The Postoperative Analgesic Effect of Transversus Abdominis Plane Block in Inguinal Hernia Repair: A Randomized Controlled Study

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Abstract

Aim: The objective of this study was to investigate the effect of preincisional (preemptive) Transversus Abdominis Plane (TAP) block on perioperative opioid consumption, hemodynamic parameters and postoperative rescue analgesic consumption in patients undergoing inguinal hernia repair.

Methods: 60 adult patients were included in this prospective randomized controlled study. The patients were divided into two groups: those who received conventional systemic analgesia (Group C) and those who received US-guided TAP block (Group TAP). By ultrasonography, normal saline (1 mL) was injected between the internal oblique and transverse abdominal muscles, and after separation was observed, 20 mL of 0.25% bupivacaine was administered. Postoperatively, 1mg/kg Tramadol HCl was given to all patients as a rescue analgesic. Perioperative hemodynamic data, perioperative total amount of remifentanil consumption amount, postoperative Visual Analogue Scale (VAS) scores, starting time and number of rescue analgesics were recorded.

Results: There was no difference in demographic data. Intraoperative remifentanil dose, VAS values at all times, need for rescue analgesics and the number of applications were significantly lower in Group TAP than in Group C ($p=0.012$, $p<0.05$, $p=0.047$). The number of patients who received rescue analgesics was significantly higher in Group C than in Group TAP ($p<0.05$). It was found that the first rescue analgesic administration time was needed later in Group TAP than in Group C ($p=0.032$). No difference was found in postoperative nausea and vomiting ($p>0.05$).

Conclusions: We concluded that preincisional TAP block is a safe and effective analgesia technique for postoperative pain control in patients undergoing unilateral inguinal hernia repair and our findings should be supported by advanced controlled randomized studies.

Keywords: *Hernia, Inguinal, transversus abdominis plane block, analgesia*

1. Introduction

More than 20 million people undergo inguinal hernia repair worldwide per year. In many countries, general or regional anesthesia is used in inguinal hernia surgery, while local anesthesia is less commonly preferred. In a study of 57,505 patients undergoing inguinal hernia repair, it was reported that 64% underwent general anesthesia, 18% underwent regional anesthesia and 18% underwent local anesthesia [1].

Pain of open inguinal hernia repair can be moderate-to-severe in intensity, with the most severe pain commonly experienced on the day of surgery[2]. Postoperative acute pain can cause immobilization, risk of respiratory failure, atelectasis, hypoxia and pneumonia. Daily life activities can be limited if inadequate analgesia is provided, and chronic pain can also impair quality of life[3]. Patients should be trained to be able to evaluate with Visual Analog Scale (VAS) or numerical rating system (NRS) to facilitate postoperative pain management[4].

Multimodal analgesia involves the simultaneous use of different pain control mechanisms to reduce the dose of a single agent, particularly opioids, while providing postoperative pain relief, augmenting analgesic efficacy and minimizing the risk of side effects[5]. This strategy attempts to avoid the use of opioids, or at least the enable the use of opioids at the lowest dose required, thus minimizing the risk of developing side effects that may even delay recovery[6].

TAP block is used in lower abdominal operations (cesarean section, inguinal hernia repair, appendectomy, abdominal hysterectomy, prostatectomy)[7]. TAP block decreases the perioperative opioid anal-

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gesic requirement in inguinal hernia repair, provides hemodynamic stability, allows early recovery from anesthesia and reduces side effects[8,9]. TAP block provides analgesia by blocking the intercostal (T_7-T_{11}), subcostal (T_{12}) and ilioinguinal-iliohypogastric (L_1-L_2) nerves, and hydrodissecting between the internal oblique and the transversus abdominis muscles through the deposition of local anesthetics[10,11]. Analgesia lasting 24 hours is provided by blocking the T_6-L_1 nerves that pass through the fascial plane[12,13].
However, little is known about the timing of TAP block and its impact on postoperative pain control. While administration of the block prior to surgical incision can reduce opioid requirements, provide better pain control in the postoperative period[14].
This study tries to answer the question whether TAP performed before surgical incision (preemptive) would provide better analgesia than conventional systemic analgesia, by comparing effects on intraoperative opioid (remifentanil) consumption amount, hemodynamic parameters and postoperative rescue analgesic (Tramadol HCl) starting time in adult patients undergoing inguinal hernia repair under general anesthesia.

