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Ilioinguinal and Iliohypogastric Nerve Blocks in Children

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Objectives: To examine ilioinguinal and iliohypogastric (ILIH) nerve block techniques among children. **Methods:** A total of 120 children, aged 1-16 years, were included in this prospective, randomized, single-blinded study. Children received an ILIH nerve block using the conventional fascial click of double "pop" technique on four different points: (Group I, n=30) ILIH block at the junction of the lateral one-fourth, the medial three-fourth in the line from the anterior superior iliac spine (ASIS) to the umbilicus; (Group II, n=28) approximately 2.5 mm medial to the ASIS; (Group III, n=30) 10 mm medial-superior to the ASIS; and (Group IV, n=30) 10mm medial-inferior to the ASIS. Intraoperative hemodynamic changes, postoperative pain intensity, time of first analgesic requirement, and correlation between BMI and groups were examined. **Results:** The average pain score 2 hours after operation was lowest in group I (1.04±1.23 [CI 95%, 0-5.3]) and highest in group IV (2.88±2.47 [CI 95%, 0-9]), a difference of statistically significance (p=0.0027). In group I only, the pain intensity had a weak, positive correlation with BMI (r=0.49, p=0.006). **Conclusion:** Group I used the best ILIH block technique.

Keywords: Pain Management, Nerve Block, Conduction Anesthesia, Abdominal Wall, Herniorrhaphy

Introduction

Ilioinguinal and iliohypogastric (ILIH) nerve block is the most common abdominal wall block used for surgical procedures of inguinal area, especially inguinal hernia repair, pediatric orchiopexy, and emergency procedures such as an obstructed hernia [1-4]. It is considerably safe, low risk, and effective block. There are many studies on the use of ILIH nerve block among adults with lower abdominal wall incisional surgeries such as cesarean sections, gynecological operations, and kidney recipient surgeries [5-8]. ILIH nerve block may be performed with the anatomical landmarks (conventional, blind technique) or with ultrasound guided (USG) techniques. There are studies that show the use of needle entry point in the medial anterior superior iliac spine (ASIS) for the anatomical landmark (AL) technique [1, 7-11]. However, there are also studies pointing out the variations of lumbar nerve origins and progress of ILIH nerves in the anterior abdominal wall [12-15]. The AL technique for ILIH block, without USG, has a reported failure rate up to 45% [3]. It is associated with incorrect local anesthetic placement in 14% of cases, inadvertent femoral nerve block, and the rare, but serious, complication of small bowel puncture [11,16,17].

The purpose of our study is to compare the efficacy of ILIH block performed with four AL techniques for postoperative pain management in pediatric inguinal surgeries. We injected local anesthetic solution under the internal oblique muscle aponeurosis using four different AL techniques.

Materials and Methods

1. Ethical statement

Ethical approval for this study was acquired from the Research Ethics Committee (Ethical Committee No 6/3/2015 06) of the Mongolian National University of Medical Science on January 21, 2015. Before surgery, parents of all children signed a written informed consent form after being verbally informed of the purpose and content of the study.

2. Study design

Children between the ages of 1-16 years in the American Society of Anesthesiologists (ASA) I-II class who were admitted to the General Surgical and Urological Departments for inguinal hernia, orchidopexy, and hydrocele repair were included in this prospective, randomized, single-blinded study at the National Center for Maternal and Child Health of Mongolia.

3. Data collection

A total of 120 children were involved in this study. Children were excluded from the study if they refused to consent, were in ASA class III-IV, or had an allergy to local anesthetics or skin infection at the injection site. Patients were randomized into four groups using sealed envelopes numbered sequentially. According to randomization, children received ILIH nerve block using the conventional fascial click of double "pop" technique on four different points:

a. Group I: Drew line from the ASIS to the umbilicus. Then, this line was divided into four equal parts, and the site of puncture was at the junction of the lateral one-fourth and the medial three-fourth [18].
b. Group II: The injection site was approximately 2.5 mm medial to the ASIS on a line drawn between the ASIS and the umbilicus [15].
c. Group III: The entry point was 10 mm medial and 10 mm superior to the ASIS.
d. Group IV: The entry point was 10mm medial and 10 mm inferior to the ASIS [19].

