Indonesian Journal of Anesthesiology and Critical Care Medicine

Journal homepage : https://ijaccm.org

# Effectiveness of Intraperitoneal Lidocaine at 3 mg/kg Body Weight on Postoperative Pain Following Laparoscopic Cholecystectomy Under General Anaesthesia

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ARTICLE INFO

Keyword :
Lidocaine
0.9% NaCl
Intraperitoneal
NRS Score
Laparoscopy
Cholecystectomy

ABSTRACT

***Introduction:*** Laparoscopic cholecystectomy often causes postoperative pain due to $CO_2$ insufflation. Intraperitoneal lidocaine has been proven effective in reducing pain and opioid consumption, although its dosage has not yet been adjusted based on body weight. This study aims to evaluate the effectiveness of 3 mg/kgBW intraperitoneal lidocaine compared to 0.9% NaCl in reducing postoperative pain after laparoscopic cholecystectomy.

***Methods:*** This double-blind randomized controlled trial (RCT) was conducted on 36 patients undergoing laparoscopic cholecystectomy between March 13 and May 14, 2025. Data normality was assessed using the Shapiro-Wilk test due to the sample size being < 50. Statistical analyses included Chi-Square, paired T-test, and multivariate logistic regression to evaluate the effectiveness of lidocaine administration postoperatively.

***Results:*** A significant difference in postoperative NRS scores was found between the lidocaine and control groups (p = 0.003), with significantly lower NRS scores in the lidocaine group. These findings align with previous studies demonstrating that intraperitoneal lidocaine significantly reduces pain scores, analgesic requirements, and postoperative nausea and vomiting. Although less effective, 0.9% NaCl also helps reduce pain by eliminating residual $CO_2$, which irritates the phrenic nerve. These combined factors strengthen the evidence that intraperitoneal irrigation, especially with lidocaine, is effective and safe in managing postoperative pain.

***Conclusion:*** Administration of 3 mg/kgBW intraperitoneal lidocaine is proven to be more effective in reducing postoperative NRS pain scores in patients undergoing laparoscopic cholecystectomy compared to 0.9% NaCl

**Citation:** Ridhuwan AMA, Zainal R, Lestari MI, Liberty IA. Effectiveness of Intraperitoneal Lidocaine at 3 mg/kg Body Weight on Postoperative Pain Following Laparoscopic Cholecystectomy Under General Anesthesia. *Indonesian Journal of Anesthesiology and Critical Care Medicine*.2026;1(2):44-52

## 1. Introduction

Laparoscopic cholecystectomy is a minimally invasive surgical procedure used to remove diseased gallbladders. Since the early 1990s, this technique has replaced the open cholecystectomy approach. The proportion of cholecystectomies performed laparoscopically has increased and it is currently indicated for the treatment of acute or chronic cholecystitis, symptomatic cholelithiasis, biliary dyskinesia, acalculous cholecystitis, gallstone pancreatitis, and gallbladder masses or polyps[1,2] Laparoscopic cholecystectomy is widely performed due to its relative ease and less invasive nature. However, this procedure can cause postoperative pain leading to patient discomfort.[3] Post-laparoscopic cholecystectomy pain has been shown to be a major cause of prolonged hospital stay. The intensity of abdominal discomfort can vary depending on the extent of the surgery and manipulation.[4].

Patients commonly report pain in the back, shoulders, and discomfort at the port incision sites. The peak pain intensity typically occurs within the first few hours postoperatively and usually diminishes after 2 to 3 days.[5] One of the causes of pain after laparoscopy is insufflation of the peritoneum with CO2 and irritation of the phrenic nerves within the peritoneal cavity. The acidic environment created by CO2 dissolution causes peritoneal irritation and damage to the phrenic nerves.[6] Various treatment modalities have been used to alleviate pain after laparoscopic cholecystectomy, including nonsteroidal anti-inflammatory drugs (NSAIDs), opioids, and local anesthetics, but they have not demonstrated consistent efficacy.[7]

