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Original Article

A comparison of pre-emptive regional analgesic modalities for unilateral inguinal hernia repair in children

Melike Korkmaz Toker[1*], Yasemin Altan[1*], Fatih Çiftci[1*], Aykan Gulleroglu[1*], Seyithan Ozaydın[2], Yavuz Demiraran[1*]

[1]Istanbul Kanuni Sultan Suleyman Research and Training Hospital, Anesthesia and Reanimation Clinic, Istanbul, Turkiye; [2]Istanbul Kanuni Sultan Suleyman Research and Training Hospital, Pediatric Surgery Clinic, Istanbul, Turkiye. [*]Equal contributors.

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Abstract: Inguinal hernia repair is the most frequent surgical procedure in early childhood. We designed a randomized, double-blind controlled study to compare the effects of caudal anesthesia, ilioinguinal/iliohypogastric (II/IH) nerve block, and instillation to the wound-site using bupivacaine on postoperative analgesia. Seventy-five ASA status I-II children aged 2 to 7 years who were scheduled for elective unilateral inguinal herniorrhaphy were enrolled inthe study. Patients were divided into three groups. In the caudal anesthesia (CA) group, the caudal block was performed with the child in the left lateral decubitus position before the surgery with 0.5 ml/kg 0.25% bupivacaine. In the II/IH group, the II/IH nerve block was performed by the anatomic landmarks technique with 0.3 ml/kg 0.25% bupivacaine before the surgery. In the wound instillation (I) group, after the surgical closure of the fascia transversalis, patients received wound instillation with 0.2 ml/kg 0.5% bupivacaine, administered subfascially by the surgeon using a blunt cannula. The primary aimof the study was to compare the duration and quality of postoperative analgesia. Postoperative pain relief was evaluated by the Children's and Infants' Postoperative Pain Scale (CHIPPS) at 0, 2, 6, and 8 hours postoperatively. There were statistically significant differences among CHIPPS scores of the patients according to groups. According to the results of the Mann-Whitney U-test, 0-hour CHIPPS scores of the cases in group I were significantly higher compared to the cases in group CA and group II/IH. There were no statistically significant differences between 2-, 6-, and 8-hour CHIPPS scores in the study according to groups. Our prospective, controlled, double-blind study demonstrates that a caudal block or an II/IH block yields a similar quality and duration of postoperative pain relief in pediatric patients undergoing unilateral inguinal hernia repair. However, wound-site instillation has inadequate effects compared to caudal and II/IH blocks in the first hours after surgery.

Keywords: Caudal epidural block, ilioinguinal/iliohypogastric nerve block, inguinal hernia repair, bupivacaine, instillation, CHIPPS

Introduction

Inguinal hernia repair is the most frequent surgical procedure in early childhood [1]. A caudal block is the regional anesthetic technique that is used most frequently in pediatric surgery [2]. Caudal analgesia with local analgesics alone is effective but is often short-lived and associated with undesired motor blockade and other complications [3]. The most common indication for ilioinguinal/iliohypogastric (II/IH) nerve block is unilateral inguinal hernia repair. An II/IH nerve block provides excellent pain relief for operations on the inguinal region (e.g. herniorrhaphy, orchidopexy, hydrocelectomy), including emergency procedures (e.g. strangulated hernia with intestinal obstruction), and it should be preferred to caudal anesthesia for these procedures [4]. An II/IH nerve blockade is one of the most common peripheral nerve block techniques in pediatric anesthesia and has been shown to be equally effective compared with caudal blockade for inguinal hernia repair [5]. Few studies suggest that the instillation of local anesthetic solution into the wound at the end of the operation can produce profound analgesia [6-8].