All children received no premedication. General anesthesia for children 0-3 years of age was induced by inhalation of up to 8vol% sevoflurane with oxygen, and after establishing venous access, 2 mcg/kg of fentanyl (№ 280715, 09052 Moscow, Russia) was given. Children aged 4 years or older had an established IV from the ward and were given 5 mg/kg of Theopental sodium (№ 4602565020385, Kurgan, Russia) and 2 mcg/kg of fentanyl intravenously. Anesthesia was maintained with 1-1.5 MAC isoflurane in air/O2 (FiO2-0.4). The children breathed spontaneously via a laryngeal mask airway.

After induction skin was disinfected, a short bevel 22G needle was used to identify the double "pop" sensations as the needle penetrated the external and internal oblique aponeurosis. Children aged 0-3 years were injected with 0.3 ml/kg of bupivacaine 0.25% (bupivacaine injection C.P., Anawin 0.5%, Batch № 51239, Neon Laboratories Limited 28, Mahal Ind. Est., Laves Rd, Andheri (East), Mumbai-400093, India), while children older than 4 years were injected 1ml per age (in years) but not more than 14 ml. Before the skin incision, the children received an acetaminophen suppository as directed by anesthesiologists and residents.

Intraoperative monitoring included ECG, heart rate (HR), pulse oximetry, and Noninvasive Blood Pressure (NIBP) before (baseline) and after induction, immediately after surgical skin incision, and at the end of operation. If the blood pressure (BP) and HR increased more than 20%, fentanyl was administered at 1mcg/kg of body weight (BW). The efficacy of the postoperative analgesia was measured using FLACC (Face, Leg, Arm, Cry, Consolibility) scale for those aged 1-3 years, as shown in Table 1, and the Wong-Baker facial pain score for those older than four years (Figure 1).

Table 1. FLACC Pain Score

Criteria	Score 0	Score1	Score 2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, uninterested	Constantly quivering chin, clenched jaw
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking, or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting, rocking back and forth, tense	Arched, rigid, or jerking
Cry	No crying (awake or asleep)	Moans or whimpers, occasionally complains	Crying steadily, screams or sobs, frequently complains
Consolability	Content, relaxed	Reassured by occasional touching, hugging, or being talked to, distractible	Difficult to console or comport

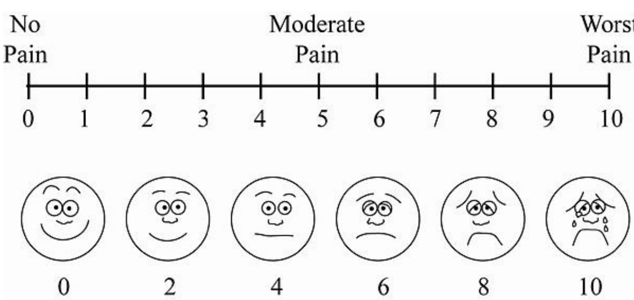

Figure 1. Wong-Baker Facial Pain Score

If the pain score was four or more, the child received an acetaminophen 20 mg/kg rectally. Pain assessment was made in a recovery room at 2nd, 4th, 6th postoperative hours. Postoperative pain evaluation was performed by recovery room nurses, anesthesiologists, and residents who were not involved in the study and blinded to the groups.

4. Outcomes

The primary outcomes were intraoperative hemodynamic changes, opioid usage, postoperative pain score, and time of first rescue pain medication in each group. The secondary outcomes were correlation between BMI and success rate for each method.

