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The effect of ultrasound-guided transversus abdominis plane block on postoperative inflammatory markers and analgesic requirements in laparoscopic cholecystectomy: a retrospective comparative study

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ABSTRACT

Introduction: Ultrasound-guided bilateral transversus abdominis plane (TAP) block is widely used for postoperative analgesia in laparoscopic cholecystectomy (LC). Its potential immunomodulatory effects on systemic inflammatory markers remain poorly characterized. This study aimed to evaluate the effect of TAP block on the postoperative neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and C-reactive protein (CRP) levels, along with key clinical outcomes.

Materials and Methods: This single-center retrospective comparative study included 100 patients who underwent elective LC under general anesthesia between October 2022 and October 2025. Following screening of 138 consecutive records and exclusion of 38 patients, participants were allocated to the TAP group (n=51; ultrasound-guided bilateral TAP block with 20 mL of 0.25% bupivacaine per side, administered at the conclusion of surgery) or the control group (n=49; standard care alone). NLR, PLR, and CRP were measured preoperatively and at 24 hours postoperatively. Clinical outcomes included 24-hour opioid consumption, VAS pain scores, complication rates, and length of hospital stay. Given the retrospective and exploratory nature of the study, a formal primary outcome was not prespecified.

Results: Baseline characteristics were comparable between the groups. Postoperative NLR (3.58 vs. 4.39; p<0.001), PLR (168.90 vs. 220.60; p<0.001), and CRP levels (32.58 vs. 44.72 mg/L; p<0.001) were all significantly lower in the TAP group. Changes in all three markers were also significantly attenuated. Twenty-four-hour opioid consumption (p=0.002) and VAS pain scores (p=0.006) were significantly lower in the TAP group. Complication rates and length of hospital stay did not differ significantly between the groups.

Conclusions: Ultrasound-guided bilateral TAP block performed at the conclusion of LC significantly attenuated postoperative systemic inflammation, as reflected by lower NLR, PLR, and CRP levels, while also reducing opioid requirements and pain scores. These findings support the inclusion of TAP block in multimodal perioperative analgesic protocols and suggest a potential immunomodulatory role that warrants confirmation in prospective randomized trials.

Keywords: Inflammatory markers, laparoscopic cholecystectomy, neutrophil-to-lymphocyte ratio, postoperative analgesia, transversus abdominis plane block

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Introduction

Laparoscopic cholecystectomy (LC) is the gold standard surgical treatment for symptomatic cholelithiasis and represents one of the most frequently performed abdominal procedures worldwide.[1,2] Although the minimally invasive approach is associated with reduced postoperative morbidity compared with open cholecystectomy, a considerable proportion of patients experience moderate-to-severe pain in the early postoperative period, which may impair mobilization, prolong hospital stay, and increase analgesic requirements.[3,4] Effective perioperative pain management therefore remains a central component of patient care.

Multimodal analgesia, combining non-opioid analgesics with regional anesthetic techniques, has emerged as the preferred strategy for postoperative pain control, aiming to minimize opioid consumption and its associated adverse effects.[5] The transversus abdominis plane (TAP) block, introduced by Rafi in 2001, targets the thoracolumbar nerves (T7–L1) within the fascial plane between the internal oblique and transversus abdominis muscles, providing somatic analgesia to the anterior abdominal wall.[6,7] With the widespread adoption of ultrasound guidance, TAP block and its modified approaches, such as the oblique subcostal technique, have become technically reliable and safe, with analgesic benefits demonstrated across a range of abdominal procedures, including cesarean section and laparoscopic bariatric surgery.[8,9] The analgesic efficacy of TAP block in LC has likewise been demonstrated in multiple randomized trials and meta-analyses.[10,11]

Beyond its analgesic properties, regional anesthesia has been proposed to modulate the neuroendocrine stress response and attenuate postoperative systemic inflammation.[12] The neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) are accessible, routinely available hematological indices that reflect surgical stress and systemic inflammatory activation.[13,14] C-reactive protein (CRP) is a well-established acute-phase reactant that reliably quantifies the magnitude of surgical trauma and the inflammatory response.[15] Despite growing interest in the immunomodulatory potential of regional anesthetic techniques, data specifically investigating the effect of TAP block on NLR, PLR, and CRP following LC are scarce.

The present study was therefore designed to retrospectively evaluate the effect of ultrasound-guided bilateral TAP block on postoperative NLR, PLR, and CRP levels and on key clinical outcomes, including opioid consumption, pain scores, complication rates, and length of hospital stay, in patients undergoing elective LC.