2. Materials and methods

The prospective, randomized and controlled clinical study was conducted between April 1, 2021, and October 1, 2021, after obtaining approval of the, Ümraniye Training and Research Hospital Ethics Committee with decision number 35 dated March 11, 2021, and the written informed consent of the patients. The study was designed in accordance with the Declaration of Helsinki defined in 2008. Written informed consent for trial was obtained from the patients.

A total of 60 adult patients 18 to 80 years, American Society of Anesthesiologists (ASA) 1-3 who underwent unilateral inguinal hernia repair were included in the study.

Exclusion criteria were inability to understand Turkish, neurocognitive dysfunction, relevant drug allergy, pregnancy, drug abuse, patients with organomegaly or coagulopathy, pain medications within 24 hours (h) before surgery and infection at the injection site.

The patients were divided into two groups using the sealed envelope method: those who received conventional systemic analgesia (Group C) and those who received US-guided TAP block (Group TAP). In group TAP, a unilateral TAP block was performed with ultrasound guidance using 20 mL of % 0.25 bupivacaine before the skin incision of surgical procedure following the induction of general anesthesia. The patients, the anesthesiologists and staff providing postoperative care were blinded to group assignments.

The primary outcome measure of the study was based on visual analogue scale (VAS) pain scores and rescue analgesic starting time postoperatively. The secondary outcome measures of the study were based on remifentanil consumption amount and hemodynamic parameters perioperatively.

2.1. Interventions

After non-invasive blood pressure, pulse oximeter (SpO_2), electrocardiogram (ECG) and bispectral index (BIS) monitorization all patients received intravenous (iv) propofol 2-2.5 mg/kg and fentanyl 1µg/kg for the induction of anesthesia. Rocuronium 0.6 mg/kg was administered, endotracheal intubation was performed and end-tidal carbon dioxide ($EtCO_2$) was monitored. The mechanical ventilation settings were adjusted to maintain an $EtCO_2$ of between 35 and 40 mmHg. Anesthesia was maintained through 1 minimum alveolar concentration (MAC) sevoflurane in 50% 0_2 + 50% air and remifentanil administered at a rate of 0.05–1 µg/kg/min. A mean arterial blood pressure (MAP) of less than 60 mmHg was considered hypotension, for which ephedrine hydrochloride 5 mg iv was administered.

After the anesthesia induction, a 38-mm linear array US probe (3-6 MHz) was dressed in a sterile cover and moved from the cephalic to the caudal direction to visualize the subcutaneous fat tissue, external oblique muscle, internal oblique muscle, transversus abdominis muscle, peritoneum and intraperitoneal cavity. Under ultrasound guidance, a 100-mm, 22-gauge TAP block needle was introduced anteriorly and inserted in plane under real-time US guidance to lie between the internal oblique and the transversus abdominis muscles.

After observing the hydrodissection of the transversus abdominis muscles and internal oblique through the injection of normal saline (1 mL) solution, 20 mL of % 0.25 bupivacaine solution was administered. The operation proceeded after the injection of local anesthetic with simultaneous visualization by ultrasound. Ondansetron 4 mg was administered intravenously as an antiemetic. No additional local anesthesia was administered by the surgeon. Group C patients was received conventional systemic analgesia paracetamol 1 gr and tenoxicam 20 mg and Group TAP was received paracetamol 1 gr for analgesic purposes 10 minutes before the end of surgery, and the patients were extubated following administration of atropine 0.03 mg/kg and neostigmine 0.05 mg/kg. Patients with an Aldrete score of 8 or greater after anesthesia were transferred to the recovery room.

