Iran Red Crescent Med J. 2018 April; 20(4):e65163. doi: 10.5812/ircmj.65163.

Published online 2018 July 29. **Research Article**

Ultrasound-Guided Transversus Abdominis Plane Block Versus Ilioinguinal/Iliohypogastric Block in Intraoperative Anesthesia and Analgesia in Pediatric Patients: A Randomized Controlled Study

Ilke Kupeli [1,*] and Sara Salcan [2]

[1] Anesthesiology and Reanimation Department, Erzincan University, Erzincan, Turkey
[2] Public Health Department, Erzincan University, Erzincan, Turkey

[*] *Corresponding author*: Anesthesiology and Reanimation Department, Mengucek Gazi Training and Research Hospital, Erzincan University, 24000, Erzincan, Turkey . Tel: +90-4462122020, Fax: +90-4462122222, Email: ilkeser2004@gmail.com

Received 2017 December 15; **Revised** 2018 February 06; **Accepted** 2018 April 03.

Abstract

Background: Regional techniques both reduce opioid requirements and provide quality pain control in patients, especially in pediatrics.
Objectives: The aim of this study was to compare the contributions of ilioinguinal/iliohypogastric (II/IH) block and transversus abdominis plane (TAP) block combined with sedation to intraoperative anesthesia and analgesia in pediatric surgery.
Methods: In this randomized controlled study, 100 patients aged 2 - 6 years were enrolled and divided into five groups: TAP block with ketamine; II/IH block with ketamine; TAP block with Sevoflurane; II/IH block with Sevoflurane; and the control group with Sevoflurane alone. Hemodynamics (mean arterial pressure (MAP) and heart rate (HR)), depth of anesthesia, Sevoflurane usage, pain score, number of children who needed analgesia, and the time to start rescue analgesia of all patients were recorded.
Results: There was no significant difference between the study groups, in HR and MAP during operations ($P > 0.05$). The amount of Sevoflurane used in the group supported with both blocks decreased significantly compared to the control group ($P < 0.001$). In the groups where the block was added until the 6th hour in the postoperative period, there were lower HR and MAP ($P < 0.05$). Pain scores were high in the first six hours in the control group ($P < 0.05$). There was a longer duration of analgesia in the ketamine + TAP group and the Ketamine + II/IH block group ($P < 0.001$) in comparison to others. A higher analgesic need was found in the control group ($P < 0.05$).
Conclusions: This study revealed that transversus abdominis plane or ilioinguinal/iliohypogastric regional blocks could have same intraoperative/ postoperative effects regarding hemodynamics and intraoperative analgesia in lower abdominal pediatric surgery. Anesthesia can be maintained using sedative medicines only.

Keywords: Anesthesia, Analgesia, Block, Iliohypogastric, lioinguinal, Pediatric, Surgery, Transversus Abdominis Plane, Ultrasound-Guided

1. Background

Regional anesthesia and analgesia techniques are frequently used to provide pain control in pediatric surgical practices. Regional techniques reduce both opioid requirements and provide quality pain control in patients (1).

Ilioinguinal/Iliohypogastric (II/IH), when nerve blocks are applied with mild general anesthesia, provide ipsilateral analgesia in the inguinal area surgeries (e.g., inguinal hernia, orchiopexy, and varicocele) (2). In the study by Yang et al. (3), it was emphasized that ultrasound-guided II/IH extended the time of postoperative analgesia, reduced the amount of local anesthetic required, and accelerated postoperative recovery.

Transversus abdominis plane (TAP) block is one of the abdominal site blocks used in both anesthesia and postoperative acute pain treatment in surgeries of the lower abdominal region (4). Ramzy Shaaban (5) determined that TAP block application provided a better analgesia than the wound site infiltration in the children to whom appendectomy was applied and in this study, the time of the first analgesic need was significantly longer in the TAP group (6.4 ± 1.5 hours) and the dose and number of rescue analgesics were significantly lower.

Both block methods have been applied so far to provide postoperative analgesia, especially in pediatric cases and in combination with general anesthesia, and there are rare case reports in terms of performing the operation with blocks only (6, 7). Likewise, in the PRAN study by Polaner

et al. (8), 95% of the 14917 blocks were performed under general anesthesia. In a study by Tekelioglu et al. (7), it was emphasized that TAP block supported by sedation without giving general anesthesia provide an opportunity for both an effective and reliable surgery and long-term postoperative pain control.

The purpose of the present study was to compare the contributions of TAP block and II/IH block combined with sedation in pediatric surgery to intraoperative anesthesia and analgesia without general anesthesia.

2. Methods

This study approved by the ethics committee of Erzincan University, Turkey (09/07), and registered in the clinical trial registration website (ClinicalTrials.gov) with the registration number of NCT02991053. Written informed consent was obtained from the parents of the study patients.

This randomized controlled trial conducted at a university hospital in the pediatric surgery operating room in 2017. Hundred pediatric patients aged 2 - 6 years undergoing elective lower abdominal surgery were enrolled. Five patients were excluded from the study because fentanyl was administered in repeated doses. The cases were candidates for inguinal hernia repair, orchiopexy, and appendectomy. The exclusion criteria were psychiatric disease, the weight of > 40 kg, cardiac-pulmonary-neurological diseases, bleeding problems, infections or wound scars in the injection site, and known allergies to local anesthetics.

2.1. Preoperative Management

All patients transferred to the operating room with established vascular access and received intravenous premedication with 0.1 mg/kg midazolam, ten minutes before the surgery. Hemodynamic values, including mean arterial pressure (MAP) and heart rate (HR), were recorded preoperatively in all patients.

2.2. Intraoperative Management

Anesthesia induction was performed with 2 mg/kg ketamine (Ketalar, Pfizer, Istanbul, Turkey) and 0.01 mg/kg Atropine (Atropin Sülfat, Osel, Istanbul, Turkey), intravenously. Patients were randomly assigned to groups using simple block randomization. All nerve blocks and operations performed by the same anesthetist and surgeon.

Group 1: Transversus abdominis plane (TAP) block was performed with 0.4 mL/kg Bupivacaine 0.25% (Marcaine, AstraZeneca, Istanbul, Turkey) and the anesthesia was maintained with only Ketamine (Ketamine + TAP group).