Materials and Methods

Study Population and Design

This single-center retrospective comparative study was conducted at the Anesthesiology Clinic of Fatih Sultan Mehmet Training and Research Hospital. The medical records of consecutive patients who underwent elective laparoscopic cholecystectomy under general anesthesia between October 2022 and October 2025 were reviewed. As the study institution does not operate an independent ethics committee, the study protocol was approved by the Ethics Committee of University of Health Sciences, Sancaktepe İlhan Varank Training and Research Hospital, the designated regional ethics authority (Approval No. 2026/112). The study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was waived by the ethics committee because of the retrospective design of the study.

The inclusion criteria were as follows: (a) age 18–65 years; (b) ASA physical status I–III; (c) elective laparoscopic cholecystectomy; and (d) complete anesthetic and laboratory records. The exclusion criteria were conversion to open surgery, preoperative infection, malignancy or systemic inflammatory disease, preoperative use of corticosteroids, immunosuppressants, or opioids, and missing laboratory or clinical data.

The patient selection process is summarized in the accompanying flowchart (Fig. 1). Briefly, a total of 138 patients were initially screened from the surgical registry. Of these, 38 were excluded: 7 for conversion to open surgery, 9 for preoperative infection or active systemic inflammatory disease, 6 for corticosteroid or immunosuppressant use, 4 for preoperative opioid use, 8 for malignancy, and 4 for incomplete laboratory or anesthetic records. The remaining 100 patients were included in the final analysis and classified into two groups based on operative anesthetic records: those who received an ultrasound-guided bilateral TAP block in addition to standard care (TAP group, n=51) and those who received standard care alone (control group, n=49).

Anesthetic Protocol

All patients underwent general anesthesia using a standardized institutional protocol. Anesthesia was induced

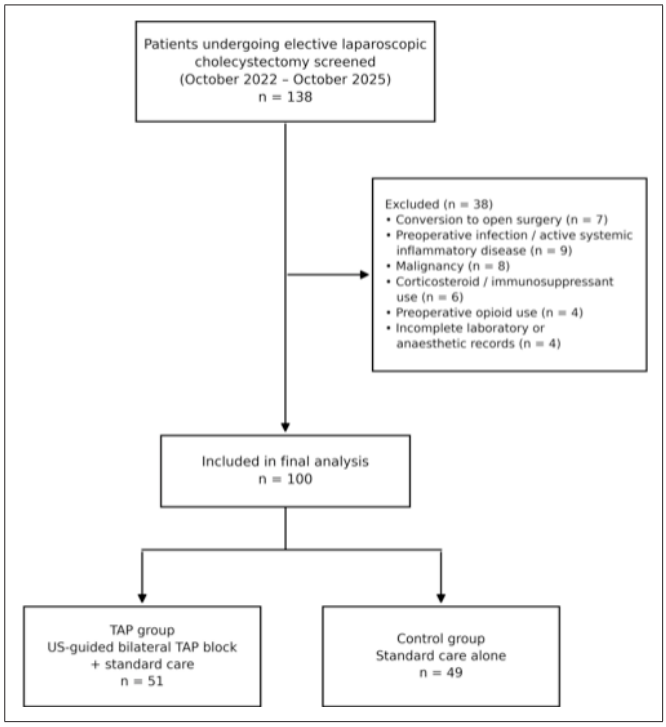

Figure 1. Flow diagram of patient selection, prepared in accordance with the STROBE guidelines. TAP: Transversus abdominis plane; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology.

with propofol (2 mg/kg), fentanyl (1–2 µg/kg), and rocuronium (0.6 mg/kg). Anesthesia was maintained with sevoflurane (2–3%) in a 50% oxygen-air mixture, with a remifentanil infusion titrated according to surgical stimulation. Both groups received intravenous paracetamol 1 g and tramadol 100 mg as standard postoperative analgesia and ondansetron 4 mg for prophylaxis against postoperative nausea and vomiting (PONV).

TAP Block Technique

In the TAP group, an ultrasound-guided bilateral TAP block was performed by an experienced anesthesiologist using a high-frequency linear probe. With the patient in the supine position, the probe was positioned in the midaxillary line between the costal margin and the iliac crest. The needle was advanced under direct ultrasound visualization into the fascial plane between the internal oblique and transversus abdominis muscles, and 20 mL of 0.25% bupivacaine was injected on each side. The block was performed at the conclusion of surgery, before emergence from anesthesia.

