

ORIGINAL RESEARCH



TAP and TAPA blocks after laparoscopic cholecystectomy: a randomized double-blind study

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Abstract

Background: Ultrasound-guided fascial plane blocks have become increasingly important for postoperative analgesia following laparoscopic cholecystectomy (LC). This study compared the analgesic effects of the transversus abdominis plane (TAP) block with the thoracoabdominal nerve block performed via a perichondral approach (TAPA) in LC patients. **Methods:** Sixty-one individuals scheduled for LC under general anesthesia were randomly assigned to receive either a TAP or TAPA block. The duration of block administration was measured. Postoperative pain intensity (Numerical Rating Scale, NRS), tramadol requirements via patient-controlled analgesia (PCA), additional rescue analgesic use, and side effects were evaluated at 2, 6, 12, and 24 hours after surgery. The primary endpoint was 24-h postoperative PCA bolus tramadol dose consumption. **Results:** The two groups were similar regarding demographic characteristics ($p > 0.05$), though the TAP group included a higher proportion of male patients ($p < 0.05$). Performing the TAPA block required more time than TAP ($p < 0.05$). Tramadol consumption at the 12th hour was significantly lower in the TAPA group, whereas PCA use at other intervals, NRS scores, and rescue analgesic requirements did not differ significantly. **Conclusions:** Both TAP and TAPA blocks provided effective analgesia after LC. Considering their equivalent efficacy, TAP may be advantageous in clinical practice due to its single injection technique and easier application. **Clinical Trial Registration:** NCT06768385, retrospectively registered.

Keywords

Laparoscopic cholecystectomy; Regional anesthesia; TAP block; TAPA block; Postoperative analgesia

1. Introduction

Laparoscopic cholecystectomy (LC) is one of the most frequently performed minimally invasive surgeries. It provides shorter hospitalization compared with open cholecystectomy [1]. Although it is less painful than laparotomy, postoperative pain remains a clinical concern. This pain is related to trocar insertion at multiple sites, pneumoperitoneum, and visceral irritation [2]. Previous studies reported that somatic pain from the incision is often stronger than visceral pain after LC [3]. Therefore, multimodal analgesia is recommended to improve comfort and recovery. The addition of regional anesthesia to multimodal analgesia helps reduce the neuroendocrine stress response caused by pain and surgical trauma [4].

In recent years, ultrasound-guided interfascial plane blocks have become popular for pain control. Several techniques have been studied in abdominal surgery. These include the pectoralis nerve (PECS) block, serratus intercostal plane block (SIBP), quadratus lumborum (QL) block, and erector spinae plane (ESP) block. Among them, the transversus abdominis plane (TAP) block is well established. In this technique, local anesthetic is injected between the internal oblique and

transversus abdominis muscles. This targets the anterior rami of thoracolumbar nerves. The TAP block is widely used for abdominal and inguinal surgery to reduce postoperative pain [5, 6].

A newer technique, the thoracoabdominal nerve block with perichondral approach (TAPA), has also been developed. It provides a sensory block between the midaxillary line and the mid-abdominal or sternal regions. This covers dermatomes T5–T12 [7, 8]. TAPA is performed by injecting local anesthetic at both the upper and lower borders of the chondrium. This blocks both the anterior and lateral branches of the intercostal nerves. Due to this anatomical spread, TAPA may provide broader analgesia than TAP.

The aim of the present study was to compare the postoperative analgesic effects of TAP and TAPA blocks in patients undergoing laparoscopic cholecystectomy.

2. Materials and methods

This prospective, randomized, single-center study was conducted following approval from the Hamidiye Clinical Research Ethics Committee of the University of Health Sciences

(Approval No: 10.11.2022/22-99). The trial was performed in accordance with the principles of the Helsinki Declaration and registered in a public clinical trials database (NCT06768385). Patient recruitment and randomization followed the CONSORT flow diagram (Fig. 1).