Group 2: The laryngeal mask airway (LMA) was inserted under Sevoflurane anesthesia and anesthesia maintained by two MAC Sevoflurane (Sevorane Likid, Abdi Ibrahim, Istanbul, Turkey) and oxygen/air mixture. TAP block was performed with 0.4 mL/kg Bupivacaine 0.25% (LMA + Sevoflurane + TAP group)

Group 3: The II/IH block was done with 0.4 mL/kg Bupivacaine 0.25%, and the anesthesia maintenance was provided with only Ketamine (Ketamine + II/IH group)

Group 4: The LMA was inserted and anesthesia maintained by 2 MAC Sevoflurane and oxygen/air mixture. II/IH block was performed with 0.4 mL/kg bupivacaine 0.25% (LMA + Sevoflurane + II/IH group)

Group 5 (control group): LMA was inserted and anesthesia maintenance was provided with the mixture of 2 MAC Sevoflurane, and oxygen/air mixture and no block was applied (Sevoflurane group). Intravenous Paracetamol was used to control postoperative pain (Parol, Atabay, Istanbul, Turkey).

Both blocks were applied as previously mentioned (9). High-frequency linear probes (SonoSite M-Turbo, Sonosite, USA) were used in all blocks. The ultrasound device was calibrated every morning.

All surgeries except for the 5th group, which did not receive the block, were started 20 minutes after the block. HR = 100 - 130 beats/min, BIS = 60 - 80, and MAP = 80 - 120 mmHg were considered as normal values. At the time of surgery, 1 mcg/kg IV Fentanyl was administered when there was movement in the patient or if the heart rate increased by 20% or more from baseline. Patients requiring additional doses of fentanyl within three minutes were excluded from the study. Anesthesia depth was assessed with bispectral index (BIS) and kept between 60 and 80. During the surgery, HR, SpO_2, MAP, BIS measurements, the amount of Sevoflurane used, and the dose of Ketamine were recorded at 5-minute intervals.

2.3. Postoperative Management

The postoperative pain was assessed with modified children's hospital of Eastern Ontario pain scale (CHEOPS) and objective pain scale (OPS) for 12 hours. The time of CHEOPS $\geq$ 6 or OPS $\geq$ 5 was recorded, and rescue analgesia was performed with 15 mg/kg dose of IV Paracetamol at that time (1). 15 mg/kg of Paracetamol was applied to all

the patients every 8 hours. If Paracetamol was ineffective, ibuprofen would be administered at 20 - 30 mg/kg.

Pain scores via CHEOPS and OPS and hemodynamic changes were followed- up and patients' need for analgesics at the time of first analgesia, nausea, and vomiting were recorded. Rescue analgesia and nausea/vomiting status were evaluated as either present or absent.

There was one observer in this study that was a pediatric surgeon.

The primary purpose of the study was to investigate the contribution of both regional anesthesia techniques to intraoperative anesthesia and analgesia and postoperative analgesia.

2.4. Statistical Analysis

We are primarily interested in the precise estimates of acceptability, as well as outcome variability that will aid in the planning of a larger, sufficiently powered efficient trial. A sample size of 20 per group will allow us to be relatively precise in our conclusions regarding the acceptability of outcomes. In the power analysis, it was determined that a total of 100 patients should be included with $\alpha = 0.05$, and the power of 85%.

Normal distribution and analysis of variance were assessed using the Kolmogorov-Smirnov test, Skewness-Kurtosis, and histogram. Numerical data are presented as the mean and standard deviation and categorical data as the number. The Chi-square test was used to compare categorical data between the groups. The Mann-Whitney U test was used to compare the mean values between two groups, and the Kruskal-Wallis test was used to compare three or more groups. Tukey's honest significant difference or nonparametric comparison tests were used in multiple comparisons. All the data were analyzed using IBM SPSS statistical package for Windows version 20 (IBM Corp., Armonk, NY, USA). A P value of < 0.05 was considered statistically significant.

3. Results

3.1. Descriptive and Preoperative Data

A total of hundred children included in this study, 55 boys and 45 girls, with a mean age of 3.9 ± 1.2 years. There was no significant difference in age, gender, preoperative BIS, HR, MAP, and SpO_2 values between the study groups ($P > 0.05$) (Table 1).

3.2. Intraoperative Data

In the between-group comparison of intraoperative values, it was determined that there was a difference between MAP values in the first 10 minutes after the block. After the 15th minute, heart rate was observed to be significantly different compared to the start of surgery ($P < 0.05$). It is observed that heart rates were higher but the means of arterial pressure were lower in the control group (Table 2).

When the cause of the difference between the groups was investigated, similar intra-operative values were found with both anesthesia methods with the application of both II/IH block and TAP block, but there was a significant difference between these four groups and the control group. This difference was due to the control group (Table 3).

In the comparison of TAP block and II/IH block, similar hemodynamic values were found in both groups in terms of HR and MAP during surgeries. When the amount of intraoperative anesthetic use was considered, the amount of Sevoflurane decreased significantly in the block groups compared to the control group ($P < 0.01$). However, when the use of ketamine was examined, it was found that even though there was less ketamine need in the group in which TAP block was added, this difference was not significant ($P > 0.05$) (Table 4).

3.3. Postoperative Data

There was a significant difference between the groups in the postoperative values. Hemodynamic indexes (HR and MAP) were higher in the control group at all follow-up hours. However, it was more significant in the first six hours ($P < 0.05$). The hemodynamic changes that occurred in the Sevoflurane group after the first six hours were not statistically significant ($P > 0.05$).

Based on there were significant differences in the CHEOPS and OPS values at first, 2nd, 4th, and sixth postoperative hours regardless of group discrimination (Table 5).

The amounts of heart rate, CHEOPS, and OPS values were significantly higher in the first six hours in the control group ($P < 0.05$). The values were similar in the block groups.

When the duration of analgesia was evaluated, it was detected that analgesia was needed at 6.2 hours in the ketamine + TAP block group, at 4.9 hours in the Ketamine + II/IH block group, at 4.7 hours in the LMA + II/IH block group, and at 2.1 hours in the control group and this was found to be statistically significant ($P < 0.001$) (Table 5).

Table 1. Descriptive and Preoperative Data[a]

Varibles	Ketamine + II/IH Group	LMA + II/IH Group	Ketamine + TAP Group	LMA + TAP Group	Control Group	Total	P Value[b]
Sex							> 0.05
Boy	11	12	10	11	11	55	
Girl	9	8	10	9	9	45	
Patient number, No.	20	20	20	20	20	100	
Age, y	4 ±1.4	3.9 ± 1.6	4.4 ±1.1	3.7 ± 1.2	3.9 ± 1.0		> 0.05
Preop BIS	85.00 ±4.2	86.30 ± 4.0	85.0 ± 3.6	85.0 ± 3.3	87.05 ± 2.9		> 0.05
Preop HR (min)	114.55±17.8	122.0 ± 15.9	113.3 ± 14.7	121.5 ± 14.3	122.05 ± 10.0		> 0.05
Preop MAP (mmHg)	95.50 ± 15.0	101.10 ± 12.8	94.5 ± 13.4	102.3 ± 13.2	103.95 ± 13.0		> 0.05

Abbreviations: II/IH, Ilioinguinal/Iliohypogastric; Preop (BIS, HR, MAP), preoperative bispectral index, heart rate, mean arterial pressure; TAP, transversus abdominis plane.
[a]Chi-Square tests.
[b]P < 0.05 was considered significant.