Lidocaine is an amino-amide local anesthetic that reduces nerve transmission by blocking sodium channels. This drug provides analgesia, decreases opioid requirements, and alleviates symptoms of nausea and vomiting. It also reduces the risk of ileus when administered as a systemic infusion.[8] Local anesthetics block nociceptive input to the central nervous system, possess anti-inflammatory properties, and are particularly effective in neuropathic pain. Furthermore, selective sympathetic blockade may significantly benefit visceral pain at lower local anesthetic doses. A meta-analysis conducted by Zhao et al. in 2018, encompassing five randomized controlled trials (RCTs) with a total of 274 patients, concluded that there were significant differences in visual analogue scale (VAS) pain scores and opioid consumption at 12, 24, and 48 hours postoperatively ($p < 0.05$) following laparoscopic cholecystectomy. Intravenous lidocaine infusion significantly reduced postoperative pain scores and opioid consumption. Additionally, the lidocaine group experienced fewer side effects.[9]

The administration of local anesthetics intraperitoneally has been shown to reduce postoperative pain.[10] Instillation of local anesthetics into the peritoneal cavity can be used to alleviate discomfort after laparoscopic surgery as an opioid-sparing alternative.[11] Yang et al. (2013) reported that intraperitoneal lidocaine significantly reduced postoperative pain and opioid consumption in patients undergoing laparoscopic cholecystectomy compared to control infusion.[12] Kang et al. (2002) found that VAS and Verbal Rating Scale (VRS) scores were significantly lower in the 200 mg lidocaine group compared to the control group (normal saline 0.9%, 200 mL) at 0–24 hours postoperatively ($p < 0.05$). Intraperitoneal lidocaine significantly decreased shoulder and abdominal pain during the first 24 hours after laparoscopic cholecystectomy.[13]

Research by Shady et al. (2018) concluded that incisional and intraperitoneal lidocaine infiltration is an easy, safe, cost-effective, and non-invasive method providing effective analgesia during the early postoperative period and facilitating early recovery after laparoscopic surgery. Their study demonstrated significant pain reduction at 1, 2, 4, and 8 hours postoperatively as measured by VAS in the group receiving subcutaneous injection of 2% lidocaine HCl (1 mL at each

port site) combined with intraperitoneal injection of 2% lidocaine (10 mL, 200 mg) in 50 mL normal saline before and after incision, compared to the group receiving routine postoperative care and intraperitoneal saline irrigation (50 mL).[14]

Another study by Kiany et al. (2022) reported that intraperitoneal administration of 5 mL 2% lidocaine after laparoscopic cholecystectomy led to greater postoperative pain reduction and was associated with lower analgesic consumption compared to subcutaneous injection of 1.5 mL 2% lidocaine at port sites.[15] Previous studies comparing intravenous and intraperitoneal lidocaine administration during hysterectomy have demonstrated significant reductions in VAS scores with both methods.

Drug absorption across the peritoneum (intraperitoneal) is influenced by factors such as drug dosage, physicochemical properties, and peritoneal characteristics, including body surface area, which correlates with body weight.[16] Previous studies on the effects of intraperitoneal lidocaine on postoperative pain following laparoscopic cholecystectomy have used heterogeneous lidocaine doses not normalized to body weight. This study aims to analyze the effectiveness of intraperitoneal lidocaine dosed at 3 mg/kg body weight on pain after laparoscopic cholecystectomy.[17]

Previous studies evaluating intraperitoneal lidocaine for postoperative pain management after laparoscopic cholecystectomy have used heterogeneous fixed doses, commonly ranging from 100 to 200 mg, without adjustment for patient body weight. Such an approach may result in underdosing or overdosing, potentially affecting both analgesic efficacy and safety. Considering that drug absorption across the peritoneum is influenced by body surface area and body weight, a weight-adjusted dosing strategy may provide more consistent analgesic effects.[13–16] Therefore, this study aims to evaluate the effectiveness of intraperitoneal lidocaine administered at a dose of 3 mg/kg body weight compared to 0.9% NaCl in reducing postoperative pain following laparoscopic cholecystectomy.

## 2. Methods

This study is a double-blind randomized controlled trial designed to evaluate the effectiveness of intraperitoneal lidocaine administration at a dose of 3 mg/kg body weight in reducing postoperative pain following laparoscopic cholecystectomy, as measured by the Numeric Rating Scale (NRS). The study was conducted at the Central Surgical Installation of Mohammad Hoesin Hospital, Palembang, from March 13 to May 14, 2025, following approval from the Research Ethics Committee and institutional permissions. The study population comprised adult patients aged 18 to 65 years with ASA physical status I–II who met the inclusion criteria and none of the exclusion criteria, which included a history of lidocaine allergy, pregnancy, previous laparotomy, or contraindications to lidocaine such as complete heart block or significant organ disease. Consecutive sampling was used to recruit a minimum of 36 subjects to account for potential dropouts.