Patients classified as American Society of Anesthesiologists (ASA) physical status I–III, aged 20–80 years and scheduled for elective laparoscopic cholecystectomy between January and June 2023 were eligible. Written informed consent was obtained from all participants. Exclusion criteria were ASA physical status classification IV, pregnancy, BMI (Body Mass Index) ≥ 35 kg/m², history of prior abdominal surgery or trauma, allergy to study medications, use of analgesics within 24 hours preoperatively, chronic opioid therapy, alcohol or drug dependence, anticoagulant therapy, or abnormal coagulation profiles. Based on a power analysis, 61 patients were required to achieve 80% study power at a 95% confidence

interval.

Patients were premedicated the evening before surgery and informed about the block technique (TAP or TAPA) and the use of the patient-controlled analgesia (PCA) system. On the day of surgery, all patients received 0.03 mg/kg intravenous midazolam before transfer to the operating room. General anesthesia was induced with propofol (2 mg/kg), rocuronium (0.5 mg/kg), and fentanyl (1 μ g/kg). Maintenance included sevoflurane 2 MAC (Minimum Alveolar Concentration) with a 50% oxygen/air mixture, combined with a continuous remifentanyl infusion (0.5–1 μ g/kg/min). Remifentanyl infusion was stopped approximately 10 minutes before the end of surgery.

Patients were allocated to TAP or TAPA groups using a web-based randomization tool (www.randomizer.org).

After induction, the block site was disinfected and prepared under sterile conditions. Blocks were performed under ultrasound guidance (FUJIFILM SonoSite, Inc., 21919 30th