We, therefore, designed a randomized, double-blind controlled study to compare the effects of

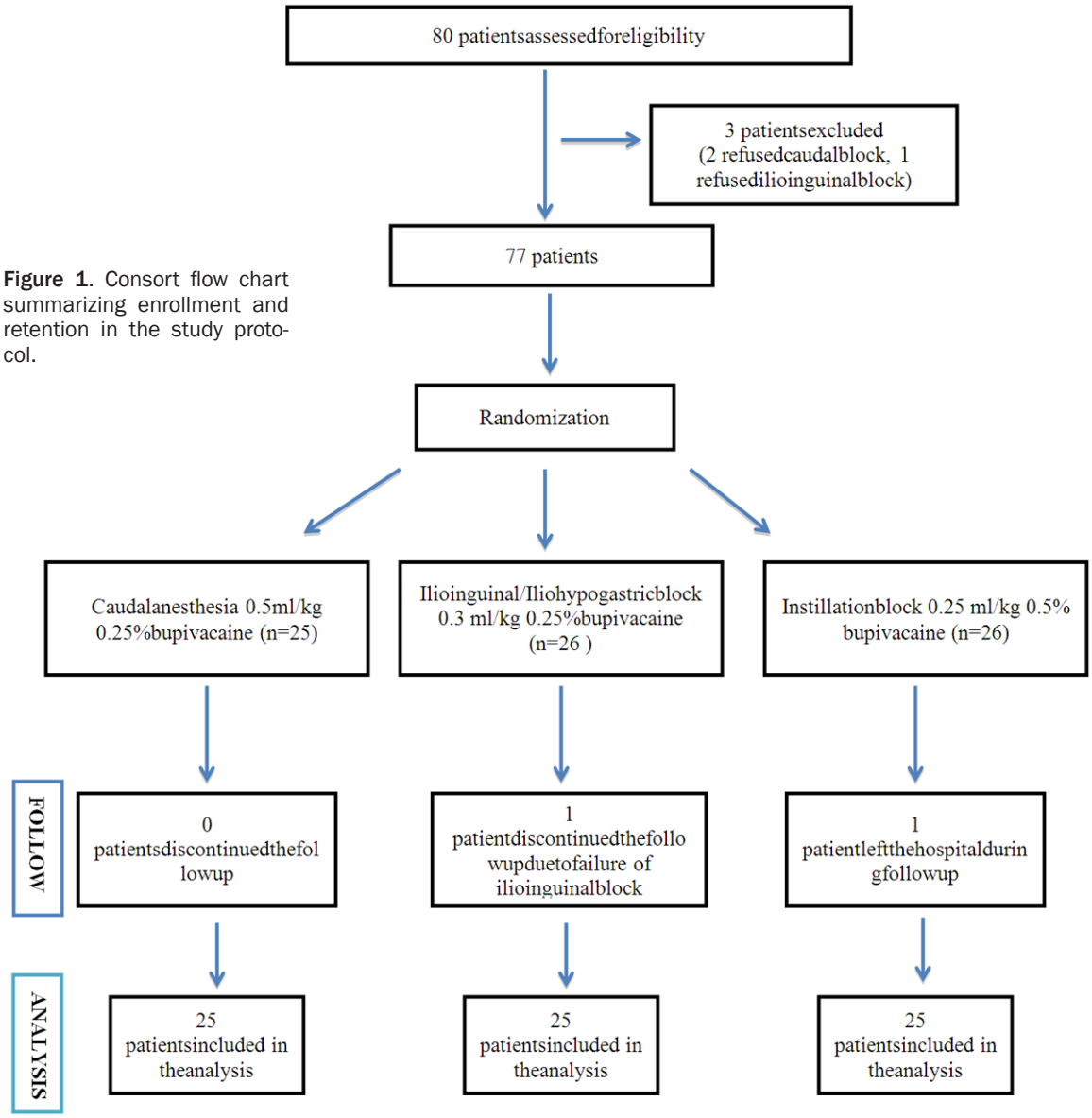

Figure 1. Consort flow chart summarizing enrollment and retention in the study protocol.

caudal anesthesia, II/IH nerve block, and instillation to the wound-site using bupivacaine on postoperative analgesia.