After anesthesia, the patients were followed up in the recovery room for one hour and the VAS score was determined at 30 and 60 minutes. Tramadol HCl 1 mg/kg was administered iv if the VAS score was above 4. Patients with an Aldrete score of over 10 were transferred to a regular ward at the end of one hour. During postoperative follow-up, the patients were continued on iv paracetamol every six hours. Tramadol HCl 1 mg/kg was administered as a rescue analgesic if the VAS score was above 4.

2.2. Data collection

The demographic data of the patients, including age and gender were recorded. The MAP, HR, SpO_2 and BIS values were recorded at 0 min (baseline, before induction) and at 5, 15, 30, 45 and 60 minutes after induction, as well as at the end of surgery (120 minutes). Remifentanil consumption amount, at the end of surgery visual analogue scale (VAS) pain scores (4., 8., 12. and 24. h), rescue analgesic starting time, number of rescue analgesic administrations used and the presence of nausea and vomiting were recorded in 24 hours. Bowel sounds were followed up in the recovery room and the ward.

2.3. Statistical methods

The study data were analyzed using IBM SPSS Statistics (Version 25.0. Armonk, NY: IBM Corp.). A Kolmogorov-Smirnov test was used to check whether the variables were normally distributed. Along with descriptive statistics (mean, standard deviation, frequency) used for the analysis of the study data, the Student's t-test, a paired sample t-test and a Chi-square test were used for the evaluation of parametric data. A p-value of less than 0.05 was considered statistically significant.

3. Results

One hundred and twenty-seven patients were approached for participation in the study from April 2021 to October 2021. Sixty-six patients were recruited and randomly assigned to their treatment group. However, 6 patients were later excluded, resulting in 60 patients in the final analyses (The Consort Flow Diagram) (Figure 1).
There was no significant difference between the groups in terms of mean age, gender distribution and operation time ($p>0.05$) (Table 1).
Total intraoperative opioid (remifentanil 1 ml=50 µgr) consumption amount was significantly lower in Group TAP than in Group C ($p=0.012$) (Table 2). The VAS scores were lower in Group TAP than in Group C at all time points ($p<0.05$) (Table 3).
There was no statistically significant difference between the groups in terms of HR, MAP, BIS and SpO_2 values ($p>0.05$) (Table 4).