The sample size was determined based on feasibility during the study period rather than a formal a priori power calculation. A total of 36 subjects (18 per group) were included, which is comparable to previous randomized controlled trials evaluating intraperitoneal lidocaine in laparoscopic cholecystectomy. This limitation is acknowledged and discussed accordingly.

Randomization was performed using a computer-generated non-block randomization method by a research assistant, allocating subjects into two groups: the intervention group receiving intraperitoneal lidocaine at 3 mg/kg diluted to 20 mL with 0.9% NaCl, and the control

group receiving 20 mL of 0.9% NaCl. Drug administration was performed by the surgeon via the trocar immediately prior to trocar removal at the end of surgery. Both patients and investigators were blinded to group allocations. Pain assessment using the Numeric Rating Scale (NRS) was conducted pre-induction and once in the early postoperative period, specifically in the post-anesthesia care unit (PACU) when patients achieved an Aldrete score ≥9, approximately 1–2 hours after surgery. Confounding variables such as age, gender, duration of surgery, intraoperative opioid dose, and postoperative analgesic use were also collected for further analysis.

Data were analyzed using SPSS version 26. Normality testing was performed using the Shapiro–Wilk test. Continuous variables were analyzed using independent t-test or Mann–Whitney U test as appropriate, while categorical variables were analyzed using Chi-square or Fisher's exact test. Changes in NRS scores within each group were analyzed using the Wilcoxon test. Although multivariate analysis was initially planned, it was not performed due to the limited sample size and the absence of statistically significant confounders in bivariate analysis. Statistical significance was set at $p < 0.05$. Adverse events such as nausea, vomiting, respiratory depression, and signs of local anesthetic systemic toxicity were monitored and managed according to established protocols. This rigorous study design aims to provide robust scientific evidence regarding the analgesic efficacy of intraperitoneal lidocaine in laparoscopic cholecystectomy.

## 3. Results

The randomized double-blind controlled trial was conducted at the Central Surgical Installation of Mohammad Hoesin Hospital, Palembang, to evaluate the effectiveness of intraperitoneal lidocaine administration compared to 0.9% NaCl on postoperative pain measured by Numeric Rating Scale (NRS) after laparoscopic cholecystectomy. Thirty-eight patients meeting inclusion and exclusion criteria were enrolled; however, two patients were excluded from the study—one due to conversion to open cholecystectomy and another requiring ICU care postoperatively—resulting in 36 participants analyzed.

The majority of subjects were female (69.4%), classified as ASA I (63.9%), had no intraoperative adhesions (83.3%), and all received postoperative analgesics. The mean age was 47.42 years, mean body weight 61.78 kg, mean preoperative NRS score 3.75, mean operative time 80.92 minutes, and median intraoperative opioid dose was 200 mcg. Baseline demographic and clinical characteristics were comparable between the lidocaine group (n=18) and control group (n=18), with no significant differences in age, sex, ASA status, body weight, operative time, presence of adhesions, intraoperative opioid dose, or preoperative pain scores.

**Table 1.** Characteristics of Subjects Undergoing Laparoscopic Cholecystectomy

| Characteristics | Value |
|---|---|
| Age | |
| - Mean ± SD | 47.42 ± 11.41 years |
| - Median | 48.0 years |
| - Range (Min-Max) | 20-64 years |
| Gender | |
| - Male | 11 (30.6%) |
| - Female | 25 (69,4%) |
| ASA Physical Status | |
| - I | 23 (63,9%) |
| - II | 13 (36,1%) |
| Body Weight | |

| | |
|---|---|
| - Mean ± SD | 61.78 ± 10.32 jg |
| - Median | 62.0 kg |
| - Range (Min-Max) | 38-90 kg |
| Operation Duration | |
| - Mean ± SD | 80.92 ± 17.69 minutes |
| - Median | 75.0 minutes |
| - Range (Min-Max) | 60-120 minutes |
| Intraoperative Adhesions | |
| - Present | 6 (16.7%) |
| - Absent | 30 (83.3%) |
| Intraoperative Opioid Dose | |
| - Mean ± SD | 200 ± 0 mcg |
| - Median | 0.0 mcg |
| - Range (Min-Max) | 200-200 mcg |
| Postoperative Analgesic Status | |
| - Received | 36 (100) |
| - Not received | 0 (0) |
| Preoperative NRS Score | |
| - Mean ± SD | 3.75 ± 1.13 |
| - Median | 4.0 |
| - Range (Min-Max) | 2-6 |
| Preoperative Pain Degree | |
| - Mild pain | 16 (44.4) |
| - Moderate pain | 20 (55.6) |

Categorical data are presented as numbers and percentages (%), while numerical data are presented as mean ± SD, median, and range.