Data Collection

Demographic data (age, sex, ASA classification, BMI, and operative duration) and perioperative data were extracted from electronic medical records. Preoperative and postoperative complete blood count and serum CRP levels were obtained from the institutional laboratory information system, with postoperative measurements obtained at 24 hours. NLR was calculated as the ratio of the absolute neutrophil count to the absolute lymphocyte count, and PLR was calculated as the ratio of the platelet count to the absolute lymphocyte count. Delta values (Δ) were defined as the arithmetic difference between postoperative and preoperative values. Postoperative data, including 24-hour opioid consumption, VAS pain scores (0–10 scale) at 24 hours, occurrence of complications, and length of hospital stay, were retrieved from postoperative follow-up records.

Statistical Analysis

Statistical analyses were performed using IBM® SPSS® Statistics (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Categorical variables are presented as frequencies and percentages, and continuous variables as medians (interquartile range [IQR]). Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. Continuous variables were compared between groups using the Mann–Whitney U test. A p-value<0.05 was considered statistically significant.

Results

Demographic and Baseline Characteristics

A total of 100 patients were included in the final analysis: 51 in the TAP group and 49 in the control group. Baseline demographic and perioperative characteristics are detailed in Table 1. No statistically significant differences were identified between the groups with respect to age (51.00 [39.50–61.50] vs. 51.00 [39.00–60.00] years; p=0.909), sex distribution (female: 74.5% vs. 73.5%; p=1.000), ASA classification (p=0.255), BMI (27.4 [25.1–30.2] vs. 27.9 [25.6–30.8] kg/m²; p=0.512), or operative duration (55.0 [45.0–65.0] vs. 57.0 [46.0–66.0] min; p=0.438). The two groups were therefore considered comparable at baseline.

Inflammatory Markers

Preoperative NLR, PLR, and CRP values were similar between the TAP and control groups (NLR: 2.10 [1.76–2.45] vs. 2.31 [1.94–2.59], p=0.108; PLR: 124.00 [107.85–137.20] vs.

Table 1. Demographic and perioperative characteristics of the study groups

Variable	TAP Group (n=51) Median (IQR) / n (%)	Control Group (n=49) Median (IQR) / n (%)	p
Age (years)	51.00 (39.50–61.50)	51.00 (39.00–60.00)	0.909
Sex			1.000
Female	38 (74.5%)	36 (73.5%)	
Male	13 (25.5%)	13 (26.5%)	
ASA physical status			0.255
ASA I	3 (5.9%)	7 (14.3%)	
ASA II	35 (68.6%)	27 (55.1%)	
ASA III	13 (25.5%)	15 (30.6%)	
BMI (kg/m²)	27.4 (25.1–30.2)	27.9 (25.6–30.8)	0.512
Operative duration (min)	55.0 (45.0–65.0)	57.0 (46.0–66.0)	0.438

TAP: Transversus abdominis plane; IQR: Interquartile range; BMI: Body mass index; ASA: American Society of Anesthesiologists. Continuous variables: Mann–Whitney U test. Categorical variables: chi-square or Fisher's exact test.

131.70 [114.10–144.50], p=0.078; CRP: 2.77 [2.36–3.27] vs. 3.01 [2.46–3.74] mg/L, p=0.170), confirming comparable inflammatory status before surgery.

In the postoperative period, all three inflammatory markers were significantly lower in the TAP group (Table 2). Postoperative NLR was 3.58 [3.00–4.20] in the TAP group versus 4.39 [3.76–4.77] in the control group (p<0.001). The magnitude of the increase in NLR from baseline (ΔNLR) was also significantly attenuated in the TAP group (1.47 [0.98–2.26] vs. 2.12 [1.25–2.78]; p=0.028). Postoperative PLR was markedly lower in the TAP group (168.90 [151.70–188.20] vs. 220.60 [187.40–242.40]; p<0.001), as was ΔPLR (52.40 [23.60–72.05] vs. 86.30 [55.20–114.40]; p<0.001). Similarly, postoperative CRP at 24 hours was significantly lower in the TAP group (32.58 [23.85–42.42] vs. 44.72

Table 2. Comparison of preoperative and postoperative inflammatory markers between the study groups

