

Association of Intraoperative Low-Dose Lidocaine Infusion with Postoperative Tramadol Requirement After Laparoscopic Cholecystectomy: A Retrospective Analysis

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Abstract

Aim: Intravenous lidocaine infusion has been proposed as an opioid-sparing adjunct in multimodal analgesia; however, its efficacy following laparoscopic cholecystectomy remains controversial. This study evaluated the association between intraoperative low-dose lidocaine infusion, postoperative tramadol consumption, and hospital length of stay. **Methods:** Ninety-four patients undergoing elective laparoscopic cholecystectomy were retrospectively analyzed. Patients received either intraoperative lidocaine infusion (1.5 mg/kg bolus plus 1 mg/kg/h infusion, n = 47) or standard multimodal analgesia alone (n = 47). Postoperative tramadol requirement, total tramadol consumption, surgical duration, and hospital length of stay were compared between groups. **Results:** Baseline characteristics were similar between groups. The number of patients requiring postoperative tramadol was lower in the lidocaine group than in the control group (8.5% vs. 19.1%); however, this difference did not reach statistical significance (p = 0.231). Total postoperative tramadol consumption was also lower in the lidocaine group, although no significant difference was observed (p = 0.167). No significant differences were observed in surgical duration (p = 0.064) or hospital length of stay (p = 0.663). **Conclusions:** Intraoperative low-dose intravenous lidocaine infusion was associated with a numerical reduction in postoperative tramadol requirement following laparoscopic cholecystectomy; however, the difference was not statistically significant. These exploratory findings should be interpreted cautiously and warrant confirmation in adequately powered prospective randomized controlled trials.

Keywords: Lidocaine; Laparoscopic Cholecystectomy; Postoperative Pain; Opioid; Enhanced Recovery After Surgery.

1. Introduction

Laparoscopic cholecystectomy is the standard surgical treatment for symptomatic cholelithiasis and benign gallbladder disease¹. Although it is associated with reduced surgical trauma and faster recovery compared with open surgery, postoperative pain

remains a relevant clinical concern. Pain after laparoscopic cholecystectomy is multifactorial and arises from trocar-site incisions, visceral irritation, pneumoperitoneum-related diaphragmatic stretching, and inflammatory responses to surgical trauma. Inadequate pain control may delay mobilization, impair recovery, and reduce patient satisfaction².

While opioids remain an important component of postoperative analgesia, their use is associated with several adverse effects, including nausea and vomiting, sedation, respiratory depression, ileus, and delayed recovery^{3,4}. Consequently, opioid-sparing multimodal analgesic strategies have become a cornerstone of contemporary perioperative care and are strongly recommended within Enhanced Recovery After Surgery (ERAS) protocols⁵.

Intravenous lidocaine has attracted increasing interest as an adjunct to multimodal analgesia because of its analgesic, antihyperalgesic, and anti-inflammatory properties⁶. Previous randomized controlled trials and meta-analyses have suggested that perioperative lidocaine administration may reduce postoperative pain and opioid consumption following abdominal surgery. However, findings in laparoscopic cholecystectomy remain inconsistent, and substantial heterogeneity exists regarding dosing regimens and reported outcomes^{7,8}.

Most available studies have evaluated moderate-to-high lidocaine infusion rates, whereas evidence regarding lower-dose regimens remains limited. In our institution, a lower-dose regimen consisting of a 1.5 mg/kg bolus followed by a 1 mg/kg/h infusion has been used in routine clinical practice at the discretion of the attending anesthesiologist. Therefore, this study aimed to evaluate the association between this low-dose intravenous lidocaine regimen and postoperative tramadol requirement as well as hospital length of stay in patients undergoing elective laparoscopic cholecystectomy.

2. Materials and Methods

This retrospective observational cohort study was conducted at a tertiary-care referral hospital. Medical records of adult patients who underwent elective laparoscopic cholecystectomy under general anesthesia between August 1, 2025 and February 1, 2026 were reviewed.

The study protocol was approved by the Eskişehir City Hospital Clinical Research Ethics Committee (Approval No: ESH/BAEK 2026/346; Date: April 9, 2026). Due to the retrospective nature of the study, the requirement for informed consent was waived. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations.