5. Statistical analysis

The study was powered to find the predicted difference between groups with a failure rate of 20%. With a type one error protection of 0.05 and a power of 0.80, 24 patients in each group were required for an appropriate study power. To increase the accuracy of the study, 30 patients were recruited for each group. Patients' characteristic and hemodynamic variables between the groups were compared using an independent Student's t-test. Mean changes of BP and HR were analyzed by using a two-way analysis of variance (ANOVA) for repeated measurements, followed by an ANOVA for multiple comparisons. Correlation was calculated using the Pearson correlation coefficient. The values are presented as mean ±SD and number (percentage) of subjects. A p-value<0.05 was considered statistically significant.

Results

A total of 120 patients (30 in each group) were enrolled. In three groups, all 30 patients completed the study, but in group II, 28 patients completed the study. Reasons for incompletion included lack of parental consent and with an upper respiratory tract infection (URI). Thus, 118 children with mean age of 53.7 months (range, 12-192 months) and weight of 18.7 kg (range, 9.2-57.2 kg) were included in the study. Patient characteristics (age, weight, height and BMI) were similar in all groups. There was no statistically significant difference in regards to the duration of the anesthesia and surgery (Table 2).

There was no relationship between the patients who received an acetaminophen suppository before the operation, intraoperative fentanyl usage, and postoperative pain intensity. Bupivacaine 0.25% was injected and the average volume was at 0.26±0.06 ml/kg BW (CI 95% [0.14-0.42] p=0.015). The average pain score at 2 hours after operation was the lowest in group I (1.04±1.23 [CI 95%, 0-5.3]) and highest in group IV (2.88±2.47 [CI 95%, 0-9]), a statistically significant difference (p=0.0027).

Table2. Patients' Characteristics and Perioperative Data

Characteristics* (Student's t-test)						
	n=118	I group (n=30)	II group (n=28)	III group (n=30)	IV group (n=30)	p- value
Age (month)	53.7±40.2	49.1±31.9	61.2±52.1	51.5±37.2	53.4±38.7	0.799
Gender (m/f)	106/12	29/1	25/3	28/2	24/6	
Body weight (kg)	18.7±9.4	19±8.3	20.8±12.7	17.9±8.4	17.3±7.6	0.462
Height (cm)	100.6±20.3	98.8±14.9	103.6±27.3	100±19.5	100±18.9	0.897
Body mass index (kg/m^2)	17.8±2.6	18.8±2.8	18.1±2.5	17.3±2.15	16.8±2.3	0.012**
Perioperative data***						
Surgical time (min)	26.8±9.3	23.5±6.3	26.8±9.4	28.9±8.8	28±11.6	0.096
Anesthesia time (min)	39.6±12.7	34.7±7.4	40.2±12.4	40.2±10.9	41.8±17.2	0.087
Initial fentanyl dose (mcg/kg)	2.06±0.27	2.05±0.16	2.03±0.2	2.04±0.3	2.14±0.3	0.296
Number of patients who received second dose of fentanyl	118/13(11%)	30/3(10%)	28/3(11%)	30/2(6%)	30/5(17%)	
Bupivacaine dose-0.25% (ml/kg)	0.26±0.06	0.24±0.06	0.24±0.05	0.28±0.06	0.27±0.06	0.015**
Number of patients who received acetaminophen before operation	118/84(71%)	30/13(43%)	28/16(57%)	30/28(93%)	30/27(90%)	
Postoperative data***						
Analgesic requirement before discharge	118/48 (40.7%)	30/12 (40%)	28/8 (28.6%)	30/14 (46.7%)	30/14 (46.7%)	
First rescue analgesic within 2 hours or block failure	118/18 (15.3%)	30/1 (3.4%)	28/4 (14.4%)	30/4 (13.3%)	30/9 (30%)	
Pain score after 2 hours	1.94±1.19	1.04±1.23	2.2±2.37	1.61±1.4	2.88±2.47	0.0027**
Pain score after 4 hours	1.7±1.7	1.58±1.68	1.66±1.34	2.04±2.02	1.5±1.7	0.623
Pain score after 6 hours	2.34±1.8	1.9±1.75	1.91±1.24	2.6±1.52	1.84±1.57	0.096

