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A COMPARISON OF CAUDAL BLOCK ALONE AND CAUDAL BLOCK WITH INTRAVENOUS DEXAMETHASONE IN PAEDIATRIC UROLOGICAL PROCEDURE FOR POSTOPERATIVE ANALGESIA

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ABSTRACT

Background: Caudal epidural block has been extensively employed as postoperative analgesia in lower infra-umbilical surgery in children, but has a shorter duration, which causes early breakthrough pain and increased rescue analgesic needs. Dexamethasone intravenously provides the effect of anti-inflammatory and central analgesia and could do more to strengthen caudal analgesia without causing more complications. This trial involved a comparison between caudal block and caudal block and intravenous dexamethasone in children who had elective paediatric urological surgeries.

Material & Methods: The study was a prospective comparative cohort study carried out at the Department of Anaesthesia, Sindh Institute of Urology and Transplantation (SIUT) between 11 November 2025 and January 2026 after approval by the Ethical Review Committee (ERC No. 596; Approval No. SIUT-ERC-2025/A-596). The participants were children aged 2-10 years of age, ASA I, who were going to undergo elective paediatric urological surgery under general anaesthesia (n=97). Group A involved caudal block using local anaesthetic only (n=48), whereas Group B involved caudal regimen and intravenous dexamethasone (n=49). Age-specific VAS/FLACC was used to measure pain at 0, 1, 2, 4, 6, 12 and 24 hours. The main outcome was time to first rescue analgesia and secondary outcomes were rescue doses, total analgesic consumption, pain scores, adverse events and length of stay.

Results: Baseline characteristics were comparable between groups ($p>0.05$). Group B had a significantly longer time to first rescue analgesia (9.42 ± 1.54 vs 5.22 ± 1.23 hours; $p<0.001$), fewer rescue doses (1.47 ± 0.50 vs 3.08 ± 0.79; $p<0.001$), and lower total analgesic consumption (21.36 ± 4.79 vs 39.49 ± 5.53 mg/kg; $p<0.001$). Pain scores from 1–24 hours were significantly lower in Group B ($p<0.001$). Postoperative adverse events and hospital stay were similar ($p>0.05$).

Conclusion; Adding intravenous dexamethasone to caudal block significantly improves postoperative analgesia without increasing adverse effects or prolonging hospital stay in paediatric urological surgery.

Keywords: Caudal block; Dexamethasone; Paediatric urology; Postoperative analgesia; FLACC; VAS.

INTRODUCTION

Postoperative pain management in children undergoing urological surgery is a crucial requirement to prevent distress, ensure an early mobilization and feeding, and overall improvement in recovery [1]. Poorly managed pain can result in neuroendocrine stress reactions, escalation of analgesic demands, and long periods of surveillance and caregiver discontent. Thus, the optimization of regional analgesic procedures is still one of the priorities in perioperative care of children [2, 3].

One of the most widely used regional anaesthesia methods in the intra-umbilical surgery of children is the caudal epidural block because it is relatively simple and has a good safety profile when used in cases of urological surgery [4]. Although the analgesia time with local anaesthetic may be effective, it may not last long to ensure sustained pain relief and analgesic effect, leading to early breakthrough pain and repeated rescue analgesic dosing, especially during the initial postoperative day [5, 6].

Dexamethasone is a corticosteroid that possesses strong anti-inflammatory and further central analgesic properties that encompass the decrease in the production of inflammatory mediators and the mitigation of peripheral and central sensitization [7, 8]. Dexamethasone can be used perioperatively and possibly used to improve the quality and duration of analgesia, which might decrease the need of rescue analgesic and lead to better scores on pain [9, 10]. Nevertheless, there is still the issue of possible adverse effects of steroids and in paediatric urological surgery, there is limited evidence on the comparison of caudal block versus caudal block and intravenous dexamethasone.

