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Opioid free anesthesia using a combination of lignocaine and ketamine in patients undergoing laparoscopic cholecystectomy: A double blinded randomized control trial

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Abstract
Background: Opioids have been used since inception by the anesthesiologists in almost all the major surgeries but it comes with its own set of side effects. Opioid free anesthesia has been the center of attraction from the past few years as it saves the patients from common side effects. Non opioid anesthesia provides a safer alternative to selected patients and also helps in enhanced recovery after surgery. We analyzed post-operative analgesic requirement of patients scheduled for elective laparoscopic cholecystectomy.
Methodology: This study has included 80 patients within the age group of 20-60 years with American society of anesthesiologist's physical status I and II who underwent laparoscopic cholecystectomy. Patients who had given consent for study, were randomly divided into 2 groups of 40 people each. The opioid free group which was the study group was administered an intravenous bolus and infusion of lignocaine and intravenous bolus of ketamine, whereas the control group received intravenous bolus of fentanyl. The primary objective was to analyze post operative pain via numeric rating scale (NRS) score during 24hrs post operative period between both the groups. The secondary objective was to analyze vital signs, post operative nausea and vomiting, mean arterial pressure (MAP), heart rate (HR), itching and also the total amount of pethidine consumed during 24hrs post-operative period.
Results: The study revealed several important findings regarding the efficacy and safety of opioid-free anesthesia (OFA) using lignocaine and ketamine in laparoscopic cholecystectomy. The OFA group had significantly mean lower postoperative fentanyl consumption at 2 hours (35.3 mcg vs. 70.1 mcg, $p<0.001$) and 6 hours (19.9 mcg vs. 38.4 mcg, $p = 0.023$), indicating better early postoperative pain control. Pain scores measured using the Numerical Rating Scale (NRS) were consistently lower in the OFA group at all time points, with significant differences at 2 hours (3.7±0.89 vs 5.6±0.49, $p<0.001$) and 6 hours (2.55±0.93 vs. 3.65±0.58, $p<0.001$). The incidence of postoperative nausea and vomiting (PONV) was significantly lower in the OFA group, with mild PONV observed in 87.5% compared to 65% in the OBA group ($p = 0.017$). Pruritus was entirely absent in the OFA group, whereas 20% of patients in the OBA group experienced itching ($p = 0.003$).
Conclusion: Opioid-free anaesthesia with lignocaine and ketamine in laparoscopic cholecystectomy provides effective pain relief while reducing opioid-related adverse effects, enhancing postoperative recovery.

Keywords: Anesthesia, ketamine, laparoscopic cholecystectomy, lignocaine, opioid

Introduction
Gallstones are a prevalent clinical problem worldwide, often necessitating surgical intervention in the form of a cholecystectomy. Laparoscopic cholecystectomy has emerged as the preferred surgical approach due to its minimally invasive nature, resulting in reduced postoperative pain, shorter hospital stays, and faster recovery times compared to traditional open surgery. Managing postoperative pain effectively is critical to ensuring optimal recovery and patient satisfaction. Traditionally, opioids have been the cornerstone of perioperative analgesia in major and day care surgeries. Despite their efficacy, the use of opioids is accompanied by several undesirable side effects, including pruritus, postoperative nausea and vomiting (PONV), respiratory depression, opioid-induced hyperalgesia, urinary retention, and paralytic ileus. These adverse effects can delay postoperative recovery, prolong hospital stays, and increase healthcare costs. [1]