Variable	TAP Group (n=51) Median (IQR)	Control Group (n=49) Median (IQR)	p
Neutrophil-to-Lymphocyte Ratio (NLR)			
Preoperative NLR	2.10 (1.76–2.45)	2.31 (1.94–2.59)	0.108
Postoperative NLR (24h)	3.58 (3.00–4.20)	4.39 (3.76–4.77)	**<0.001***
ΔNLR	1.47 (0.98–2.26)	2.12 (1.25–2.78)	**0.028***
Platelet-to-Lymphocyte Ratio (PLR)			
Preoperative PLR	124.00 (107.85–137.20)	131.70 (114.10–144.50)	0.078
Postoperative PLR (24h)	168.90 (151.70–188.20)	220.60 (187.40–242.40)	**<0.001***
ΔPLR	52.40 (23.60–72.05)	86.30 (55.20–114.40)	**<0.001***
C-Reactive Protein (CRP, mg/L)			
Preoperative CRP	2.77 (2.36–3.27)	3.01 (2.46–3.74)	0.170
Postoperative CRP (24h)	32.58 (23.85–42.42)	44.72 (35.20–55.19)	**<0.001***
ΔCRP	30.70 (20.72–40.30)	41.45 (32.68–52.75)	**<0.001***

TAP: Transversus abdominis plane; IQR: Interquartile range; NLR: Neutrophil-to-lymphocyte ratio; PLR: Platelet-to-lymphocyte ratio; CRP: C-reactive protein; Δ: postoperative minus preoperative value. Postoperative measurements obtained at 24 hours postoperatively. Continuous variables: Mann–Whitney U test. *p<0.05.

Table 3. Postoperative clinical outcomes of the study groups

Variable	TAP Group (n=51) Median (IQR) / n (%)	Control Group (n=49) Median (IQR) / n (%)	p
Opioid consumption (mg)	10.00 (0.00–10.00)	10.00 (10.00–15.00)	**0.002***
VAS pain score at 24h	3.00 (2.00–4.00)	4.00 (3.00–5.00)	**0.006***
Complication — n (%)	1 (2.0%)	3 (6.1%)	0.357
Length of hospital stay (days)	1.00 (1.00–1.00)	1.00 (1.00–1.00)	0.989

TAP: Transversus abdominis plane; IQR: Interquartile range; VAS: Visual analogue scale. Opioid consumption recorded as tramadol dose (mg). Continuous variables: Mann–Whitney U test. Categorical variables: Fisher's exact test. *p<0.05.

[35.20–55.19] mg/L; p<0.001), and the increase in CRP from baseline (ΔCRP) was substantially attenuated (30.70 [20.72–40.30] vs. 41.45 [32.68–52.75]; p<0.001).

Postoperative Clinical Outcomes

Twenty-four-hour postoperative opioid consumption was significantly lower in the TAP group (median, 10.00 [0.00–10.00] mg vs. 10.00 [10.00–15.00] mg; p=0.002). VAS pain scores at 24 hours were also significantly lower in the TAP group (3.00 [2.00–4.00] vs. 4.00 [3.00–5.00]; p=0.006). Complication rates were low in both groups (TAP: 2.0% vs. control: 6.1%; p=0.357), and the length of hospital stay was one day for the majority of patients in both groups, with no significant difference between the groups (p=0.989). Postoperative clinical outcomes are summarized in Table 3.

Discussion

The present retrospective study demonstrates that ultrasound-guided bilateral TAP block, administered at the conclusion of elective LC, is associated with a significant attenuation of the postoperative systemic inflammatory response, as reflected by lower NLR, PLR, and CRP values, together with meaningful reductions in postoperative opioid consumption and pain scores compared with standard care alone. These findings extend the well-documented analgesic benefits of TAP block to the domain of immunoinflammatory modulation and strengthen the rationale for its incorporation into multimodal perioperative protocols.

The analgesic efficacy of TAP block in LC is supported by a substantial body of evidence. Multiple randomized controlled trials and meta-analyses have consistently demonstrated that TAP block reduces postoperative pain scores and decreases opioid requirements.[10,11,16] The findings of the present study are concordant with this evidence: patients in the TAP group exhibited significantly lower 24-hour VAS scores and opioid consumption. A large retrospective series of 515 patients undergoing LC likewise reported lower early postoperative pain scores and analgesic requirements with TAP block.[17] In addition, meta-analytic evidence indicates that TAP block reduces the incidence of postoperative nausea, particularly in tramadol-based analgesic regimens.[18] However, postoperative nausea and vomiting were not evaluated as outcomes in the present study. The post-incisional timing employed in this study is consistent with evidence suggesting that postoperative TAP block may provide at least equivalent analgesic benefit to preoperative administration, in part by modulating the inflammatory milieu that evolves during the surgical procedure.[16]

