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Effect of Intraoperative Lidocaine vs. Dexmedetomidine Infusion on Postoperative Opioid Use in Laparoscopic Cholecystectomy

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ABSTRACT

Background: Laparoscopic cholecystectomy is a commonly performed abdominal procedure associated with significant postoperative pain that is often treated with opioids, resulting in delayed recovery and adverse effects. The objective of this study was to compare the intraoperative intravenous lidocaine infusion versus dexmedetomidine infusion on postoperative opioid requirement in patients undergoing laparoscopic cholecystectomy under general anaesthesia. **Methods:** A total of 300 ASA class I-II adults aged 18-60 years, scheduled for elective laparoscopic cholecystectomy were randomized into two groups: Group L (lidocaine) received a 1.5 mg/kg bolus followed by 2 mg/kg/h infusion, and Group D (dexmedetomidine) received a 1 ug/kg loading followed by 0.5 ug/kg/h infusion. Statistical analysis was performed by t-test and chi-square using SPSS v26 with a $p < 0.05$ for significance level

Results: Lidocaine significantly decreased 24-hour opioid consumption (12.6 ± 4.1 mg versus 15.8 ± 4.7 mg, $p < 0.001$). Pain scores were lower at 6 hours (3.2 ± 0.9 vs. 3.8 ± 1.0, $p = 0.001$) and 24 hours (2.5 ± 0.8 vs. 3.1 ± 0.9, $p < 0.001$). Extubation time was shorter with lidocaine (9.4 ± 2.1 vs. 11.2 ± 2.6 min, $p < 0.001$). The incidence of PONV, 23 (15.3%) vs. 41 (27.3%), $p = 0.10$, and post-anaesthesia care unit (PACU) stay (42.5 ± 8.7 vs. 44.1 ± 9.2 min, $p = 0.31$) were not significantly different.

Conclusion: Intraoperative intravenous lidocaine infusion resulted in superior opioid-sparing and analgesic effects compared to dexmedetomidine, supporting its use as a valuable adjunct.

Keywords: Cholecystectomy, Laparoscopic, Dexmedetomidine, Anaesthesia, General, Lidocaine, Pain, Postoperative.

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INTRODUCTION

Laparoscopic cholecystectomy is one of the most common abdominal procedures worldwide, associated with significant postoperative pain that usually requires the use of opioids, raising concerns of nausea, vomiting, sedation, and dependence [1]. Seeking effective opioid-sparing analgesics, there has been increased attention on systemic adjuncts such as intravenous lidocaine and dexmedetomidine for perioperative analgesia [2].

Intravenous lidocaine infusion has been shown to have multi-modal effects, including analgesic, anti-hyperalgesic, and anti-inflammatory effects, with evidence of decreased opioid use and shortened length of hospital stay in abdominal surgical cases [3]. Lidocaine has also been added to enhanced recovery after surgery (ERAS) protocols and shown to improve bowel recovery and decrease postoperative ileus [4]. In addition, its mechanism is related to sodium channel blockade and central desensitization, which reduces nociceptive transmission and causes opioid sparing [5].

Dexmedetomidine, an α2-agonist, is a sedative, anxiolytic, and analgesic agent that lacks respiratory depression and hence is an attractive adjuvant in general anaesthesia [6]. Clinical trials have shown that intraoperative dexmedetomidine attenuates perioperative opioid dose and improves quality of recovery, but its long-lasting sedative effect may delay extubation [7]. Meta-analyses show its effectiveness in reducing postoperative pain scores, but with inconsistent incidence regarding hemodynamic stability [8].

Although both agents have been tested individually in the setting of laparoscopic cholecystectomy, there is little direct comparative evidence. Pooled analyses indicate that intravenous lidocaine may result in earlier mobilization and lower pain scores, and that dexmedetomidine has greater sedation but less consistent analgesic benefit [9]. A study compared lidocaine with dexmedetomidine in laparoscopic cholecystectomy and found that lidocaine better reduced opioid consumption, but dexmedetomidine had superior hemodynamic stability [10]. Furthermore, combined infusion regimens are under investigation, with preliminary studies showing additive analgesic effects and recovery profiles [11].

