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Original Research Article

A Prospective Study Comparing Intravenous Lidocaine and Dexmedetomidine Infusion for Post-operative Analgesia in Laparoscopic Cholecystectomy

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Conflict of interest: Nil

Abstract:

Background: Laparoscopic cholecystectomy, though minimally invasive, is often associated with considerable post-operative pain due to visceral irritation, pneumoperitoneum-induced stretch, and trocar site trauma. Effective perioperative analgesia is crucial to improve patient comfort, reduce opioid consumption, and facilitate early mobilization. Intravenous lidocaine and dexmedetomidine, both known for their analgesic and anti-inflammatory properties, have been investigated as adjuncts for perioperative pain control. This study aimed to compare the efficacy of perioperative infusion of lidocaine versus dexmedetomidine in attenuating post-operative pain in patients undergoing elective laparoscopic cholecystectomy.

Methods: A prospective, randomized, controlled study was conducted in the Department of Anaesthesia at Government Medical College and Hospital, Bettiah, Bihar India from December 2023 to November 2024 . A total of 90 adult patients (ASA I and II) scheduled for elective laparoscopic cholecystectomy were randomly allocated into two groups: Group L received intravenous lidocaine infusion (1.5 mg/kg bolus followed by 2 mg/kg/hr infusion), and Group D received intravenous dexmedetomidine (1 µg/kg bolus followed by 0.5 µg/kg/hr infusion), both starting 10 minutes before induction and continued intraoperatively. Pain scores were assessed using the Visual Analog Scale (VAS) at 1, 2, 4, 8, 12, and 24 hours post-operatively. Total analgesic consumption, time to first rescue analgesia, and adverse effects were also recorded.

Results: VAS scores were significantly lower in the dexmedetomidine group at 1 and 2 hours post-operatively ($p < 0.05$), while lidocaine showed better analgesic profile beyond 4 hours, especially at 8 and 12 hours ($p < 0.05$). Total tramadol consumption over 24 hours was lower in the lidocaine group (95.6 ± 18.4 mg) compared to dexmedetomidine group (112.7 ± 21.1 mg), with a statistically significant difference ($p = 0.01$). Time to first rescue analgesia was longer in the lidocaine group. Sedation scores were higher in the dexmedetomidine group in the early recovery period, while lidocaine was associated with faster post-operative awakening and minimal hemodynamic fluctuations.

Conclusion: Both lidocaine and dexmedetomidine provide effective perioperative analgesia in laparoscopic cholecystectomy. However, intravenous lidocaine infusion offers superior late post-operative pain control, reduces opioid requirement, and facilitates quicker recovery, making it a preferable option in enhanced recovery protocols.

Keywords: Lidocaine, Dexmedetomidine, Laparoscopic Cholecystectomy, Post-Operative Pain, Intravenous Infusion, VAS Score, Opioid-Sparing.

Introduction

Laparoscopic cholecystectomy has become the gold standard for the surgical management of symptomatic gallstone disease due to its minimally invasive nature, shorter hospital stays, and faster recovery. Despite its advantages over open surgery, significant post-operative pain persists during the early recovery phase. This pain is multifactorial, resulting from abdominal wall incisions, visceral manipulation, diaphragmatic irritation from residual carbon dioxide, and peritoneal stretching [1,2]. If not adequately managed, post-operative pain can lead to complications such as respiratory distress,

increased opioid requirement, delayed ambulation, and prolonged hospital stay. Effective pain management, therefore, plays a pivotal role in improving patient satisfaction and facilitating early recovery, particularly in the context of enhanced recovery after surgery (ERAS) protocols [3,4].

Traditionally, opioids have been the mainstay for post-operative analgesia, but their use is limited by side effects such as nausea, vomiting, respiratory depression, sedation, and risk of dependence. As a result, attention has shifted toward opioid-sparing multimodal analgesia techniques, incorporating systemic agents with analgesic, anti-inflammatory, and anti-hyperalgesic properties. Among these, intravenous lidocaine and dexmedetomidine have emerged as promising agents for perioperative pain control [5,6]. Lidocaine, an amide local anesthetic, possesses anti-inflammatory and analgesic properties when administered intravenously. It modulates sodium channels, reduces spinal cord sensitization, and inhibits the release of inflammatory cytokines. When used in the perioperative setting, lidocaine has been shown to reduce opioid consumption, improve bowel function, and shorten hospital stay, especially in abdominal surgeries [7,8].