Research problem and knowledge gap was The analgesic effect of caudal block using local anaesthetic is not sufficient to provide adequate postoperative analgesia for paediatric urological surgery, and there is scanty local comparative evidence on whether intravenous dexamethasone can safely supplement caudal analgesia without exerting undue adverse effect and without addition to hospitalisation. The Research question was Does the intravenous dexamethasone to caudal block add to the effects of caudal block on the postoperative analgesic effects in children undergoing elective paediatric urological surgery?

The Objective was To compare the analgesic efficacy and safety of caudal block alone versus caudal block with intravenous dexamethasone in children undergoing elective paediatric urological procedures, in terms of time to first rescue analgesia, rescue analgesic requirements, pain scores, adverse events, and length of hospital stay.

The Hypothesis was Caudal block with intravenous dexamethasone extends postoperative analgesia and decreases the postoperative rescue analgesic need than caudal block does, but does not reduce postoperative adverse events or hospitalization.

The rationale was establishing an effective and safe adjuvant strategy for caudal analgesia may improve postoperative comfort, reduce analgesic burden, and support standardized paediatric perioperative pain protocols in urological practice.

METHODOLOGY

The current prospective comparative cohort study was carried out at the Sindh institute of urology and transplantation (SIUT) which is a tertiary care referral centre that offers specialized services in paediatric urology and anaesthesia. The research was conducted in the Department of Anaesthesia, SIUT, 2 Months study period 11 November 20205- January 2026. The SIUT is a high-volume academic hospital that has standardized perioperative care guidelines and paediatric surgical units. The objective of the study was to compare analgesic effect and safety of both caudal block and caudal block with intravenous dexamethasone in children that underwent elective paediatric urological procedures.

Ethical approval for the study was obtained from the Ethical Review Committee (ERC) of the Sindh Institute of Urology and Transplantation (SIUT). The study was approved under ERC Number: 596 and Approval Number: SIUT-ERC-2025/A-596, issued on November 11, 2025.

The research was approved of the principles of the Declaration of Helsinki. Informed consent of all children who were enrolled was also taken in written form beforehand by the parents or legal guardians. The confidentiality of the patient information was upheld and the study was conducted with full voluntary participation, the ability of the participant to withdraw at any point without any consequences on clinical care.

WHO sample size calculator was used to compare two independent groups since the sample is calculated. A study power of 80% and confidence level of 95% were based on the fact that previous literature reported a clinically meaningful difference in time to first rescue analgesia between groups [4].

The minimum required sample size was calculated to be 96 patients. To account for possible dropouts or incomplete data, a total of 97 patients were enrolled in the study, with 48 children allocated to Group A (caudal block alone) and 49 children to Group B (caudal block with intravenous dexamethasone).

All children aged between 2 and 10 years who were electively taken through paediatric urological surgeries under the general anaesthesia were eligible to be included. The selection of only the patients with an American Society of Anesthesiologists (ASA) physical status I was performed to maintain a homogenous low-risk group.

The exclusion criteria were parental refusal of consent, allergy to local anaesthetics or dexamethasone, caudal injection site local infection, congenital spinal anomalies, neurological conditions, chronic use of analgesics or any severe systemic disease.

Following standard preoperative assessment and preoperative fasting as per the institutional regulations, general anaesthesia was administered in a standardized manner to all children. When the anaesthesia had been induced and normal monitoring was established, a caudal block was done under aseptic conditions with the landmark method.

Group A patients were treated with caudal block containing local anaesthetic. Group B: patients in this group underwent caudal block using the same local anaesthetic regimen and intravenous administration of dexamethasone followed by the administration of block.

All patients were standardized according to the type and dose of local anaesthetic. To reduce variability of the operators, all the procedures were conducted by consultant anaesthesiologists who had training on paediatric regional anaesthesia. Age-specific validated pain scales (VAS/FLACC) were used to evaluate postoperative pain 0, 1, 2, 4, 6, 12, and 24 hours postoperative. When the pain score had surpassed the institutional set-point of pain, the rescue analgesia was administered.