In addition, the supplemental analgesia needed in the early period in six patients in the block groups while the analgesia need was observed in 12 patients in the control group. Nausea and vomiting were observed only in the control group (Table 4).

Concerning the duration of analgesia and the number of rescue analgesia, the lowest analgesia duration, and the highest analgesia need were observed in the control group (P < 0.05) (Tables 5 - 6).

In the postoperative comparisons of the two blocks, there was no significant difference between the groups in terms of HR, MAP, CHEOPS, OPS values, and the number of rescue analgesia. When the duration of analgesia was examined, it was determined that the TAP block have a relatively longer action period, but this was not statistically significant (Table 7). In addition, nausea and vomiting were not observed in the groups to which block was added.

4. Discussion

In the present study, the effect of two regional anesthesia techniques on the intraoperative anesthetic use and intraoperative analgesia in pediatric lower abdominal surgery was evaluated. The superiority of perioperative effects of Transversus abdominis plane or ilioinguinal/iliohypogastric blocks, to which general anesthesia (Sevoflurane) or sedation (ketamine) was added, could not be shown. Anesthesia maintenance in these surgeries can be performed with mild sedation added to the regional blocks.

Regional anesthesia techniques have been shown to reduce perioperative stress response (10). As in the present study, even though there was no intraoperative comparison of two regional methods, some studies in the literature have reported that better intraoperative hemodynamics were achieved in the groups to which block was applied and reduced the use of intraoperative Sevoflurane (1, 7, 11). On the other hand, in the present study, similar hemodynamic values were found in both groups in terms of HR and MAP at all intraoperative hours in comparisons with the TAP block and II/IH block. In the control group, HR and MAP values were higher. When the amount of intraoperative anesthetic use was examined, the Sevoflurane use in the block groups decreased significantly. The ketamine need in the group with TAP block was less than others; however, this difference was not statistically significant. This was associated with the fact that regional techniques, regardless of being TAP block or II/IH block, decrease the response to surgical stimulation and thus decrease the anesthetic need.

For postoperative pain control in children, regional analgesia is preferred more often because it is easier to apply and does not require additional equipment and care (12). There are many studies in the literature comparing postoperative analgesia with two blocks in pediatric patients, but the results are contradictory (9, 13-16). While the TAP block is associated with longer analgesia time, lower pain scores, and less analgesic need in some studies (13-15), it is argued in some studies that II/IH block is preferred in the postoperative period (9, 16, 17). In the meta-analysis of Wang et al. (18) in 2016, it was emphasized that ultrasound-

Table 2. Intraoperative Data[a]

Time	Ketamine + II/IH Group	LMA + II/IH Group	Ketamine + TAP Group	LMA + TAP Group	Control Group	P Value
0 (Start time)						
HR	117.3 ± 15.6	123.6 ± 13.2	113.8 ± 15.4	122.0 ± 15.2	122.5 ± 10.7	0.154
MAP	94.5 ± 14.6	97.6 ± 12.7	93.9 ± 12.5	99.2 ± 12.0	82.0 ± 3.8	< 0.001[b]
After 5 min						
HR	121.6 ± 12.0	125.1 ± 11.8	117.5±15.2	123.2±15.9	123.2 ± 9.7	0.441
MAP	93.7 ± 10.8	98.6 ± 8.6	94.3 ± 10.2	99.4 ± 8.3	84.7 ± 5.9	< 0.001[b]
After 10 min						
HR	114.2 ± 13.8	119.9 ± 12.6	111.8 ± 15.4	119.3 ± 15.7	122.7 ± 11.0	0.090
MAP	92.9 ± 9.9	98.8 ± 5.9	94.2 ± 10.2	96.0 ± 9.1	85.8 ± 6.2	< 0.001[b]
After 15 min						
HR	108.6 ± 10.8	114.3 ± 10.3	107.2 ± 12.0	114.8 ± 12.3	121.5 ± 9.9	< 0.001[b]
MAP	88.8 ± 8.4	93.6 ± 6.8	90.6 ± 9.3	92.3 ± 6.8	84.7 ± 5.2	< 0.003[b]
After 20 min						
HR	108.0 ± 11.1	113.5 ± 11.4	105.5±12.7	109.3 ± 12.9	121.7 ± 10.1	< 0.001[b]
MAP	85.5 ± 8.5	87.7 ± 9.1	88.0 ± 9.5	87.6 ± 9.7	82.2 ± 4.4	0.042[b]
Skin incision						
HR	106.6 ± 14.3	110.9 ± 13.8	109.3 ± 11.3	107.8±11.9	124.3 ± 7.7	< 0.001[b]
MAP	90.6 ± 13.2	94.5 ± 15.6	92.6 ± 12.9	92.7 ± 14.2	86.4 ± 6.1	0.038[b]
After 10 min						
HR	108.8 ± 15.7	113.8 ± 16.6	107.4±14.1	108.6±14.4	123.4 ± 7.6	0.003[b]
MAP	85.3 ± 8.6	87.0 ± 10.0	89.1 ± 10.4	87.7 ± 11.2	85.0 ± 2.9	0.593
After 20 min						
HR	107.5 ± 12.8	111.8 ± 13.6	105.2 ± 13.1	105.2 ± 11.9	119.7 ± 9.7	< 0.001[b]
MAP	88.0 ± 12.5	87.1 ± 12.1	89.2 ± 11.8	87.4 ± 11.5	85.3 ± 2.7	0.846
After 30 min						
HR	105.9 ± 15.2	110.3 ±16.4	104.3 ± 14.6	103.3 ± 14.3	120.7 ± 10.3	< 0.001[b]
MAP	88.6 ± 13.4	85.4 ± 12.1	89.9 ± 13.2	86.7 ± 12.1	85.2 ± 5.1	0.660
Sevoflurane, mL/h	0	12 ± 0.3	0	8 ± 0.3	19 ± 0.3	< 0.001[b]
Ketamine, mg	67.2 ± 28.7		62.5 ± 22.3			0.563

Abbreviations: HR, heart rate (min); MAP, mean arterial pressure (mmHg).
[a] One way ANOVA.
[b] The mean difference is significant at the 0.05 level.

guided II/IH nerve or TAP blocks reduce the need for analgesia during surgery and reduce the pain scores significantly. Similarly, in the study of Okur et al. (19), it was determined that in the groups with a block, the pain scores were lower, the duration of analgesia was longer, and the need for rescue analgesia was less. In the present study, no difference was found between the two regional anesthesia methods in terms of postoperative hemodynamics, pain scores, analgesia duration, the number of people requiring analgesia, and nausea and vomiting rates. The prominent detail is the painless duration elapsed between the Ketamine + block groups and LMA + Sevoflurane + block groups. When ketamine was added to the blocks, the duration of the analgesia increased by two hours. This effect was associated with the anti-hyperalgesic effect of ketamine, a part of multimodal analgesia (20).