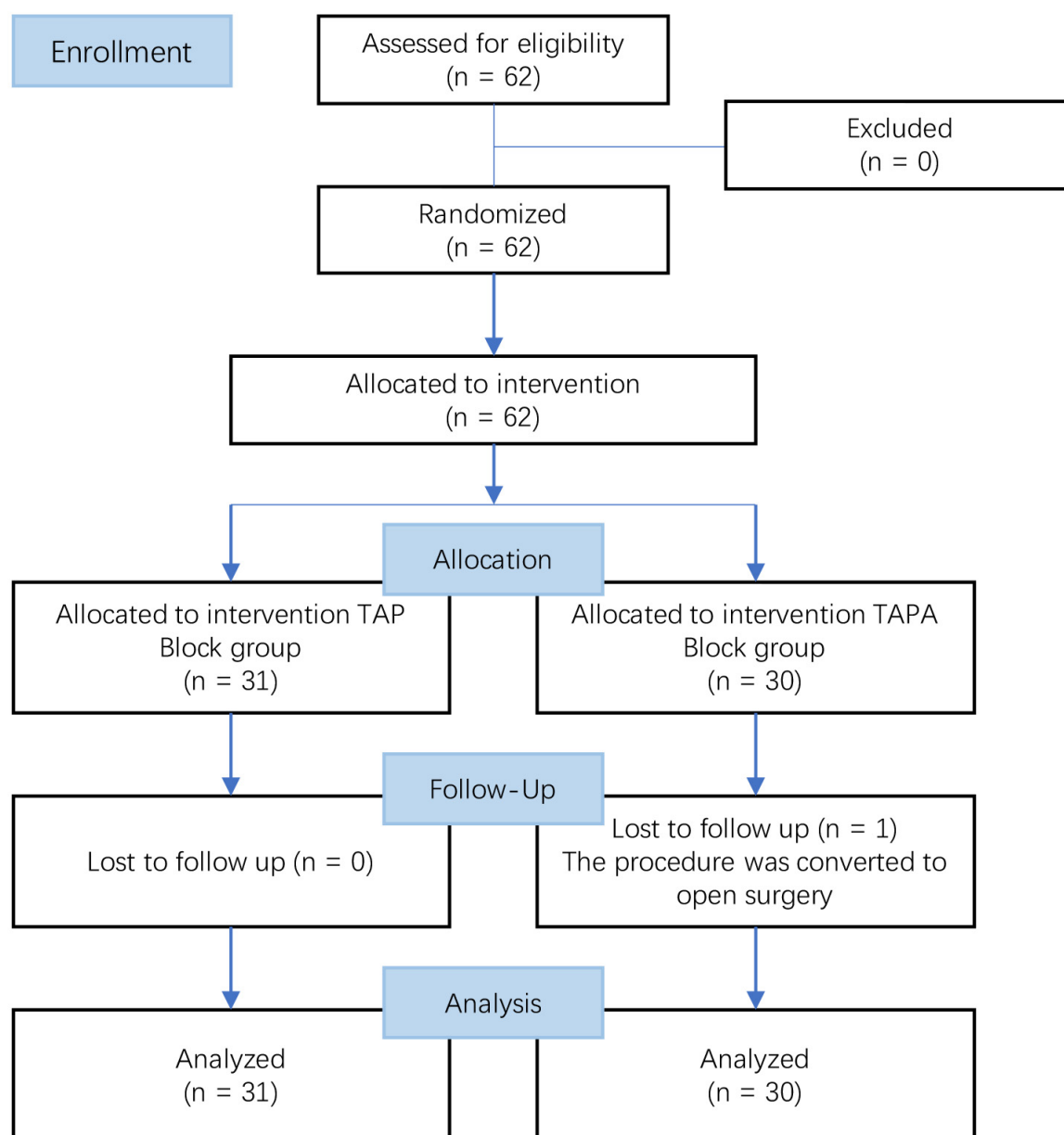


FIGURE 1. CONSORT flow diagram of the study. TAPA: thoracoabdominal nerve block with perichondral approach; TAP: transversus abdominis plane.

Drive SE, Bothell, WA, USA). All blocks were performed by the same anesthesiologist experienced in regional anesthesia, while perioperative and postoperative monitoring was conducted by another anesthesiologist blinded to group assignment.

TAP Block: A peripheral block needle (Stimuplex®, A100, B Braun, Melsungen, HE, Germany) was inserted under ultrasound guidance to deliver 30 mL of 0.25% bupivacaine between the fascia of the internal oblique and the transversus abdominis muscles at the midaxillary line (Fig. 2A).

TAPA Block: At the 9th–10th rib levels, 20 mL of 0.25% bupivacaine was injected into the costochondral tissue, followed by an additional 10 mL between the costochondral fascia and the external oblique muscle fascia, also under ultrasound visualization. The time required for block administration was defined as the interval between ultrasound probe placement and completion of the injection (Fig. 2B).

All operations were carried out by the same surgical team using a standardized three-port LC technique without drain placement. Pneumoperitoneum pressure was set at 12 mmHg. After terminating the remifentanyl infusion, all patients received ondansetron (8 mg) and paracetamol (1 g) near the conclusion of surgery. Postoperatively, an intravenous PCA device (tramadol 5 mg/mL, bolus dose 20 mg, lock-out 30 min) was connected before emergence from anesthesia. Patients were extubated and transferred to recovery, with PCA activated once they achieved an Aldrete score ≥ 9 . Additionally, 1 g paracetamol was administered every 8 hours.

Pain intensity was assessed using the Numerical Rating Scale (NRS: 0 = no pain, 10 = worst pain imaginable) at 2, 6, 12, and 24 hours. If NRS exceeded 4, patients received 50 mg intravenous dextketoprofen as rescue analgesia.

The primary endpoint was 24-hour PCA tramadol consumption. Secondary endpoints included NRS scores, need for additional analgesics, and side effects (nausea/vomiting).

Sample size calculation: The required sample size was estimated using the G*Power software (version 3.1.9, Faul, Erdfelder, Lang, & Buchner, Mannheim, BW, Germany). Reference values were derived from a study by Ertürk *et al.* [8], which reported a mean NRS score of 1.18 ± 0.39 at the 12th postoperative hour in patients receiving a TAPA block. Assuming a 25% difference between groups in 12-hour pain scores, a priori power analysis indicated that 28 participants per group would provide 80% power at a significance level of $\alpha = 0.05$. To compensate for potential dropouts, 62 patients were enrolled. Ultimately, one patient from the TAPA group was excluded due to conversion to open surgery, and data from 61 patients were analyzed.

