Efficacy of unilateral laparoscopic-guided abdominal wall block vs local infiltration in postoperative analgesia following laparoscopic cholecystectomy: a single-center randomized controlled trial

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KEY WORDS

laparoscopic cholecystectomy, local anesthetic infiltration, postoperative regional anesthesia, transversus abdominis plane block

ABSTRACT

INTRODUCTION Effective postoperative analgesia is crucial for recovery after laparoscopic cholecystectomy (LC). Although local anesthetic infiltration (LAI) is commonly used, transversus abdominis plane (TAP) block may offer improved outcomes.

AIM We aimed to evaluate the efficacy and safety of unilateral laparoscopic-assisted TAP (L-TAP) block, LAI, and their combination (L-TAP+LAI) for postoperative pain management after LC.

MATERIALS AND METHODS In this prospective, randomized clinical trial, 160 eligible patients undergoing LC were allocated into 4 equal-sized groups: L-TAP, LAI, L-TAP+LAI, and control, and were blinded to group assignment. The primary outcome was pain intensity measured using the Numerical Rating Scale (NRS) at 2, 6, and 24 hours postoperatively. Secondary outcomes comprised pain intensity at the umbilical, subcostal, and substernal wounds, the number of patients requiring analgesics, and local complications assessed postoperatively.

RESULTS Each group comprised 40 patients. The L-TAP group had lower NRS scores at 2, 6, and 24 hours postoperatively than the LAI group ($P = 0.003$, $P = 0.02$, and $P = 0.046$, respectively). Similarly, subcostal pain was lower in the L-TAP than in the LAI cohort ($P = 0.008$, $P = 0.01$, and $P < 0.001$, respectively). No major complications were observed. Ecchymosis occurred most frequently in the LAI group ($P = 0.03$).

CONCLUSIONS Laparoscopic-guided unilateral TAP block is a safe and effective method for postoperative analgesia in LC. It provides superior pain control and fewer wound-related complications than LAI, supporting its use as a practical intraoperative alternative to trocar-site infiltration.

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INTRODUCTION Gallbladder stones (cholelithiasis) are a common condition, with epidemiological studies reporting a global prevalence of 6% (5%–11%, depending on the continent).[1] Laparoscopic cholecystectomy (LC) is widely considered the gold standard treatment for symptomatic gallstone disease.[2] Effective postoperative analgesia is crucial for patient comfort and optimal clinical outcomes. Although opioids remain an important option for managing severe postoperative pain, their use is limited due to significant adverse effects, including respiratory depression, sedation, nausea, vomiting, and delayed gastrointestinal recovery. Therefore, alternative regional anesthesia techniques are routinely used for postoperative pain control.[3]

The most basic approach involves local anesthetic infiltration (LAI) at the surgical wound site. A more recent and increasingly adopted method is transversus abdominis plane (TAP) block, first introduced in 2001 as a pre-emptive analgesic technique.[4] This approach provides analgesia by blocking the spinal nerves from T6 to L2. The original TAP block technique involved a "blind" needle insertion using the loss-of-resistance method to identify anatomical landmarks within the Petit triangle. Subsequent advancements introduced ultrasound guidance, allowing for more precise and safer deposition of local anesthetics.[5] More recently, laparoscopic-assisted TAP (L-TAP) block administration has been implemented. Initially employed in nephrectomy procedures in 2011,[6] this approach has since been incorporated into LC protocols during the early phase of surgery.[7]

Given the significant impact of postoperative pain on recovery, continuous evaluation and optimization of regional anesthesia strategies are essential to identify the most effective approaches for routine surgical practice.

AIM The aim of our study was to assess the efficacy and safety of unilateral L-TAP block, LAI, and their combination (L-TAP+LAI) for postoperative pain management following LC.

