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Impact of Ultrasonography-Guided Transversus Abdominis Plane Block and Local Anesthetic Infiltration in the Surgical Field on Postoperative Analgesic Requirements for Laparoscopic Cholecystectomy Procedures

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ABSTRACT

Introduction: This study aimed to assess the impact of intraperitoneal local anesthetic infiltration and ultrasonography-guided transversus abdominis plane (TAP) block on postoperative pain intensity and opioid usage within the first 24 hours after laparoscopic cholecystectomy.

Methods: Sixty patients classified under the American Society of Anesthesiologists 1-2-3 risk groups participated in this prospective, controlled, and randomized study and were divided. into three groups. The TAP group (n=20) underwent bilateral TAP blocks with 20 mL of 0.25% bupivacaine. prior to surgical incision. The following gallbladder removal by the surgical team, the intraperitoneal group (n=20) received 10 mL of 0.5% bupivacaine infiltration into the bladder bed. The control group (n=20) did not receive local anesthesia via TAP block or intraperitoneally. Postoperative pain scores on the Numeric Rating Scale [(NRS) 0-10] were recorded at 1, 2, 4, 8, and 24 hours. Additionally, the total tramadol dosage (mg) consumed at the 24th postoperative hour and the frequency of additional analgesic use were documented in the case report form.

Results: The postoperative NRS scores of both the TAP block and intraperitoneal groups were significantly lower than those of the control group ($p<0.05$). Moreover, there was no notable difference between the TAP block and intraperitoneal groups concerning NRS scores ($p>0.05$). Similarly, no significant variance was observed in the total tramadol dosage among the TAP block, intraperitoneal, and control groups ($p>0.05$).

Conclusion: The analgesic efficiencies of TAP block and intraperitoneal local anesthesia infiltration were similar, and both groups provided more effective analgesia than the control group.

Keywords: Intraperitoneal local anesthesia infiltration, pain, transversus abdominis plane block

Introduction

In recent years, laparoscopic cholecystectomy has become the gold standard for the treatment of cholelithiasis. The primary advantages of this approach include rapid patient mobilization and reduced postoperative pain compared with other surgical methods. Although pain after laparoscopic cholecystectomy is generally less than that after open cholecystectomy, it remains a common issue during recovery. Unlike pain from the abdominal wall after laparotomy, pain from post-laparoscopic cholecystectomy involves visceral, parietal, and shoulder (somatic) components, which may manifest at varying times and intensities (1).

Transversus abdominis plane (TAP) block is one of the commonly employed regional blocks for postoperative analgesia following abdominal procedures (2,3). This study aimed to compare two frequently utilized methods-intraperitoneal local anesthetic infiltration and ultrasonography (USG)-guided TAP block-both of which have demonstrated efficacy in postoperative analgesia in prior research. The comparison focuses on the assessment of postoperative analgesia efficacy and opioid consumption.

Methods

We enrolled a total of 60 male and female patients aged 18 to 70 who were scheduled for laparoscopic cholecystectomy at the general surgery

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department of a tertiary level training and research hospital between July and December 2019. Approval for the study was granted by the Ethics Committee of University of Health Sciences Türkiye, İstanbul Training and Research Hospital (approval number: 2019/1912, date: 26.07.2019). The sample size was determined with an 80% confidence level and a 5% margin of error, yielding (n=16). Each of the three groups comprised 20 patients. Prior to commencement, patients underwent comprehensive procedures and provided signed informed consent. Patients were allocated to groups based on their sequence of arrival to the operating room: Patient group 1 received a TAP block (group TAP), patient group 2 underwent local anesthesia infiltration into the Gallbladder Bed (Group Intraperitoneal), and patient group 3 served as the control group.

Patients were instructed. to rate their pain intensity using the Numeric Rating Scale (NRS) before the operation, which ranges from 1 to 10, with 10 representing the highest pain level (comparable to normal labor pain, kidney stone, or toothache). Additionally, they were trained on how to use the patient-controlled analgesia (PCA) device to enable postoperative pain measurement.