Statistical analysis was conducted using SPSS software (version 28.0, Statistical Package for the Social Sciences Inc, Istanbul, Turkey). Continuous variables were described as either mean $\pm$ standard deviation (SD) or median with interquartile range, depending on the distribution. Categorical variables were summarized as numbers and percentages. The Kolmogorov-Smirnov test was applied to evaluate data normality. For comparisons, continuous data were analyzed with the independent samples *t*-test or the Mann-Whitney U test depending on normality, whereas categorical data were examined using the chi-square test or Fisher's exact test. Statistical significance was set at $p < 0.05$.

3. Results

A total of 61 patients were included in the final analysis (16 females, 45 males). The demographic and clinical characteristics of the groups are summarized in Table 1.

No statistically significant differences were observed between the TAP and TAPA groups in terms of age, body weight, height, BMI, ASA scores, or operative duration ($p > 0.05$). However, the proportion of male patients was significantly greater in the TAP group compared to the TAPA group ($p < 0.05$). When evaluating block application times, the TAPA group exhibited a significantly longer duration (516 s) compared to the TAP group (276 s) ($p < 0.05$) (Table 1).

Pain scores measured with the NRS did not differ significantly between the two groups across all assessment time

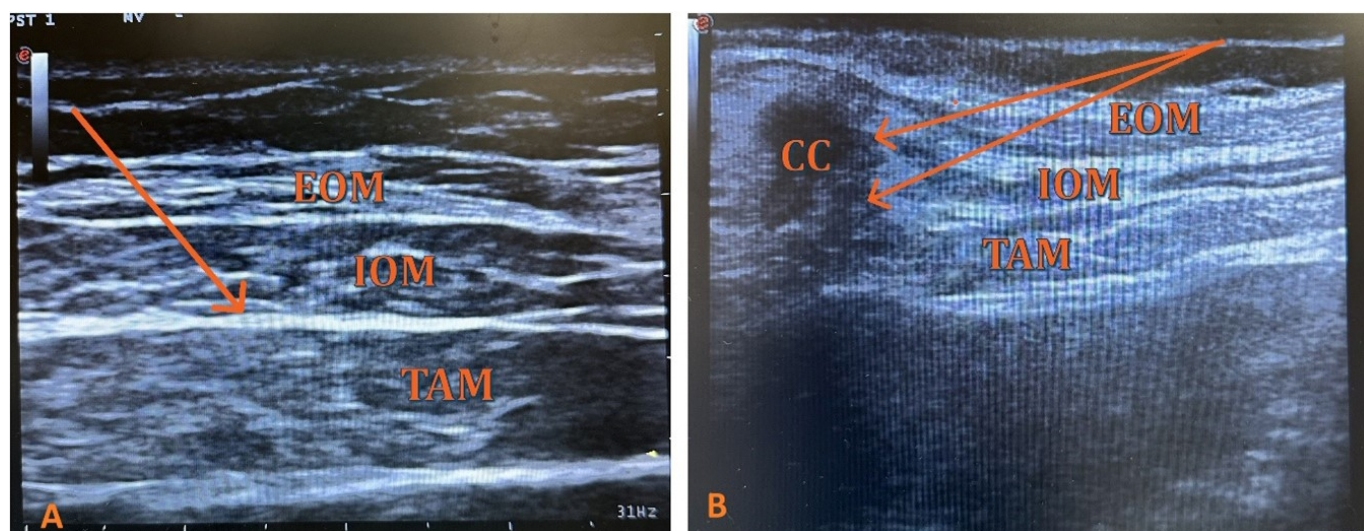


FIGURE 2. Ultrasonographic image of TAP and TAPA blocks. Local anesthetic injection sites for TAP (A) and TAPA (B) blocks. CC: costal cartilage; EOM: external oblique muscle; IOM: internal oblique muscle; TAM: transversus abdominis muscle.