MATERIALS AND METHODS **Study population** This prospective, randomized clinical study was conducted at the Department of Oncological and General Surgery, University Clinical Hospital in Olsztyn, Poland, between September 2021 and June 2023. Eligible participants were between 20 and 85 years old, categorized as physical status I or II according to the American Society of Anesthesiologists (ASA) classification, and scheduled for LC due to symptomatic cholelithiasis confirmed on ultrasonography. The exclusion criteria comprised ASA classes III and IV, contraindications to laparoscopy, pre- or perioperative diagnosis of acute cholecystitis, chronic analgesic use, spinal degenerative joint disease, allergy to local anesthetics, opioid or alcohol dependence, psychiatric or neurological disorders, and lack of consent. Preoperative data included the following demographic and clinical characteristics: age, sex, height, weight, body mass index (BMI), prior surgeries, comorbidities, tobacco use, and previous opioid exposure.

Patient allocation The patients were randomized the day before surgery using a simple 1:1 allocation sequence generated in Microsoft Excel 2016 (Microsoft Corp., Redmond, Washington, United States). The randomization sequence was generated by an independent investigator (MK) not involved in patient recruitment or outcome assessment. Group assignments were placed in sequentially numbered, opaque, sealed envelopes prepared by the study coordinator, and opened just before the surgery by a surgeon not involved in postoperative pain assessment (MK). The statistician and participants were blinded to group allocation. The patients were allocated into 1 of 4 groups: LAI, L-TAP, L-TAP+LAI, and controls (no regional anesthesia). The participants retained the right to withdraw from the study at any stage. Postoperative pain was assessed by nursing staff unaware of group allocation.

Perioperative care and surgical treatment All patients received standardized preoperative medication consisting of oral midazolam (7.5 mg) 1 hour before surgery and intravenous fluid boluses calculated at 1 ml/kg of body weight per hour of preoperative fasting. General anesthesia was induced with intravenous propofol and remifentanil. Following preoxygenation, the patients received propofol (2 mg/kg), atracurium (1 mg/kg), and fentanyl (1 μg/kg), followed by endotracheal intubation and mechanical ventilation. Anesthesia was maintained with sevoflurane at 1 minimum alveolar concentration in a 50:50 oxygen-to-air mixture and continuous remifentanil infusion (0.25–1 μg/kg/min), with continuous hemodynamic monitoring.

LC was performed using a standardized 4-port technique: an 11-mm optical trocar above the umbilicus, an 11-mm working trocar below the xiphoid process, and 2 5-mm working trocars below the right costal margin. The procedure involved pneumoperitoneum induction (12 mm Hg), introduction of laparoscopic instruments, dissection of the Calot triangle, gallbladder separation from the liver bed, and extraction of the specimen through the umbilical port. A drain was inserted through the 5-mm side port if the operator deemed it necessary (due to damage to the liver capsule and gallbladder wall caused by bile leakage). For regional anesthesia, 20 ml of 0.25% bupivacaine diluted with saline was used. To ensure consistency across the groups, all patients receiving regional techniques were administered the same volume and concentration of local anesthetic during the initial intraoperative phase.

Treatment In the LAI group, the fascia at the optical trocar site was infiltrated with local anesthetic after skin incision and before trocar insertion. The remaining anesthetic was administered into the interfacial planes at the other trocar sites under laparoscopic visualization. A total 20-ml dose of 0.25% bupivacaine was evenly distributed among the 4 port sites. In the L-TAP group, unilateral block was performed immediately after laparoscope insertion into the peritoneal cavity. A needle was inserted 2 cm below the costal margin along the right mid-axillary line (1–2 fingerbreadths below the palpable lower edge of the tenth rib), targeting the plane between the internal oblique and transversus abdominis muscles at the T6 dermatome. Correct needle placement was confirmed by the appearance of the Doyle bulge, characterized by distension of the internal oblique muscle fibers visualized through the parietal peritoneum. A total of 20 ml of 0.25% bupivacaine were used for