Despite a growing body of evidence, there is still controversy regarding the relative superiority of lidocaine over dexmedetomidine as the preferred intraoperative adjunct. Existing studies have a wide range of sample sizes, infusion protocols, and outcome endpoints, restricting generalizability. This discrepancy is further emphasized in the South Asian setting, where publications on opioid-sparing techniques during laparoscopic cholecystectomy are limited, and practice patterns remain variable [12]. Given the growing burden of surgical cases and the detrimental impact of opioid dependence, a local head-to-head comparison in a tertiary care setting is justified [13]. Beyond analgesia, both agents may have clinical relevance in hemodynamic variables, extubation time, and postoperative nausea and vomiting, which in turn impact patient recovery and hospital resource utilization [14].

This study aims to compare intraoperative intravenous lidocaine infusion versus dexmedetomidine infusion in patients undergoing laparoscopic cholecystectomy under general anaesthesia. The primary outcome measure is to compare the patients' postoperative opioid consumption in the two groups. Secondary objectives are to evaluate pain scores, postoperative nausea and vomiting, and recovery profiles to guide evidence-based opioid sparing strategies for surgical anaesthesia.

METHODS

This comparative cross-sectional study was conducted to compare the effect of intraoperative intravenous lidocaine infusion versus dexmedetomidine infusion on postoperative opioid requirement in patients undergoing laparoscopic cholecystectomy under general anaesthesia. It was carried out in the Department of Anaesthesia, Fatima Memorial Hospital, over six months from September 2024 to February 2025, after obtaining ethical approval (vide letter no. FMH-26/04/2024-1RB-1396, dated August 22, 2024). All the participants provided written informed consent.

A total of 300 patients were enrolled through non-probability consecutive sampling, with 150 included in each group. The sample size was calculated using OpenEpi version 3.0.0 (released 2013, Atlanta, GA, USA), based on 80% power, 95% confidence interval, assuming a clinically significant mean difference between groups to be 20% in 24-hour opioid consumption, with the standard deviation from previous trials. A minimum sample size of 132 (66 per group) was required. To achieve greater statistical power, allow for drop-out, and improve subgroup analysis, the final sample size was determined to be 300 patients (150 per group) [15].

Eligible participants were adult patients aged 18–60 years of either gender, classified as American Society of Anesthesiologists (ASA) physical status I or II, and scheduled for laparoscopic cholecystectomy under general anaesthesia. Patients with hypersensitivity to local anaesthetics or dexmedetomidine, cardiovascular disease, hepatic or renal impairment, drug or alcohol dependence, chronic pain or regular use of analgesics, uncontrolled diabetes or hypertension, or intake of non-steroidal anti-inflammatory drugs within 24 hours before surgery were excluded.

Baseline variables such as age, sex, body mass index, ASA class, and surgical indication were recorded on a structured proforma. Group A received intravenous lidocaine comprising a bolus dose of 1.5 mg/kg infused slowly over 10 minutes, administered 30 minutes before incision, followed by continuous infusion at 2 mg/kg/h via infusion pump until the end of surgery. Group B was given dexmedetomidine with a loading dose of 1 µg/kg over 10 minutes, followed by continuous infusion at 0.5 µg/kg/h until completion of surgery. No additional local anaesthetic was administered perioperatively. Postoperative pain was measured by the visual analogue scale (VAS) at 6 and 24 hours, and opioid requirement was converted to intravenous morphine equivalents. Secondary outcomes were postoperative nausea and vomiting (PONV) rate, extubation time, and post-anaesthesia care unit (PACU) stay.

Data were analysed using SPSS version 26.0 (released 2019, IBM Corp., Armonk, NY). Continuous variables were compared using t-tests, and categorical data using chi-square tests. Effect sizes were presented as mean difference (MD) or odds ratio (OR) with 95% confidence interval (CI). $P < 0.05$ was defined as statistically significant.

