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A Comparative Study Of Caudal Epidural Block Versus Ultrasound-Guided Ilioinguinal-Iliohypogastric Nerve Block For Postoperative Analgesia In Older Children Undergoing Inguinal Surgeries

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ABSTRACT

Background: Effective postoperative pain control in pediatric inguinal surgeries is crucial for enhanced recovery and patient comfort. While caudal epidural block has long been the standard regional technique, ultrasound-guided ilioinguinal-iliohypogastric (USG II/IH) nerve block has recently gained traction due to its precision and safety. This study compares the efficacy and safety of caudal block versus USG II/IH block in older children undergoing elective inguinal procedures.

Methods: A prospective, randomized, comparative clinical study was conducted on 60 children aged 6–12 years, ASA I–II, scheduled for unilateral herniotomy or orchidopexy under general anesthesia. They were randomized into two groups: Group C (caudal block, n=30) received 1 mL/kg of 0.25% bupivacaine, and Group I (USG II/IH block, n=30) received 0.2 mL/kg of 0.25% bupivacaine. Primary outcome measured was duration of postoperative analgesia. Secondary outcomes included FLACC pain scores at 1, 2, 4, and 6 hours post-op, need for rescue analgesia, intraoperative hemodynamic stability, and any complications.

Results: Demographic variables and baseline characteristics were statistically comparable between the groups. Group I exhibited significantly longer duration of analgesia (6.78 ± 1.03 hours) than Group C (4.12 ± 0.85 hours; $p < 0.0001$). FLACC scores were significantly lower in Group I at all time points (1, 2, 4, 6 hours; $p < 0.001$). Rescue analgesia requirement was lower in Group I (40%) compared to Group C (70%; $p = 0.015$). Complications such as motor block and urinary retention occurred in 10% of Group C but were absent in Group I. Hemodynamic parameters remained stable and comparable in both groups.

Conclusion: Ultrasound-guided ilioinguinal-iliohypogastric block provides superior and longer-lasting postoperative analgesia with fewer complications than caudal block in older children undergoing unilateral inguinal surgeries, making it a preferable regional anesthetic technique in this population.

1. INTRODUCTION

Effective postoperative pain management in pediatric patients has undergone significant evolution over the past century. The quest for safer and more effective regional anesthetic techniques began in the early 1900s, with the caudal epidural block first described in pediatric patients in the 1930s. This technique gained popularity for its reliability in providing intraoperative and postoperative analgesia for lower abdominal and perineal surgeries in children (Valverde et al., 2003)[1]. Over the decades, caudal blocks became the gold standard for pediatric regional anesthesia due to their ease of administration and predictability.

Simultaneously, peripheral nerve blocks have witnessed significant advancements, particularly with the advent of ultrasound guidance, which has revolutionized safety and precision. Among these, the ilioinguinal-iliohypogastric (II/IH) nerve block has emerged as a viable alternative to caudal anesthesia for surgeries involving the inguinal region, such as herniotomy and orchidopexy. The introduction of ultrasound guided II/IH blocks allows for direct visualization of nerve structures and local anesthetic spread, thereby reducing complications and improving block success (Willschke et al., 2006) [2].

Current pain management guidelines advocate for a multimodal and regional approach to minimize opioid exposure and enhance recovery. In older children (>6 years), both caudal epidural blocks and ultrasound-guided II/IH nerve blocks are widely used, yet their comparative efficacy and safety remain a topic of clinical relevance (Cravero et al., 2019)[3]. Caudal blocks provide broader segmental analgesia, while II/IH blocks are more localized but carry fewer risks of motor block or urinary retention.

This study aims to compare these two best-practice recommendations—caudal block versus ultrasound-guided II/IH block—in older children undergoing inguinal surgeries, to determine which technique offers superior postoperative analgesia, fewer complications, and greater patient satisfaction.

2. MATERIALS AND METHODS

Study Design and Setting

This prospective, randomized, comparative clinical study was conducted over a period of six months in the Department of Anaesthesiology at Karpaga Vinayaga Institute of Medical Sciences and Research Centre after obtaining Institutional Ethics Committee approval and written informed consent from parents or legal guardians.

Study Population

Sixty children aged 6 to 12 years, classified as ASA physical status I or II, and scheduled for elective inguinal surgeries (e.g., herniotomy or orchidopexy) under general anesthesia with regional block, were included in the study.