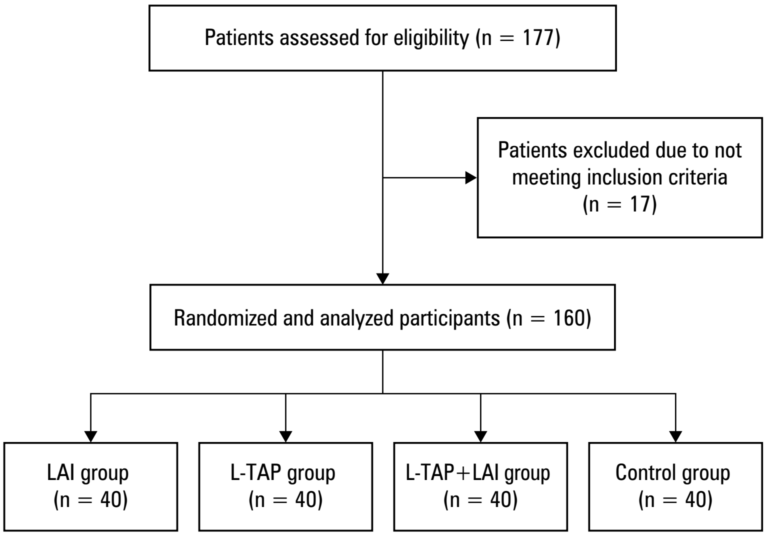

FIGURE 1 Patient flow diagram according to the CONSORT guidelines

Abbreviations: LAI, local anesthetic infiltration; L-TAP, laparoscopic-assisted transversus abdominis plane block; L-TAP+LAI, laparoscopyic-assisted transversus abdominis plane block combined with local anesthetic infiltration

L-TAP block. In the L-TAP+LAI group, a combination of both techniques was employed. A total of 10 ml of 0.25% bupivacaine were used for L-TAP block, and the remaining 10 ml were administered via wound infiltration following the same protocol as in the LAI group. The total volume of 0.25% bupivacaine (20 ml) was similar in the LAI, L-TAP, and L-TAP+LAI groups. In the control group, no regional anesthesia was administered, and postoperative pain was managed exclusively with intravenous agents. All patients received standardized postoperative analgesia. Metamizole was administered at 6, 12, 18, and 24 hours postoperatively, except when the pain intensity was 0–1 on the Numerical Rating Scale (NRS) or if a patient received oxycodone. Paracetamol was added when pain intensity exceeded 4, and oxycodone when it exceeded 6 according to the NRS. In the case of strong pain (>8 as per the NRS), the patients received a combination of paracetamol and oxycodone. The participants were verticalized in the fourth hour after LC.

Study outcomes and outcome measures The primary outcome was pain intensity measured using the NRS directly after surgery and at 2, 6, and 24 hours postoperatively. The time points were selected based on the duration of the bupivacaine effect,[8] and in the case of 24 hours—based on the concept of pre-emptive analgesia, which assumes that blocking the generation of pain stimuli in the initial phase of the procedure (during the period of bupivacaine effect) limits the development of peripheral and central sensitization, reducing the intensity of pain after the direct pharmacological effect of the drug has subsided.[9] The secondary outcomes were as follows: 1) the number of patients requiring postoperative administration of metamizole, paracetamol, or oxycodone at 6, 12, 18, and 24 hours postsurgery; 2) localized pain intensity at umbilical, substernal, and subcostal wound sites, as measured by the NRS directly after surgery and at 2, 6, and 24 hours postoperatively; and 3) local postoperative complications assessed according to the Clavien–Dindo grading scale. Data on gallbladder calculi size, drain insertion, and operative time were recorded for each patient.

Statistical analysis Descriptive statistics for demographic and clinical characteristics were presented according to the data distribution. The normality of data distribution was assessed with the Shapiro–Wilk test. Group comparisons for categorical variables were carried out using the χ^2 test or the Fisher–Freeman–Halton test for contingency tables with low expected frequencies (<5). For non-normally distributed continuous variables, the Kruskal–Wallis test was applied. Data are expressed as median (interquartile range [IQR]). Following a significant result, post hoc pairwise comparisons were conducted using the Dunn test to control for multiple testing. A *P* value below 0.05 was deemed significant. The analysis was performed using Statistica software, version 13 (TIBCO Software Inc., Palo Alto, California, United States) and R software, version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria).

