and observational study design.

Table 1: Consolidated demographic characteristics, analgesic outcomes and procedure-related findings.

Findings	Number of patients, N (%)	Mean ± SD
Total patients	16 (100%)	7.5±4.1
Age (years)	-	7.5±4.1
Male	13 (81.3%)	-
Female	3 (18.7%)	-
ASA physical status	I–IV	-
Overall duration of analgesia (minutes)	-	513.7±162
Male analgesia duration (minutes)	13 (81.3%)	521.5±159
Female analgesia duration (minutes)	3 (18.7%)	480±207
Lumbar incision	5 (31.3%)	468±160.9
Penile incision	11 (68.8%)	534.5±166.3
Hypotension	0 (0%)	-
Bradycardia	0 (0%)	-
Failed caudal block	0 (0%)	-
Transient motor blockade	1 (6.3%)	-

A total of 16 paediatric patients were included in the case series. No patients were excluded after inclusion. The mean age of the patients was 7.5 ± 4.1 years. Of the 16 patients, 13 (81.3%) were male and 3 (18.7%) were female.

The overall mean duration of postoperative analgesia was 513.7 ± 162 minutes. Five patients (31.3%) underwent surgery involving a lumbar incision, while 11 (68.8%) underwent surgery involving a penile incision. No episodes of clinically significant hypotension, bradycardia, or failed caudal block were observed. Transient motor blockade occurred in 1 patient (6.3%) and resolved spontaneously.

There was a total of 110 babies in the study including 3 sets of twins. There were 46 (41.8%) babies with IUGR. Eleven major adverse outcomes were noted in the study - 2 stillbirths, 6 babies required immediate respiratory support and three babies had respiratory distress subsequently.

Out of the 6 babies who required immediate resuscitation, one expired in immediate neonatal period due to birth asphyxia (intrapartum fetal distress at 32 weeks in woman with severe preeclampsia), one expired after 10 days due to metabolic complications and the rest four survive.

The mean duration of postoperative analgesia was 468.0 ± 160.9 minutes in patients undergoing surgery with a lumbar incision and 534.5 ± 166.3 minutes in those with a penile incision. No clinically significant haemodynamic instability was observed. Heart rate, blood pressure and pulse oximetry remained within clinically acceptable limits throughout the perioperative period. One patient (6.3%) developed transient motor blockade lasting approximately 2 hours, which resolved spontaneously without neurological sequelae.

DISCUSSION

The present case series evaluated the clinical efficacy and safety of 0.125% bupivacaine with dexmedetomidine for single-shot caudal epidural analgesia using a 20G IV cannula in children undergoing elective urological surgery.

The postoperative analgesia was significantly longer than the control group lasting for 513.7 ± 162 minutes (mean) with stable hemodynamic changes throughout intraoperative and postoperative times.⁸ There were no episodes of clinically significant hypotension, bradycardia, respiratory depression or failed caudal block in any patients. One child developed transient motor blockade that normalized spontaneously without residual neurological deficit, supporting an acceptable safety profile.⁹ The present case series demonstrates also agree with earlier research showing that dexmedetomidine is an effective adjuvant to local anesthetics in pediatric caudal analgesia. More recent studies demonstrate that

dexmedetomidine as an adjunct to bupivacaine improved postoperative pain relief, reduced the need for rescue analgesics, but did not increase elderly, older serious adverse effects.¹⁰ The current study demonstrates the safety of a very low-dose dexmedetomidine ($1 \mu\text{g/kg}$) in pediatric regional anesthesia as it lacked any major cardiovascular complications.¹¹

A key feature of this study has been the study of a 20G IV cannula. Examinations, after improving it to enter into posterior consensus without discovering the membrane compared to gold standard analysis. Once the epidural space is successfully identified and access gained to that space, metal needle removal while retaining the flexible plastic cannula in the epidural space might allow for less tissue trauma more stability during drug administration.¹² This change is simple, inexpensive and a potentially beneficial step at institutions where dedicated caudal needles are not commonly available. Although these results are promising, they should be interpreted with caution owing to the small sample size, single-centre and observational design of the study and no control group.¹³ Furthermore, most of the postoperative pain assessment relied mostly on clinicians' judgment regarding pain intensity instead of validated pediatric pain scoring systems. Hence the study proposes that in paediatric urological surgery caudal epidural analgesia with 0.125% bupivacaine and dexmedetomidine delivered via a 20G IV cannula is an economical safe & effective modality of treatment.¹⁴ These results should now be validated in further large scale randomized controlled trials and its utility in routine clinical practice.

Limitations

There are some limitations to the present study. One, the sample size was small ($n=16$), which could compromise statistical power and ability to detect differences between subgroups. Second, this was a single centre case series without a control group observational, which may limit the external validity of the findings to other institutions and patient populations. Third, the study design precluded a direct comparison of dexmedetomidine's independent analgesic effect due to absence of randomization and controlled bupivacaine. Postoperative pain evaluation, moreover, was performed relying mostly on clinical observations rather than validated pediatric pain assessment scales that could have limited the objective measurement of pain assessment. Finally, long-term neurological outcomes were not evaluated; therefore, conclusions regarding the long-term safety of this technique cannot be drawn. Finally, the study focused only on pediatric patients undergoing elective urological surgery, which may raise concerns about generalizability to children undergoing other surgical procedures.

CONCLUSION

The present case series indicates that Single-shot caudal epidural analgesia (CEA) with 0.125% bupivacaine plus

dexmedetomidine is a safe and effective technique for children undergoing elective urological surgery using the 20G IV Cannula. It has been shown to deliver extended postoperative analgesia (>8.5 hours), with stable hemodynamic parameters and few complications. Temporary motor blockade was observed in one patient, which resolved spontaneously without treatment.

It was also a real challenging, practical, safe and cost-effective finding that the 20G IV cannula can be used instead of traditional caudal needle which makes it even handily available especially in resource-poor conditions. These results indicate that it is appropriate to use dexmedetomidine as an adjuvant to bupivacaine for caudal analgesia in children. Longer term safety, the optimal dosing regimen, and efficacy compared with other regional analgesic techniques requires confirmation in larger multicenter randomized controlled trials.

Recommendations

Future research should focus on conducting large multicenter randomized controlled trials to validate the findings, comparing dexmedetomidine with other caudal adjuvants such as clonidine, ketamine, fentanyl, and morphine, and evaluating different dexmedetomidine doses to determine the optimal analgesic regimen.

Further studies should also assess long-term neurological safety, analyze the cost-effectiveness of the 20G IV cannula technique, and compare the IV cannula technique with conventional caudal needle techniques under ultrasound guidance.

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