*Data presented as mean ± SD; number and percentage. **Data statistically significant.*** ANOVA multiple comparisons

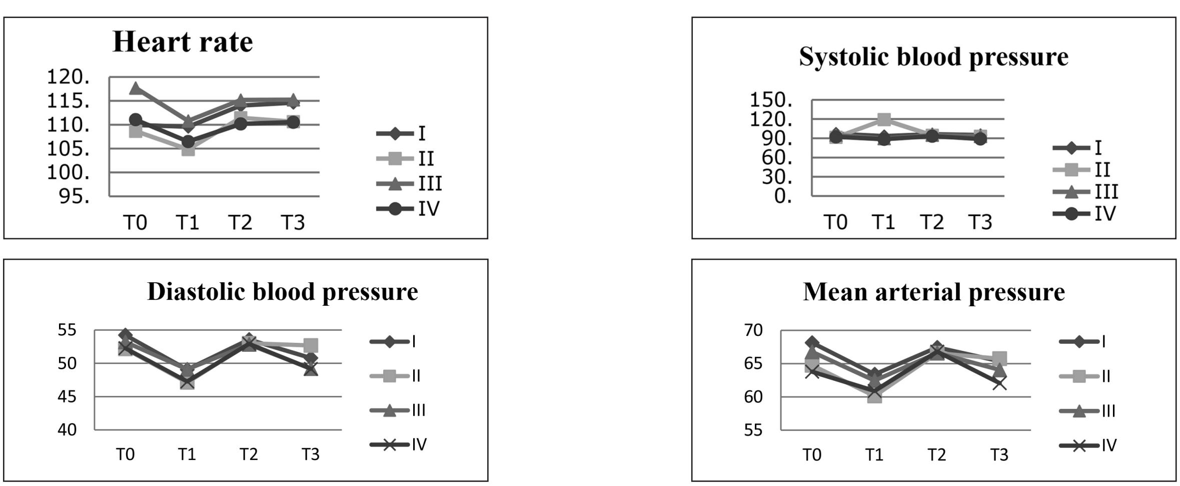

Figure 2. Hemodynamic Variables During the Intraoperative Period for All Groups
T0-before induction, T1-after induction, T2-after skin incision, T3-end of surgery
Two-way ANOVA with repeated measurements: HR p=0.08, systolic BP p=0.248, diastolic BP p=0.888, mean arterial pressure p=0.46 were considered not statistically significant.

Table 3. Postoperative Pain Score

	Postoperative pain score (2 hours)				Postoperative pain score (4 hours)				Postoperative pain score (6 hours)				
	0	**1-3**	**4-6**	**7-10**	**0**	**1-3**	**4-6**	**7-10**	**0**	**1-3**	**4-6**	**7-10**	
Inguinal hernia (N=63)													
I group	7	5	0	0	4	7	1	0	1	10	1	0	12
II group	4	9	1	2	4	10	1	2	2	12	3	0	17
III group	6	10	2	0	6	10	2	0	1	14	3	0	18
IV group	4	6	5	1	4	6	5	1	4	6	5	1	16
Orchidopexy (N=27)													
I group	2	5	1	0	3	4	1	0	1	7	0	0	8
II group	1	4	0	0	2	3	0	0	1	4	0	0	5
III group	0	6	2	0	0	7	0	1	0	7	1	0	8
IV group	1	3	2	0	2	2	2	0	2	2	2	0	6
Hydrocele (N=28)													
I group	6	4	0	0	5	4	0	1	4	5	0	1	10
II group	3	2	1	0	3	2	1	0	2	4	0	0	6
III group	2	2	0	0	2	1	1	0	1	2	1	0	4
IV group	2	5	0	1	5	3	0	0	2	5	0	1	8
Summary (N=118)													
I group	15	14	1	0	12	15	2	1	6	22	1	1	30
	50%	46.6%	3.4%		40%	50%	6.7%	3.3%	20%	73.3%	3.3%	3.3%	
II group	8	16	2	2	9	15	2	2	5	20	3	0	28
	28.6%	57%	7.2%	7.2%	32%	53.6%	7.2%	7.2%	17.9%	71.4%	10.7%		
III group	8	18	4	0	8	18	3	1	2	23	5	0	30
	26.6%	60%	13.3%		26.7%	60%	10%	3.3%	6.6%	76.7%	16.7%		
IV group	7	14	7	2	11	11	7	1	8	13	7	2	30
	23.3%	46.7%	23.3%	6.7%	36.7%	36.7%	23.3%	3.3%	26.7%	43.4%	23.3%	6.7%	