The significant suppression of postoperative NLR, PLR, and CRP in the TAP group represents a novel and clinically relevant observation. NLR and PLR are cost-effective, widely available hematological indices validated as markers of surgical stress and systemic inflammatory activation.[13,14] An elevated postoperative NLR reflects a shift toward a proinflammatory and relatively immunosuppressed state, characterized by neutrophilia and lymphopenia, that has been associated with adverse perioperative outcomes in multiple surgical settings.[14] The significant attenuation of ΔNLR and ΔPLR in the TAP group suggests that effective somatic afferent blockade may dampen the neuroendocrine-driven inflammatory cascade triggered by nociceptive signals arising from abdominal wall injury. This mechanistic interpretation is supported by prior evidence demonstrating that regional anesthesia attenuates surgical stress hormone release and modulates perioperative immune function.[12]

The significant reduction in postoperative CRP at 24 hours in the TAP group further corroborates these findings. CRP

is a sensitive hepatic acute-phase reactant synthesized in response to interleukin-6 and other proinflammatory cytokines.[15] Its postoperative magnitude is widely accepted as a surrogate measure of surgical trauma. A lower ΔCRP in the TAP group suggests that interruption of afferent nociceptive input from the abdominal wall, achieved by the TAP block, translates into a measurable attenuation of the hepatic acute-phase response. Similar immunomodulatory effects have been reported with other regional techniques, including epidural analgesia and erector spinae plane block, in abdominal surgery.[12,19]

The comparable complication rates and identical lengths of hospital stay between the groups suggest that the sample size may have been insufficient to detect differences in these relatively rare events. The median hospital stay of one day in both groups is consistent with contemporary enhanced recovery pathways for LC and reflects the routine ambulatory nature of this procedure at our center. Future studies with longer follow-up and larger sample sizes may be better positioned to assess whether the observed immunoinflammatory benefits of TAP block translate into clinically meaningful differences in complication rates or readmission.

Limitations

Several limitations of this study merit consideration. The retrospective design introduces the potential for selection bias and unmeasured confounding; patients receiving TAP block may have differed from controls in variables not captured in the dataset. The single-center nature of the study limits generalizability. Opioid consumption was recorded as tramadol dose rather than morphine equivalents, precluding direct comparison with published studies that use standardized opioid metrics. CRP was measured at a single postoperative time point (24 hours), preventing assessment of the temporal profile of inflammatory resolution beyond the first postoperative day. The relatively modest sample size may have reduced statistical power for secondary endpoints. Given the retrospective and exploratory nature of this study, a formal primary outcome was not prespecified, and multiple endpoints were evaluated simultaneously; this should be considered when interpreting the results, as the possibility of type I error due to multiple comparisons cannot be excluded. Postoperative opioid consumption and VAS pain scores were assessed only at 24 hours; serial measurements at 6, 12, and 18 hours would have better characterized the temporal analgesic profile of the TAP block, which exerts its primary effect in the early postoperative period. The absence of such data is acknowledged as a significant limitation. A patient flowchart is provided in accordance with the STROBE reporting guidelines, detailing the number of patients screened, the reasons for exclusion at each stage, and the final number included in each group. Notwithstanding these limitations, the baseline comparability of the groups with respect to all available demographic and inflammatory variables supports the internal validity of the observed between-group differences.

Conclusion

Ultrasound-guided bilateral TAP block performed at the conclusion of laparoscopic cholecystectomy significantly attenuates the postoperative systemic inflammatory response, as reflected by reduced NLR, PLR, and CRP levels at 24 hours, while concurrently reducing postoperative opioid requirements and pain scores. These findings support the integration of TAP block into multimodal perioperative analgesic strategies for laparoscopic cholecystectomy and suggest a potential immunomodulatory role that warrants confirmation in prospective randomized controlled trials.

Disclosures

Ethics Committee Approval: The study was approved by University of Health Sciences, Sancaktepe İlhan Varank Training and Research Hospital Ethics Committee (No: 2026/112, Date: 25.02.2026).

Informed Consent: Informed consent was waived by the ethics committee due to the retrospective design of the study.

Conflict of Interest: The authors declare that there is no conflict of interest.

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