Ethics The study protocol was approved by the Institutional Bioethics Committee of the Institutional Bioethics Committee at Warmia and Mazury Medical Chamber in Olsztyn (31/2021/VIII), and all procedures were conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to inclusion. The study was registered at ClinicalTrials.gov (NCT07176299).

RESULTS Characteristics of the study population A total of 177 patients were assessed for eligibility, of whom 160 were randomized and included in the study. The participants were recruited consecutively from eligible patients scheduled for LC during the study period. Forty patients were allocated to 1 of 4 groups: LAI, L-TAP, L-TAP+LAI, and controls, as shown in **FIGURE 1**. Median (IQR) patient age was 59.5 (46–71) years. Women comprised 68.1% of the study population (n = 109). Thirty-five patients (21.2%) were smokers. Median (IQR) BMI of the study participants was 27.3 (24.2–30.1) kg/m^2, and 42 (26.2%) had a BMI of 30 kg/m^2 or higher.

There were no significant differences among the groups in terms of baseline demographics, ASA class, surgical complications, gallbladder calculi size, drain insertion, and operative time. Bupivacaine was administered 3 to 7 minutes after the beginning of the surgery. Detailed patient characteristics are presented in **TABLE 1**.

Primary outcome Significant differences in the NRS score between the groups were found

TABLE 1 Characteristics of the study population

Characteristic		LAI group (n = 40)	L-TAP group (n = 40)	L-TAP+LAI group (n = 40)	Control group (n = 40)	*P* value
Age, y		62 (47–72)	62 (45–71.2)	58 (52–71.2)	56 (44.2–63)	0.37
Sex	Women	24 (60)	24 (60)	32 (80)	29 (72.5)	0.14
	Men	16 (40)	16 (40)	8 (20)	11 (27.5)	
BMI, kg/m²		27.8 (25.8–30.5)	27.7 (24.6–30.9)	25.6 (23.9–28.7)	26.5 (23.8–31.5)	0.43
Smoking status	Smoker	11 (27.5)	4 (10)	12 (30)	7 (17.5)	0.1
	Nonsmoker	29 (82.5)	36 (90)	28 (70)	33 (82.5)	
ASA class		2 (1–2)	2 (1–2)	2 (1–2)	2 (1–2)	0.97
Drain insertion	Yes	19 (47)	16 (40)	22 (55)	16 (40)	0.48
	No	21 (53)	24 (60)	18 (45)	24 (60)	
Size of gallbladder calculi, mm		15 (10–20)	15 (10–25)	20 (15–30)	17.5 (9–30)	0.06
Operative time, min		55 (50–70)	55 (50–65)	55 (50–65)	55 (45–65)	0.93
Complications during surgery	Yes	0	0	0	1 (2)	>0.99
	No	40 (100)	40 (100)	40 (100)	39 (98)	

Data are presented as number (percentage) or median (interquartile range).