Material and methods

After obtaining the approval of the local ethics committee and written parental consent, a total of 77 ASA status I-II children aged 2 to 7 years who were scheduled for elective unilateral inguinal herniorrhaphy were enrolled in the study. Exclusion criteria were contraindication to caudal epidural and II/IH nerve block (infection at the site of block, bleeding diathesis, pre-existing neurological or spinal disease, or abnormalities of the sacrum) or a known allergy to local anesthetics (**Figure 1**).

Patients were randomly assigned to 1 of 3 groups using a computer generated random number table the caudal anesthesia (CA) group, the ilioinguinal/iliohypogastric (II/IH) group, and the wound-site instillation (I) group. The investigators, attending anesthetists, and patients were blinded to the computer-generated randomization schedule. Patients fasted for 6 hours before the procedure. Clear fluids were allowed up to 3 hours before the procedure. Patients received premedication with 0.5 mg/kg (maximum 15 mg) oral midazolam 30 min-

Table 1. Children's and infants' postoperative pain scale

Item	Score 0	Score 1	Score 2
Crying	None	Moaning	Screaming
Facial expression	Relaxed smiling	Wry mouth	Grimacing
Posture of the trunk	Neutral	Variable	Reared up
Posture of the legs	Neutral	Kicking	Tightened
Motor restlessness	None	Moderate	Restless

Table 2. Distribution of the descriptive characters

Age: *Mean ± SD (Min-Max)*		4.08±1.61 (2-7)
Gender: *n (%)*	Female	18 (24.0)
	Male	57 (76.0)
Weight: *Mean ± SD (Min-Max)*		16.71±4.61 (9-30)
Operation Time: *Mean ± SD (Min-Max)*		53.80±18.41 (20-95)

utes before surgery. Before induction of anesthesia, vital signs were documented, including heart rate, systolic and diastolic blood pressures, saturation percent of O_2, and respiratory rate. General anesthesia was induced with 1 μg/kg fentanyl and 3 mg/kg propofol. Anesthesia was maintained with 1-1.5% sevoflurane in O_2/N_2O. In all patients, spontaneous breathing was permitted via a laryngeal mask airway (LMA) of appropriate size.

In the CA group, the caudal block was performed with the child in the left lateral decubitus position. After insertion of a 25-gauge needle (EpicanPaed, Braun, Germany) into the caudal epidural space, verification of successful needle placement was based on 4 predictors: ability to locate the sacral hiatus, sensation of a pop on piercing the ligament, lack of resistance to injection, and lack of subcutaneous swelling and negative aspiration for blood and cerebrospinal fluid. 0.5 ml/kg of 0.25% bupivacaine (Bustesin 100 mg/20 ml, VEM, Turkiye) was injected.

In the II/IH group, the II/IH nerve block was performed by insertion of a short beveled needle at the junction of lateral 1/4 and medial 3/4 on the line drawn between the anterior superior iliac spine and umbilicus. The needle was initially inserted perpendicular to the skin, then declined to 45-60° directed to the middle of the inguinal ligament, then slowly advanced until the aponeurosis of the external oblique muscle was transversed, after which the drug was injected. The local anesthetic solution was 0.3 ml/kg of 0.25% bupivacaine.

In the I group, on completion of the operation after the surgical closure of the fascia transversalis, patients received wound instillation with 0.2 ml/kg of 0.5% bupivacaine administered subfascially by the surgeon using a blunt cannula.

Heart rate, non-invasive blood pressure, and peripheral oxygen saturation were recorded after induction of anesthesia every 5 minutes intra-operatively and every 5 minutes in the recovery room for 1 hour. After the surgery, the patients were transferred to the recovery room when they were sufficiently awake and capable of maintaining an open airway.