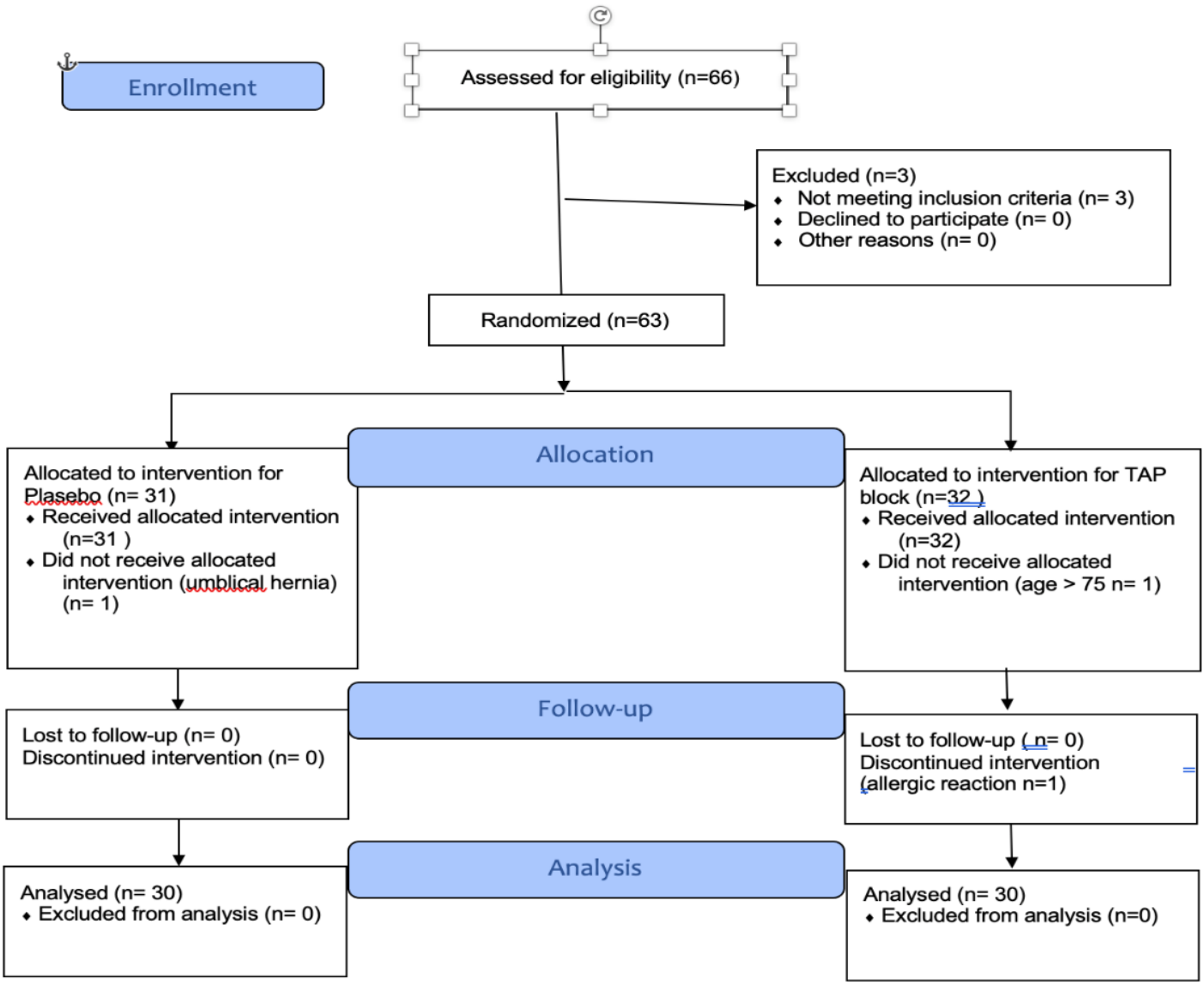

Figure 1
Consort Flow Diagram

Table 1
Demographic data

		Group C (n:30)	Group TAP (n:30)	p-value
Gender n (%)	Male	25 (83.3)	27 (90.0)	
	Female	5 (16.7)	3 (10)	b0.445
Age (year)	Mean±SD	52.27±16.03	54.40±13.85	
	Min-Max (Median)	20–72 (58)	30–79 (57)	a0.583
ASA (1/2/3)		10/15/5	7/18/5	b0.670
Operation	Mean±SD	58.77±24.09	60.50±14.28	
time (min)	Min-Max (Median)	20–115 (58)	35–100 (60)	a0.736

[a]Student's t-test [b]Chi-square test p<0.05 n=number of patients, Mean±SD Mean Standard Deviation, Min: Minimum, Max: Maximum, ASA: American Society of Anesthesiologists

Table 2
Total opioid (remifentanil) consumption in the groups

Remifentanil consumption amount (1ml=50µgr)	Group C	Group TAP	p
Mean±SD	4.56±1.66	3.25±2.23	0.012
Min-Max (Median)	1/8 (4)	1/7 (2)	

Remifentanil dose (50 mcg= 1ml)