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; others, see **FIGURE 1**

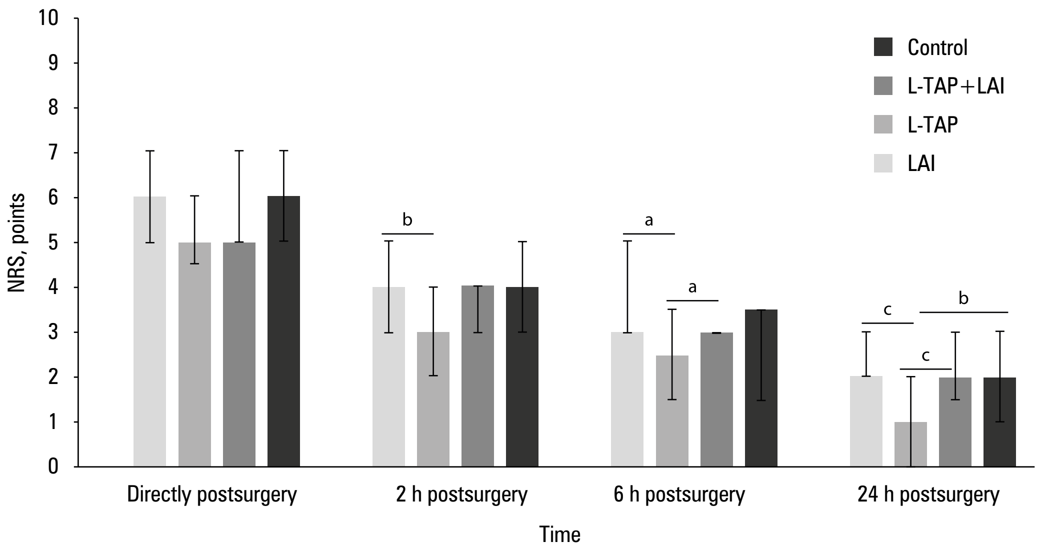

FIGURE 2 Pain intensity in the study groups measured by the Numerical Rating Scale (NRS) directly postsurgery and at 2, 6, and 24 hours postoperatively. Data are presented as median (interquartile range). Intergroup differences were assessed using the Kruskal–Wallis test.

a $P < 0.05$
b $P < 0.01$
c $P < 0.001$

Abbreviations: see **FIGURE 1**

at 2, 6, and 24 hours postsurgery but not directly after the procedure. Two hours postoperatively, median (IQR) NRS score was lower in the L-TAP than the LAI group (3 [2–4] vs 4 [3.5–5] points; $P = 0.003$), and no other pairwise differences were observed. At 6 hours, it was lower in the L-TAP group, as compared with the LAI (median [IQR], 3 [2–4] vs 3 [3–5] points; $P = 0.02$) and the L-TAP+LAI cohorts (median [IQR], 3 [2–4] vs 3 [3–4] points; $P = 0.046$). At 24 hours postoperatively, median (IQR) pain intensity was lower in the L-TAP group, as compared with the LAI cohort (1 [0–2] vs 2 [2–3] points; $P < 0.001$), the L-TAP+LAI group (1 [0–2] vs 2 [1.5–3] points; $P < 0.001$), and the controls (1 [0–2] vs 2 [1–3]; $P = 0.01$; **FIGURE 2**). Pain scores in each group declined with time ($P < 0.001$).

Secondary outcomes Analgesic use was similar across the groups, with the controls registering the highest paracetamol use at 6 hours postoperatively ($P < 0.001$) and lowest metamizole use at 24 hours postsurgery ($P < 0.001$; **TABLE 2**).

Pain intensity at individual wound sites (umbilical, subcostal, and substernal) showed significant differences between the LAI and L-TAP groups. In the L-TAP cohort, median (IQR) NRS score at umbilical and substernal wounds at 24 hours postsurgery was lower than in the LAI group (1 [0.5–2] vs 2 [1.5–3] points; $P = 0.007$ and 2 [1–3] vs 1 [0.5–2] points; $P < 0.001$, respectively). Median (IQR) subcostal pain was lower in the L-TAP group than the LAI cohort at 2, 6, and 24 hours postoperatively (3 [2–3] vs 3 [3–5] points; $P = 0.008$; 2 [2–3] vs 3 [2–4] points; $P = 0.01$; and 1 [0.5–2] vs 2 [1–3] points; $P < 0.001$, respectively). A difference in subcostal pain at 6 hours was noted between the LAI and control groups ($P = 0.002$). There were no differences between the other groups and time points (**TABLE 3**).