The present study has some strong points. Our study reminds us that a mild sedation-assisted TAP or II/IH block

Table 3. Comparison of P Values Between Groups[a]

	Ketamine + II/IH and LMA + II/IH Group	Control Group and Ketamine + II/IH Group	LMA + II/IH and Control Group	Ketamine + TAP and LMA + TAP	Control Group and Ketamine + TAP	LMA + TAP and Control Group	Ketamine + II/IH and Ketamine TAP	LMA + II/IH and LMA + TAP
0 Starting time								
HR	0.161	0.246	0.807	0.071	0.056	0.912	0.487	0.726
MAP	0.408	< 0.001[b]	< 0.001[b]	0.162	0.002[b]	< 0.001[b]	0.890	0.695
After 5 min								
HR	0.403	0.702	0.649	0.174	0.174	0.978	0.350	0.672
MAP	0.087	0.002[b]	< 0.001[b]	0.075	< 0.001[b]	< 0.001[b]	0.859	0.767
After 10 min								
HR	0.200	0.055	0.517	0.090	0.044[b]	0.433	0.600	0.895
MAP	0.029[b]	0.010[b]	< 0.000[b]	0.505	0.002[b]	< 0.000[b]	0.687	0.249
After 15 min								
HR	0.109	< 0.001[b]	0.044[b]	0.035[b]	< 0.001[b]	0.058	0.702	0.901
MAP	0.046[b]	0.088	< 0.001[b]	0.476	0.014[b]	0.002[b]	0.518	0.567
After 20 min								
HR	0.138	< 0.001[b]	0.030[b]	0.314	< 0.000[b]	< 0.001[b]	0.521	0.279
MAP	0.416	0.230	0.046[b]	0.897	0.035[b]	0.048[b]	0.389	0.987
After skin incision								
HR	0.269	< 0.001[b]	< 0.001[b]	0.705	< 0.001[b]	< 0.001[b]	0.521	0.706
MAP	0.341	0.311	0.041[b]	0.990	0.131	0.128	0.624	0.298
After 10 min								
HR	0.260	< 0.001[b]	0.035[b]	0.780	< 0.001[b]	< 0.001[b]	0.769	0.298
MAP	0.559	0.904	0.482	0.631	0.156	0.346	0.219	0.837
After 20 min								
HR	0.274	0.002[b]	0.045[b]	0.990	< 0.000[b]	< 0.000[b]	0.587	0.112
MAP	0.793	0.440	0.610	0.590	0.257	0.550	0.646	0.937
After 30 min								
HR	0.334	0.002[b]	0.024[b]	0.826	< 0.001[b]	< 0.000[b]	0.729	0.156
MAP	0.394	0.365	0.957	0.386	0.209	0.694	0.759	0.747
Sevoflurane		< 0.001[b]	< 0.001[b]		< 0.001[b]	< 0.001[b]		0.127
Ketamine							0.563	

Abbreviations: HR, heart rate (min); MAP, mean arterial pressure (mmHg).
[a] Multiple comparison, student's t test, Mann-Whitney U test.
[b] The mean difference is significant at the 0.05 level.

may be preferred in some surgical procedures alone to avoid possible adverse effects of general anesthesia in children. The reliability was improved by using two different methods for the evaluation of postoperative pain. The cases were managed by the same anesthetist and the same surgeon to exclude the differences in practice. Our study had no missing value.

The present study has some weak points. This single-center study cannot be generalized. Further work is needed to make generalizations. We could not consider and assess the postoperative agitation effect of Sevoflurane (21). Third, our follow-up time was limited to 12 hours since

Table 4. Intraoperative Comparison of Transversus Abdominis Plane Block, with Ilioinguinal/Iliohypogastric Block[a]

	Ketamine + II/IH and Ketamine + TAP		P Value	LMA + II/IH and LMA + TAP		P Value
0 min						
HR	117.3 ± 15.6	113.8 ± 15.4	0.487	123.6 ± 13.2	122.0 ± 15.2	0.726
MAP	94.5 ± 14.6	93.9 ± 12.5	0.890	97.6 ± 12.7	99.2 ± 12.0	0.695
After 5 min						
HR	121.6 ± 12.0	117.5 ± 15.2	0.350	125.1 ± 11.8	123.2 ± 15.9	0.672
MAP	93.7 ± 10.8	94.3 ± 10.2	0.859	98.6 ± 8.6	99.4 ± 8.3	0.767
After 10 min						
HR	114.2 ± 13.8	111.8 ± 15.4	0.600	119.9 ± 12.6	119.3 ± 15.7	0.895
MAP	92.9 ± 9.9	94.2 ± 10.2	0.687	98.8 ± 5.9	96.0 ± 9.1	0.249
After 15 min						
HR	108.6 ± 10.8	107.2 ± 12.0	0.702	114.3 ± 10.3	114.8 ± 12.3	0.901
MAP	88.8 ± 8.4	90.6 ± 9.3	0.518	93.6 ± 6.8	92.3 ± 6.8	0.567
After 20 min						
HR	108.0 ± 11.1	105.5 ± 12.7	0.521	113.5 ± 11.4	109.3 ± 12.9	0.279
MAP	85.5 ± 8.5	88.0 ± 9.5	0.389	87.7 ± 9.1	87.6 ± 9.7	0.987
Skin incision						
HR	106.6 ± 14.3	109.3 ± 11.3	0.521	110.9 ± 13.8	107.8 ± 11.9	0.706
MAP	90.6 ± 13.2	92.6 ± 12.9	0.624	94.5 ± 15.6	92.7 ± 14.2	0.298
After 10 min						
HR	108.8 ± 15.7	107.4 ± 14.1	0.769	113.8 ± 16.6	108.6 ± 14.4	0.298
MAP	85.3 ± 8.6	89.1 ± 10.4	0.219	87.0 ± 10.0	87.7 ± 11.2	0.837
After 20 min						
HR	107.5 ±12.8	105.2 ± 13.1	0.587	111.8 ±13.6	105.2 ± 11.9	0.112
MAP	88.0 ± 12.5	89.2 ± 11.8	0.646	87.1 ± 12.1	87.4 ± 11.5	0.937
After 30 min						
HR	105.9 ± 15.2	104.3 ± 14.6	0.729	110.3 ±16.4	103.3 ± 14.3	0.156
MAP	88.6 ± 13.4	89.9 ± 13.2	0.759	85.4 ± 12.1	86.7 ± 12.1	0.747
Sevoflurane, mL	0	0		12 ± 0.3	8 ± 0.3	0.127
Ketamine, mg	67.2 ± 28.7	62.5 ± 22.3	0.563			