Data is presented in number and percentage.

In group I only, the pain intensity had weak positive correlation with BMI (r=0.49, p=0.006), and in the other groups, there was no relationship between pain and BMI. There was no relationship between BW or age to group or pain intensity.

In all group, hemodynamic variables such as HR, diastolic BP and mean arterial pressure decreased after induction and increased after the skin incision, though this was not statistically significant (Figure 2).

A total of 63 inguinal hernias, 27 orchiopexies, and 28 hydrocele repairs were performed. Surgical time was correlated with surgical diagnosis (p=0.001).

Success rate in group I was 96.6% (29), in group II was 85.6% (24), in group III was 86.6% (26), in group IV was 70% (21). 11.8% of all children (I-1, II-2, III-4, IV-7) had moderate pain and 3.4% of children (II-2, IV-2) had severe pain (Table 3).

Discussion

ILIH nerve block is a simple and effective technique for pain relief of the lower abdominal wall region. It is based on surface anatomy and visible skin landmarks, namely, the tubercle of the pubis, the inguinal ligament, and the anterior superior spine of the ilium and umbilicus.

The success rate of the ILIH nerve block is determined by an accurate placement of the needle in close proximity to the nerve and an accurate volume of local anesthetic solution. The USG technique always superior to AL technique because it improves the quality of the nerve block, decreases the volume of local anesthetic, and reduces the risk of complications [2, 20, 21, 22]. In addition, there have been case reports of a new USG technique of ILIH nerve block for difficult cases and high risk patients [23,24].

Although the USG technique is superior, this technique depends on the availability of ultrasound machines. In many rural hospitals in Mongolia and other developing nations, there is a shortage of medical resources such as ultrasounds, and thus, the conventional AL technique is still used as a part of multimodal analgesia for inguinal and lower abdominal wall surgeries. Our study was on ILIH nerve block efficacy using four different AL techniques (without USG). These four techniques are used frequently in the pediatric population, but the reported overall success rates has varied. Thus, our attempt was to find the most effective and safest method of ILIH nerve block for children.

Overall failure rate varies from 28-45%, which may depend on, 1) Anatomical variance of ILIH nerves. 2) Piercing points of those nerves through muscle layers. 3) Anesthetists' experience [3, 28].

A knowledge of exact anatomical positions would enhance the success of the ILIH nerve block, especially when using the blind, AL technique. The anatomic pathway of the nerve that has been published in literature, but the results are varied and there are even evidences of the absence of ilioinguinal (IL) nerve [13]. In addition, while there are many cadaver studies of ILIH nerve topographic anatomy, the cadavers are mostly adults, which has made it difficult to pinpoint exact anatomical positions for pediatric ILIH nerve blocks.

In our study, the mean age was 53.7 months and the overall combined success rate of all four techniques of ILIH nerve block was 84.2%. According to our findings, success rate was higher in groups using a point close, medial, and superior to the ASIS compared to those using a medial and inferior point (96.6-85.6% vs 70%). In our study, the difference of pain relief among the groups was statistically significant ($p=0.0027$).