The most frequent postoperative complication was ecchymosis at the regional anesthesia site,

TABLE 2 Postsurgery analgesic use in the study population

Medication	Time point	LAI group (n = 40)	L-TAP group (n = 40)	L-TAP+LAI group (n = 40)	Control group (n = 40)	*P* value
Metamizol	6 h postsurgery	40 (100)	38 (95)	36 (90)	37 (92.5)	0.25
	12 h postsurgery	39 (97.5)	37 (92.5)	35 (87.5)	40 (100)	0.08
	18 h postsurgery	37 (92.5)	35 (87.5)	36 (90)	32 (80)	0.45
	24 h postsurgery	36 (90)	32 (80)	34 (85)	21 (52.5)	<0.001
Paracetamol	6 h postsurgery	5 (12.5)	3 (7.5)	7 (17.5)	19 (47.5)	<0.001
	12 h postsurgery	7 (17.5)	4 (10)	11 (27.5)	9 (22.5)	0.21
	18 h postsurgery	6 (15)	0	5 (12.5)	6 (15)	0.04
	24 h postsurgery	1 (2.5)	1 (2.5)	4 (10)	2 (5)	0.53
Oxycodone	6 h postsurgery	6 (15)	4 (10)	3 (7.5)	9 (22.5)	0.26
	12 h postsurgery	3 (7.5)	1 (2.5)	2 (5)	3 (7.5)	0.88
	18 h postsurgery	1 (2.5)	0	1 (2.5)	0	>0.99
	24 h postsurgery	0	0	0	0	>0.99

Data are presented as number (percentage).

Abbreviations: see **FIGURE 1**

TABLE 3 Pain intensity at umbilical, substernal, and subcostal wounds, as measured by the Numerical Rating Scale

Wound site	Time point	LAI group (n = 40)	L-TAP group (n = 40)	L-TAP+LAI group (n = 40)	Control group (n = 40)	*P* value
Umbilical wound	Directly postsurgery	6 (5–7)	5 (4.5–6)	5 (4.5–6)	6 (5–7.5)	0.05
	2 h postsurgery	5 (4–5)	4 (3–5)	4 (3–5)	5 (3–6)	0.28
	6 h postsurgery	4 (3–5)	3 (2–4)	3 (2–4)	3 (1.5–4)	0.04
	24 h postsurgery	2 (1.5–3)	1 (0.5–2)	2 (1–3)	2 (1–3)	0.009
Substernal wound	Directly postsurgery	3 (3–4)	3 (2–3)	3 (3–4)	3 (2–4)	0.02
	2 h postsurgery	3 (3–3)	3 (2–3.)	3 (3–3)	3 (2–4)	0.05
	6 h postsurgery	3 (2–3)	2 (2–3)	3 (2–3)	2 (1–3)	0.05
	24 h postsurgery	2 (1–3)	1 (0.5–2)	2 (1–2)	1 (0–3)	<0.001
Subcostal wound	Directly postsurgery	3 (3–5)	3 (2–4)	3 (2.5–5)	4 (2–4)	0.19
	2 h postsurgery	3 (3–5)	3 (2–3)	3 (3–4)	3 (2–4)	0.004
	6 h postsurgery	3 (2–4)	2 (2–3)	3 (2–3)	2 (1–3)	<0.001
	24 h postsurgery	2 (1–3)	1 (0.5–2)	2 (1–2)	1 (0–3)	<0.001

Data are presented as median (interquartile range).

Abbreviations: see **FIGURE 1**

observed in 12 patients. No wound dehiscence was reported. All complications were classified as grades I or IIa according to the Clavien–Dindo classification. Group-specific complications are summarized in **TABLE 4**.

DISCUSSION This randomized study compared the analgesic effectiveness and safety of unilateral L-TAP block, LAI, and their combination in patients undergoing LC. The results demonstrated that unilateral L-TAP block provided the most consistent pain relief, with a significantly lower NRS score at 24 hours postoperatively. Numerous studies employed ultrasound-guided TAP blocks[10-13] and bilateral L-TAP blocks[14-26]; however, unilateral L-TAP block in LC has rarely been investigated.[27,28] Cevikkalp et al[27] compared the analgesic effectiveness of bilateral L-TAP block, unilateral L-TAP block, LAI, and standard anesthesia in LC. The results showed no considerable differences in pain scores (apart from a lower pain score in bilateral L-TAP block 1 h postoperatively) and no differences in rescue analgesic use. A study by Venkatraman et al[28] demonstrated that unilateral L-TAP block was a suitable alternative to ultrasound-guided block in LC. Therefore, our findings, together with the available literature on unilateral L-TAP block, suggest that a single, intraoperative, unilateral L-TAP block can offer postoperative pain control in LC, comparable to or better than that achieved with other techniques. This approach may reduce procedural time and

