Original Article

Comparison of Caudal Block versus General Anaesthesia in Paediatric Infraumbilical Surgeries

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Abstract

Background: Postoperative pain after paediatric infraumbilical surgery can delay recovery and increase agitation. Caudal block provides segmental analgesia for subumbilical procedures and can reduce systemic analgesic requirements. The objective is to compare caudal block with general anaesthesia in terms of haemodynamic stability, postoperative pain, rescue analgesic need, recovery profile and adverse events in children undergoing elective infraumbilical surgeries. **Material and Methods:** In this prospective comparative study, 60 children at Kamineni Institute of Medical Sciences, Narketpally, Telangana, India, from August 2024 to July 2025 were divided into Group C (caudal block, n=30) and Group G (general anaesthesia, n=30). Demographic profile, intraoperative heart rate, mean arterial pressure, FLACC scores, rescue analgesia, recovery time and complications were recorded. **Results:** Baseline characteristics and duration of surgery were comparable. At 15 and 30 minutes after incision, heart rate and mean arterial pressure were lower in Group C. FLACC scores at 30 minutes, 1 hour, 2 hours and 4 hours were significantly lower in Group C. Time to first rescue analgesia was longer with caudal block (348.6 ± 61.4 minutes) than with general anaesthesia (96.8 ± 28.7 minutes). Recovery time, emergence agitation and postoperative nausea/vomiting were also lower in Group C. **Conclusion:** Caudal block provided superior early postoperative analgesia, smoother recovery and fewer minor adverse events than general anaesthesia alone, while maintaining perioperative safety in paediatric infraumbilical surgeries.

Keywords: Caudal block; General anaesthesia; Paediatric anaesthesia; Infraumbilical surgery; FLACC score; Postoperative analgesia; Emergence agitation.

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Introduction

Infraumbilical surgeries constitute a major proportion of paediatric surgical workload and include procedures such as inguinal hernia repair, orchidopexy, circumcision, hypospadias correction and perineal procedures.[1] Although these operations are often short and elective, inadequate perioperative analgesia causes sympathetic stimulation, delayed recovery, feeding difficulty, sleep disturbance and behavioural distress in children. General anaesthesia remains widely used because it provides unconsciousness, amnesia and immobility; however, it does not provide sustained segmental postoperative analgesia unless combined with local or regional techniques.[2,3] Consequently, postoperative pain, emergence agitation and increased rescue analgesic use remain important concerns in routine paediatric anaesthetic practice.[3]

Caudal epidural block is one of the most frequently performed regional anaesthetic techniques in children. The relatively superficial sacral hiatus, predictable spread of local anaesthetic within the epidural space and strong applicability to subumbilical dermatomes make it useful for lower abdominal, urogenital and perineal surgeries.[2] Large clinical series and paediatric regional anaesthesia audits have shown high success rates and low complication rates when caudal block is performed by trained anaesthesiologists with appropriate dose calculation and monitoring.[4-5] In addition to pain relief, caudal block reduces the need for intraoperative anaesthetic supplementation and systemic opioids, thereby contributing to smoother emergence and better early postoperative comfort.[6]

Assessment of pain in young children is challenging because many patients cannot reliably express pain intensity. The Face, Legs, Activity, Cry and Consolability (FLACC) scale provides a validated behavioural method for assessing postoperative pain in infants and young children, and it is widely used in clinical studies and recovery units.[7] Early pain control also influences non-pain outcomes. Sevoflurane-based general anaesthesia has been associated with emergence agitation in children, and studies have reported that effective regional analgesia, including caudal block, can reduce agitation during recovery.[8-11] Hence, comparison of caudal block and general anaesthesia using pain scores, haemodynamic response, recovery profile and

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complications gives clinically relevant information for day-to-day paediatric anaesthesia practice.

Although caudal block is well established, local institutional evidence remains valuable because operative case mix, anaesthetic protocols, monitoring practices and postoperative analgesic thresholds vary among centres. The present study was conducted at Kamineni Institute of Medical Sciences, Narketpally, Telangana, India. The objective of the study was to compare caudal block versus general anaesthesia in paediatric patients undergoing elective infraumbilical surgeries with respect to demographic comparability, intraoperative haemodynamic parameters, postoperative FLACC pain scores, time to first rescue analgesia, total rescue analgesic requirement, recovery characteristics and adverse events.