Given the significant side effects associated with opioids, the concept of non-opioid anesthesia has gained traction in recent years. Non-opioid anesthesia encompasses a multimodal approach to pain management that excludes opioid medications, thereby minimizing the risks associated with opioid use. Enhanced Recovery After Surgery (ERAS) protocols advocate for non-opioid anesthesia to facilitate faster recovery, reduce opioid dependence, and improve patient outcomes. The pharmacologic agents utilized in non-opioid anesthesia include paracetamol, nonsteroidal anti-inflammatory drugs (NSAIDs), COX-2 inhibitors such as etoricoxib, local anesthetics like lignocaine, alpha-2 agonists like dexmedetomidine, NMDA receptor antagonists like ketamine, gabapentinoids, magnesium, and beta-blockers such as esmolol. These drugs work through different mechanisms to provide effective analgesia while minimizing opioid-related complications. Non-opioid anesthesia is particularly beneficial in high-risk populations, including obese patients, individuals with obstructive sleep apnoea patients with chronic respiratory diseases, those with opioid addiction, and patients undergoing cancer surgeries. [2], [3]

Ketamine, a phencyclidine derivative, plays a pivotal role in non-opioid anesthesia due to its unique pharmacological profile. It primarily acts as an NMDA receptor antagonist, preventing central sensitization and reducing pain transmission. Additionally, ketamine exhibits muscarinic antagonism and voltage-gated sodium channel blockade, contributing to its analgesic properties. In a multimodal analgesic regimen, ketamine has been shown to decrease opioid consumption by approximately 33%, making it a valuable adjunct in perioperative pain management. Low-dose ketamine (less than 0.5 mg/kg) has demonstrated good analgesic efficacy with minimal side effects, making it suitable for use in various surgical procedures, including laparoscopic cholecystectomy. Ketamine has been found to prevent opioid tolerance and hyperalgesia, enhancing the overall effectiveness of pain management strategies. [4],[5],[6]

Lignocaine, another key agent in non-opioid anesthesia, is a local anesthetic that blocks voltage-gated sodium channels on nerve cells, thereby reducing pain transmission. In addition to its local anesthetic effects, lignocaine has anti-inflammatory properties, making it effective in reducing postoperative pain and the need for opioids. Its utility extends beyond pain control, as lignocaine is also beneficial in attenuating the hemodynamic response during laryngoscopy and intubation, reducing the risk of laryngospasm and tachycardia. Given its safety profile and efficacy, lignocaine has become a cornerstone of multimodal analgesia protocols. Recognizing the benefits of ketamine and lignocaine in non-opioid anesthesia, a randomized controlled trial was designed to evaluate postoperative pain outcomes in patients undergoing elective laparoscopic cholecystectomy. This trial aims to compare the postoperative pain scores using the Numeric Rating Scale (NRS) during the first 24 hours after surgery between a non-opioid anesthesia group receiving ketamine and lignocaine and a control group receiving fentanyl. The hypothesis driving this study is that non-opioid anesthesia will provide superior postoperative pain control, reduce opioid consumption, and enhance recovery in patients undergoing laparoscopic cholecystectomy. [7], [8], [9], [10]

The study was conducted at Peerless Hospital and BK Roy Research Center, a reputed tertiary care hospital in Kolkata known for its comprehensive medical services and advanced surgical practices. This institution provided an ideal setting for the research due to its high patient load, diverse case mix, and well-equipped surgical and anesthetic facilities. The hospital's commitment to evidence-based practice and clinical research further strengthened the relevance of conducting the trial in this setting, as it allowed for the systematic evaluation of new anaesthetic approaches to improve patient care.

The relevance of this study lies in addressing a crucial aspect of perioperative management postoperative pain control which directly impacts patient recovery, hospital stay, and overall surgical outcomes. By evaluating non-opioid anesthesia protocols in a real-world tertiary care environment, the study aimed to provide actionable insights that could be implemented in routine clinical practice. The findings have the potential to influence future anesthetic guidelines, reduce opioid reliance, and promote safer, more effective pain management strategies in laparoscopic surgeries.