The location of ILIH nerves is closer to the ASIS in younger children than in adults. Van Schoor et al. performed study on a sample of 25 infant and neonatal cadavers. The results showed that the mean distances of left and right IL nerves to the ASIS were 1.9±0.9 mm and 2.0±0.7 mm, respectively. The mean distances of the left and right iliohypogastric (IH) nerves to the ASIS were 3.3mm and 3.9±1.0 mm, respectively. Thus, the authors suggested an insertion point closer to the ASIS, approximately 2.5 mm from the ASIS on a line drawn between the ASIS and the umbilicus [15].

In adult cadaver studies, ILIH nerves were located more medially than in infants. The ILIH nerves arise from lumbar plexus in many different ways, as a described Klaassen et al. In a study with 100 cadavers, the IL nerve entered the abdominal wall 2.8±1.1 cm medial and 4 ± 1.2 cm inferior to the ASIS, and the IH nerve entered the abdominal wall 2.8 ± 1.3 cm medial and 1.4 ± 1.2 cm inferior to the ASIS [25]. James L Whiteside et al. studied the course of ILIH nerves from 11 fresh, frozen cadavers, identifying and mapping thirteen IH and sixteen IL nerves. On average, the proximal end of IL nerve entered the abdominal wall 3.1±1.5 cm (0.9-6.3 cm) medial and 3.7±1.5 cm (-0.5-5.9cm) inferior to the ASIS. The IH nerve entered abdominal wall 2.1±1.8 cm (-1.6-5 cm) medial and 0.9±2.8 cm (-5.4-5.5cm) inferior to the ASIS [26].

Another difficulty of the ILIH block is that there has been no agreement on where the needle should be placed: in between the external and the internal oblique muscles? or between the internal oblique and the transversus muscle? Most studies suggest that one click method is less dangerous than double click methods. In our study, no complications were observed. The proximal trunks of IL and IH nerves enter the transversus muscle close and superior to the ASIS, and both nerves are close to each other. In fact, the site where the nerve perforates the internal oblique muscle is subject to great anatomical variability.

Jamierson et al. suggested that for an anesthetic blocking of the entire nerve supply of the lower abdominal wall, the point selected should be within a restricted area where the nerves are closest together, 3-4 cm above and medial to the ASIS and over the crest of the ilium. In their opinion, the optimal point would be at the 4-6 cm posterior tip the ASIS, along the lateral aspect of the external lip of the ilium, where the ILIH nerves lie together as they perforate the transversus muscle [14].

Eichenberger et al. studied the accuracy of a selective ILIH nerve block in ten cadavers using USG and confirmed by anatomical dissection. If using the blind, AL technique, they suggested a new injection point 5 cm cranial and 5 cm posterior to the ASIS may be advantageous and reduce failure rates. In this area, the median distance of the IL nerve to the iliac bone was 6.0 mm, and the distance the two nerves was 10.4 mm [27].

Several descriptions of the conventional technique have been published, all of which are based on a subjective feeling of a "fascial click" when the needle pierces the muscle fascia.

In the clinical study, failure rates have variation and are determined by intraoperative hemodynamic changes, postoperative pain intensity, rescue analgesic, and opioid requirements. In a study by Lim et al., the efficacy of ILIH nerve block with a single shot or double shot technique under the external oblique aponeurosis was compared. In the single shot group, the local anesthetic was given one fingerbreadth medial to the ASIS, and in the double shot group, one third of the total local anesthetic was given like the single shot group and two third was deposited 0.5 cm above and lateral to the mid inguinal point. The success rates of both techniques were similar, at 72% [28].

In the study by Kundra et al., 132 children were randomly allocated into four groups: control group, ILIH block at 1 cm inferior-medial to the ASIS, 1-2 cm medial to the ASIS, and 2 cm superior-medial to the ASIS. The overall success rate was 94%, and the authors conclude that ILIH block can be successfully accomplished from any point if the needle bevel lies between the two muscle planes above and below the internal oblique muscle [29].