Mean±SD Mean Standard Deviation Min: Minimum Max:Maximum

Table 3
Visual Analogue Scale (VAS) in the groups

Time		Group C	Group TAP	p-value
30. min	Mean±SD	3.77±1.50	2.87±1.38	0.019
	Min / Max (Median)	2.00/7.00 (3)	1.00/3.00(2)	
1. h	Mean±SD	4.10±1.42	2.83±1.09	< 0.05
	Min / Max(Median)	1.00/8.00 (5)	1.00/4.00 (3)	
4. h	Mean±SD	3.99±1.05	2.40±0.81	0.015
	Min / Max (Median)	2.00/8.00 (6)	1.00/5.00 (3)	
8. h	Mean±SD	4.7±1.31	1.80±0.81	0.01
	Min / Max (Median)	2.00/9.00 (6)	1.00/5.00 (2)	
12. h	Mean±SD	3.70±0.65	2.00±0.69	< 0.05
	Min / Max (Median)	2.00/6.00 (4)	1.00/5.00 (2)	
24. h	Mean±SD	2.20±0.61	1.00±0.67	< 0.05
	Min / Max (Median)	1.00/6.00 (3)	1.00/3.00 (1)	

Student's t-test p<0.05. Mean±SD Mean Standard Deviation, Min: Minimum, Max:Maximum, VAS: Visual Analogue Scale hr: hour. min:minute

The number of patients administered rescue analgesics was statistically significant lower in Group TAP than in Group C (p<0.05) (Tables 5). The rescue analgesic starting time was longer in Group TAP than in Group C (p=0.032) (Tables 6).

There was no significant difference in the number of patients experiencing postoperative nausea and vomiting (p>0.05) (Table 7). Bowel sounds were present in all patients. There was no sign suggestive of perforation.

4. Discussion

This prospective, randomized study investigated the analgesic efficacy of preincisional TAP block and its effects on hemodynamic parameters, and the intraoperative opioid comsumption amount and postoperative rescue analgesic starting time in patients undergoing unilateral inguinal hernia repair under general anesthesia.

In our study, intraoperative opioid requirement (total remifentanil dose consumed) and VAS scores were lower in the TAP block group at all measurement points. The need for rescue analgesics was higher in patients without non-TAP block. Similarly, we found that rescue analgesic starting time was longer in the TAP block group.

Postoperative pain is common among patients undergoing surgery, and approximately 70 percent of patients report pain intensity to be moderate or severe.[15] Pain management strategies employed before starting surgery with the aim of reducing the intensity of pain before and after surgery, and to prevent progression to the development of permanent chronic pain, are known as preemptive analgesia.[16] The most remarkable feature of preemptive analgesia is the initiation of antinociceptive therapy before surgical incision.[6] In the study by Çanakçı et al.[17], the TAP block applied for the purposes of preemptive analgesia was reported to provide effective intraoperative hemodynamic control and effective postoperative pain control, to decrease inflammation and surgical stress by decreasing the levels of proinflammatory cytokines TNF-α and IL-1β in the first postoperative 24 hours, and to exert immunomodulatory activity. The TAP block was performed before the surgical incision in the present study, and no difference was found in the hemodynamic data or BIS values of the groups.

In their study, Venkatraman et al.[18] reported that USG-guided TAP block provided adequate postoperative analgesia in patients undergoing inguinal hernia repair, while also decreasing the analgesic requirement and improving VAS scores, and. The procedure was also associated with fewer postoperative complications. Aveline et al.[19] reported ultrasound-guided TAP block to be superior to conventional iliohypogastric nerve blocks in the provision of pain relief and decreased opioid requirement. In their randomized study, however, Petersen et al.[20] reported that a unilateral TAP block performed in combination with a paracetamol or ibuprofen containing basic analgesic regimen in patients undergoing inguinal hernia repair showed no postoperative analgesic efficacy over a placebo or ilioinguinal nerve block with wound site infiltration.