Abbreviations: HR, heart rate (min); MAP, mean arterial pressure (mmHg).
[a] Student's t-test and Mann-Whitney U test.

the primary purpose of the present study was intraoperative anesthesia and analgesia. Longer follow-up periods can more clearly determine the postoperative effects of the two blocks.

4.1. Conclusion

In this study, investigating the effect of two regional anesthesia techniques on the intraoperative anesthetic use and intraoperative analgesia in pediatric lower abdominal surgery. The perioperative effects of transversus abdominis plane or ilioinguinal/iliohypogastric blocks to which general anesthesia (Sevoflurane) or sedation (ketamine) was added and have not any superiority to others. However, it was thought that they caused a better preoperative process compared to the control group without a block. Therefore, both block methods can be preferred as a part of general anesthesia or sedation, children can be protected from the side effects of general anesthesia, and better patient and family satisfaction can be achieved with a longer painless postoperative period.

Table 5. Postoperative Data[a]

	Ketamine + II/IH Block	Lma + II/IH Block	Ketamine + TAP Block	LMA + TAP Block	LMA + Sevoflurane (Control)	P Value
PACU 0 min						
HR	106.7 ± 16.9	111.1 ± 17.5	103.6 ± 16.5	106.4 ± 17.6	122.2 ± 14.6	0.006[b]
MAP	85.3 ± 11.5	79.0 ± 10.8	87.2 ± 12.7	84.7 ± 13.2	89.6 ± 4.3	0.042[b]
CHEOPS	1.1 ± 0.4	0.7 ± 0.5	1.1 ± 0.6	1.0 ± 0.6	3.9 ± 2.2	< 0.000[b]
OPS	0.10± 0.3	0.1 ± 0.4	0.4 ± 0.6	0.3± 0.7	3.8 ± 2.4	< 0.000[b]
PACU after 30 min						
HR	109.3 ± 13.2	113.3 ± 15.1	107.8 ± 13.0	109.6 ± 14.7	122.7 ±11.3	0.005[b]
MAP	85.5 ± 13.9	84.5 ± 10.7	91.4 ± 14.2	87.2 ± 14.0	87.5 ± 6.1	0.458
CHEOPS	0.8 ± 0.5	0.8 ± 0.7	0.9 ± 0.8	0.9 ± 0.7	3.8 ± 1.4	< 0.000[b]
OPS	0.5 ± 1.0	0.7 ± 1.0	0.5 ± 0.8	0.6 ± 1.0	3.7 ± 1.4	< 0.000[b]
PACU after 60 min						
HR	110.7 ±14.4	113.3 ± 15.6	108.1 ± 13.3	110.3 ± 13.9	121.4 ± 11.1	0.030[b]
MAP	87.3 ± 10.6	88.3 ± 8.5	91.1 ± 11.1	92.2 ± 10.4	87.2 ± 6.2	0.334
CHEOPS	1.6 ± 1.2	1.7 ± 1.2	1.5 ± 1.1	1.6 ± 1.3	3.2 ± 1.0	< 0.000[b]
OPS	1.8 ± 1.8	2.3 ± 1.7	1.8 ± 1.5	2.0 ± 1.9	3.4 ± 1.5	0.031[b]
PACU after 2 h						
HR	107.6 ± 15.3	115.7 ±14.8	108.0 ± 12.6	112.4 ± 13.7	121.9 ± 9.8	0.006[b]
MAP	86.6 ± 11.7	85.3 ± 6.8	89.5 ± 13.5	87.8 ± 12.3	86.4 ± 7.1	0.777
CHEOPS	2.3 ± 2.6	2.7 ± 2.5	2.2 ± 2.3	2.5 ± 2.8	3.9 ± 1.9	0.003b
OPS	2.2 ± 2.7	3.1 ± 2.5	2.6 ± 2.3	2.7 ± 2.6	3.7 ± 2.2	0.060
PACU after 3 h						
HR	107.9 ± 14.9	114.4 ± 15.4	106.8 ± 13.3	107.9 ± 13.3	118.9 ± 9.9	0.022[b]
MAP	86.4 ± 10.6	85.4 ± 7.0	88.0 ± 12.0	89.2 ± 11.3	85.7 ± 4.4	0.682
CHEOPS	1.7 ± 1.8	2.6 ± 1.9	1.8 ± 1.5	2.1 ± 1.9	2.5 ± 1.2	0.411
OPS	1.8 ± 1.8	2.6 ± 2.0	1.8 ± 1.4	2.0 ± 1.9	2.1 ± 1.2	0.553
PACU after 4 h						
HR	107.5 ± 13.3	112.7 ± 15.5	107.1 ± 13.2	107.3 ± 12.7	120.6 ± 8.7	0.004[b]
MAP	84.3 ± 10.3	83.5 ± 6.3	87.0 ± 10.8	84.1 ± 10.6	86.2 ± 5.5	0.706
CHEOPS	0.95 ± 0.9	1.7 ± 1.0	1.7 ± 1.0	1.6 ± 1.0	2.5 ± 1.2	0.026
OPS	1.3 ± 1.2	2.0 ± 1.1	1.8 ± 1.1	1.8 ± 1.1	2.9 ± 1.6	0.005[b]
PACU after 6 h						
HR	108.6 ± 15.2	115.6 ± 15.9	109.2 ± 15.3	110.2 ± 14.9	123.6 ±12.2	0.009[b]
MAP	87.3 ± 9.8	86.1 ± 6.7	90.4 ± 9.7	91.1 ± 9.4	89.9 ± 4.5	0.261
CHEOPS	1.7 ± 1.5	2.5 ± 2.1	2.1 ± 1.6	2.4 ± 1.9	3.6 ± 1.9	0.022[b]
OPS	1.4 ± 1.8	2.2 ± 1.5	2.0 ± 2.0	2.1 ± 1.8	4.0 ± 2.5	< 0.001[b]
PACU after 8 h						
HR	110.4 ± 17.0	115.8 ± 17.2	108.6 ± 16.2	112.8 ± 17.8	122.5 ± 12.6	0.071
MAP	91.0 ± 9.9	85.3 ± 8.6	90.8 ± 11.6	89.0 ± 11.4	87.7 ± 5.3	0.326
CHEOPS	3.9 ± 1.3	4.1 ± 1.2	3.6 ± 1.5	3.7 ± 1.4	3.6 ± 0.9	0.714
OPS	4.0 ± 1.3	3.8 ± 1.1	3.8 ± 1.3	3.8 ± 1.5	3.6 ± 0.8	0.945
PACU after 12 h						
HR	109.5 ± 17.2	114.6 ± 17.0	111.5 ± 14.3	114.0 ± 15.2	119.6 ± 9.9	0.274
MAP	84.4 ± 11.2	81.5 ± 8.5	90.2 ± 12.4	88.6 ± 13.1	85.3 ± 4.8	0.078
CHEOPS	2.2 ± 2.0	1.7 ± 0.9	2.7 ± 1.9	1.9 ± 1.5	2.4 ± 0.5	0.252
OPS	2.2 ± 2.1	1.7 ± 1.5	2.9 ± 2.0	2.2 ± 1.8	2.4 ± 0.5	0.297
Analgesia time, h	6.1 ± 3.5	4.7 ± 2.0	6.2 ± 3.4	4.9 ± 3.0	2.1 ± 1.7	< 0.000[b]
Rescue analgesia, No.	6/20	5/20	6/20	6/20	12/20	0.021[b]
Nausea and vomiting	0/20	0/20	0/20	0/20	8/20	< 0.000[b]