Dexmedetomidine, a highly selective α2-adrenergic agonist, offers analgesia, anxiolysis, and sedation without significant respiratory depression. It acts centrally to decrease sympathetic outflow and modulates pain pathways at the spinal and supraspinal levels. In surgical patients, perioperative dexmedetomidine has been associated with reduced opioid requirement, attenuation of the surgical stress response, and improved hemodynamic stability [9,10]. However, its use may be accompanied by bradycardia, hypotension, and delayed emergence from anesthesia. While both lidocaine and dexmedetomidine have been individually explored for post-operative analgesia, direct comparisons between the two, particularly in the context of laparoscopic cholecystectomy, remain limited in Indian literature [11].

In the evolving landscape of ERAS protocols and opioid-sparing strategies, it is important to determine the most effective agent that balances analgesia with minimal side effects. The present study was undertaken to compare the analgesic efficacy of intravenous lidocaine versus dexmedetomidine infusion in patients undergoing elective laparoscopic cholecystectomy. Conducted at a tertiary care government institution in Bettiah, Bihar, this study also aims to evaluate total opioid requirement, time to first rescue analgesia, sedation levels, and hemodynamic effects of both drugs, thereby guiding evidence-based perioperative pain management in resource-limited settings [12,13].

Methodology

This prospective, randomized, controlled, single-blinded clinical study was conducted over a period of December 2023 to November 2024 in the Department of Anaesthesia at Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India. A total of 90 adult patients, aged 18 to 60 years, of either sex, classified as American Society of Anesthesiologists (ASA) physical status I or II, and scheduled for elective laparoscopic cholecystectomy under general anesthesia were enrolled in the study. Patients with a history of cardiac conduction abnormalities, chronic opioid or analgesic use, allergy to lidocaine or dexmedetomidine, hepatic or renal impairment, psychiatric illness, pregnancy, or those requiring conversion to open cholecystectomy were excluded.

Participants were randomly allocated into two equal groups (n = 45 each) using computer-generated random numbers and sealed opaque envelopes. Group L (lidocaine group) received an intravenous bolus of lidocaine at a dose of 1.5 mg/kg over 10 minutes before induction of anesthesia, followed by a continuous infusion at 2 mg/kg/hr until the end of surgery. Group D (dexmedetomidine group) received an intravenous bolus of dexmedetomidine at 1 μg/kg over 10 minutes before induction, followed by a continuous infusion at 0.5 μg/kg/hr intraoperatively. Standard fasting guidelines were followed. All patients were premedicated with intravenous midazolam 0.03 mg/kg and glycopyrrolate 0.004 mg/kg. Anesthesia was induced with propofol 2 mg/kg and fentanyl 2 μg/kg, followed by atracurium 0.5 mg/kg to facilitate tracheal intubation. Anesthesia was maintained with isoflurane in oxygen–nitrous oxide mixture and intermittent doses of atracurium. Hemodynamic parameters including heart rate, mean arterial pressure (MAP), and oxygen saturation were monitored continuously.

The intraoperative infusion of the study drug was discontinued at the time of skin closure. At the end of surgery, residual neuromuscular blockade was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. Post-operatively, all patients were transferred to the recovery room where they were monitored for 24 hours. Post-operative pain was assessed using the Visual Analog Scale (VAS) ranging from 0 (no pain) to 10 (worst imaginable pain) at predefined intervals: 1, 2, 4, 8, 12, and 24 hours. Patients were given rescue analgesia with intravenous tramadol 50 mg whenever VAS ≥ 4. The total tramadol consumption within 24 hours, time to first rescue analgesia, post-operative sedation scores using the Ramsay Sedation Scale, and any adverse effects such as nausea, vomiting, bradycardia, hypotension, or delayed recovery were recorded.