RESULTS

Table 1: Demographical and Clinical Characteristics of Study Participants

Variable	Group L (Lidocaine) (n=150)	Group D (Dexmedetomidine) (n=150)	Test Used	Test Value	p-value
Age (years, mean ± SD)	42.1 ± 10.8	41.6 ± 11.2	Independent t-test	t = 0.25	0.80
Gender (Male)	64 (42.7%)	59 (39.3%)	Chi-square test	χ^2 = 0.06	0.81
BMI (kg/m², mean ± SD)	26.4 ± 3.1	26.1 ± 3.5	Independent t-test	t = 0.48	0.63
ASA Physical Status (I / II)	86 (57.3%) / 64 (42.7%)	82 (54.7%) / 68 (45.3%)	Chi-square test	χ^2 = 0.12	0.72
Smoking status (Yes/No)	27 (18.0%) / 123 (82.0%)	32 (21.3%) / 118 (78.7%)	Chi-square test	χ^2 = 0.17	0.68
Hypertension (Yes/No)	25 (16.7%) / 125 (83.3%)	30 (20.0%) / 120 (80.0%)	Chi-square test	χ^2 = 0.20	0.65
Diabetes mellitus (Yes/No)	18 (12.0%) / 132 (88.0%)	20 (13.3%) / 130 (86.7%)	Chi-square test	χ^2 = 0.06	0.80
Duration of surgery (min)	75.8 ± 12.6	76.4 ± 11.9	Independent t-test	t = –0.28	0.78

*n = Number of participants, BMI = Basal Metabolic Index, ASA = American Society of Anaesthesiologist Physical Status Classification System, SD = Standard Deviation, % = Percentage, * = Statistical significance at <0.05*

A total of 300 patients were evaluated for the comparison of intraoperative intravenous lidocaine and dexmedetomidine infusion during laparoscopic cholecystectomy. Baseline demographics and clinical variables were balanced between groups. Lidocaine substantially decreased 24-hour opioid consumption and postoperative pain scores compared with dexmedetomidine. No significant differences were found regarding PONV or rescue antiemetics, and extubation time was shorter with lidocaine. These results indicate the use of lidocaine as an effective opioid-sparing technique. Demographical and clinical characteristics of the study population are presented in **Table 1**.

Table 2: Intraoperative and Postoperative Clinical Parameters

Variable	Group L (n=150)	Group D (n=150)	Test Used	Test Value	p-value
Mean intraoperative HR (bpm)	82.5 ± 7.2	78.6 ± 6.9	Independent t-test	t = 3.09	0.002*
Mean intraoperative MAP (mmHg)	84.2 ± 5.8	82.7 ± 6.0	Independent t-test	t = 1.45	0.15
Extubation time (min)	9.4 ± 2.1	11.2 ± 2.6	Independent t-test	t = –4.11	<0.001*
PACU stay (min)	42.5 ± 8.7	44.1 ± 9.2	Independent t-test	t = –1.01	0.31

*n = Number of participants, HR = Heart Rate, MAP = Mean Arterial Pressure, PACU = Post-Anesthesia Care Unit, SD = Standard Deviation, * = Statistical significance at <0.05*

Baseline demographics and clinical variables were similar between groups, including age (42.1 ± 10.8 vs 41.6 ± 11.2 years, p=0.80), gender (p=0.81), BMI (p=0.63), ASA status, smoking status, hypertension, diabetes, and operative duration (p = 0.78), implying that groups were similar with reduced confounding. **Table 2** illustrates the intraoperative and postoperative clinical features of the study participants.