TABLE 1. Demographic data, operation, and block durations in the TAP and TAPA groups.

	Group TAP		Group TAPA		<i>p</i>
	Mean $\pm$ SD/n (%)	Median	Mean $\pm$ SD/n (%)	Median	
Age (yr)	54.7 $\pm$ 13.4	59.0	55.1 $\pm$ 11.7	54.5	0.697 ^m
Sex					
Female	3 (9.7%)		13 (43.3%)		0.003 χ^2
Male	28 (90.3%)		17 (56.7%)		
Weight (kg)	77.3 $\pm$ 11.3	77.0	78.1 $\pm$ 12.5	76.0	0.800 ^t
Height (m)	173.2 $\pm$ 6.3	174.0	172.3 $\pm$ 9.7	172.0	0.663 ^t
BMI (kg/m ²)	25.8 $\pm$ 3.9	25.0	26.4 $\pm$ 4.7	26.1	0.676 ^m
ASA classification					
I	11 (35.5%)		8 (26.7%)		0.173 χ^2
II	18 (58.1%)		15 (50.0%)		
III	2 (6.5%)		7 (23.3%)		
Operation duration (min)	71.6 $\pm$ 28.3	60.0	69.0 $\pm$ 21.5	65.0	0.868 ^m
Block duration (min)	4.6 $\pm$ 2.2	5.0	8.6 $\pm$ 2.7	8.0	<0.001 ^m

Values are expressed as Mean $\pm$ SD or n (%). ^m: Mann-Whitney *u* test. ^t: *t* test. χ^2 : Chi-square test. Bold *p*-value: significant difference between the two groups (*p* < 0.05). ASA: American Society of Anesthesiologists; BMI: Body mass index; TAP: transversus abdominis plane; TAPA: thoracoabdominal nerve block with perichondral approach; SD: standard deviation.

points (2, 6, 12, and 24 hours). Similarly, PCA bolus usage was comparable between the groups at 2, 6, and 24 hours. However, at the 12th hour, the TAP group required a higher number of PCA boluses compared with the TAPA group (*p* = 0.026) (Table 2).

During the postoperative period, additional analgesic administration was necessary in 6 patients in the TAPA group and 5 patients in the TAP group (Fig. 3).

In our study, block administration did not lead to any complications in any of the patients. Nausea and vomiting were observed as side effects in only one patient from the TAPA group (*p* = 0.492).

4. Discussion

This randomized study compared the analgesic effects of the TAP and TAPA blocks in patients undergoing laparoscopic cholecystectomy. Both techniques were shown to provide effective postoperative analgesia, with the main difference being reduced tramadol demand at the 12th postoperative hour in the TAPA group. Despite this, overall NRS scores and the need for additional rescue analgesics did not differ significantly between groups, suggesting comparable efficacy.

Effective pain management following LC is essential to facilitate early mobilization and decrease the risk of postoperative complications [2]. Although patient-controlled opioid analgesia remains a widely used method, its adverse effects can limit clinical utility. For this reason, interfascial plane blocks have become increasingly popular as part of multimodal strategies.

The TAP block is an established regional technique that has consistently demonstrated benefits in abdominal surgery [9]. Several meta-analyses confirmed its superiority over local infiltration in reducing pain within the first 24 postoperative

hours [10, 11]. Retrospective analyses have also highlighted its effectiveness in laparoscopic cholecystectomy cases, consistent with our findings in the TAP group [12].

The TAPA block, initially described by Tulgar *et al.* [13], is a newer technique designed to anesthetize both the anterior and lateral branches of the thoracoabdominal nerves. Following its initial description, Tulgar *et al.* [14] proposed a modification termed the m-TAPA block, characterized by injecting the anesthetic agent only along the lower border of the chondrial region. In a previous randomized trial, Ertürk and Ersoy demonstrated reduced pain scores with TAPA compared to m-TAPA, though overall tramadol use was similar [8]. In our study, patients in the TAPA group required fewer PCA boluses at the 12th hour, likely due to the broader sensory coverage achieved by blocking the lateral cutaneous branches. Nevertheless, no meaningful differences were found in pain scores or total tramadol consumption, supporting the notion that both techniques are effective.