Collected data were compiled in Microsoft Excel and analyzed using SPSS version 25. Descriptive statistics were used for demographic variables, and continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed in percentages. Intergroup comparisons of quantitative data were performed using the unpaired Student's t-test, while categorical variables were analyzed using the Chi-square test or Fisher's exact test as appropriate. Repeated measures ANOVA was applied to compare VAS scores over time. A p-value of <0.05 was considered statistically significant for all analyses.

Results

A total of 90 patients undergoing elective laparoscopic cholecystectomy were successfully enrolled and randomized into two groups of 45 each: Group L (lidocaine) and Group D (dexmedetomidine). The baseline characteristics including age, sex, weight, and ASA physical status were comparable between the two groups. Intraoperative parameters such as surgery duration and hemodynamic stability were maintained in both groups, although a higher incidence of intraoperative bradycardia and hypotension was observed in the dexmedetomidine group. Post-operative VAS scores showed a biphasic trend: the dexmedetomidine group had better pain control during the early post-operative hours, while lidocaine demonstrated superior analgesia in the later recovery period (8–24 hours). Total 24-hour tramadol consumption was significantly lower in Group L. The time to first rescue analgesia was also delayed in the lidocaine group, suggesting more sustained analgesic action. Sedation scores were higher in the dexmedetomidine group during the first 2 hours, while lidocaine was associated with faster emergence and minimal adverse effects.

Table 1: Demographic Profile of Study Participants

Variable	Group L (n = 45)	Group D (n = 45)	p-value
Age (years)	38.9 ± 9.1	39.6 ± 8.7	0.68
Gender (M/F)	18/27	20/25	0.67
Weight (kg)	61.2 ± 6.9	62.4 ± 7.3	0.42
ASA I/II	29/16	28/17	0.82

Table 2: Intraoperative Duration Parameters

Variable	Group L (min)	Group D (min)	p-value
Surgery duration	54.2 ± 8.3	55.7 ± 9.1	0.38
Anesthesia duration	72.3 ± 10.2	73.5 ± 11.6	0.56

Table 3: Comparison of Mean VAS Scores Over Time

Time Post-op	Group L (mean ± SD)	Group D (mean ± SD)	p-value
1 hour	3.9 ± 1.0	3.2 ± 1.1	0.01
2 hours	3.4 ± 0.9	2.7 ± 1.0	0.003
4 hours	3.0 ± 1.0	3.2 ± 1.1	0.31
8 hours	2.2 ± 0.9	3.0 ± 1.0	0.001
12 hours	1.9 ± 0.8	2.7 ± 1.1	0.002
24 hours	1.4 ± 0.6	1.7 ± 0.7	0.08

Table 4: Total Tramadol Requirement in 24 Hours

Group	Mean Tramadol (mg) ± SD	p-value
Group L	95.6 ± 18.4	
Group D	112.7 ± 21.1	0.01

Table 5: Time to First Rescue Analgesia

Group	Mean Time (hours) ± SD	p-value
Group L	5.2 ± 1.4	
Group D	3.6 ± 1.3	0.002

Table 6: Post-operative Sedation Scores

Time	Group L (mean ± SD)	Group D (mean ± SD)	p-value
1 hour	2.1 ± 0.6	3.4 ± 0.8	<0.001
2 hours	2.0 ± 0.5	3.1 ± 0.7	<0.001

Table 7: Incidence of Adverse Events

Adverse Effect	Group L F (%)	Group D F (%)	p-value
Bradycardia	1 (2.2%)	6 (13.3%)	0.04
Hypotension	2 (4.4%)	5 (11.1%)	0.23
Nausea/Vomiting	4 (8.9%)	6 (13.3%)	0.51
Delayed Awakening	0 (0.0%)	3 (6.7%)	0.08

Table 8: Intraoperative Heart Rate Trends

Time Point	Group L (bpm)	Group D (bpm)	p-value
Baseline	82.4 ± 6.7	83.2 ± 7.1	0.58
After induction	76.1 ± 6.3	69.8 ± 5.9	0.001
Post-extubation	80.2 ± 6.5	72.5 ± 6.7	0.001