The first major outcome was time to first rescue analgesia. The secondary outcomes were total number of rescue doses, total consumption of analgesics during 24 hours, the need in rescue analgesia, postoperative pain rating, adverse events, and the length of hospital stay. Baseline demographic data, surgical data, intra operative data, post operative pain data, analgesic needs, adverse events and length of stay were documented on a provided structured data collecting proforma by trained anaesthesia residents who did not participate in the block procedure. To ensure the completeness and accuracy of all data, the principal investigator cross-checked all data on a daily basis.

Measures taken to improve measurement reliability included standardized anaesthesia protocols, standard pain assessment instruments and preset rescue analgesia criteria. Trained nursing staff that was blinded to groups conducted all of the pain assessments. The data entry was verified twice and 10 percent records audited randomly to verify the data integrity.

The SPSS version 26 was used to perform data analysis. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test the normality of continuous variables. Data that were normally distributed were represented by mean ± standard deviation, whereas those that were not normally distributed were represented by median and interquartile range (IQR). The Mann-Whitney U test was used to make between-group comparisons of continuous variables. The chi-square test or Fisher exact test was used to compare categorical variables where possible. Cramer V was used as an effect size of categorical outcomes. A p-value that was below 0.05 was taken as significant.

RESULTS

There was no difference between the two groups in terms of baseline demographic and surgical characteristics. The study did not find any statistically significant differences between children undergoing caudal block alone and caudal block with intravenous dexamethasone in the areas of age, weight, and duration of surgery, and sex distribution, or procedure type ($p > 0.05$ across everything). Both groups of patients were of ASA physical status I, meaning a homogeneous low-risk study population.

Table 1. Baseline characteristics of the study population (n = 97)

Variable	Group A: Caudal alone (n=48)	Group B: Caudal + IV dexamethasone (n=49)	p-value
Age (years), mean ± SD	5.69 ± 2.57	5.49 ± 2.42	0.710
Weight (kg), mean ± SD	19.61 ± 4.99	18.83 ± 5.34	0.407
Duration of surgery (min), mean ± SD	57.98 ± 18.17	61.41 ± 17.40	0.429
Male sex, n (%)	34 (70.8)	35 (71.4)	0.948
ASA I, n (%)	48 (100.0)	49 (100.0)	—
Procedure type, n (%)			0.094
• Circumcision	14 (29.2)	13 (26.5)	
• Herniotomy	11 (22.9)	12 (24.5)	
• Hypospadias repair	17 (35.4)	9 (18.4)	
• Orchidopexy	6 (12.5)	15 (30.6)	

Values are presented as mean ± standard deviation or number (percentage). p-values for continuous variables were calculated using the Mann–Whitney U test. p-values for categorical variables were calculated using the chi-square test. No statistical comparison was performed for ASA status as all patients were ASA I.

The time to first rescue analgesia was significantly more in children that had caudal block using intravenous dexamethasone than in children that had caudal block alone (9.42 ± 1.54 vs 5.22 ± 1.23 hours; $p < 0.001$). The dexamethasone group also needed to be administered much less rescue analgesic and their total analgesic consumption during the first 24 hours was significantly lower ($p = 0.001$ in both). Moreover, children in the dexamethasone group were much less likely to need rescue analgesia than children in the caudal-alone group (53.1% vs 83.3; $\chi^2 = 10.219$, df = 1, $p = 0.001$; Cramer V = 0.325).

Table 2. Postoperative analgesia outcomes

Outcome	Group A: Caudal alone (n=48)	Group B: Caudal + IV dexamethasone (n=49)	p-value
Time to first rescue analgesia (hours), mean ± SD	5.22 ± 1.23	9.42 ± 1.54	< 0.001
Total rescue doses in 24 h, mean ± SD	3.08 ± 0.79	1.47 ± 0.50	< 0.001

Total analgesic consumption (mg/kg), mean ± SD	39.49 ± 5.53	21.36 ± 4.79	< 0.001
Required rescue analgesia, n (%)	40 (83.3)	26 (53.1)	0.001 †

†Chi-square (χ^2) = 10.219, df = 1, Cramer's V = 0.325.