Abbreviation: MAP, mean arterial pressure; CHEOPS, children's hospital of Eastern Ontario pain scale; HR, heart rate (min); MAP, mean arterial pressure (mmHg).
[a] One-way ANOVA, Mann-Whitney U test.
[b] The mean difference is significant at the 0.05 level.

Table 6. Comparison of P Values Between Groups in Postoperative Periods[a]

	Ketamine + II/IH and LMA + II/IH	LMA + Sevoflurane (Control) and Ketamine + II/IH	LMA + II/IH and LMA + Sevoflurane (Control)	Ketamine + TAP and LMA + TAP	LMA + Sevoflurane (Control) and Ketamine + TAP	Lma + TAP and LMA + Sevoflurane (Control)	Ketamine + II/IH and Ketamine TAP	LMA + II/IH and LMA + TAP
PACU 0 min								
HR	0.401	0.004[b]	0.039[b]	0.604	< 0.001[b]	0.004[b]	0.567	0.399
MAP	0.072	0.220	0.003[b]	0.475	0.493	0.163	0.624	0.141
CHEOPS	0.338	< 0.001[b]	< 0.001[b]	0.891	< 0.001[b]	< 0.001[b]	0.999	0.135
OPS	0.999	< 0.001[b]	< 0.001[b]	0.793	< 0.001[b]	< 0.001[b]	0.084	0.305
PACU after 30 min								
HR	0.359	0.002[b]	0.030[b]	0.675	< 0.001[b]	0.003[b]	0.711	0.438
CHEOPS	0.999	< 0.001[b]	< 0.001[b]	0.999	< 0.001[b]	< 0.001[b]	0.661	0.677
OPS	0.569	< 0.001[b]	< 0.001[b]	0.776	< 0.001[b]	< 0.001[b]	0.864	0.885
PACU after 60 min								
HR	0.545	0.016[b]	0.068	0.607	0.003b	0.013[b]	0.557	0.526
CHEOPS	0.795	< 0.001[b]	< 0.001[b]	0.795	< 0.001[b]	< 0.001[b]	0.796	0.810
OPS	0.420	0.006[b]	0.051	0.654	0.005[b]	0.017[b]	0.928	0.673
PACU after 2 h								
HR	0.061	< 0.001[b]	0.148	0.308	0.002[b]	0.028[b]	0.928	0.470
CHEOPS	0.563	0.036	0.125	0.699	0.031[b]	0.074	0.949	0.813
PACU after 3 h								
HR	0.133	0.012[b]	0.297	0.798	0.006[b]	0.012[b]	0.807	0.164
PACU after 4 h								
HR	0.202	0.002[b]	0.056	0.961	< 0.001[b]	0.002[b]	0.934	0.237
CHEOPS	0.021[b]	< 0.001[b]	0.021[b]	0.885	0.014[b]	0.010[b]	0.025	0.766
OPS	0.086	< 0.001[b]	0.038[b]	0.902	0.011[b]	0.008[b]	0.197	0.496
PACU after 6 h								
HR	0.141	0.002[b]	0.091	0.831	0.003[b]	0.005[b]	0.902	0.281
CHEOPS	0.152	< 0.001[b]	0.065	0.611	0.012[b]	0.044[b]	0.378	0.878
OPS	0.239	0.002[b]	0.004[b]	0.875	0.002[b]	0.003[b]	0.339	0.929
Analgesia								
P	0.125	< 0.001[b]	0.005[b]	0.154	< 0.001[b]	0.003[b]	0.929	0.808
Rescue analgesia								
P	0.738	0.047[b]	0.021[b]	0.999	0.047[b]	0.047[b]	0.999	0.731
Nausea and vomiting								
P	0.999	< 0.001[b]	< 0.001[b]	0.999	< 0.001[b]	< 0.001[b]		

[a] Multiple Comparison, Student's t-test, Mann-Whitney U test.
[b] The mean difference is significant at the 0.05 level.