The exclusion criteria were patients undergoing open cholecystectomy, those with allergies to anesthetic drugs, individuals with infections at the site of TAP block application, patients with chronic pain and/or undergoing pain treatment, individuals with bleeding disorders, those with mental health disorders, emergency cases, pregnant women, patients classified as ASA 3-4, individuals with surgical durations exceeding 2 hours for various reasons, patients requiring conversion to open surgery, and those unable to use the PCA device due to nausea or device-related issues.

All patients underwent endotracheal intubation following intravenous (i.v.) administration of 1 mg/kg lidocaine, 5 mg/kg thiopental sodium, 2 µg/kg fentanyl and 0.5 mg/kg following routine ASA monitoring. Anesthesia maintenance was achieved using a combination of 50% oxygen and 50% nitrous oxide along with 2% sevoflurane.

In the TAP block group, the Petit points (defined as the anterior wall of the Petit's triangle, comprised of the external oblique muscle; the posterior wall, by the latissimus dorsi; and the lower border, by the iliac crest) were identified and prepared before the initiation of surgery following orotracheal intubation. A high-frequency linear ultrasound probe (GE Healthcare, LOGIQ 200 PRO, USA) was placed on the mid-axillary line in the transverse plane on the abdominal wall between the costal margin and the iliac crest. To ensure optimal imaging quality, necessary adjustments were made in USG, and the probe was positioned to visualize the skin-subcutaneous layer, external oblique muscle, internal oblique muscle, transversus abdominis muscle, and peritoneal membrane from top to bottom. The insertion of a 21-gauge, 100 mm block needle (StimuplexR A, Braun, Insulated Needle, USA) using an in-plane technique between the internal oblique and transversus abdominis muscles was confirmed with 1% lidocaine.

20 mL of 0.25 % bupivacaine. (Bustesin® 0.5 %, Vem, Türkiye). was administered under real-time visualization. The procedure was performed bilaterally.

The intraperitoneal group, patients received 10 mL of 0.5% bupivacaine administered by the general surgical team following gallbladder removal. The drain was closed until the procedure was completed. Conversely, no local anesthetic was administered to patients in the control group.

Intraoperatively, all participants received i.v. tramadol (1 mg/kg) following cholecystectomy. Upon completion of surgery, the patient was extubated with 0.015 mg/kg of atropine antagonized with 0.04 mg of neostigmine.

Statistical Analysis

Postoperatively, a PCA device was affixed to all patients. The PCA device used was the CADD Legacy Patient Control Analgesia device Model 6300 Ambulatory Infusion (Pump smith Medical ASD, Inc. St. Paul, MN 55112 USA), delivering 300 mg tramadol/100 cc mediflex with a bolus dose of 10 mg and a lockout interval of 15 minutes.

Postoperative pain scores on the NRS (0-10) were documented at the 1st, 2nd, 4th, 8th, and 24th hours. The total dosage of tramadol (in milligrams) administered within the first 24 hours postoperatively, as well as the frequency of supplementary analgesic use, was documented in the case report form.

Results

Table 1 presents the comparative data within the study. Table 2 illustrates that there were no significant differences between age, body mass index, total tramadol dosage, or additional analgesic use among the TAP block, intraperitoneal, and control groups ($p>0.05$). NRS values were significantly lower in the TAP block and intraperitoneal groups compared with the control group ($p<0.05$), as depicted in Table 3. There were no. significant differences in NRS values between the TAP block and intraperitoneal groups ($p>0.05$).

Within the intraperitoneal group, NRS values at the 4th, 8th, and 24th hours exhibited a significant decrease compared with the 1st hour ($p<0.05$). Similarly, in the TAP block and control groups, NRS values at the 2nd, 4th, 8th, and 24th hours demonstrated a significant decrease compared with the 1st hour ($p<0.05$) (Table 3). Furthermore, the decrease in NRS

Table 1. Data compared within the scope of the study

	Min.-max.	Median	Mean ± SD, (n %)
Age	26-63	48	45.1±10.2
BMI	20-43	29	29.3±4.9
Total tramadol	10-300	100	112.8±72.5
NRS			
1st hour	0.0-10.0	5.0	5.0±2.4
2nd hour	0.0-8.0	4.0	3.8±1.6
4th hour	0.0-7.0	3.0	3.1±1.4
8th hour	0.0-7.0	2.0	2.7±1.4
24th hour	0.0-5.0	2.0	2.3±1.0
Using supplemental analgesics		7	12%
Not using additional analgesics		53	88%

Min.: Minimum, max.: Maximum, SD: Standard deviation, NRS: Numerical rating scale, BMI: Body mass index

values at the 2nd hour was significantly higher in the TAP block and control groups than in the intraperitoneal group ($p<0.05$). There was no significant. difference in the decrease in NRS values between the TAP block and control groups at the 2nd hour ($p>0.05$). Moreover, there were no significant decreases in NRS values at the 4th, 8th, and 24th hours among the TAP block, control, and intraperitoneal groups ($p>0.05$) (Table 3).