Materials and Methods

The study was conducted at Peerless Hospital and BK Roy Research Center, Kolkata, and it was designed as a prospective, randomized, double-blinded trial to compare the efficacy of non-opioid anesthesia with opioid-based anesthesia in patients undergoing elective laparoscopic cholecystectomy. The inclusion criteria for the study were patients scheduled for elective laparoscopic cholecystectomy with an American Society of Anesthesiologists (ASA) Physical Status classification of I or II, aged between 20 to 60 years, and with a Body Mass Index (BMI) ranging from 20 to 30 kg/m². Patients with higher ASA classifications (≥3), a BMI greater than 30 kg/m², psychiatric illnesses, chronic pain history exceeding six months, cardiac or renal diseases, or a history of alcohol or drug abuse were excluded from the study. Randomization of the participants into two groups was achieved using a computer-generated number sequence, ensuring the integrity of the double-blinded design.

In the non-opioid group, patients received intravenous lignocaine at a bolus dose of 1 mg/kg just before intubation, followed by a continuous infusion of lignocaine at 1 mg/kg/hour administered via a syringe pump until the removal of the gallbladder. Additionally, intravenous ketamine at a bolus dose of 0.4 mg/kg was administered immediately after the removal of the gallbladder to ensure sustained analgesia. In contrast, the control group, which followed an opioid-based protocol, was administered intravenous fentanyl at a bolus dose of 2 mcg/kg prior to induction of anesthesia. During the intraoperative period, additional intermittent doses of fentanyl at 0.4 mcg/kg were administered if the patients' mean arterial pressure (MAP) or heart rate (HR) increased by more than 20% from their baseline values, ensuring adequate hemodynamic stability and pain control.

In both groups, ASA standard monitors were used in the operating room to continuously monitor the patients' vital signs. Premedication was given to all patients, including glycopyrrolate at 5 mcg/kg to reduce secretions, dexamethasone (4 mg) to prevent postoperative nausea and vomiting (PONV), and ondansetron (4 mg) as an antiemetic. Preoxygenation was performed before the induction of anesthesia to ensure optimal oxygenation. Anesthesia

induction was achieved using intravenous propofol at a dose of 2 mg/kg, providing smooth and rapid sedation. Muscle relaxation was facilitated with rocuronium bromide at 0.7 mg/kg to enable endotracheal intubation. The patients were ventilated with a mixture of sevoflurane at 1% concentration, along with a nitrous oxide-to-oxygen ratio of 1:2. For additional pain management during surgery, paracetamol (1 gm) and diclofenac aqua (75 mg) were administered intravenously.

The primary objective of the study was to assess postoperative pain using the Numeric Rating Scale (NRS) at various time intervals 2, 6, 12, and 24 hours after surgery to compare pain control between the non-opioid and control groups. The NRS is a widely used pain assessment tool where patients rate their pain on a scale from 0 to 10, with 0 indicating no pain and 10 representing the worst pain imaginable. The secondary objectives included evaluating vital signs such as MAP and HR, assessing the incidence and severity of postoperative nausea and vomiting using a four-point Verbal Rating Scale (VRS) that categorized PONV as none, mild, moderate, or severe, and quantifying the total amount of fentanyl consumed during the 24-hour postoperative period. By analyzing these parameters, the study aimed to determine whether non-opioid anesthesia could provide effective pain relief while minimizing the adverse effects associated with opioid use, ultimately promoting faster recovery and improving patient outcomes

Sample Size

The study done by *Vishnuraj KR* [15] *et al* showed the Post-operative fentanyl consumption at 2 hours in opoids and non opoids patient was significant (p<0.0001). Taking this study as reference the sample size was calculated using the formula:

$N = \{Z_{(1-\alpha/2)} + Z_{(1-\beta)}\} \times \{2\sigma^2\} / (\mu_1 - \mu_2)^2$

$Z_{(1-\alpha/2)}$ - (the Value of the standard normal variate at 5% error) =1.96

$Z_{(1-\beta)}$ - (Considering 90% power) =1.28

SD = σ = 24 (as per reference)