Materials and Methods

Study design and setting: This prospective comparative study was conducted in the Department of Anaesthesiology at Kamineni Institute of Medical Sciences, Narketpally, Telangana, India. The study period extended from August 2024 to July 2025. Children scheduled for elective infraumbilical surgeries were screened during the pre-anaesthetic evaluation and enrolled after confirming eligibility. The study was planned to compare perioperative analgesic efficacy and recovery profile between caudal block and general anaesthesia in routine paediatric surgical practice. Written informed consent was obtained from parents or legal guardians before enrolment. Participant confidentiality was maintained throughout data collection, analysis. No patient-identifying information was included.

Study population and sample size: A total of 60 children were included and divided into two equal groups of 30 patients each. Group C received caudal block, and Group G received general anaesthesia. Children in ASA physical status I or II scheduled for elective infraumbilical surgery were considered eligible. Children with local infection at the sacral region, coagulation abnormality, spinal deformity, neurological disease, allergy to local anaesthetic drugs, emergency surgery or refusal of consent were excluded. The sample size of 60 was selected as a feasible institutional sample for one study period and to provide equal group comparison for primary clinical outcomes.

Anaesthetic technique: All children underwent standard preoperative fasting and evaluation. In the operating room, heart rate, non-invasive blood pressure, oxygen saturation and electrocardiography were monitored. In Group C, caudal epidural block was performed under aseptic precautions with calculated local anaesthetic dose according to institutional paediatric protocol after light sedation or induction as clinically appropriate. Adequacy of block was assessed before surgical incision. In Group G, conventional general anaesthesia was administered with airway management and systemic analgesia as per institutional protocol. Additional analgesia or conversion of technique was planned if intraoperative signs of inadequate analgesia occurred.

Outcome assessment: Baseline demographic details, ASA physical status and duration of surgery were recorded. Intraoperative heart rate and mean arterial pressure were documented at baseline and at predefined time points after incision. Postoperative pain was assessed using the FLACC scale at 30 minutes, 1 hour, 2 hours, 4 hours and 6 hours.[7] Rescue analgesia was administered when the pain score exceeded the institutional threshold or when clinically indicated. Time to first rescue analgesia, number of rescue analgesic doses in 24 hours, recovery time, emergence agitation, postoperative nausea/vomiting, urinary retention, motor weakness, respiratory depression and features of local anaesthetic toxicity were recorded.

Statistical analysis: Data were entered in a spreadsheet and analysed using standard statistical methods. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequency and percentage. Intergroup comparison of continuous variables was performed using the independent samples t-test, while categorical variables were compared using the chi-square test or Fisher exact test as appropriate. A p-value less than 0.05 was considered statistically significant.

Results

A total of 60 children undergoing elective infraumbilical surgeries were included in the study. The patients were divided into two equal groups: Group C received caudal block, and Group G received general anaesthesia. Each group included 30 patients. All enrolled children completed the study and were included in the final analysis.

The demographic variables were comparable between the two groups. The mean age was 5.2 ± 2.1 years in Group C and 5.5 ± 2.3 years in Group G. The mean body weight was 17.8 ± 4.6 kg in Group C and 18.2 ± 4.9 kg in Group G. Male predominance was observed in both groups, which was consistent with the higher number of male children undergoing infraumbilical procedures such as hernia repair and circumcision. No statistically significant difference was observed between the groups with respect to age, weight, sex distribution, ASA physical status or duration of surgery [Table 1].

Table 1: Baseline demographic and clinical characteristics of the study population

Variable	Group C: Caudal block (n=30)	Group G: General anaesthesia (n=30)	p-value
Age, years	5.2 ± 2.1	5.5 ± 2.3	0.598
Weight, kg	17.8 ± 4.6	18.2 ± 4.9	0.745
Male	22 (73.3%)	21 (70.0%)	0.774
Female	8 (26.7%)	9 (30.0%)	0.774
ASA I	24 (80.0%)	23 (76.7%)	0.754
ASA II	6 (20.0%)	7 (23.3%)	0.754
Duration of surgery, minutes	42.6 ± 9.8	44.1 ± 10.4	0.568

Intraoperative haemodynamic parameters remained stable in both groups. However, children in the caudal block group showed comparatively lower intraoperative heart rate and mean arterial pressure after surgical incision, indicating better attenuation of the surgical stress response. The difference was statistically significant at 15 and 30 minutes after incision. No episode of clinically significant hypotension, bradycardia or oxygen desaturation was observed in either group [Table 2].