Table 7. Postoperative Comparison of TAP Block with II/IH Block[a]

	Ketamine + II/IH and Ketamine + TAP		P Value	LMA + II/IH and LMA + TAP		P Value
PACU 0 min						
HR	106.7 ± 16.9	103.6 ± 16.5	0.567	111.1 ± 17.5	106.4 ± 17.6	0.399
MAP	85.3 ± 11.5	87.2 ± 12.7	0.624	79.0 ± 10.8	84.7 ± 13.2	0.141
CHEOPS	1.1 ± 0.4	1.1 ± 0.6	0.999	0.7 ± 0.5	1.0 ± 0.6	0.135
OPS	0.1± 0.3	0.4 ± 0.6	0.084	0.1 ± 0.4	0.3± 0.7	0.305
PACU 30 min						
HR	109.3 ± 13.2	107.8 ± 13.0	0.711	113.3 ± 15.1	109.6 ± 14.7	0.438
CHEOPS	0.8 ± 0.5	0.9 ± 0.8	0.661	0.8 ± 0.7	0.9 ± 0.7	0.677
OPS	0.5 ± 1.0	0.5 ± 0.8	0.864	0.7 ± 1.0	0.6 ± 1.0	0.885
PACU 60 min						
HR	110.7 ±14.4	108.1 ± 13.3	0.557	113.3 ± 15.6	110.3 ± 13.9	0.526
CHEOPS	1.6 ± 1.2	1.5 ± 1.1	0.796	1.7 ± 1.2	1.6 ± 1.3	0.810
OPS	1.8 ± 1.8	1.8 ± 1.5	0.928	2.3 ± 1.7	2.0 ± 1.9	0.673
PACU 2 h						
HR	107.6 ± 15.3	108.0 ± 12.6	0.928	115.7 ±14.8	112.4 ± 13.7	0.470
CHEOPS	2.3 ± 2.6	2.2 ± 2.3	0.949	2.7 ± 2.5	2.5 ± 2.8	0.813
PACU 3 h						
HR	107.9 ± 14.9	106.8 ± 13.3	0.807	114.4 ± 15.4	107.9 ± 13.3	0.164
PACU 4 h						
HR	107.5 ± 13.3	107.1 ± 13.2	0.934	112.7 ± 15.5	107.3 ± 12.7	0.237
CHEOPS	0.9 ± 0.9	1.7 ± 1.0	0.025	1.7 ± 1.0	1.6 ± 1.0	0.766
OPS	1.3 ± 1.2	1.8 ± 1.1	0.197	2.0 ± 1.1	1.8 ± 1.1	0.496
PACU 6 h						
HR	108.6 ± 15.2	109.2 ± 15.3	0.902	115.6 ± 15.9	110.2 ± 14.9	0.281
CHEOPS	1.7 ± 1.5	2.1 ± 1.6	0.378	2.5 ± 2.1	2.4 ± 1.9	0.878
OPS	1.4 ± 1.8	2.0 ± 2.0	0.339	2.2± 1.5	2.1 ± 1.8	0.929
Analgesia						
P	6.1 ± 3.5	6.2 ± 3.4	0.929	4.7 ± 2.0	4.9 ± 3.0	0.808
Rescue analgesia						
P	6/20	6/20	0.999	5/20	6/20	0.731
Nausea-vomiting						
P	0	0		0	0	

[a] Student's t-test, Mann-Whitney U test.

Footnote

Authors' Contribution: Study concept and design, Ilke Kupeli; acquisition of data, Ilke Kupeli; analysis and interpretation of data, Ilke Kupeli; and Sara Salcan; drafting of the manuscript, Ilke Kupeli; critical revision of the manuscript for important intellectual content, Ilke Kupeli and Sara Salcan; statistical analysis, Ilke Kupeli; administrative, technical, and material support, Ilke Kupeli and Sara Salcan; study supervision, Ilke Kupeli and Sara Salcan.