The primary goal of our study was to compare the duration, quality, and adverse effects of postoperative analgesia for 3 techniques: caudal anesthesia, II/IH nerve block, and wound-site infiltration anesthesia. Postoperative pain relief was evaluated using the Children's and Infants' Postoperative Pain Scale (CHIPPS) [9] and by measuring the duration of analgesia at 2, 6, and 8 hours following recovery from anesthesia (see **Table 1**). At the same time, staff nurses and parents evaluated children's behaviors and sleep quality with reference to a 4-point scale (sleepy, score 0; calm/cheerful, score 1; restless, score 2; tense/tearful, score 3). Nursing staff unaware of group allocation made postoperative assessments. Residual motor block was evaluated using a modified Bromage Scale (no motor block, score 0; able to move knees and feet, score 1; able to move feet, score 2; complete block of motor limb, score 3) 2 hours after surgery. In the case of a CHIPPS score of 4 or more, 15 mg/kg paracetamol was administered intravenously. Side effects (emesis, urinary retention, motor weakness, and sedation) and the total number of analgesic doses required in the first 6 hours were recorded. All patients were observed in the hospital for at least 8 hours because of the possible side effects of caudal blocks.

Results

The study was conducted at Istanbul Kanuni Sultan Suleyman Research and Training Hospital between September 2014 and January 2015 with a total of 75 participants (24% [n=18] females and 76% [n=57] males).

Table 3. Assessment of the CHIPPS measurements at 0, 2, 6, and 8 hours

		Group CA (n=25)	Group II/IH (n=25)	Group I (n=25)	[a]P
Hour 0 CHIPPS	*Mean ± SD*	0.96±1.34	1.20±1.58	2.28±1.81	*0.018**
	Min-Max (Median)	0-6 (1.00)	0-5 (0.00)	0-6 (3.00)	
Hour 2 CHIPPS	*Mean ± SD*	1.80±1.63	2.20±2.06	2.36±2.22	*0.524*
	Min-Max (Median)	0-4 (2.00)	0-5 (3.00)	0-6 (2.00)	
Hour 6 CHIPPS	*Mean ± SD*	1.00±1.58	0.88±1.27	0.44±0.82	*0.409*
	Min-Max (Median)	0-4 (0.00)	0-4 (0.00)	0-2 (0.00)	
Hour 8 CHIPPS	*Mean ± SD*	1.48±1.64	1.28±1.28	1.96±1.65	*0.341*
	Min-Max (Median)	0-4 (1.00)	0-5 (1.00)	0-4 (2.00)	

*[a]Kruskal Wallis Test. *P<0.05.*

Table 4. Assessment of changes between hour 0 and Hours 2, 6, and 8 CHIPPS measurements according to groups

CHIPPS		Group CA (n=25)	Group II/IH (n=25)	Group I (n=25)	[a]P
Hours 0-2	Difference	-0.84±2.08	-1.00±2.50	-0.08±1.80	*0.220*
	[b]P	*0.027**	*0.045**	*0.896*	
Hours 0-6	Difference	-0.04±2.09	0.32±1.82	1.84±1.68	*0.001***
	[b]P	*0.695*	*0.388*	*0.001***	
Hours 0-8	Difference	-0.52±1.81	-0.08±1.58	0.32±1.11	*0.258*
	[b]P	*0.128*	*0.790*	*0.137*	

*[a]Kruskal Wallis Test. [b]Wilcoxon Signed Rank Test. *P<0.05, **P<0.05.*

Weight measurements of the patients in the study ranged from 9 to 30 kg, with a mean of 16.71±4.61 kg. The operation times of the patients in the study ranged from 20 to 95 minutes, with an average of 53.80±18.41 minutes (see **Table 2**).

There were no statistically significant differences between the age distribution of cases (P>0.05) and the weight measurements of cases (P>0.05) among the 3 groups.