Mean Analgesia within the first 2 hours Group 1(μ_1) = 79.0

Mean Analgesia within the first 2 hours Group 1(μ_2) = 61.4

So

$N = \{1.96 + 1.28\} \times \{2 \times 24^2\} / (79 - 61.4)^2$

$= 39.07$

≈ 40

So, in each group 40 subjects were considered

Considering 2 groups the final Sample size is (40+40) = 80

Statistical Analysis

Categorical variables were expressed as the number and percentage of patients and compared across the two groups using Pearson's Chi-Square Test for Independence of Attributes or Fisher's Exact Test, as appropriate. Continuous variables were expressed as mean ± standard deviation and compared between the two groups using an unpaired t-test when the data followed a normal distribution. If the data did not follow a normal distribution, the Mann-Whitney U test was applied.

The statistical analysis was performed using SPSS software, version 25. An alpha level of 5% was used, meaning any p-value less than 0.05 was considered statistically significant.

Results

The study population was comprised of 80 participants with a mean age of 41.13 years (±9.38), indicating a middle-aged cohort commonly representative of individuals undergoing surgical interventions. This balanced age distribution supports the generalizability of findings across adult populations within this age range. Additionally, the mean Body Mass Index (BMI) of the participants was 26.65 kg/m² (±2.15), falling within the overweight category, which aligns with contemporary population trends. The uniformity of BMI within the study population ensures that weight-related factors were not disproportionately influencing the outcomes of postoperative pain management or adverse effects like PONV.

In terms of gender distribution, the study had a predominance of female participants, with 51 females compared to 29 males. This skewed distribution might reflect the underlying conditions necessitating surgery, which could vary between genders. It is important to acknowledge the potential implications of gender-based physiological and pharmacological differences on drug metabolism and postoperative outcomes, such as pain perception and susceptibility to side effects. Nonetheless, the inclusion of both genders allows for a broader understanding of the comparative efficacy and safety of opioid-free and opioid-based regimens.

The severity of postoperative nausea and vomiting (PONV) was also documented, with 61 participants (76.25%) experiencing mild symptoms and 19 participants (23.75%) reporting moderate symptoms. The predominance of mild PONV suggests that overall postoperative care was effective in managing this common complication, though nearly a quarter of the population experienced moderate discomfort. These findings highlight the need for targeted strategies, especially for individuals more prone to moderate PONV, potentially influenced by their opioid exposure. Understanding the distribution of PONV severity in the study population provides valuable insights into optimizing postoperative protocols to enhance patient recovery and satisfaction.

Table 1: Distribution of Study Groups as per Drug intervention and Sociodemographic profile, Duration of Surgery (n=80)

Parameters	Opoid Free Groups	Opoid Based Groups	P value
Age (years)	39.8±8.9	42.4±9.7	
Gender (M, F)	15,25	14,26	
BMI (kg/m^2)	27.19±1.95	26.12±2.23	
Duration of Surgery	54.32±5.9	55.5±5.24	0.349

The sociodemographic profile and intervention-based categorization of the study groups in this analysis provide critical insights into the distribution and comparability of the participants. The mean age of participants in the opioid-free group was 39.8 years (±8.9), while it was slightly higher in the opioid-based group at 42.4 years (±9.7). This difference was not statistically significant (p = 0.349), indicating that the age distribution was relatively similar across the two groups. This similarity helps ensure that age-related factors did not introduce bias, allowing for a more

valid comparison of outcomes related to the drug interventions.

Gender distribution was also comparable between the groups. The opioid-free group comprised 15 males and 25 females, whereas the opioid-based group included 14 males and 26 females. This near-equal gender distribution across both groups ensures that the influence of gender on drug response and surgical outcomes is minimal and balanced, providing a robust basis for drawing conclusions about the effects of the interventions.