TABLE 4 Local postoperative complications

Complication	LAI group (n = 40)	L-TAP group (n = 40)	L-TAP+LAI group (n = 40)	Control group (n = 40)	*P* value
Ecchymosis at the injection site	8 (20)	1 (2.5)	3 (7.5)	NA	0.04
Wound infection	2 (5)	0	2 (5)	0	0.33
Wound hematoma	0	0	1 (2.5)	1 (2.5)	>0.99
Other	2 (5)	0	0	1 (2.5)	0.62

Data are presented as number (percentage).

Abbreviations: NA, not applicable; others, see FIGURE 1

cost, aligning with the Enhanced Recovery After Surgery principles that emphasize efficiency and opioid-sparing analgesia.[29] In this context, intraoperative nerve-targeted analgesia has been proposed as an adjunct to multimodal pain management in minimally-invasive procedures.[30-32]

The superiority of L-TAP block over LAI observed in our study is consistent with previous trials. Ra et al[10] reported significantly lower pain scores at all time points within the first 24 hours following bilateral ultrasound-guided TAP with levobupivacaine. A meta-analysis of 668 patients across 10 randomized controlled trials reported that TAP block significantly reduced resting- and movement-associated pain scores, as well as opioid consumption, with a lower incidence of postoperative nausea and vomiting.[14] Similarly, a randomized, double-blind trial including 80 patients found lower NRS scores in the TAP group, as compared with the periportal LAI cohort, both at rest and during coughing.[15] Another trial comprising 86 patients undergoing LC showed that bilateral subcostal L-TAP block with 0.25% bupivacaine provided superior pain relief at 30 minutes postoperatively, with 37% of the patients requiring no rescue analgesia.[16] Importantly, this approach was approximately 20 times less costly than ultrasound-guided TAP, while offering similar analgesia. Soytürk et al[17] also reported no difference in pain intensity or opioid consumption between laparoscopic- and ultrasound-guided TAP, suggesting the potential cost-effectiveness of the laparoscopic approach.

The L-TAP and LAI combination in our study did not enhance pain relief, which was observed also in other studies.[18,19] This finding should be interpreted in the context of split local anesthetic volumes used in the combined group (10 ml per technique). Therefore, this comparison reflects the effect of combined techniques at reduced individual volumes rather than a pure assessment of potential synergistic benefit. Di Mauro et al[18] reported no additional benefit from combining TAP with LAI. A separate trial from Sri Lanka found even higher pain scores at 6 hours postoperatively in the combined approach group, as compared with LAI alone.[19] Importantly, the effectiveness of TAP block has been reported to rely on the volume rather than the concentration of the local anesthetic.[20] Therefore, the weaker analgesic effect in the L-TAP+LAI group may have resulted from the fact that the volumes administered during L-TAP and into the interfascial plane were 2 times lower (10 ml) than the volumes used in the groups treated by either LAI or L-TAP alone (20 ml). Although the total volumes and concentration of bupivacaine were similar in all groups, the dispersion of the drug may have differed.

Our study's assessment of wound-specific pain offers additional insights. The L-TAP group experienced significantly lower subcostal pain than the LAI group at multiple time points. This finding aligns anatomically with the TAP block effect on the thoracolumbar nerves (T6–L1), which innervate the subcostal and substernal regions.[4,33] However, the sensory coverage of TAP block can vary based on the approach used. Cadaveric and imaging studies have shown that classic TAP blocks typically cover T7–L1, while ultrasound--guided approaches more commonly span from T10 to L1.[34,35] In contrast, LAI primarily targets peripheral nociceptors at the incision site, effectively reducing somatic incisional pain but offering less relief for deeper or more complex innervation patterns.[36]