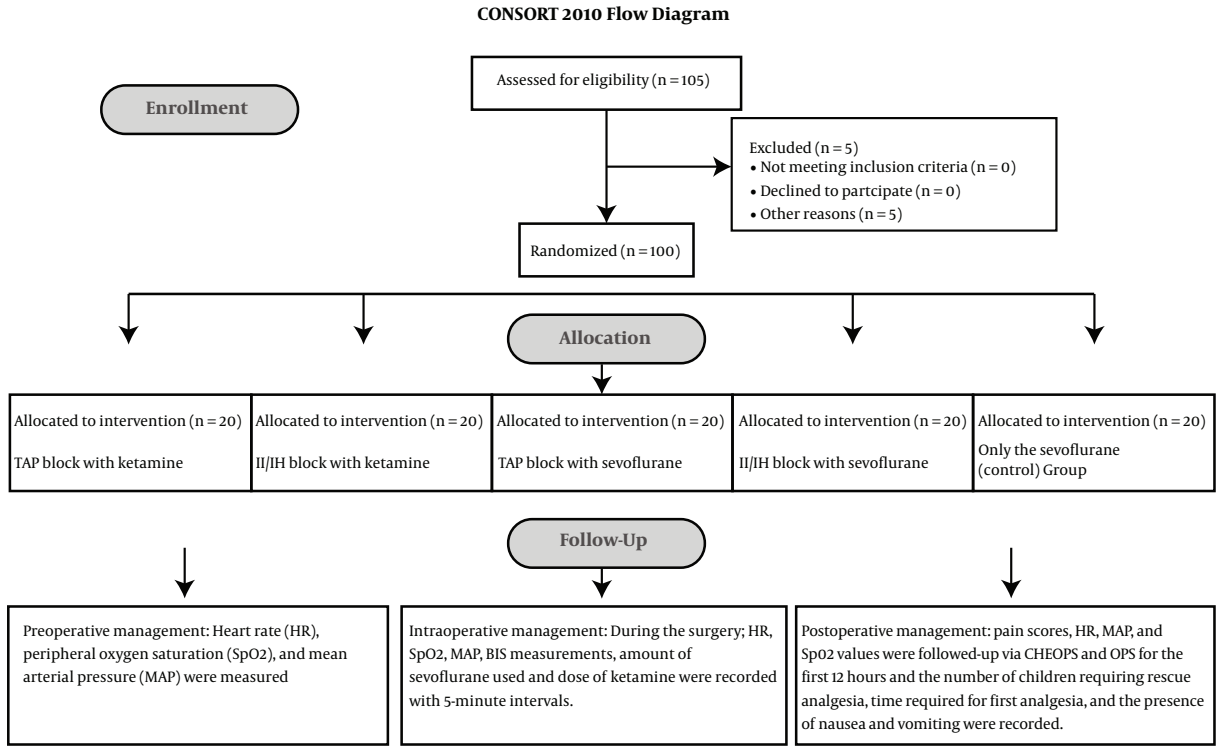

Figure 1. Consort 2010 flow diagram

References

1. Alsadek WM, Al-Gohari MM, Elsonbaty MI, Nassar HM, Alkonaiesy RM. Ultrasound guided TAP block versus ultrasound guided caudal block for pain relief in children undergoing lower abdominal surgeries. *Egypt J Anaesth*. 2015;**31**(2):155–60. doi: 10.1016/j.egja.2015.03.001.
2. Willschke H, Marhofer P, Machata AM, Lonnqvist PA. Current trends in paediatric regional anaesthesia. *Anaesthesia*. 2010;**65 Suppl 1**:97–104. doi: 10.1111/j.1365-2044.2010.06242.x. [PubMed: 20377551].
3. Yang L, Xu Y, Wang Z, Zhang W. Application of Ultrasound-Guided Ilioinguinal/Iliohypogastric Nerve Block in Pediatric Same-Day Surgery. *Indian J Surg*. 2015;**77**(6):512–6. doi: 10.1007/s12262-015-1301-0. [PubMed: 26884660]. [PubMed Central: PMC4744206].
4. Tanaka M, Mori N, Murakami W, Tanaka N, Oku K, Hiramatsu R, et al. [The effect of transversus abdominis plane block for pediatric patients receiving bone graft to the alveolar cleft]. *Masui*. 2010;**59**(9):1185–9. [PubMed: 20857679].
5. Ramzy Shaaban A. Ultrasound guided transversus abdominis plane block versus local wound infiltration in children undergoing appendectomy: A randomized controlled trial. *Egypt J Anaesth*. 2014;**30**(4):377–82. doi: 10.1016/j.egja.2014.06.005.
6. Stuart-Smith K. Hemiarthroplasty performed under transversus abdominis plane block in a patient with severe cardiorespiratory disease. *Anaesthesia*. 2013;**68**(4):417–20. doi: 10.1111/anae.12108. [PubMed: 23252578].
7. Tekelioglu UY, Demirhan A, Sit M, Kurt AD, Bilgi M, Kocoglu H. Colostomy with Transversus Abdominis Plane Block. *Turk J Anaesthesiol Reanim*. 2015;**43**(6):424–6. doi: 10.5152/TJAR.2015.89410. [PubMed: 27366540]. [PubMed Central: PMC4894187].
8. Polaner DM, Taenzer AH, Walker BJ, Bosenberg A, Krane EJ, Suresh S, et al. Pediatric Regional Anesthesia Network (PRAN): a multi-institutional study of the use and incidence of complications of pediatric regional anesthesia. *Anesth Analg*. 2012;**115**(6):1353–64. doi: 10.1213/ANE.0b013e31825d9f4b. [PubMed: 22696610].
9. Mohamed MH, Kamal MM. Comparison of postoperative analgesia of ultrasound-guided ilioinguinal/iliohypogastric nerve block versus ultrasound-guided TAP block for pediatric inguinal hernia repair. *Ain-Shams J Anaesthesiol*. 2015;**8**(4):658–63. doi: 10.4103/1687-7934.172763.
10. Bosenberg A. Pediatric regional anesthesia update. *Paediatr Anaesth*. 2004;**14**(5):398–402. doi: 10.1111/j.1460-9592.2004.01338.x. [PubMed: 15086851].
11. Kim SH, Chun DH, Chang CH, Kim TW, Kim YM, Shin YS. Effect of caudal block on Sevoflurane requirement for lower limb surgery in children with cerebral palsy. *Paediatr Anaesth*. 2011;**21**(4):394–8. doi: 10.1111/j.1460-9592.2011.03530.x. [PubMed: 21299684].
12. Fell D. Postoperative analgesia in children. *Br J Anaesth*. 1993;**70**(1):4–5. doi: 10.1093/bja/70.1.4. [PubMed: 8431331].
13. Sahin L, Soydinc MH, Sen E, Cavus O, Sahin M. Comparison of 3 different regional block techniques in pediatric patients. A prospective randomized single-blinded study. *Saudi Med J*. 2017;**38**(9):952–9. [PubMed: 28889155]. [PubMed Central: PMC5654031].
14. Findlow D, Aldridge LM, Doyle E. Comparison of caudal block using bupivacaine and ketamine with ilioinguinal nerve block for orchidopexy in children. *Anaesthesia*. 1997;**52**(11):1110–3. [PubMed: 9404178].

15. Aveline C, Le Hetet H, Le Roux A, Vautier P, Cognet F, Vinet E, et al. Comparison between ultrasound-guided transversus abdominis plane and conventional ilioinguinal/iliohypogastric nerve blocks for day-case open inguinal hernia repair. *Br J Anaesth*. 2011;**106**(3):380–6. doi: 10.1093/bja/aeq363. [PubMed: 21177284].
16. Fredrickson MJ, Paine C, Hamill J. Improved analgesia with the ilioinguinal block compared to the transversus abdominis plane block after pediatric inguinal surgery: a prospective randomized trial. *Paediatr Anaesth*. 2010;**20**(11):1022–7. doi: 10.1111/j.1460-9592.2010.03432.x. [PubMed: 20964768].
17. Stav A, Reytman L, Stav MY, Troitsa A, Kirshon M, Alfici R, et al. Transversus Abdominis Plane Versus Ilioinguinal and Iliohypogastric Nerve Blocks for Analgesia Following Open Inguinal Herniorrhaphy. *Rambam Maimonides Med J*. 2016;**7**(3). doi: 10.5041/RMMJ.10248. [PubMed: 27487311]. [PubMed Central: PMC5001793].
18. Wang Y, Wu T, Terry MJ, Eldrige JS, Tong Q, Erwin PJ, et al. Improved perioperative analgesia with ultrasound-guided ilioinguinal/iliohypogastric nerve or transversus abdominis plane block for open inguinal surgery: a systematic review and meta-analysis of randomized controlled trials. *J Phys Ther Sci*. 2016;**28**(3):1055–60. doi: 10.1589/jpts.28.1055. [PubMed: 27134411]. [PubMed Central: PMC4842423].
19. Okur O, Tekgul ZT, Erkan N. Comparison of efficacy of transversus abdominis plane block and iliohypogastric/ilioinguinal nerve block for postoperative pain management in patients undergoing inguinal herniorrhaphy with spinal anesthesia: a prospective randomized controlled open-label study. *J Anesth*. 2017;**31**(5):678–85. doi: 10.1007/s00540-017-2378-3. [PubMed: 28616651].
20. Moyse DW, Kaye AD, Diaz JH, Qadri MY, Lindsay D, Pyati S. Perioperative Ketamine Administration for Thoracotomy Pain. *Pain Physician*. 2017;**20**(3):173–84. [PubMed: 28339431].
21. Dahmani S, Stany I, Brasher C, Lejeune C, Bruneau B, Wood C, et al. Pharmacological prevention of sevoflurane- and desflurane-related emergence agitation in children: a meta-analysis of published studies. *Br J Anaesth*. 2010;**104**(2):216–23. doi: 10.1093/bja/aep376. [PubMed: 20047899].