Body mass index (BMI) and the duration of surgery further reflect the homogeneity of the study population. The opioid-free group had a mean BMI of 27.19 kg/m² (±1.95), slightly higher than the 26.12 kg/m² (±2.23) observed in the opioid-based group. The difference in BMI, though measurable, did not pose a significant disparity. Similarly, the duration of surgery was almost equivalent in both groups, with 54.32 minutes (±5.9) for the opioid-free group and 55.5 minutes (±5.24) for the opioid-based group. These findings collectively shows the comparability of the two groups in terms of sociodemographic characteristics and surgical parameters, ensuring that the impact of drug interventions on outcomes can be assessed without the confounding effects of these variables.

Table 2: Distribution of Study Groups as per mean Pethidine Consumption and Time (n =80)

Parameters	Opoid Free Groups(n=40)) (mean ± SD)	Opoid Based Groups (n=40) (mean ± SD)	P value
Post-operative Pethidine consumption			
2h	35.3±39.9	70.1±11.6	<0.001
6h	19.9±35.2	38.4±36.1	0.023
12h	2.5±15.8	7.1±21.7	0.282
24h	0	0	-

The comparison of postoperative pethidine consumption between the opioid-free and opioid-based groups reveals notable differences in analgesic requirements at various time points. At 2 hours post-surgery, the opioid-free group had a significantly lower mean fentanyl consumption (35.3±39.9 µg) compared to the opioid-based group (70.1±11.6 µg), with a highly significant p-value of <0.001. This indicates that patients in the opioid-free group required less analgesic support during the immediate postoperative period, suggesting a potential advantage of the opioid-free regimen in managing early postoperative pain. Similarly, at 6 hours, fentanyl consumption remained significantly lower in the opioid-free group (19.9±35.2 µg) compared to the opioid-based group (38.4±36.1 µg, p = 0.023), further supporting the notion that the opioid-free approach may contribute to a reduction in analgesic needs over a prolonged period.

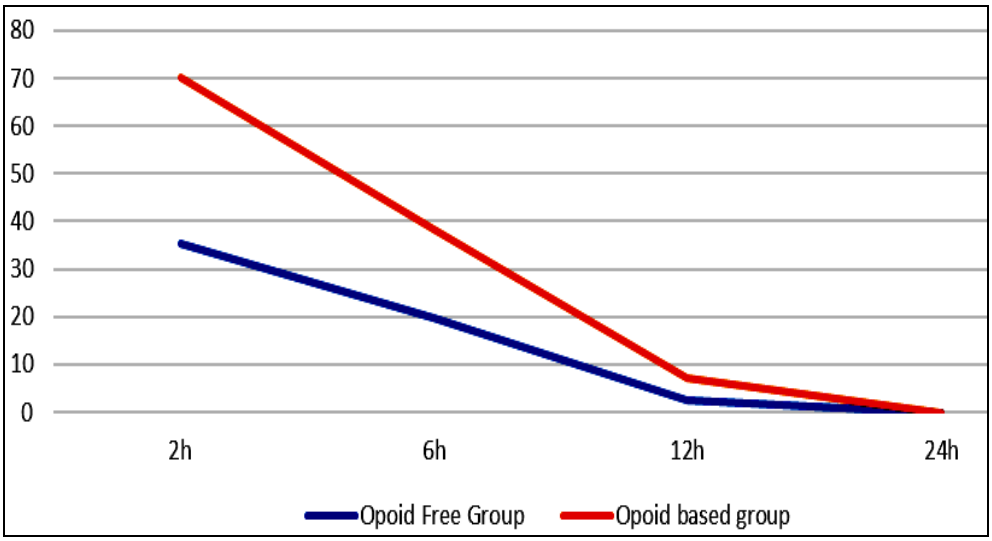

Fig 1: Distribution of Study Groups as per mean Pethidine Consumption and Time (n =80)

Interestingly, at 12 hours post-surgery, the mean fentanyl consumption was low in both groups, with no significant difference (2.5±15.8 µg in the opioid-free group versus 7.1±21.7 µg in the opioid-based group, p = 0.282). By 24 hours, neither group required any additional fentanyl, indicating that postoperative pain may have subsided sufficiently in both cohorts. These findings suggest that while the opioid-free approach offers a clear reduction in fentanyl requirements during the early postoperative hours, the analgesic needs converge over time, highlighting the importance of optimizing pain management strategies during the critical early postoperative period.