There were statistically significant differences among CHIPPS scores of the patients according to groups (P=0.018; P<0.05). According to the results of the Mann-Whitney U-test, which was conducted to determine the difference, 0-hour CHIPPS scores of the cases in group I were significantly higher compared to the scores in group CA and group II/IH (P=0.006; P=0.018; P<0.05). There were no significant differences between the other groups (P>0.05) (see **Table 3**). There were no statistically significant differences between 2-, 6-, and 8- hour CHIPPS scores of the cases in the study according to groups (P>0.05).

In the caudal anesthesia group, an increase of a mean 0.84 per unit at the 2-hour CHIPPS measurement was statistically significant compared to the 0-hour CHIPPS measurements of the cases in the study (P=0.027; P<0.05). In the II/IH nerve block group, an increase of a mean 1.00 per unit in the 2-hour CHIPPS measurements was statistically significant compared to the 0-hour CHIPPS measurements of the cases in the study (P=0.045; P<0.05). In the wound infiltration group, the decrease of a mean 1.84 per unit in the 6-hour CHIPPS measurements was statistically significant compared to the 0-hour CHIPPS measurements of the cases in the study (P=0.001; P<0.01) (see **Table 4** and **Figure 2**).

There were no statistically significant differences among the groups' distribution of behavior situations at hour 2 (P>0.05) (see **Table 5**). There were substantial statistically significant differences among the groups' distribution of behavior situations at hour 6 (P=0.001; P<0.01). With 52% of the cases in group CA assigned a score of 1 at hour 6, this group's behavior score was significantly higher than those of groups II/IH and I (see **Figure 3**).

There were no statistically significant differences between the distribution of analgesic requirements at hour 2 according to groups (P>0.05). There were no statistically significant differences between the distribution of analgesic requirements at hour 6 according to groups (P>0.05) (see **Table 6**).

Statistical analysis

For statistical analysis, the NCSS (Number Cruncher Statistical System) 2007 and PASS (Power Analysis and Sample Size) 2008 Statistical Software (Utah, USA) programs were used. Data were analyzed using descriptive statistical methods (mean, standard deviation, median, frequency, rate, and minimum and

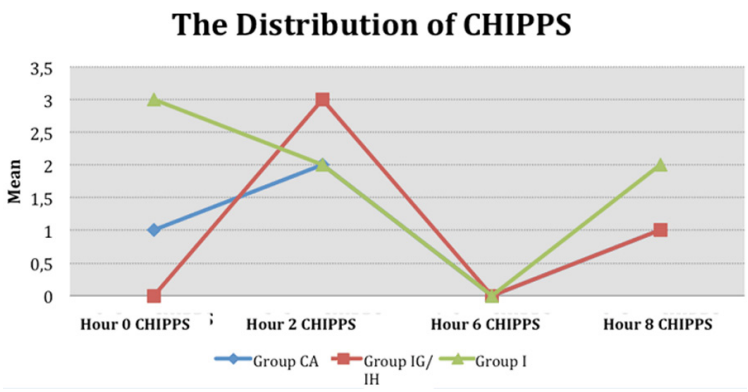

Figure 2. The distribution of CHIPPS scores according to groups.

Table 5. Evaluation of behavior types at hours 2 and 6 according to groups

		Group CA (n=25)	Group II/IH (n=25)	Group I (n=25)	[a]P
		n (%)	n (%)	n (%)	
Hour 2 Behavior	Score 0	21 (84.0)	17 (68.0)	14 (56.0)	
	Score 1	1 (4.0)	1 (4.0)	4 (16.0)	
	Score 2	3 (12.0)	4 (16.0)	6 (24.0)	
	Score 3	0 (0.0)	3 (12.0)	1 (4.0)	
Min-Max (Median)		0-2 (0.00)	0-3 (0.00)	0-3 (0.00)	*0.121*
Hour 6 Behavior	Score 0	5 (20.0)	17 (68.0)	19 (76.0)	
	Score 1	13 (52.0)	4 (16.0)	3 (12.0)	
	Score 2	3 (12.0)	2 (8.0)	2 (8.0)	
	Score 3	4 (16.0)	2 (8.0)	1 (4.0)	
Min-Max (Median)		0-3 (1.00)	0-3 (0.00)	0-3 (0.00)	*0.001**