Table 3: Postoperative Outcomes (Primary and Secondary Endpoints)

Outcome	Group L (n=150)	Group D (n=150)	Effect Size (95% CI)	Test Used	Test Value	p-value
24h opioid consumption (mg morphine eq)	12.6 ± 4.1	15.8 ± 4.7	MD = –3.2 (–4.8 to –1.6)	Independent t-test	t = –4.31	<0.001*

VAS pain score at 6h (mean ± SD)	3.2 ± 0.9	3.8 ± 1.0	MD = –0.6 (–0.9 to –0.3)	Independent t-test	t = –3.33	0.001*
VAS pain score at 24h (mean ± SD)	2.5 ± 0.8	3.1 ± 0.9	MD = –0.6 (–0.9 to –0.3)	Independent t-test	t = –3.76	<0.001*
PONV incidence (n, %)	23 (15.3%)	41 (27.3%)	OR = 0.48 (0.20–1.17)	Chi-square test	χ^2 = 2.63	0.10
Rescue antiemetic use (n, %)	14 (9.3%)	32 (21.3%)	OR = 0.37 (0.13–1.06)	Chi-square test	χ^2 = 3.62	0.057

*n = Number of participants, VAS = Visual Analogue Scale, PONV = Postoperative Nausea and Vomiting, MD = Mean Difference, OR = Odds Ratio, CI = Confidence Interval, SD = Standard Deviation, % = Percentage, * = Statistical significance at <0.05*

Lidocaine was associated with a slightly higher intraoperative HR (82.5 ± 7.2 vs. 78.6 ± 6.9 bpm, p = 0.002), whereas MAP was similar (p = 0.15). Extubation time was shorter with lidocaine (9.4 ± 2.1 vs. 11.2 ± 2.6 min, p < 0.001), and PACU stay was not significantly different (p = 0.31). These results highlight that lidocaine was associated with a more rapid recovery without loss of stability. Postoperative outcomes, including primary and secondary endpoints, are indicated in **Table 3**.

Lidocaine significantly decreased the 24h opioid consumption (12.6 ± 4.1 vs 15.8 ± 4.7 mg, p < 0.001), and lowered VAS pain score at 6h (3.2 ± 0.9 vs 3.8 ± 1.0, p = 0.001) and 24h (2.5 ± 0.8 vs 3.1 ± 0.9, p < 0.001). Lidocaine resulted in lower PONV, 23 (15.3%) vs. 41 (27.3%), p = 0.10, and antiemetic use, 14 (9.3%) vs. 32 (21.3%), p = 0.057, but these differences were not significant, suggesting that lidocaine offered better analgesia and opioid-sparing effects with trends toward reduced PONV.

DISCUSSION

The objective of this study was to compare the relative efficacy of intraoperative intravenous lidocaine infusion to dexmedetomidine infusion on postoperative opioid requirements in patients undergoing laparoscopic cholecystectomy under general anaesthesia. The results support that lidocaine has a more potent opioid-sparing effect than dexmedetomidine, with further advantages in terms of pain relief and recovery profiles.

Patients treated with lidocaine needed significantly less opioids and had lower postoperative pain scores than those receiving dexmedetomidine. These observations are consistent with randomized trials showing that lidocaine infusion increases analgesia and reduces opioid consumption in abdominal surgeries, especially in the context of enhanced recovery protocols [16]. Another study found that lidocaine infusion not only decreased the need for opioids but also resulted in improved patient satisfaction with recovery from minimally invasive procedures [17]. Lidocaine was also shown to reduce time to ambulation and hospital discharge, demonstrating greater quality of recovery from trials of laparoscopic cholecystectomy [18].

Dexmedetomidine, however, showed less consistent analgesic effect depending on the doses, which is consistent with meta-analyses showing that while providing sedation and hemodynamic stability, it is not always associated with reduced postoperative opioid requirements [19]. In a multicenter trial, dexmedetomidine delayed extubation time due to its sedative effect, which is comparable to our observation of shorter emergence with lidocaine [20]. In contrast, some studies have suggested that dexmedetomidine was effective in reducing intraoperative opioid use, although this was often offset by bradycardia and hypotension [21].

A randomized controlled trial comparing lidocaine and dexmedetomidine during laparoscopic cholecystectomy reported that lidocaine is better at reducing the need for opioids and pain scores [22]. Another study showed similar findings, with lidocaine being better at improving gastrointestinal recovery and decreasing ileus compared with dexmedetomidine, which showed little effect on bowel function [23]. Conversely, a study showed the benefit of dexmedetomidine in blunting the stress response during pneumoperitoneum, which was not studied in our trial but is of hemodynamic interest [24].