Table 3: Distribution of Study Groups as per NRS score and Time (n =80)

Parameters	Opoid Free Groups(n=40) (mean ± SD)	Opoid Based Groups(n=40) (mean ± SD)	P value
NRS Score			
2h	3.7±0.89	5.6±0.49	<0.001
6h	2.55±0.93	3.65±0.58	<0.001
12h	1.73±0.58	2.25±0.74	0.001
24h	1±0	1.175±0.38	0.005

The comparison of postoperative pain intensity, as measured by the Numerical Rating Scale (NRS), highlights significant differences between the opioid-free and opioid-based groups at various time points. At 2 hours post-surgery, the opioid-free group reported a substantially lower mean NRS score (3.7±0.89) compared to the opioid-based group (5.6±0.49), with a highly significant p-value of <0.001. This trend persisted at 6 hours, where the opioid-free group continued to experience less pain, with an NRS score of 2.55±0.93 versus 3.65±0.58 in the opioid-based group (p<0.001). These findings suggest that the opioid-free regimen was associated with more effective early postoperative pain control, potentially reducing patient discomfort and improving recovery experiences during the critical early hours.

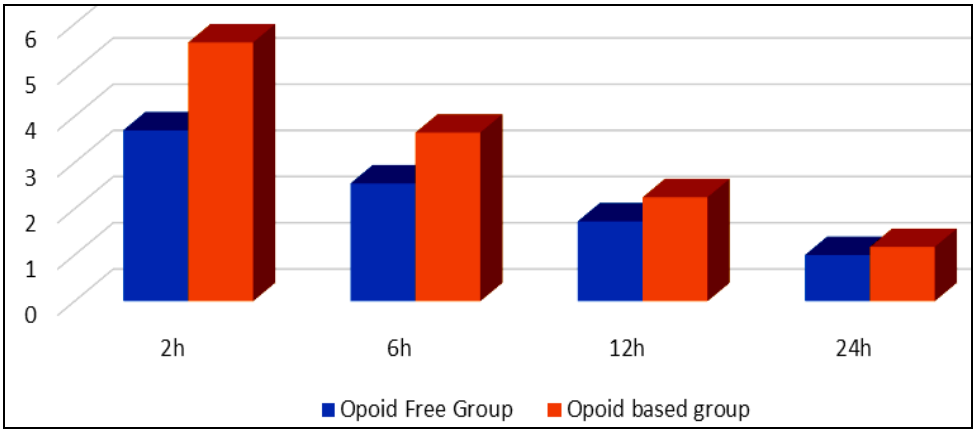

Fig 2: Distribution of Study Groups as per NRS score and Time (n =80)

The difference in pain intensity remained significant at 12 and 24 hours post-surgery, although the scores in both groups showed a declining trend. At 12 hours, the mean NRS score was lower in the opioid-free group (1.73±0.58) compared to the opioid-based group (2.25±0.74, p = 0.001). By 24 hours, pain levels were minimal in both groups, with the opioid-free group recording a mean NRS score of 1±0 and the opioid-based group slightly higher at 1.175±0.38 (p = 0.005).

Table 4: Distribution of Study Subject as per incidence of PONV (n= 80)

Parameters	Opoid Free Groups (n=40) No (%)	Opoid Based Groups (n=40) No (%)	P value
PONV Severity			
Mild	35(87.5)	26(65)	0.017
Moderate	5(12.5)	14(35)	

The analysis of postoperative nausea and vomiting (PONV) severity demonstrates a significant difference between the opioid-free and opioid-based groups. In the opioid-free group, the majority of participants (87.5%) experienced mild PONV, whereas only 65% of participants in the opioid-based group reported mild symptoms. This difference, with a p-value of 0.017, indicates a statistically significant reduction in the severity of PONV in the opioid-free group. These findings suggest that avoiding opioids in the postoperative period may help mitigate the common side effects of nausea and vomiting, enhancing patient comfort and recovery.