The two groups had similar scores in pain at 0 hours (p = 0.951). After 1 hour, children in the caudal block and dexamethasone group all showed significantly lower pain scores than children in the caudal block group (p < 0.001 at 1, 2, 4, 6, 12 and 24 hours). Most of the differences were the highest at early postoperative period (1-6 hours) showing better quality of analgesic with dexamethasone as an adjunct.

Table 3. Postoperative pain scores (VAS/FLACC) over time

Time after surgery	**Group A: Caudal alone (n=48) Mean ± SD**	**Group B: Caudal + IV dexamethasone (n=49) Mean ± SD**	**p-value†**
0 hour	2.03 ± 0.29	2.03 ± 0.32	0.951
1 hour	3.61 ± 0.58	2.21 ± 0.45	<0.001
2 hours	4.10 ± 0.66	2.73 ± 0.44	<0.001
4 hours	4.26 ± 0.64	2.87 ± 0.48	<0.001
6 hours	4.05 ± 0.60	2.73 ± 0.43	<0.001
12 hours	2.73 ± 0.62	1.37 ± 0.48	<0.001
24 hours	2.43 ± 0.67	1.09 ± 0.48	<0.001

†Mann–Whitney U test (2-tailed).

The rate of postoperative adverse events, such as postoperative nausea and vomiting, sedation, block failure, urinary retention, and additional intraoperative analgesia was similar in the two groups, and no statistically significant differences were found (p > 0.05). Median length of stay in children who were given caudal block alone and caudal block and intravenous dexamethasone was also similar (18.0 [IQR 4.72] vs 18.3 [IQR 7.70] hours; p = 0.857). Altogether, the introduction of dexamethasone was not related to the higher risk of postoperative complications and long-term hospitalization.

Table 4. Postoperative adverse effects and length of hospital stay

Adverse event	**Group A: Caudal alone n (%) / Median (IQR)**	**Group B: Caudal + Dexa n (%) / Median (IQR)**	**χ^2 / U (test statistic)**	**p-value**	**Cramer's V**
PONV	11 (22.9%)	15 (30.6%)	χ^2 = 0.732	0.392	0.087
Sedation	6 (12.5%)	4 (8.2%)	χ^2 = 0.493	0.483	0.071
Block failure	3 (6.3%)	2 (4.1%)	χ^2 = 0.233*	0.629	0.049
Urinary retention	4 (8.3%)	7 (14.3%)	χ^2 = 0.854	0.355	0.094
Additional intraoperative analgesia	12 (25.0%)	10 (20.4%)	χ^2 = 0.292	0.589	0.055

Length of hospital stay (hours)	18.0 (IQR 4.72)	18.3 (IQR 7.70)	U = 1151.0	0.857	-

Values are presented as n (%) or median (interquartile range). Chi-square test was used for categorical variables. *Fisher's exact test was used where expected cell counts were < 5. Length of hospital stay was compared using the Mann–Whitney U test. No postoperative adverse event or length of hospital stay differed significantly between groups.

DISCUSSION

The intravenous dexamethasone supplementation of caudal block in this prospective comparative cohort study significantly enhanced the quality and duration of postoperative analgesia in children undergoing elective paediatric urological surgery, without either boosting the adverse effects or extending hospital stay. The main conclusion was that there was a significant increase in the time to the first rescue analgesia and that there were lower rescue analgesic requirements, less total analgesic consumption, and invariable lower scores in the postoperative pain scale in the dexamethasone group. The prolongation of analgesia in the dexamethasone group is in line with a number of recent studies on the assessment of systemic steroids as analgesic adjuvants. According to Sharif et al., intravenous dexamethasone had a significant effect on the duration of caudal analgesia and the opioid needs in children requiring herniotomy due to the anti-inflammatory and central analgesic properties of dexamethason[11]. Similarly, a recent meta-analysis study by Singh et al. also has shown that perioperative intravenous dexamethasone had a significant effect on postoperative pain scale and opioid use during post-caesarean pain.