Table 4

Perioperative BIS, HR, MAP and SpO2 values in the groups

Time		BIS			HR			MAP			SPO2		
		Group C	Group TAP	p	Group C	Group TAP	p	Group C	Group TAP	p	Group C	Group TAP	p
0.min	Mean±SD Min / Max (Median)	94.23±4.97 85/98 (97)	96.27±2.74 87/99 (98)	0.064	80.90±13.37 48/119 (80)	83.83±16.59 59/125 (78)	0.454	115.93±13.98 91/128 (104)	113.68±15.94 91/125 (111)	0.568	97.93±1.86 93/100 (98)	98.27±1.70 95/100 (99)	0.471
5. min	Mean±SD Min / Max (Median)	41.17±9.68 30/61 (37)	37.83±7.53 29/58 (36)	0.142	80.57±17.56 51/130 (80)	81.17±20.09 53/128 (79)	0.902	96.50±13.13 70/117 (95)	87.93±17.82 52/113 (91)	0.062	98.90±1.18 96/100 (99)	99.13±1.11 96/100 (100)	0.434
15.min	Mean±SD Min / Max (Median)	39.03±10.24 30/70 (37)	37.53±7.12 30/57 (38)	0.513	71.03±13.52 50/105 (70)	71.53±17.02 50/116 (63)	0.900	92.77±13.31 69/121 (92)	87.97±12.31 70/123 (86)	0.152	98.73±1.11 96/100 (99)	99.10±1.06 97/100 (99)	0.197
30. min	Mean±SD Min / Max (Median)	39.26±9.21 30/60 (39)	38.33±8.16 30/61 (37)	0.697	63.26±8.74 48/78 (63)	62.41±11.16 50/88 (60)	0.756	84.15±11.35 63/107 (84)	86.04±15.70 61/125 (81)	0.614	98.67±1.24 96/100 (99)	98.93±1.41 94/100 (99)	0.477
45. min	Mean±SD Min/Max (Median)	41.21±14.70 30/88 (39)	40.59±11.79 30/82 (40)	0.882	62.21±9.44 47/89 (63)	61.23±7.81 51/80 (61)	0.717	85.11±14.40 66/116 (83)	83.13±14.05 57/111 (85)	0.668	99.00±1.00 97/100 (99)	99.05±1.00 97/100 (99)	0.885
60. min	Mean±SD Min / Max (Median)	47.75±20.55 30/88 (41)	41.80±11.05 28/62 (40)	0.442	60.88±12.99 55/71 (65)	73.10±14.05 55/96 (68)	0.992	84.88±12.99 66/99 (87)	84.80±17.74 59/112 (85)	0.992	98.25±2.31 93/100 (99)	99.20±0.92 98/100 (99)	0.250
Cessation	Mean±SD Min / Max (Median)	88.23±4.95 81/98 (88)	88.63±3.68 81/95 (85)	0.161	77.00±13.82 49/107 (78)	88.60±26.26 49/118 (100)	0.932	111.87±16.10 78/123 (103)	88.60±26.26 49/118 (100)	0.991	98.40±1.40 94/100 (99)	98.90±1.37 94/100 (99)	0.169

Table 5
The number of rescue analgesic administrations according to time between groups.

Time		Group C	Group TAP	p-value
3. min	No	20 (67.7)	30 (100)	0.015
	Yes	10 (33.3)	0 (0.0)	
1. h	No	18 (60.0)	30 (100.0)	< 0.05
	Yes	12 (40.0)	0 (0.0)	
4. h	No	19 (63.3)	29 (97.7)	0.021
	Yes	11 (36.6)	1 (3.3)	
8. h	No	20 (66.7)	28 (93.3)	< 0.05
	Yes	10 (33.3)	2 (6.7)	
12. h	No	19 (63.3)	27 (90.0)	< 0.05
	Yes	11 (36.7)	3 (10.0)	
24. h	No	27 (90.0)	30 (100.0)	0.047
	Yes	3 (10.0)	0 (0.0)	

*Chi-square test *p<0.05. n=number of patients h: hours. min:minute

Table 6
Postoperative Rescue analgesic administration starting time in the groups