Patients aged 18 years or older with American Society of Anesthesiologists (ASA) physical status I–III who underwent elective laparoscopic cholecystectomy during the study period were eligible for inclusion. Patients with known hypersensitivity to lidocaine or other perioperative analgesic agents, severe hepatic or renal dysfunction, chronic opioid use, chronic corticosteroid therapy, conversion to open surgery, or incomplete perioperative records were excluded from the analysis. All consecutive eligible patients meeting the study criteria were included in the final cohort.

General anesthesia was induced using intravenous propofol, fentanyl, and rocuronium and maintained with sevoflurane or desflurane according to institutional practice. All patients received a standardized multimodal analgesic regimen consisting of intravenous acetaminophen and a non-steroidal anti-inflammatory drug (NSAID).

Patients were subsequently categorized according to whether intraoperative lidocaine infusion had been administered. The decision to administer intraoperative intravenous lidocaine was made at the discretion of the attending anesthesiologist as part of routine clinical practice, and no predefined study-specific criteria were used for treatment

allocation. In the lidocaine group, patients received an intravenous bolus of 1.5 mg/kg lidocaine immediately after anesthetic induction followed by continuous infusion at 1 mg/kg/h until the completion of surgery. Patients in the control group received the standard multimodal analgesic regimen without lidocaine infusion.

Postoperatively, acetaminophen and NSAID treatment were continued according to institutional protocols. Rescue analgesia was provided with intravenous tramadol according to clinical assessment and routine institutional practice and total tramadol consumption during the first 24 postoperative hours was recorded. No standardized pain-score threshold for rescue tramadol administration was consistently documented in the retrospective records.

Patient data were retrospectively obtained from electronic medical records, anesthesia charts, and the hospital information management system. Demographic variables, including age, sex, body mass index (BMI), ASA physical status classification, smoking status, and comorbid conditions, were recorded. Perioperative variables included surgical duration and length of hospital stay. Postoperative analgesic outcomes were assessed by documenting the requirement for rescue tramadol administration and the total amount of tramadol consumed during the first 24 postoperative hours. Detailed data on cumulative intraoperative opioid consumption, antiemetic administration, and anesthetic depth were not consistently available in the retrospective records and therefore could not be included in the analysis.

The primary outcome of the study was the requirement for postoperative tramadol administration within the first 24 hours following surgery. Secondary outcomes included total postoperative tramadol consumption, length of hospital stay, and surgical duration. These outcomes were selected to evaluate both the opioid-sparing potential of intraoperative lidocaine infusion and its possible contribution to postoperative recovery.

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed variables were expressed as mean $\pm$ standard deviation and compared using the independent samples t-test, whereas non-normally distributed variables were reported as median (minimum–maximum) values and compared using the Mann–Whitney U test. Categorical variables were expressed as frequencies and percentages and analyzed using the Pearson chi-square test or Fisher’s exact test, as appropriate. All statistical tests were two-sided, and a p-value of less than 0.05 was considered statistically significant. For the primary outcome, the effect size was expressed as the relative risk (RR) and absolute risk difference, with corresponding 95% confidence intervals (CIs).

3. Results

A total of 94 patients were included in the final analysis, comprising 47 patients in the control group and 47 patients in the lidocaine group.

Baseline demographic and clinical characteristics are presented in Table 1. The mean age was 50.83 ± 13.41 years in the control group and 53.17 ± 11.91 years in the lidocaine group ($p = 0.374$). Mean body mass index was 28.86 ± 3.38 kg/m² and 28.61 ± 4.16 kg/m² in the control and lidocaine groups, respectively ($p = 0.753$). There were no statistically significant differences between groups regarding sex distribution (32/15 vs. 33/14, $p = 0.821$), ASA physical status ($p = 0.455$), smoking status (14/33 vs. 14/33, $p = 1.000$), or the presence of comorbid diseases (25/22 vs. 24/23, $p = 0.836$).