[12]. The mean time to first rescue analgesia in our study was almost twice in the dexamethasone group than that of caudal block alone, a result that is consistent with the publications of Zhang et al. network meta-analysis, which revealed that systemic steroids were effective as adjuvants in extending the time to first rescue analgesia when caudal block was used as the sole analgesic agent [13]. Its mechanism of action is thought to be through inhibition of the production of the prostaglands, inhibition of peripheral and central sensitization and inhibition of inflammatory mediators at the surgical site.

Our dexamethasone group registered significantly lower scores in pain between 1 and 24 hours postoperative; this finding is consistent with recent randomized trials conducted in paediatric urological and infra-umbilical surgery. Mohamed et al. showed that the adjuvant agents in combination with caudal blocks lowered the initial and subsequent postoperative pain scores especially in the initial 6 hours of the study, which also was the phase when the intergroup variation was highest in our group [14]. The clinical significance of this early postoperative advantage is that pain levels at this stage can be the most severe, and may be the most indicative of further analgesic demands.

The other significant finding in our study was that children who needed rescue analgesia in the dexamethasone group were significantly less. This result is in line with the conclusions of recent systematic reviews revealing that perioperative dexamethasone decreases the rate and frequency of breakthrough pain in children patients [15]. The intermediate effect size (Cramer V = 0.325) was also a pointer that this difference is not only statistically significant, but also clinically significant.

In terms of safety, there were no significant differences in the occurrence of postoperative adverse events (postoperative nausea and vomiting, sedation, block failure, urinary retention, and the necessity of further intraoperative analgesia) in the two groups. This agrees with modern literature that a single dose of intravenous dexamethasone during perioperation is safe during paediatric anaesthesia and has no relation with the rates of infection, delayed wound healing, or neurological issues [16, 17]. Specifically, the recent meta-analyses have concluded that dexamethasone does not augment postoperative complications when administered as an analgesic adjunct in children[18].

The duration of hospital stay was also similar with the median hospital stay of about 18 hours in both groups. Such observation is in line with the research findings that though dexamethasone enhances the quality of analgesia, it may or may not reduce the length of stay in short-stay paediatric urological surgeries [19, 20]. It indicates that the time of discharge within this population is more determined by surgical and institutional factors rather than by analgesic method used solely.

There are a number of strengths in our study. Internal validity is supported by the prospective nature of the design, the homogenous ASA I population, standardized anaesthesia mono-intervention, the blinding of the pain evaluation and extensive postoperative follow-up. Nonetheless, there are some shortcomings that need to be mentioned. To begin with, it was a single-centre study that had a relatively small sample, which can be a limitation of generalization. Second, despite the fact that the pain assessors did not know what groups they were dealing with, the entire anaesthesia team could not be blinded. Third, there was no evaluation of neurodevelopmental outcomes in the long term, although there were no short-term neurological complications.

Regardless of these constraints, our results contribute to the increasing evidence base of intravenous dexamethasone administration as an effective and safe method of adding to caudal analgesia in paediatric urological surgery. Future multicentre randomized controlled studies that are larger in size and length of follow up can help shed more light on the best dosing techniques and safety on a long term basis.

CONCLUSION

In conclusion, the addition of intravenous dexamethasone to caudal block significantly enhances postoperative analgesia in children undergoing paediatric urological procedures by prolonging the duration of analgesia, reducing rescue analgesic requirements, lowering total analgesic consumption, and improving postoperative pain scores. Importantly, these benefits were achieved without an increase in adverse events or prolongation of hospital stay. Intravenous dexamethasone appears to be a safe, effective, and practical adjunct to caudal analgesia in routine paediatric urological practice.

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