There was no significant difference in the 4th hour NRS value compared to the 2nd hour, 8th hour NRS value compared to the 4th hour, and 24-hour NRS value compared to the 8th hour in the TAP block, intraperitoneal, and control groups ($p>0.05$) (Table 3). The changes in NRS values over time in the three groups determined for the study are depicted in Figure 1.

Discussion

Acute postoperative pain following laparoscopic cholecystectomy manifests in three distinct types: Incisional (somatic), visceral, and shoulder pain. The intensity and duration of pain following laparoscopic cholecystectomy can vary significantly among individuals and are often unpredictable. Typically, pain reaches its peak on the day of the operation and the following day, gradually subsiding over the course of 3-4 days. However, it is worth noting that approximately 13% of patients may experience persistent severe pain during the first week after surgery (4).

Given the multifaceted nature of pain during laparoscopic procedures, multimodal analgesia is essential. In clinical practice, alongside oral cyclooxygenase-2 inhibitors and non-steroidal anti- inflammatory drugs, various approaches, such as PCA, opioids, local anesthetic infiltration at the surgical trocar entry site (PSI), intraperitoneal local anesthetic infiltration, rectus sheath block, TAP block, or their combinations, are recommended (5-8). In this study, we aimed to compare the effectiveness of two analgesic protocols routinely utilized by our surgical and anesthesia teams, which are integral components of our multimodal analgesic regimen in our clinical setting.

Ongoing studies are investigating whether preoperative analgesic administration contributes to postoperative pain relief (7). In our study, the TAP block was administered following anesthesia induction and before surgical incision.

The literature extensively explores the effects of intraperitoneal local anesthetic administration on postoperative pain; however, conclusive information regarding optimal dosage and timing remains elusive (9-12). Although some studies have indicated that intraperitoneal use of local anesthetics reduces postoperative pain and analgesic consumption, others have suggested inadequacies in its efficacy.

Several studies in the literature explore the impact of administration timing on postoperative pain following intraperitoneal injection of

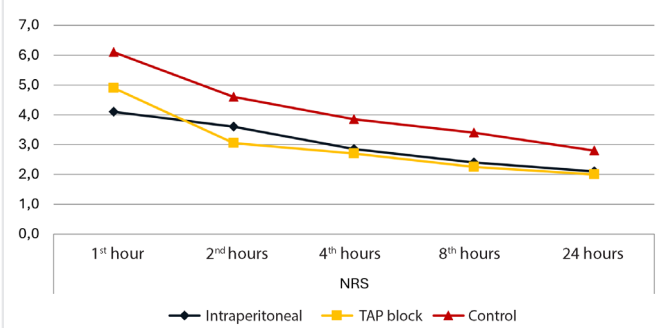

Figure 1. Change in NRS values between groups
NRS: Numerical rating scale, TAP: Transversus abdominis plane

Table 2. Demographic data and additional analgesia usage rates

	Intraperitoneal		TAP block		Control		p
	Mean ± SD, (n %)	Median	Mean ± SD, (n %)	Median	Mean ± SD, (n %)	Median	
Age	47.3±9.0	48.5	43.0±10.8	43.5	45.2±10.9	49.5	0.482[K]
BMI	30.4±4.5	29.0	29.9±4.4	29.0	28.4±5.8	28.0	0.414[K]
Tramadol	106.5±79.6	85.0	98.5±63.3	100.0	133.5±72.6	100.0	0.316[K]
Use of additional analgesics							
Not used	18	90%	19	95%	16	80%	0.322[K]
Used	2	10%	1	5%	4	20%	