In our study, overall analgesic requirements declined over time in all groups; however, total opioid and nonopioid consumption did not differ significantly between them. In contrast, pain intensity showed marked differences and was lowest in the L-TAP group, starting from 2 hours postoperatively. These findings are consistent with previous studies demonstrating improved pain scores with TAP block without a corresponding reduction in total analgesic use.[15] Although not demonstrated in our study, there is growing evidence supporting the ability of TAP block to reduce opioid requirements, particularly during the critical first 24 hours when pain is most intense. Minimizing opioid exposure remains a clinical priority due to associated risks, such as nausea, delayed gastrointestinal recovery, and dependency.[29,37] A meta-analysis in laparoscopic colorectal surgery confirmed the benefit of TAP block in reducing postoperative opioid use on day 1, without increasing the incidence of complications.[38] Another meta-analysis including 48 clinical studies on TAP block during LC reported that they decreased opioid consumption significantly and provided effective analgesia.[39]

Comparative studies between TAP block and trocar-site LAI remain limited. This represents an important gap, as port-site LAI continues to be widely used.[40-43] Arik et al[49] reported that unilateral subcostal ultrasound-guided TAP block was associated with lower opioid consumption than port-site LAI, whereas Cevikkalp et al[27] found no differences between these 2 techniques in terms of pain scores and use of rescue analgesics. Three studies concerning comparison of other block types with LAI demonstrated that blocking procedures provided superior analgesia to LAI (external oblique intercostal and rectus sheath block,[41] erector spinae plane block,[42] and thoracoabdominal nerve block).[43] Moreover, LAI has been also shown to provide less pain relief in comparison with epidural analgesia in surgical hepatectomy.[44]

Complication data reaffirm the safety of TAP block, which is associated with a low rate of adverse events.[45] In our study, ecchymosis occurred significantly more frequently in the LAI group, probably due to the superficial nature and multiple punctures inherent in LAI, as compared with single, deeper injection used in the L-TAP approach. Signs of local wound irritation, such as redness and swelling, appeared only in the LAI and L-TAP+LAI groups. While not classifiable as wound infections, these findings suggest greater tissue reactivity in techniques involving multiple punctures. L-TAP block, characterized by a single deep injection, appeared to be better tolerated and may offer a more favorable safety profile in the early postoperative period. The rates of hematoma and wound dehiscence were low across all groups, consistent with earlier reports.[46,47]

The key strengths of this study are its randomized design with balanced distribution of participants across the intervention arms and the inclusion of 3 regional techniques within the same study framework. Moreover, the evaluation of postoperative pain at multiple anatomical sites offers a nuanced understanding of analgesic effectiveness across different wound locations.

Limitations Our study's main limitations include a lack of a formal a priori sample size calculation and a small, relatively homogeneous study population, which may have hindered the analysis and the detection of secondary outcomes, especially differences in opioid consumption. The extrapolation of the study results to higher-risk patients or those undergoing emergency surgery is also difficult. The single-center study design may have also limited the generalizability of the results. The follow-up period was restricted to 24 hours, precluding conclusions about chronic pain, delayed recovery, and long-term safety. Another limitation, already addressed above, is that, in the L-TAP+LAI group, bupivacaine volumes administered during L-TAP and into the interfascial plane were 2 times lower than in the LAI or L-TAP cohorts, which could have introduced differences in the drug dispersion in the tissue. Finally, the observed pain reduction in the L-TAP group was not large and lower than values considered clinically significant by some authors,[48,49] but it still indicates that L-TAP block is at least as good as other regional anesthesia techniques studied.

CONCLUSIONS Unilateral L-TAP proved to be a safe and effective analgesic technique for patients undergoing LC during the first 24 hours postsurgery. It resulted in lower pain scores and fewer wound-related complications, as compared with LAI. Importantly, the combination of L-TAP and LAI at split volumes did not provide better analgesic effect than L-TAP alone. The use of L-TAP may be a practical alternative to more complex or invasive regional anesthesia techniques.

ARTICLE INFORMATION

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