Inclusion Criteria

- Children aged 6–12 years
- ASA I or II
- Elective unilateral inguinal hernia or undescended testis surgery
- Informed consent obtained from parents/guardians

Exclusion Criteria

- Known allergy to local anesthetics
- Coagulopathy or local infection at the block site
- Neurological or spinal abnormalities
- Developmental delay or inability to assess pain scores
- Refusal by parent or anesthesiologist

Randomization and Group Allocation

Patients were randomly allocated into two groups (n = 30 each) using a computer-generated randomization table:

- Group C (Caudal Block): Received 1 mL/kg of 0.25% bupivacaine caudally
- Group I (II/IH Block): Received 0.2 mL/kg of 0.25% bupivacaine via ultrasound-guided ilioinguinal/iliohypogastric nerve block

Procedure

All children were premedicated with oral midazolam (0.5 mg/kg) 30 minutes before surgery. Standard monitors (ECG, NIBP, SpO_2) were applied. After induction of general anesthesia with propofol and airway secured with LMA, regional blocks were

administered by an experienced anesthesiologist:

Caudal Block: In the left lateral position using the landmark technique

II/IH Block: Under high-frequency linear ultrasound probe guidance, LA was deposited between the internal oblique and the transversus abdominis

Outcome Measures

Primary Outcome: Duration of postoperative analgesia (time to first analgesic request)

Secondary Outcomes: Intraoperative hemodynamic stability, FLACC pain scores at 1, 2, 4, and 6 hours post-op, need for rescue analgesia, and any complications

Postoperative Care

Pain was assessed using the Face, Legs, Activity, Cry, Consolability (FLACC) scale. Rescue analgesia (paracetamol 15 mg/kg IV) was administered when FLACC ≥ 4.

Statistical Analysis

Data were analyzed using SPSS version 26. Continuous variables were expressed as mean ± SD and compared using the Student's t-test. Categorical data were analyzed with the Chi-square test or Fisher's exact test. A p-value < 0.05 was considered statistically significant.

3. RESULTS

The results of this study compare the effectiveness of caudal epidural block versus ultrasound-guided ilioinguinal-iliohypogastric nerve block for postoperative analgesia in older children undergoing inguinal surgeries.

TABLE 1: Demographic and Baseline Characteristics of the Study Population

Variable	Group C (Caudal)	Group I (II/IH)	P-value	Significance
Age (years), mean ± SD	8.49 ± 1.47	8.47 ± 1.59	0.95	NS
Weight (kg), mean ± SD	25.11 ± 3.80	24.87 ± 4.22	0.81	NS
Duration of surgery (min), mean ± SD	44.68 ± 4.89	43.26 ± 5.26	0.17	NS
Sex (Male/Female)	16 / 14	17 / 13	0.79	NS
ASA Grade I / II	21 / 9	20 / 10	0.41	NS

Table 1 - The demographic profile of both groups was statistically comparable, indicating proper randomization and group homogeneity. There were no significant differences in age, weight, sex distribution, ASA grades, or duration of surgery ($p > 0.05$). This ensures that the observed differences in analgesic outcomes between the caudal and II/IH groups are unlikely due to baseline confounders. Such equivalence supports the internal validity of the study and strengthens the reliability of outcome comparisons.

TABLE 2: Comparison of Primary and Secondary Outcomes Between Group C (Caudal Block) and Group I (USG II/IH Block)

Outcome	Group C (Caudal Block)	Group I (USG II/IH Block)	*p*-value	Significance
Primary Outcome				
Duration of Analgesia (hours)	4.12 ± 0.85	6.78 ± 1.03	< 0.0001	Significant
Secondary Outcomes				
FLACC Score at 1 hr	2.5 ± 0.6	1.8 ± 0.5	0.001	Significant

Outcome	Group C (Caudal Block)	Group I (USG II/IH Block)	*p*-value	Significance
FLACC Score at 2 hrs	3.4 ± 0.7	2.1 ± 0.6	< 0.001	Significant
FLACC Score at 4 hrs	4.6 ± 0.9	3.2 ± 0.7	< 0.001	Significant
FLACC Score at 6 hrs	5.1 ± 1.1	3.8 ± 0.9	< 0.001	Significant
Need for Rescue Analgesia (%)	70%	40%	0.015	Significant
Complications (e.g., motor block, urinary retention)	3 cases (10%)	0 cases (0%)	0.076	Not Significant

Table 2 - The ultrasound-guided ilioinguinal/iliohypogastric (II/IH) block (Group I) demonstrated superior performance in providing postoperative analgesia compared to the caudal block (Group C) in children undergoing unilateral inguinal surgeries. Patients in Group I experienced significantly longer durations of analgesia and consistently lower FLACC pain scores at 1, 2, 4, and 6 hours postoperatively, reflecting better overall pain control. The requirement for rescue analgesia was also notably reduced in this group. Moreover, the II/IH block was associated with a lower volume of local anesthetic and no observed complications, highlighting its safety and efficacy. In contrast, while the caudal block provided adequate analgesia, it was associated with a higher incidence of minor complications and a shorter duration of pain relief. However, the caudal approach remains advantageous for more extensive or bilateral lower abdominal procedures due to its broader dermatomal coverage. Thus, the II/IH block is preferred for unilateral, superficial surgeries, while caudal block suits more extensive cases.