An interesting finding was the gender imbalance between the groups, with fewer women randomized to TAP. While some literature suggests women may report higher pain sensitivity, this factor did not influence NRS scores in our study. In both groups, this gender difference was not taken into account as patients were selected by randomization. Some studies suggest that women are more sensitive to pain than men [15, 16]. However, our results are not consistent with this suggestion.

Although interfascial plane blocks are recognized as effective options for postoperative analgesia, their use in daily practice may be limited by the relatively long procedure time required for administration [17, 18]. In our trial, both TAP and TAPA blocks were applied immediately after induction of anesthesia with patients maintained in the supine position. Because the TAPA block necessitates injections at two separate

TABLE 2. PCA bolus doses, NRS, and additional analgesic requirements for TAP and TAPA groups.

	Group TAP		Group TAPA		<i>p</i>
	Mean ± SD/n (%)	Median	Mean ± SD/ n (%)	Median	
PCA bolus					
2nd hour	1.84 ± 1.71	2.00	1.10 ± 0.88	1.00	0.135 ^m
6th hour	0.94 ± 1.21	0.00	0.50 ± 0.63	0.00	0.309 ^m
12th hour	0.94 ± 1.34	0.00	0.27 ± 0.45	0.00	0.026^m
24th hour	0.32 ± 0.65	0.00	0.20 ± 0.41	0.00	0.553 ^m
NRS					
2nd hour	2.23 ± 1.36	2.00	1.97 ± 1.13	2.00	0.468 ^m
6th hour	1.58 ± 0.72	1.00	1.83 ± 0.91	1.50	0.322 ^m
12th hour	1.74 ± 1.06	1.00	2.00 ± 0.87	2.00	0.123 ^m
24th hour	1.32 ± 0.54	1.00	1.60 ± 0.77	1.00	0.161 ^m
Additional analgesia needs					
2nd hour	5 (16.1%)		4 (13.3%)		0.758 ^{x²}
6th hour	0 (0.0%)		1 (3.3%)		0.492 ^{x²}
12th hour	1 (3.2%)		0 (0.0%)		1.000 ^{x²}
24th hour	0 (0.0%)		0 (0.0%)		1.000 ^{x²}
Nausea-vomiting (+)	0 (0.0%)		1 (3.3%)		0.492 ^{x²}

^{x²}: Chi-square test. ^m: Mann-whitney u test. **Bold p-value: significant difference between the two groups ($p < 0.05$).**

NRS: Numerical Rating Scale; PCA: Patient Controlled Analgesia; TAP: transversus abdominis plane; TAPA: thoracoabdominal nerve block with perichondral approach; SD: standard deviation.