		Group C	Group TAP	p-value
Rescue analgesic starting time (h)	Mean±SD	2.15±2.59	4.45±2.51	0.032

Student's t-test p<0.05, Mean±SD Mean Standard Deviation

Table 7
Nausea and vomiting in the groups

Nausea and Vomiting (n)		Group C	Group TAP	p-value
30. min	No	29 (96.7)	30 (100)	0.313
	Yes	1 (3.3)	0 (0.0)	
1. h	No	29 (96.7)	30 (100.0)	0.236
	Yes	1 (3.3)	0 (0.0)	
4. h	No	29 (96.7)	30 (100.0)	0.313
	Yes	1 (3.3)	0 (0.0)	
8. h	No	30 (100.0)	30 (100.0)	
	Yes	0 (0.0)	0 (0.0)	-
12. h	No	30 (100.0)	30 (100.0)	
	Yes	0 (0.0)	0 (0.0)	-
24. h	No	30 (100.0)	30 (100.0)	-
	Yes	0 (0.0)	0 (0.0)	

*Chi-square test * p<0.05 n=number of patients h: hour. min:minute

There have been several meta-analyses reporting that paracetamol can reduce opioid consumption by 20 percent and to have fewer perioperative side effects.[6,21,22] There is also valuable evidence supporting the efficacy of the use of acetaminophen in combination with another non-opioid agent, such as a non-steroid anti-inflammatory drug or a COX-2 inhibitor, in an attempt to improve postoperative analgesia and reduce opioid consumption.[23] Similar to these reports, the patients in TAP block group in the present study received multimodal analgesia involving intravenous paracetamol infusion and tramadol where necessary for the treatment of postoperative acute pain, in addition to the preincisional TAP block. The number of tramadol HCl consumed in the group that underwent TAP block was lower and the rescue analgesic starting time was longer. In a study of 50 patients, Jain et al. [24] reported that the addition of a US-guided TAP block to the systemic administration of conventional analgesics resulted in a decrease in VAS scores and a rescue analgesic requirement. The authors also reported that early mobilization facilitated the early return of bowel sound, decreased the length of hospital stay and decreased the incidence of nausea and vomiting. They also reported a significant decrease in postoperative pain and opioid consumption in patients undergoing TAP block for laparoscopic intraperitoneal mesh repair. In their investigation of the effects of TAP block on sufentanil consumption and postoperative analgesia in patients undergoing laparoscopic cholecystectomy, El-Dawlaty et al.[25] administered 1 MAC sevoflurane and additional dose of sufentanil to patients in the two groups, based on hemodynamic data. They reported intraoperative sufentanil consumption to be significantly lower in the group that underwent the TAP block than in the non-TAP block group. Perioperative 1 MAC sevoflurane and remifentanil were used also in the present study. The total remifentanil dose was lower in the TAP block group than in the control group.

Undesired complications such as visceral perforation and pelvic hematoma can develop in rare cases during the delivery of TAP block[26,27]. No major complication was observed in the present study patients. The use of US guidance while performing the TAP block increases the safety of the procedure.

5. Conclusions

It was found in the present study that preincisional TAP block in patients undergoing unilateral inguinal hernia repair under general anesthesia reduced perioperative total opioid consumption amount and prolonged rescue analgesic starting time, while decreasing the number of administrations of rescue analgesic.

We concluded that preincisional TAP block is a safe and effective analgesia technique for postoperative pain control in patients undergoing unilateral inguinal hernia repair and our findings should be supported by advanced controlled randomized studies.

4.1. Limitations

The present study was limited by its short follow-up duration of only 24 hours and its disregard of operation times, recovery times, time to discharge, total rescue analgesic consumption and cost-effectiveness. In addition, only preincisional TAP block was examined, and so the efficacy of postincisional TAP block was not investigated.

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None.

Statement of ethics

This study was approved by Ümraniye Training and Research Hospital with the protocol number (decision number 35 dated March 11, 2021)

Conflict of interest statement

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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