Table 1. Comparison of Demographic and Clinical Characteristics Between Groups

Variable	Control (n = 47)	Lidocaine (n = 47)	p
Age, years	50.8 ± 13.4	53.2 ± 11.9	0.374*
BMI, kg/m ²	28.9 ± 3.4	28.6 ± 4.2	0.753*
Female sex, n (%)	32 (68.1)	33 (70.2)	0.821**
ASA I/II/III, (n)	15/31/1	12/35/0	0.455**
Smoking, n (%)	14 (29.8)	14 (29.8)	1.000**
Comorbidity, n (%)	25 (53.2)	24 (51.1)	0.836**

* Independent samples *t*-test, ** Chi-square test

Perioperative outcomes are summarized in Table 2. The mean surgical duration was longer in the lidocaine group compared with the control group (76.28 ± 19.90 min vs. 66.70 ± 28.86 min); however, this difference did not reach statistical significance (*p* = 0.064). Likewise, length of hospital stay was similar between groups, with a median duration of 72 hours in both groups [72 (29–240) vs. 72 (25–120) hours, *p* = 0.663].

Postoperative analgesic requirements were also evaluated. Within the first 24 postoperative hours, 9 patients (19.1%) in the control group required rescue tramadol compared with 4 patients (8.5%) in the lidocaine group. The absolute risk difference was –10.6 percentage points (95% CI: –24.4 to 3.2), corresponding to a relative risk of 0.44 (95% CI: 0.15–1.34). The difference was not statistically significant (*p* = 0.231). Similarly, total postoperative tramadol consumption during the first 24 hours tended to be lower in the lidocaine group (overall consumption: 800 mg vs. 1400 mg); however, no statistically significant difference was detected between the groups (*p* = 0.167). Overall, intraoperative low-dose lidocaine infusion showed a numerical trend toward reduced postoperative tramadol requirement and consumption; however, these differences did not reach statistical significance.

Table 2. Perioperative Variables and Postoperative Analgesic Requirements

Outcome	Control (n = 47)	Lidocaine (n = 47)	<i>p</i>
Surgical duration (min)	66.7 ± 28.9	76.3 ± 19.9	0.064*
Length of stay (h)	72 (29–240)	72 (25–120)	0.663**
Patients requiring tramadol, n (%)	9 (19.1)	4 (8.5)	0.231***
Tramadol consumption (mg)	0 (0–200)	0 (0–200)	0.167**

* Independent samples *t*-test, ** Mann–Whitney *U* test, *** Fisher's exact test

4. Discussion

In this retrospective cohort study, we evaluated the association between intraoperative low-dose intravenous lidocaine infusion and postoperative tramadol requirement in patients undergoing elective laparoscopic cholecystectomy. The principal finding of our study was that patients who received lidocaine infusion demonstrated a numerically lower requirement for postoperative tramadol compared with those managed with standard multimodal analgesia alone. Specifically, the proportion of patients requiring rescue tramadol was 8.5% in the lidocaine group compared with 19.1% in the control group. Although the point estimate suggested a lower risk of rescue tramadol use in the lidocaine group (RR, 0.44), the wide 95% confidence interval (0.15–1.34) included the possibility of no effect. Therefore, this finding should be interpreted cautiously and considered

exploratory rather than evidence of treatment efficacy. In contrast, no significant differences were observed with respect to hospital length of stay or surgical duration.

Postoperative pain following laparoscopic cholecystectomy is multifactorial in origin and involves somatic, visceral, and inflammatory components. Despite the minimally invasive nature of the procedure, moderate postoperative pain remains common and may adversely affect early mobilization, oral intake, patient satisfaction, and overall recovery. Consequently, considerable attention has been directed toward opioid-sparing analgesic strategies that can improve postoperative comfort while minimizing opioid-related adverse effects. Within this context, intravenous lidocaine has emerged as a promising adjunct because of its analgesic, antihyperalgesic, and anti-inflammatory properties.

The potential analgesic effects of systemic lidocaine have been attributed to modulation of nociceptive and inflammatory pathways, which may contribute to reduced postoperative analgesic requirements. Therefore, it has been incorporated into several Enhanced Recovery After Surgery (ERAS) pathways^{5,6}.