Table 9: Intraoperative MAP Trends

Time Point	Group L (mmHg)	Group D (mmHg)	p-value
Baseline	92.8 ± 7.3	93.1 ± 6.9	0.83
After induction	87.4 ± 6.6	81.3 ± 5.7	0.002
Post-extubation	91.1 ± 7.1	85.9 ± 6.3	0.004

Table 10: Recovery Parameters

Parameter	Group L (min)	Group D (min)	p-value
Time to eye opening	6.8 ± 1.1	9.5 ± 1.4	<0.001
Time to obey commands	8.2 ± 1.3	11.1 ± 1.8	<0.001
Time to PACU discharge	36.2 ± 5.8	48.9 ± 6.1	<0.001

Table 11: Patient Satisfaction Scores

Score (1–5)	Group L F (%)	Group D F (%)
5 (Highly satisfied)	29 (64.4%)	21 (46.7%)
4 (Satisfied)	13 (28.9%)	17 (37.8%)
3 or less	3 (6.7%)	7 (15.5%)

Table 12: Surgeon and Anesthetist Feedback

Parameter	Group L Mean ± SD	Group D Mean ± SD	p-value
Surgeon rating (0–10)	8.8 ± 1.1	9.1 ± 0.9	0.14
Anesthesia management ease (0–10)	9.2 ± 0.8	8.6 ± 1.0	0.03

Discussion

The present study demonstrates that both intravenous lidocaine and dexmedetomidine are effective adjuncts for perioperative analgesia in patients undergoing laparoscopic cholecystectomy, though their analgesic profiles vary across time points [14]. Patients receiving dexmedetomidine exhibited superior pain relief during the early post-operative period, specifically within the first two hours after surgery, likely due to its central sympatholytic and sedative effects [15]. However, this initial advantage was not sustained beyond the early recovery phase. In contrast, lidocaine provided significantly better pain control during the late post-operative period, particularly from 8 to 12 hours, indicating a prolonged analgesic and anti-hyperalgesic effect even after discontinuation of infusion [16,17]. The reduction in total 24-hour opioid requirement in the lidocaine group further reinforces its opioid-sparing potential, which is critical in minimizing opioid-related side effects such as nausea, vomiting, sedation, and delayed recovery. Moreover, the prolonged time to first rescue analgesia observed with lidocaine infusion suggests a sustained peripheral and central modulation of pain pathways [18].

In terms of safety and hemodynamic stability, lidocaine maintained a more favorable profile, with minimal incidences of bradycardia, hypotension, or excessive sedation. Dexmedetomidine, while effective for early pain control, was associated with higher sedation scores and a greater incidence of intraoperative hemodynamic disturbances, which may limit its utility in ambulatory settings or fast-track protocols. Additionally, recovery metrics such as time to eye opening, response to commands, and readiness for PACU discharge were faster in the lidocaine group, suggesting a smoother emergence profile and better suitability for ERAS pathways [19,20]. Although dexmedetomidine was rated positively for providing a calm surgical field and patient comfort in the immediate post-operative phase, lidocaine showed greater consistency in maintaining intraoperative hemodynamics and post-

operative lucidity, which may be more advantageous in high-volume day-care surgical practices. Overall, the findings of this study underscore the distinct pharmacodynamic profiles of both agents and support the preferential use of lidocaine infusion for longer-lasting analgesia, lower opioid need, and enhanced recovery in patients undergoing laparoscopic cholecystectomy [21,22].

Conclusion

Both intravenous lidocaine and dexmedetomidine are effective in managing perioperative pain in laparoscopic cholecystectomy, with differing temporal profiles. While dexmedetomidine provides better early post-operative analgesia, lidocaine offers superior late analgesic effects, reduces opioid consumption, and promotes faster recovery. Based on its sustained analgesic efficacy and favorable recovery profile, lidocaine infusion may be preferred in enhanced recovery and ambulatory surgical protocols.

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