TABLE 3: Comparison of Intraoperative Hemodynamic Stability

Parameter	Group C (Caudal Block)	Group I (USG II/IH Block)	*p*-value	Significance
Mean Heart Rate Variation >20%	2/30 (6.7%)	1/30 (3.3%)	0.552	Not Significant
Mean Arterial Pressure Variation >20%	3/30 (10%)	2/30 (6.7%)	0.640	Not Significant
Episodes of Bradycardia (HR <60 bpm)	1/30 (3.3%)	0/30 (0%)	0.312	Not Significant
Episodes of Hypotension (MAP <60 mmHg)	1/30 (3.3%)	0/30 (0%)	0.312	Not Significant

Table 3 - Both groups exhibited similar intraoperative hemodynamic stability, with no statistically significant differences in heart rate or blood pressure variations. Hemodynamic parameters remained within acceptable limits throughout the procedure. Isolated incidents of bradycardia and hypotension were observed, primarily in the caudal block group, but these events were minor and managed effectively without complications. Overall, both the caudal and ultrasound-guided II/IH blocks were well-tolerated, with stable intraoperative profiles and no clinically significant hemodynamic disturbances.

4. DISCUSSION

Our findings are consistent with Varsha et al[4]. that both caudal and USG II/IH blocks with bupivacaine and dexmedetomidine offer effective analgesia in pediatric hernia surgeries. Their findings align with ours, showing longer analgesia and fewer complications with the USG II/IH block, reinforcing its advantage in unilateral inguinal procedures due to greater safety and efficiency.

A meta-analysis by Desai et al[5]. confirmed that ultrasound-guided peripheral blocks reduce opioid use and adverse effects compared to caudal anesthesia, supporting our lower FLACC scores and diminished rescue-analgesia needs.

Nafie et al[6]. demonstrated superior pain control with USG II/IH over caudal blocks, echoing our significant reduction in postoperative FLACC scores. Willschke et al[2]. originally reported enhanced precision and success rates using ultrasound for

II/IH, which underpins our zero-complication rate and consistent block efficacy[4].

A recent randomized trial by Amna Zaheer et al[7]. concluded that USG II/IH provided equivalent analgesia as caudal block but required lower bupivacaine volumes—mirroring our findings. A systematic review by Zhou et al[8]. found that ultrasound-guided ilioinguinal/iliohypogastric blocks have fewer adverse reactions compared to blind techniques, strengthening the safety argument.

The comparative trial by EP175 [2] documented success rates exceeding 95% for USG II/IH with minimal local anesthetic volume, consistent with our procedural metrics[7]. In contrast, a caudal-favored study by "Agony of Choice" [8] emphasized better early intraoperative analgesia with caudal blocks, which may explain their persistent use in extensive cases [8].

Zhou Y et al[9] studies found that ilioinguinal/iliohypogastric blocks provided longer analgesia, lower pain scores, and reduced rescue analgesia needs compared to caudal blocks, with comparable safety and hemodynamic stability in pediatric patients. Sekmenli et al. (2023) found IL/IH superior to wound infiltration in pain control, reinforcing our improved FLACC scores in localized surgery[10].

Polat et al. (2022) observed that ultrasound-guided peripheral blocks offer longer-lasting analgesia than caudal epidurals for lower limb procedures, hinting at similar benefits in inguinal surgeries[11]. A pediatric caudal review (Butterworth, 2019) highlighted caudal's reliability and simplicity but cautioned variable spread and potential urinary retention, reflected in our minor complications[12].

Öksüz et al. (2020) compared caudal with TAP blocks and noted similar efficacy; suggests block selection be tailored to surgical extent[13]. Ponde et al. (2021) found that ultrasound guidance significantly improves caudal success and reduces technical failures, reinforcing the importance of imaging in both techniques[14]. Finally, Lundblad et al. (2021) confirmed that adjuncts like dexmedetomidine significantly prolong II/IH analgesia, comparable to caudal benefits, supporting our protocol rationale[15].

5. CONCLUSION

Ultrasound-guided II/IH block offers longer-lasting analgesia, lower pain scores, and fewer complications than caudal block, making it a safer and more effective choice for unilateral pediatric inguinal surgeries.

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