Table 2. Distribution of Study Subject Characteristics Based on Treatment Groups

| Characteristics | Lidocain n (%) | Control n (%) | P Value |
|---|---|---|---|
| Age (years) | 49.96 ± 9.25 | 45.78 ± 13.29 | 0.396[a] |
| Gender | | | |
| - Male | 6 (33.3%) | 5 (27.8%) | 0.131[b] |
| - Female | 12 (66.7%) | 13 (72.2%) | |
| Body Weight (kg) | 65.06 ± 11.64 | 58.50 ± 7.80 | 0.055[a] |
| Operation Duration (minutes) | 75.0 (60-120) | 85.0 (60-120) | 0.650[c] |
| Intraoperative Adhesions | | | |
| - Present | 4 (22.2%) | 2 (11.1%) | 0.658[d] |
| - Absent | 14 (77.8%) | 16 (88.9%) | |
| Intraoperative Opioid Dose (mcg) | 200 (200-200) | 200 (200-200) | - |
| Postoperative Analgesic Use | | | |
| - Yes | 18 (100%) | 18 (100%) | - |
| - No | 0 (0%) | 0 (0%) | |
| Preoperative NRS Score | 4 (2-6) | 3 (2-6) | 0.584[b] |
| Preoperative Pain Severity | | | |
| - Mild Pain | 6 (33.3%) | 10 (55.6%) | 0.180[b] |
| - Moderate Pain | 12 (66.7%) | 8 (44.4%) | |

a. Independent t-test; b. Chi-square test; c. Mann-Whitney test; d. Fisher's exact test

*Significant if p ≤ 0.05

Analysis of NRS score changes showed a statistically significant reduction from pre- to postoperative scores in both groups ($p < 0.001$ for lidocaine group; $p = 0.002$ for control group). However, postoperative pain scores were significantly lower in the lidocaine group compared to controls (median NRS 2 vs. 3; $p = 0.003$), indicating superior analgesic efficacy of intraperitoneal lidocaine.

Table 3. Analysis of NRS Changes from Pre-Operative to Post-Operative in Each Treatment

| Variable | NRS | | P Value |
|---|---|---|---|
| | Pre-Operative | Post-Operative | |
| Lidocaine | 4.0 (2-6) | 2.0 (0-3) | <0.001* |
| Control | 3.0 (2-6) | 3.0 (1-4) | 0.002* |

*Wilcoxon Test, *significant if p<0.05

Table 4. Analysis of Differences in NRS and Post-Operative Pain Levels Between Treatments

| Variable | Group | | P Value |
|---|---|---|---|
| | Lidocaine | Control | |
| NRS Post-Operative | 2.0 (0-3) | 3.0 (1-4) | 0.003* |
| Pre-Operative Pain Levels | | | |
| - No Pain | | | |
| - Mild Pain | 4(22.2) | 0 (0) | |
| - Moderate Pain | 14 (77.8) | 15 (83.3) | |
| | 0 (0) | 3 (16.7) | |

*Mann Whitney Test, *significant if p<0.05

No adverse events related to the interventions were observed in either group, including no occurrences of altered consciousness, hemodynamic instability, arrhythmias, allergic reactions, nausea, vomiting, or seizures. These findings suggest that intraperitoneal lidocaine at 3 mg/kg diluted in 0.9% NaCl is a safe and effective method to reduce postoperative pain following laparoscopic cholecystectomy.