While most of the evidence favors lidocaine, there are discrepancies. A study concluded that dexmedetomidine provided similar analgesia to lidocaine in gynecologic laparoscopy and that the surgical setting and patient characteristics might be determinants of outcome [25]. Likewise, some authors suggested that dexmedetomidine is more effective in patients with greater baseline anxiety because of its anxiolytic properties, while lidocaine is mainly analgesic [26]. These differences highlight the need for the choice of agent to be tailored to both surgical and patient factors.

The results of this study have clinical implications. Lidocaine is cheap, accessible, and easily integrated into ERAS pathways, making it an attractive option for resource-limited settings. Prior studies have consistently shown it to be an effective modality at improving postoperative recovery profiles, and thus should be adopted as a first-line opioid-sparing adjunct [27,28]. At a systems level, there is a core importance of preventing errors in dosing and infusion protocols, as demonstrated by studies on prescription accuracy and safety in clinical practice [29]. Furthermore, incorporating lidocaine into the standard perioperative regimen is also consistent with personalized medicine strategies, such as biomarker predictions of analgesic response [30,31].

Resistance to adopting pain-sparing techniques is comparable to trends observed in other clinical studies due to patients' and clinicians' beliefs [32]. The necessity of thorough preoperative evaluation is further highlighted by the fact that comorbidities, including chronic illnesses and renal impairment, may change drug metabolism and postoperative results [33]. Furthermore, an increased awareness of multi-organ contributions to pain and recovery (e.g., neurotrophin-mediated pathways) emphasizes the complexity of perioperative physiology beyond pain [34]. Finally, the co-existence of respiratory comorbidities, including asthma, influences the selection of anaesthetic drugs, and safety information from community pharmacy management of asthma is pertinent to perioperative practice [35].

Limitations of this research include its single-center design, which may limit generalizability, and a cross-sectional study design, which cannot determine causal associations. Confounding factors such as baseline psychological state, preoperative opioid exposure, and minor differences in intraoperative anaesthetic practice were not adequately addressed. Non-probability consecutive sampling may also cause selection bias, making the study population less representative of the overall population. Furthermore, we did not include biomarker-based predictive factors of analgesic response, which could have improved mechanistic insight into outcomes. Future studies should include multicenter randomized controlled trials in diverse populations, include longitudinal follow-up for chronic postsurgical pain, and evaluation of individualized multimodal regimens including lidocaine, among other non-opioid analgesics, to optimize recovery after laparoscopic cholecystectomy.

CONCLUSION

This study showed that intraoperative intravenous lidocaine infusion significantly reduced postoperative opioids and pain scores and allowed for earlier extubation than dexmedetomidine in patients undergoing laparoscopic cholecystectomy. These findings directly address this primary objective of the study and support the superiority of lidocaine as an effective opioid-sparing adjunct in this operative setting. The results also confirm the clinical importance of lidocaine to facilitate faster recovery without hemodynamic compromise.

The implications are of special significance for improved recovery protocols and for reducing opioid-related complications in resource-limited healthcare systems. Lidocaine is cost-effective and safe, making it an ideal product for routine perioperative use. Future research should involve multicenter, randomized studies with larger and more diverse populations, evaluate long-term outcomes such as chronic postsurgical pain, and investigate biomarker-guided individualized analgesic strategies.

LIST OF ABBREVIATIONS

ASA	American Society of Anesthesiologists
ERAS	Enhanced Recovery After Surgery
MAP	Mean Arterial Pressure
PACU	Post-Anaesthesia Care Unit
PONV	Postoperative Nausea and Vomiting

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CONFLICT OF INTEREST

None

ETHICAL APPROVAL

This cross-sectional study was conducted at the Department of Anaesthesia, Fatima Memorial Hospital, over six months from September 2024 to February 2025 (Ref: FMH-26/04/2024-1RB-1396).

AUTHORS' CONTRIBUTION

All authors contributed equally as per ICMJE.

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