Additional analgesic needs

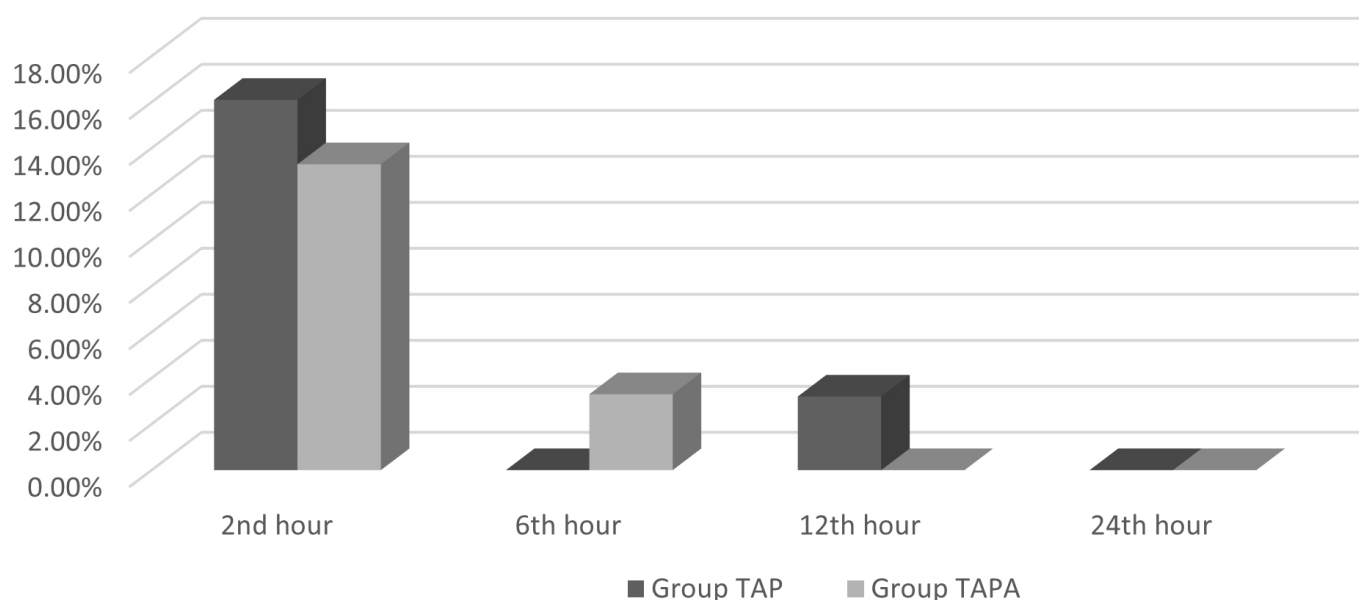


FIGURE 3. Comparison of additional analgesic needs in both groups. TAP: transversus abdominis plane; TAPA: thoracoabdominal nerve block with perichondral approach.

anatomical sites, its performance took longer compared with TAP (average duration: TAP 276 sec, TAPA 516 sec). Despite this difference, both interventions were carried out smoothly without delaying the initiation of surgery. When contrasted with techniques such as the erector spinae plane (ESP) and quadratus lumborum (QL) blocks, which usually require positioning the patient laterally, TAP and TAPA offer a practical benefit by being feasible in the supine position. In addition, the analgesic contribution of interfascial blocks closer to the epidural space, including ESP and QL, is still debated due to the possibility of epidural spread [19, 20].

With respect to complications, no block-related adverse events were observed. Only one individual in the TAPA group experienced nausea and vomiting. This observation is in line with prior reports suggesting that TAP block may help reduce postoperative nausea and vomiting [21, 22].

Several limitations of our work should be acknowledged. First, intraoperative depth of anesthesia was not evaluated. Furthermore, we did not assess parameters such as dermatome distribution of the block or postoperative functional recovery time. Another limitation relates to the choice of analgesic comparator: most previous studies assessing regional techniques have reported outcomes using morphine, whereas tramadol was selected in our protocol. Nevertheless, tramadol is a well-established option for moderate to severe acute postoperative pain, with a lower rate of opioid-related side effects compared to morphine [23]. It also provides a faster onset of analgesia while offering comparable efficacy in patients undergoing laparoscopic cholecystectomy [24].

5. Conclusions

Our findings indicate that both TAP and TAPA blocks provide effective postoperative pain relief in patients undergoing laparoscopic cholecystectomy. While the TAPA block was associated with lower tramadol use at a single time point (12 hours), overall analgesic outcomes were comparable between the two techniques.

Given their similar efficacy, the TAP block may be favored in routine clinical practice due to its single-injection approach, ease of application, and long-standing use in perioperative pain management. Integrating either TAP or TAPA into a multimodal analgesia protocol can enhance postoperative comfort and support faster recovery in patients undergoing laparoscopic cholecystectomy.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

DMY and YY—designed the research study; wrote the manuscript. DMY, YY and AE—performed the research. DMY—analyzed the data. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This prospective, randomized controlled study was conducted following approval from the Health Sciences University Hamidiye Clinical Research Ethics Committee (No: 10.11.2022/22-99). Written informed consent was obtained from all participating patients before their inclusion in the study.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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