Our findings are generally consistent with the existing literature evaluating perioperative intravenous lidocaine administration in laparoscopic and abdominal surgery. Randomized controlled trials conducted in patients undergoing laparoscopic cholecystectomy have reported that lidocaine infusion may improve postoperative pain control and reduce opioid requirements. Lauwick et al. demonstrated that intraoperative lidocaine infusion reduced postoperative fentanyl requirements and improved recovery parameters⁹. Similarly, Song et al. reported that perioperative lidocaine administration accelerated postoperative recovery and reduced analgesic requirements³. Shakir et al. observed lower pain scores and reduced rescue analgesic requirements in patients receiving intravenous lidocaine¹⁰. Likewise, Dennis et al. reported a 43% reduction in intraoperative opioid consumption among patients undergoing laparoscopic cholecystectomy who received lidocaine infusion¹¹.

The results of randomized trials are further supported by meta-analyses. Zhao et al. demonstrated that intravenous lidocaine significantly reduced postoperative pain and opioid consumption following laparoscopic cholecystectomy². In one of the most recent systematic reviews and meta-analyses, Awan et al. evaluated 14 studies involving 898 patients and reported that perioperative lidocaine administration was associated with lower opioid requirements and improved postoperative recovery⁸. Taken together, these findings suggest that systemic lidocaine may serve as an effective opioid-sparing component of multimodal analgesic protocols.

Nevertheless, the literature remains heterogeneous, and not all studies have demonstrated similar benefits. Several randomized controlled trials have shown improvements in early postoperative pain scores without significant reductions in postoperative opioid consumption or hospital length of stay. For example, Cho et al. reported that although lidocaine provided beneficial analgesic effects during the immediate postoperative period, these effects became less pronounced during subsequent ward follow-up¹². Similarly, Akelma et al. observed reduced early analgesic requirements but no significant reduction in cumulative opioid consumption during the first 24 postoperative hours¹³. In a randomized controlled trial involving 98 patients, Sarakatsianou et al. reported that intraoperative lidocaine infusion did not significantly reduce postoperative opioid consumption or pain scores after laparoscopic cholecystectomy. The authors suggested that discrepancies among studies may result from heterogeneity in lidocaine dosing protocols, infusion duration, concomitant analgesic regimens, outcome measures, sample sizes, and study designs⁷. These variations indicate that the analgesic efficacy of intravenous lidocaine may not be uniform across all patient populations and perioperative settings and may be influenced by patient selection, dosing regimens, and multimodal analgesic strategies.

One of the noteworthy aspects of our study is the relatively low lidocaine dose utilized. Most studies evaluating lidocaine during laparoscopic cholecystectomy have employed infusion rates ranging from 1.5 to 3 mg/kg/h following an initial loading dose. In contrast, patients in our cohort received a loading dose of 1.5 mg/kg followed by a maintenance infusion of only 1 mg/kg/h. Despite this conservative regimen, a substantial numerical reduction in postoperative tramadol requirement was observed. This numerical trend raises the possibility that lower infusion rates may have an opioid-sparing effect; however, the present study was not sufficiently powered to establish treatment efficacy, and this hypothesis requires confirmation in prospective studies. Although definitive conclusions cannot be drawn from the present study, our findings provide preliminary evidence supporting the feasibility of low-dose protocols in routine clinical practice.

Another important finding was the absence of a significant difference in hospital length of stay between the groups ($p = 0.663$). This result is not unexpected because hospital stay is a complex outcome influenced not only by pain control but also by institutional discharge policies, surgeon preferences, patient expectations, social circumstances, postoperative complications, and healthcare system characteristics. Consequently, interventions that improve analgesia may not necessarily result in shorter hospitalization. Demonstrating such an effect may be particularly challenging in procedures such as laparoscopic cholecystectomy, where baseline hospital stays are already relatively short.