## 4. Discussion

This study involved 36 subjects, with a majority being female (69.4%), and most classified as ASA physical status I (63.9%). The majority of patients did not have intraoperative adhesions (83.3%) and all received postoperative analgesics. The mean age of participants was 47.42 years, with an average body weight of 61.78 kg, a preoperative NRS pain score of 3.75, an average operative duration of 80.92 minutes, and a uniform intraoperative opioid dose of 200 mcg. These characteristics align with previous epidemiological data reported by Bray et al. and Alves et al., where females predominated in laparoscopic cholecystectomy populations, and the most affected age group was in the mid-40s to mid-50s. The demographic similarities support the representativeness of the sample within the context of laparoscopic cholecystectomy patients.[18,19]

Randomization in this trial was successfully implemented, resulting in two comparable groups with no significant differences in baseline characteristics such as age, gender, ASA status, body weight, operative time, preoperative NRS scores, and presence of adhesions. This balanced distribution reduces the risk of selection bias and confounding, strengthening the internal validity of the study findings. Both groups uniformly received postoperative analgesics, further standardizing postoperative management.[20]

The core finding of this study is that intraperitoneal lidocaine at 3 mg/kg significantly reduced postoperative pain intensity measured by NRS compared to the control group receiving 0.9% NaCl.

These results are consistent with previous studies evaluating local anesthetics for pain management after laparoscopic cholecystectomy. For example, Ahmed et al. reported that intraperitoneal lidocaine decreased abdominal pain scores and opioid consumption more effectively than saline or other local anesthetics within the first 24 hours postoperatively.[21] Yang et al. similarly demonstrated that intraperitoneal lidocaine lowered total postoperative pain severity, reduced fentanyl use, and improved patient satisfaction compared to controls, supporting the notion that this route and dosage are clinically beneficial.[12] Khan et al.'s findings, showing comparable efficacy between lidocaine and bupivacaine, reaffirm lidocaine as a viable, effective option in this context.[22]

The analgesic effect of lidocaine is likely mediated through its inhibition of sodium channels, reducing nerve excitability, and by mitigating the phrenic nerve irritation caused by carbon dioxide insufflation during laparoscopy—a principal mechanism underlying postoperative shoulder and abdominal pain. Lidocaine's local anti-inflammatory properties may further contribute to improved pain outcomes.[23,24]

Interestingly, the control group receiving intraperitoneal 0.9% NaCl also exhibited a statistically significant, though lesser, reduction in pain scores. This analgesic effect is attributed to saline's potential to facilitate removal of residual carbon dioxide from the subdiaphragmatic region, thereby decreasing chemical irritation and referred pain mediated by the phrenic nerve. Several studies corroborate the role of intraperitoneal saline irrigation in attenuating postoperative pain and discomfort following laparoscopic procedures.[24,25]

The effectiveness of intraperitoneal lidocaine relative to saline was highlighted by the significant difference in postoperative NRS scores between the two groups, underscoring the added benefit of the local anesthetic agent. This difference, combined with the absence of adverse effects in either group, points to lidocaine's safety and tolerability in this application.

Regarding safety, lidocaine administered intraperitoneally at a dose of 3 mg/kg body weight remains within the established safety threshold. The generally accepted maximum safe dose of lidocaine without epinephrine is 4.5 mg/kg. Intraperitoneal administration results in gradual systemic absorption, leading to lower peak plasma concentrations compared to intravenous administration.[8,23] In this study, no signs of local anesthetic systemic toxicity, such as neurological symptoms, cardiac arrhythmias, or hemodynamic instability, were observed, supporting the safety of this dosing regimen.

This study has several limitations. First, postoperative pain was assessed at a single early postoperative time point, which may not reflect pain trajectories over longer follow-up periods. Second, the relatively small sample size and single-center design may limit generalizability. Future studies with larger sample sizes and repeated postoperative pain assessments are recommended to further validate these findings.

## 5. Conclusion

The majority of patients undergoing laparoscopic cholecystectomy in this study were female (69.4%), classified as ASA I (63.9%), had no intraoperative adhesions (83.3%), and all received postoperative analgesics. The mean age was 47.42 years, mean body weight 61.78 kg, preoperative median NRS scores were 4 in the lidocaine group and 3 in the control group. Postoperatively, the median NRS score decreased to 2 in the lidocaine group while remaining 3 in the control group. Both groups showed a significant reduction in NRS scores from preoperative to postoperative

assessments. Importantly, the postoperative NRS score was significantly lower in the lidocaine group compared to the control group, indicating that intraperitoneal lidocaine effectively reduces postoperative pain following laparoscopic cholecystectomy.

**Funding**

None

**Ethics Aprroval**

Ethical approval for this study was obtained from the Institutional Research Ethics Committee and the relevant institutional authorities of Mohammad Hoesin Hospital.

**Acknowledgments**

None

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