Table 2: Comparison of intraoperative haemodynamic parameters

Parameter	Group C: Caudal block (n=30)	Group G: General anaesthesia (n=30)	p-value
Baseline heart rate, beats/min	104.5 ± 11.6	106.2 ± 12.1	0.580
Heart rate at 15 min	98.4 ± 10.2	112.6 ± 13.4	<0.001
Heart rate at 30 min	96.8 ± 9.7	110.3 ± 12.8	<0.001
Baseline MAP, mmHg	71.2 ± 6.8	72.1 ± 7.2	0.621
MAP at 15 min, mmHg	68.5 ± 6.1	76.8 ± 7.5	<0.001
MAP at 30 min, mmHg	67.9 ± 5.9	75.4 ± 7.1	<0.001

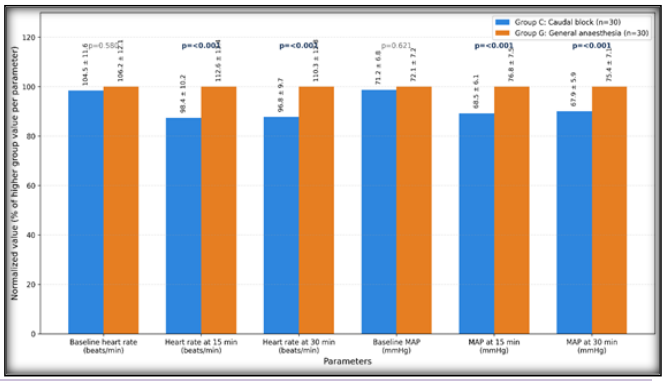

Figure 1: Comparison of intraoperative haemodynamic parameters

Postoperative pain scores were lower in the caudal block group during the early postoperative period. At 30 minutes, 1 hour, 2 hours and 4 hours after surgery, the mean FLACC pain scores were significantly lower in Group C compared with Group G. The duration of postoperative analgesia was markedly prolonged in the caudal block group. The mean time to first rescue analgesic requirement was 348.6 ± 61.4 minutes in Group C compared with 96.8 ± 28.7 minutes in Group G, and this difference was statistically significant. The total number of rescue analgesic doses during the first 24 hours was also lower in Group C [Table 3].

Table 3: Comparison of postoperative analgesic profile

Parameter	Group C: Caudal block (n=30)	Group G: General anaesthesia (n=30)	p-value
FLACC score at 30 min	1.2 ± 0.8	3.8 ± 1.1	<0.001
FLACC score at 1 hour	1.4 ± 0.9	4.2 ± 1.3	<0.001
FLACC score at 2 hours	1.8 ± 1.0	4.6 ± 1.4	<0.001
FLACC score at 4 hours	2.6 ± 1.2	3.9 ± 1.3	<0.001
FLACC score at 6 hours	3.4 ± 1.4	3.6 ± 1.2	0.555
Time to first rescue analgesia, minutes	348.6 ± 61.4	96.8 ± 28.7	<0.001
Total rescue analgesic doses in 24 hours	1.1 ± 0.4	2.4 ± 0.6	<0.001
Children requiring rescue analgesia within 2 hours	2 (6.7%)	21 (70.0%)	<0.001

Recovery characteristics were better in the caudal block group. The mean recovery time was shorter in Group C compared with Group G. Emergence agitation was less frequent among children receiving caudal block. Postoperative nausea and vomiting were observed more commonly in the general anaesthesia group. No major complications such as respiratory depression, local anaesthetic toxicity, neurological deficit or accidental dural puncture were reported [Table 4].

Table 4: Comparison of recovery characteristics and adverse events

Parameter	Group C: Caudal block (n=30)	Group G: General anaesthesia (n=30)	p-value
Recovery time, minutes	18.5 ± 5.6	29.4 ± 7.8	<0.001
Emergence agitation	2 (6.7%)	9 (30.0%)	0.020
Postoperative nausea/vomiting	1 (3.3%)	6 (20.0%)	0.044
Urinary retention	2 (6.7%)	1 (3.3%)	0.554
Motor weakness	1 (3.3%)	0 (0.0%)	0.313
Respiratory depression	0 (0.0%)	1 (3.3%)	0.313
Local anaesthetic toxicity	0 (0.0%)	0 (0.0%)	-

Overall, caudal block provided superior postoperative analgesia, reduced early postoperative pain scores, delayed the need for rescue analgesia and decreased total analgesic requirement during the first 24 hours after surgery. General anaesthesia was associated with higher early postoperative pain scores, greater rescue analgesic use and a higher frequency of emergence agitation and postoperative nausea/vomiting. Both techniques were safe, but caudal block demonstrated better perioperative analgesic efficacy in paediatric infraumbilical surgeries.