[a]*Kruskal Wallis Test.* *P<*0.05.*

maximum). The Kruskal-Wallis test was used in the comparison of three or more groups without normal distribution and the Mann-Whitney U-test was used in the determination of the group causing the difference. The Wilcoxon signed ranks test was used to compare the parameters without normal distribution within groups. Pearson's chi-square test was used in the comparison of qualitative data. *P*-values <0.01 and <0.05 were considered statistically significant.

Discussion

Caudal anesthetics usually provide analgesia for approximately 4-6 hours. However, its complications include bone marrow puncture, intestinal damage, and the danger of an increase of the blood concentration, and these complications can lead to systemic toxicity [10, 11]. The II/IH blocks can provide an approximately similar duration of analgesia as a caudal anesthetic with less local anesthetic solution. Despite its popularity, when conventional methods are used, the II/IH nerve block only has a success rate of 70-80% in some published series [12]. Several complications such as colonic or small bowel puncture [13, 14], pelvic hematoma [15], femoral nerve palsy, and quadriceps muscle paresis [16, 17] have been described.

This study compared the analgesic effects of caudal epidural block versus II/IH nerve block versus wound-site infiltration using bupivacaine in inguinal surgeries in children 2-7 years old. The results of our study have shown that a caudal block with 0.5 ml/kg of 0.25% bupivacaine or an II/IH block with 0.3 ml/kg of 0.25% bupivacaine yields a similar quality and duration of postoperative pain relief in pediatric patients undergoing minor urological procedures. We found both techniques effective in reducing pain, and there were no significant differences between the 2 groups statistically. Whereas, when we compared the 0-hour CHIPPS scores of all 3 groups, the scores of the group receiving wound instillation with a local anesthetic solution performed by the surgeon on completion of surgery were found to be significantly higher than the other groups.

Machotta et al. [18] compared the postoperative pain relief for inguinal herniotomy in children provided by instillation of bupivacaine into the wound with that provided by a caudal block. They found that instillation of bupivacaine into a wound provides postoperative pain relief following hernia repair, which is as effective as that provided by a postoperative caudal block. A study published by Casey et al. [19] showed that instillation of bupivacaine into the wound provided postoperative analgesia that was as

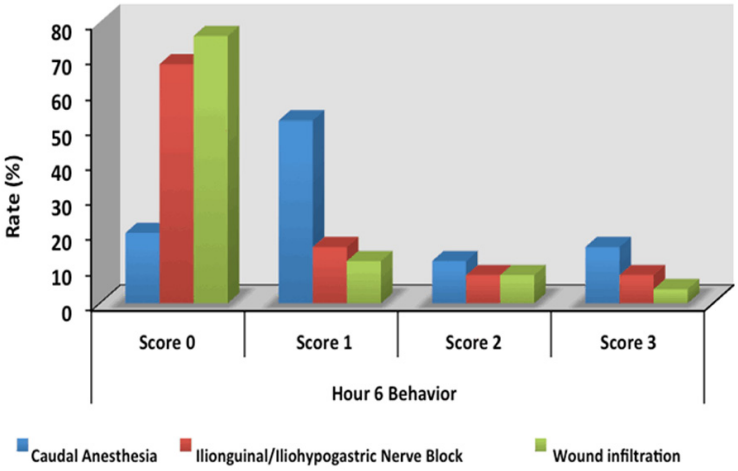

Figure 3. Distribution of behavior scores at hour 6 according to groups.