Our findings regarding hospital length of stay are consistent with the heterogeneous results reported in the literature. Li et al. found no significant difference in length of stay between lidocaine and control groups in their meta-analysis¹⁴. Similarly, Zhao et al. reported that lidocaine did not significantly reduce hospital stay². In the Cochrane review, lidocaine was associated with an average reduction of 0.37 days in hospital stay; however, the authors emphasized that this effect was not clinically consistent because of low-quality evidence and wide confidence intervals¹⁵. Although some studies have shown that lidocaine infusion may accelerate postoperative recovery by reducing pain scores and promoting earlier mobilization, these benefits do not always translate into shorter hospitalization. Therefore, length of hospital stay should not be considered a sole indicator of lidocaine efficacy.

Although surgical duration was slightly longer in the lidocaine group than in the control group (76.28 ± 19.90 min vs. 66.70 ± 28.86 min), this difference did not reach statistical significance ($p = 0.064$). Our findings are consistent with previous studies indicating that intravenous lidocaine infusion does not directly affect operative duration. Randomized controlled trials in laparoscopic cholecystectomy have reported comparable operative times between treatment groups^{7,16,17}. Similarly, studies involving patients with higher body mass index (BMI) found no significant differences in operative duration¹¹. These findings support the notion that lidocaine infusion is a safe adjunctive analgesic technique that does not interfere with the technical aspects of surgery and that its primary benefits are related to postoperative pain control and opioid-sparing effects rather than operative efficiency.

The interpretation of our findings also highlights the distinction between statistical significance and clinical significance. Although postoperative tramadol requirement was numerically lower in the lidocaine group, the difference was not statistically significant and the confidence interval around the effect estimate was wide. Therefore, the observed difference should be interpreted cautiously. The present findings should be considered exploratory and hypothesis-generating, and adequately powered prospective studies are needed to determine whether low-dose lidocaine provides a clinically relevant opioid-sparing effect.

Several strengths of the present study should be acknowledged. First, the analysis was performed in a relatively homogeneous surgical population undergoing the same

operative procedure. Second, both groups received comparable multimodal analgesic regimens, allowing a more focused assessment of the contribution of lidocaine infusion. Third, the study provides real-world clinical data regarding a low-dose lidocaine protocol, an area that remains relatively underrepresented in the current literature.

However, certain limitations should be considered when interpreting our findings. The retrospective design introduces an inherent risk of selection bias, information bias, and unmeasured confounding. Furthermore, lidocaine administration was based on the attending anesthesiologist's clinical decision, which may have introduced additional selection bias. Detailed data on cumulative intraoperative opioid consumption, antiemetic administration, and anesthetic depth were not consistently available and therefore could not be compared between groups. These unmeasured perioperative factors may have influenced postoperative analgesic requirements. The study was conducted at a single center and included a relatively small number of patients, limiting both statistical power and generalizability. Furthermore, differences in perioperative analgesic protocols, patient characteristics, and institutional practices across centers may limit the applicability of our findings to other clinical settings and patient populations. Additionally, postoperative pain intensity was not assessed using standardized pain scoring systems such as the Visual Analog Scale (VAS) or Numeric Rating Scale (NRS). Therefore, tramadol requirement should be interpreted as an indirect measure of postoperative analgesic need rather than a direct measure of pain intensity, as rescue analgesic administration may have been influenced by individual pain perception, clinician judgment, and institutional analgesic practices. Information regarding postoperative nausea and vomiting, return of bowel function, patient satisfaction, and quality-of-recovery measures was also unavailable. Future prospective randomized controlled trials incorporating standardized pain and recovery outcomes are needed to further define the role of low-dose lidocaine infusion in laparoscopic cholecystectomy.

5. Conclusion

In conclusion, intraoperative low-dose intravenous lidocaine infusion was associated with a numerical reduction in postoperative tramadol requirement among patients undergoing laparoscopic cholecystectomy; however, this difference did not reach statistical significance. Given the retrospective design and limited sample size, these findings should be considered exploratory and should not be interpreted as evidence of treatment efficacy. Adequately powered prospective randomized controlled trials are needed to determine whether low-dose intravenous lidocaine provides a clinically relevant opioid-sparing benefit in this setting.

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Ethics Committee Approval: This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Eskişehir City Hospital Clinical Research Ethics Committee on April 9, 2026 (Approval No: ESH/BAEK 2026/346).

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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