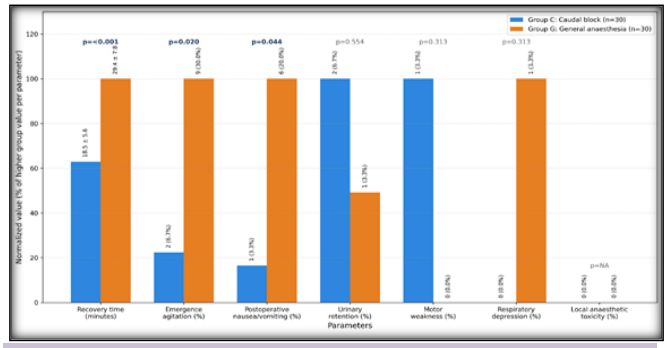

Figure 2: Comparison of recovery characteristics and adverse events

Discussion

The present study compared caudal block with general anaesthesia in 60 children undergoing elective infraumbilical surgeries. The demographic and clinical variables were comparable between the two groups, which strengthens the interpretation of postoperative analgesic outcomes. Age, weight, sex distribution, ASA physical status and duration of surgery showed no significant intergroup difference. This baseline similarity reduces the likelihood that differences in pain scores, haemodynamic response or recovery profile were explained by unequal patient characteristics or surgical duration.

The caudal block group demonstrated lower heart rate and mean arterial pressure at 15 and 30 minutes after incision. This finding indicates better attenuation of nociceptive input during surgical stimulation. The result is consistent with the pharmacological basis of caudal epidural block, which interrupts sensory transmission from infraumbilical dermatomes and reduces sympathetic response to surgical incision. Previous paediatric studies have also reported reduced intraoperative anaesthetic requirement and improved pain control when caudal epidural block is added to or compared with conventional anaesthetic approaches.[6] The absence of clinically significant bradycardia, hypotension or desaturation in the present study supports the haemodynamic safety of the technique when appropriate monitoring and dose calculation are followed.

Postoperative analgesic outcomes clearly favoured caudal block. FLACC scores were significantly lower at 30 minutes, 1 hour, 2 hours and 4 hours, while the difference disappeared by 6 hours. This pattern reflects the expected duration of single-shot caudal local anaesthetic action. The time to first rescue analgesia was more than three times longer in the caudal block group, and total rescue analgesic doses during 24 hours were lower. These findings agree with earlier evidence describing caudal block as an effective modality for early postoperative analgesia in paediatric infraumbilical procedures.[12-14] The use of FLACC scoring also strengthens clinical relevance, because this scale is validated for behavioural pain assessment in young children.[7]

Recovery parameters were also better with caudal block. Shorter recovery time, lower emergence agitation and lower postoperative nausea/vomiting were observed in Group C. Pain is an important contributor to postoperative agitation in children, particularly after volatile anaesthesia, and studies have reported that effective caudal analgesia can reduce agitation during emergence.[8-10] The lower frequency of nausea/vomiting in the caudal group is clinically meaningful because reduced systemic analgesic use and smoother recovery can improve early feeding, parental satisfaction and discharge readiness. These findings support the use of regional analgesia as part of a child-centred perioperative strategy.[11]

No major adverse event was recorded in either group. Minor events such as urinary retention and transient motor weakness were infrequent. Large paediatric series and regional anaesthesia network data have shown that caudal epidural block is associated with high success and low serious complication rates when performed by trained clinicians. Thus, in the present study setting, caudal block provided a favourable balance of analgesic efficacy and safety. The results support caudal block as an effective anaesthetic and analgesic option for appropriately selected paediatric infraumbilical surgeries.

Limitations

This was a single-centre study with a modest sample size of 60 children. The surgical procedures were grouped under infraumbilical surgeries, so procedure-specific analgesic variation was not separately analysed. Long-term outcomes, parental satisfaction and discharge readiness were not assessed. Blinding of postoperative assessors was not specified, which introduces observer-related bias in pain scoring.

Conclusion

Caudal block was associated with better perioperative analgesic efficacy than general anaesthesia alone in children undergoing elective infraumbilical surgeries. It produced lower early postoperative FLACC pain scores, delayed the first requirement of rescue analgesia and reduced the total number of rescue analgesic doses during the first 24 hours. Children receiving caudal block also had shorter recovery time, lower emergence agitation and fewer episodes of postoperative nausea/vomiting. Haemodynamic stability was maintained, and no major complication was observed. These findings support caudal block as a safe and effective anaesthetic-analgesic technique for selected paediatric infraumbilical procedures in tertiary care practice.

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Conflicts of interest

There are no conflicts of interest.

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