[m]Mann-Whitney U test, [χ²]Chi-square test, [K]Kruskal-Wallis test. BMI: Body mass index; TAP: Transversus abdominis plane, Min.: Minimum, max.: Maximum, SD: Standard deviation

Table 3. Comparison of NRS between groups

	Intraperitoneal		TAP block		Control		p
	Mean ± SD, (n %)	Median	Mean ± SD, (n %)	Median	Mean ± SD, (n %)	Median	
NRS							
1st hour	4.1±2.1	4.0	4.9±2.8	5.0	6.1±1.9	6.0	0.021[K]
2nd hour	3.6±1.5	3.5	3.1±1.2	3.0	4.6±1.8	4.5	0.005[K]
4th hour	2.9±1.0	3.0	2.7±1.2	3.0	3.9±1.7	4.0	0.023[K]
8th hour	2.4±0.8	2.0	2.3±1.3	2.0	3.4±1.6	3.0	0.034[K]
24th hour	2.1±0.7	2.0	2.0±1.0	2.0	2.8±1.2	3.0	0.034[K]

[m]Mann-Whitney U test, [w]Wilcoxon test, [K]Kruskal-Wallis test, NRS: Numerical rating scale, TAP: Transversus abdominis plane

local anesthetic (11,13). In our study, the TAP block was conducted pre-incision, with local anesthetic applied to the exit site of the gallbladder bed.

Johns et al. (14) conducted a meta-analysis in 2012 involving nine studies with 413 patients to evaluate the analgesic effects of TAP block following abdominal surgery. The analysis demonstrated the efficacy and safety of the TAP block, resulting in a significant reduction in morphine requirement by - 23.71 mg ($p<0.002$) and 38.08 mg ($p<0.0001$) at 24 and 48 hours postoperatively, respectively. Notably, no significant differences were observed in postoperative nausea and vomiting. or pain scores (14).

In our study, tramadol consumption was 106.5 mg ($p>0.005$) in the group receiving bupivacaine at the gallbladder bed, 98.5 mg ($p>0.005$) in the TAP block group, and 133.5 mg ($p>0.005$) in the control group. These findings indicate comparable tramadol consumption between the TAP block and bupivacaine at the gallbladder bed groups. Moreover, compared with the control group, both groups exhibited decreased narcotic consumption.

TAP block has the potential to provide analgesia to the abdominal wall; nevertheless, achieving visceral analgesia may necessitate a broader dispersion of local anesthetics. Magnetic resonance imaging investigations have indicated substantial paravertebral spread. extending from T5 to L1 with posterior approach TAP blocks, whereas such spread was absent with subcostal TAP blocks (15). In our study, we opted for the posterior TAP block approach, anticipating that it would offer visceral analgesia, and administered bilateral posterior TAP blocks to our patients.

Concerns arose regarding the efficacy of TAP block in upper abdominal surgery. However, consistent with findings by Bisgaard, there was no discernible distinction in analgesic usage between patients undergoing TAP block and those receiving local anesthetic application to the gallbladder bed in the Fowler position within our study cohort.

Study Limitations

The limitations of our study. include its single-center nature and the small number of samples. Multicenter studies with more patients are needed.

Conclusion

In this study, we assessed the effectiveness of ultrasound-guided TAP block. and intraperitoneal local anesthetic administration in patients undergoing laparoscopic cholecystectomy under general anesthesia. We compared the postoperative pain levels, opioid consumption, and additional analgesic requirements among the three groups. NRS pain scores at all assessment time points were comparable between the TAP block and intraperitoneal local anesthesia groups, but were significantly lower than those of the control group. The analysis of total tramadol consumption revealed that the control group had the highest tramadol consumption, although no significant intergroup differences were observed. The variability in individual tramadol utilization likely contributed to the high standard deviation values. Our findings indicate that both TAP block and intraperitoneal local anesthesia offer similar analgesic efficacy, exceeding that of the control group.

In conclusion, US-guided TAP block and intraperitoneal local anesthesia application significantly improved postoperative pain scores.

Ethics Committee Approval: Approval for the study was granted by the Ethics Committee of University of Health Sciences Türkiye, İstanbul Training and Research Hospital (approval number: 2019/1912, date: 26.07.2019).

Informed Consent: Prior to commencement, patients underwent comprehensive procedures and provided signed informed consent.

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