Table 6. Evaluation of hours 2 and 6 analgesic requirements according to groups

Analgesic Requirement		Group CA (n=25) n (%)	Group II/IH (n=25) n (%)	Group I (n=25) n (%)	[a]P
Hour 2	Score 0	14 (56.0)	9 (36.0)	7 (28.0)	
	Score 1	11 (44.0)	16 (64.0)	18 (72.0)	
Min-Max (Median)		0-1 (0.00)	0-1 (1.00)	0-1 (1.00)	*0.118*
Hour 6	Score 0	12 (48.0)	9 (36.0)	8 (32.0)	
	Score 1	7 (28.0)	7 (28.0)	7 (28.0)	
	Score 2	6 (24.0)	8 (32.0)	9 (36.0)	
	Score 3	0 (0.0)	1 (4.0)	1 (4.0)	
Min-Max (Median)		0-2 (1.00)	0-3 (1.00)	0-3 (1.00)	*0.354*

[a]*Kruskal Wallis Test.* *P<*0.05.*

effective as that produced by an II/IH block in children following hernia repair. Since these 2 studies performed the caudal technique and wound instillation technique on the completion of the operation, their scores might be similar. But in our study, caudal and II/IH blocks were conducted before surgery to avoid a supplemental analgesic requirement at the end of the surgery.

Seyedhejazi et al. [20] compared the analgesic effects of caudal blocks and II/IH nerve blocks using bupivacaine-clonidine performed in children undergoing inguinal hernia repair. They found that an II/IH nerve block was as effective as a caudal block in terms of the quality and duration of postoperative analgesia. Like this study, our study showed that Group CA and Group II/IH yielded a similar quality and duration of postoperative pain relief.

Abdellatif [21] assessed whether ultrasound (US)-guided II/IH nerve blocks with local anesthetic would provide comparable postoperative analgesia to blind technique caudal block following pediatric unilateral groin surgery. He found that US-guided II/IH nerve blocks are an ideal postoperative analgesic for unilateral groin surgery in children, particularly for hernia repairs, and they are as effective as caudal blocks. In a prospective randomized study by Willschke and coworkers [22] the use of a US-guided II/IH block was compared with the landmark-based approach. It was clearly demonstrated that the use of the US-guided technique was associated with a significantly higher success rate. In our clinic, although an ultrasound device was present, our experience in its use in pediatrics was inadequate; consequently the II/IH nerve block was performed by insertion of a short beveled needle at the junction of lateral 1/4 and medial 3/4 on the line drawn between the anterior superior iliac spine and umbilicus.

There was no difference in the doses of postoperative pain rescue medication administered to the studied groups in inpatient services. There were no different side effects among the groups in our study. None of the patients had any motor weakness at 8 hours. Similarly, evaluation by the staff nurses and parents of the children's behaviors and sleep quality with reference to a 4-point scale did not show a significant difference among groups.

The requirement for postoperative analgesia was assessed by the staff nurses, and in the case of a CHIPPS score of 4 or more, 15 mg/kg paracetamol was administered intravenously. In our study, there was no difference in the required doses for postoperative analgesia.

One weakness of our study was an inability to make use of a US-guided II/IH block. Therefore,

intramuscular and intraperitoneal injection of local anesthetics may not have been safely avoided. Another weak point is that we used local anesthetic concentrations of 0.25%. Comparison of local anesthetic potency has been standardized by the use of the minimum local anesthetic concentration (MLAC or ED50) [23]. To our knowledge, the MLAC of local anesthetics has not been assessed in pediatric patients receiving caudal blocks [24].

In summary, our prospective, controlled, double-blind study demonstrates that a caudal block or an II/IH block yields a similar quality and duration of postoperative pain relief in pediatric patients undergoing unilateral inguinal hernia repair. This result is also supported by previous reports that compared the effectiveness of these blocks. However, the wound-site instillation technique has inadequate effects compared to caudal and II/IH blocks in the first hours after surgery.

Disclosure of conflict of interest

None.

Address correspondence to: Melike Korkmaz Toker, Istanbul Kanuni Sultan Suleyman Research and Training Hospital, Anesthesia and Reanimation Clinic, Istanbul, Turkiye. E-mail: meltoker@gmail.com

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