In a similar study, Seyedhejazi et al. randomly clustered 113 children into two groups to receive ILIH block. In the first group, the needle was inserted at lateral ¼ point of ASIS-umblicus line with angle of 45-60 towards midpoint of inguinal ligament, immediately deep to the external oblique muscle aponeurosis. In the second group, the needle was injected 1cm above and medial to the ASIS, initially directed posterolaterally to contact the inner lip of the ileum, and then withdrawn while injecting local anesthetic during needle moving. Authors did not clarify which muscle plane the local anesthetic was injected in in group 2. Failure was defined as the need for analgesia during operation. The success rates were almost similar across two groups, at 94.8% and 94.5%, respectively. In this study, analgesia was required in the first 1-2 hours in 15 cases in group 1(25.9%), and 10 cases in group 2 (18.2%) [1].

There are many studies using different needle entry points with different success rates. A study on co-blockade of an intercostal nerve and ILIH nerve for kidney transplant using an injection at the junction of the lateral one fourth and the medial three fourths found a decreased morphine requirement in treatment group compared to control group [8].

In a study of catecholamine plasma levels in orchiopexy surgery, a comparing ILIH nerve block which was performed that an entry point should be 1 cm medial and inferior to the ASIS. A caudal block in 30 children, Mostafa et al. found that a caudal epidural block was more effective than a single fascial click IINB in suppressing the stress response. Five patients (33.3%) from ILIH block group, who had a pain score of greater than five, received i.v. fentanyl in the PACU [30].

Willschke et al. performed the ILIH block in 100 children using the conventional single fascial click technique at 1-2 cm medial and inferior to the ASIS or the USG technique. The intraoperative fentanyl requirement was 26% and 4% in the conventional and USG group, respectively, and postoperative rectal acetaminophen needs was 40% and 6%, respectively [2].

As a described Van Schoor, Weintraud et al. performed the ILIH block in 66 children and injected local anesthetics under external oblique aponeurosis and studied the implications of plasma levels of bupivacaine using USG versus AL. The intraoperative fentanyl requirement was greater in the AL technique (25.8%) [31].

In all these studies, the authors used single "pop" sensation techniques, injecting local anesthetics under external oblique muscle aponeurosis, with failure rates ranging from 25.8% to 33% [31, 1, 2, 28, 30]. In Kundra's study, injection of the local anesthetics above and below internal oblique muscle aponeurosis demonstrate a success rate of 94% [29].

Willschke et al. studied ILIH nerves in the children aged 1 month to 8 years using USG, and in all cases, they found that the ILIH nerves were lying between the internal oblique and transversus abdominis muscles. The measured distance from the ASIS to the inguinal nerve was 6.7 (SD 2.9) mm, and the r value of the correlation between weight and depth of the IL nerve was weak (r=0.44) [2]. In our study, the pain intensity had positive correlation with BMI in only group I (r=0.49, p=0.006), and there was no relationship between pain and BMI in the other groups.

The limitations of our study, as follows, indicate the necessity of further studies. First, to increase statistic power in future studies, we must recruit more patients in each group and further divide into age groups. Secondly, without USG, it is difficult to validate if the local anesthetic solution was injected in right fascial plane. Thus, to improve our study design, we must conduct a study using USG as a control.

In conclusion, ILIH nerve block can be used safely and successfully as a part of multimodal analgesia in children. According to the anatomical variance of ILIH nerves, and clinical studies including ours, we conclude that the injection of local anesthetics in right muscle plane is more important than entry point of needle, however, when administering a pediatric ILIH block using AL, we recommend the puncture site to be in the junction lateral one fourth and the medial three fourths in a line from the ASIS to umbilicus (a technique described Von Bahr). This technique has a more dynamic character than other static points, which is very important for children who have an anatomic variance due to growth. Furthermore, we suggest the use of a double click injection technique under internal oblique aponeurosis) if injecting at the points medial and superior to the ASIS and a double click injection technique in the plane under external and internal oblique aponeurosis if using a medial and inferior point to the ASIS

Conflict of Interest

The authors state no conflict of interest.

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