Conversely, moderate PONV was more prevalent in the opioid-based group, with 35% of participants experiencing moderate symptoms compared to just 12.5% in the opioid-free group. This disparity highlights the potential drawbacks of opioid use, which is known to exacerbate PONV. The significant reduction in moderate PONV severity among patients in the opioid-free group shows the importance of exploring alternative pain management strategies to improve postoperative outcomes. By minimizing the incidence and severity of PONV, opioid-free regimens may contribute to better overall patient satisfaction and a smoother recovery process.

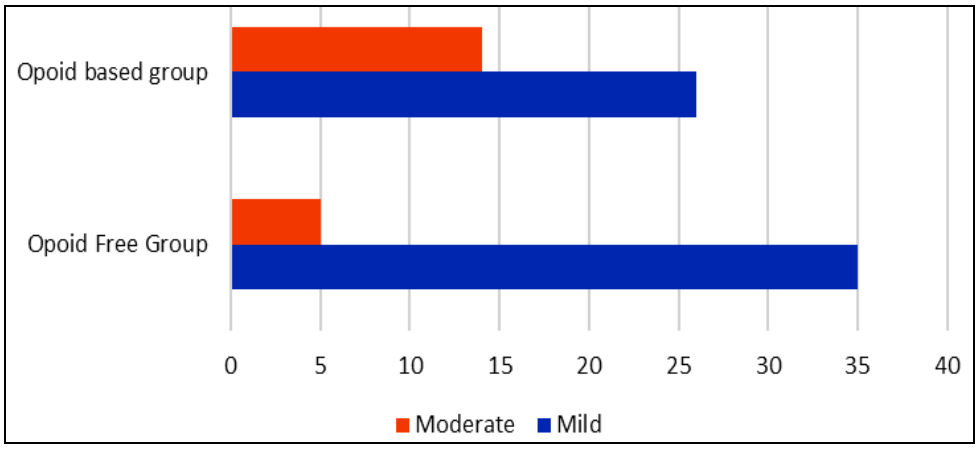

Fig 3: Distribution of Study Subject as per incidence of PONV (n= 80

Table 5: Distribution of Study Subject as per ASA PS score

Parameters	Opoid Free Groups (n=40) No (%)	Opoid Based Groups (n=40) No (%)	P value
ASA PS Score			
I	7(17.5)	7(17.5)	-
II	33(82.5)	33(82.5)	

The distribution of study participants based on the American Society of Anesthesiologists Physical Status (ASA PS) score was identical across the opioid-free and opioid-based groups, indicating comparable baseline health status among the two cohorts. In both groups, a majority of participants (82.5%) were classified as ASA PS II, reflecting individuals with mild systemic disease that does not limit physical activity. Only a small proportion (17.5%) in each group were classified as ASA PS I, representing healthy individuals with no systemic disease. This uniformity in ASA PS score distribution ensures that the groups were well-matched in terms of their preoperative health conditions, minimizing potential confounding effects related to baseline health status. Consequently, any observed differences in postoperative outcomes, such as pain management efficacy or incidence of side effects, can be more confidently attributed to the interventions rather than disparities in patients health.

Table 6: Distribution of Study Subject as per Itching and Intervention (n=80)

Parameters	Opoid Free Groups (n=40) No (%)	Opoid Based Groups (n=40) No (%)	P value
Itching			
Present	0(0)	8(20)	0.003
Absent	40(100)	32(80)	

The occurrence of postoperative itching showed a significant difference between the opioid-free and opioid-based groups, highlighting an adverse effect commonly associated with opioid use. In the opioid-free group, none of the participants (0%) reported itching, whereas 8 participants (20%) in the opioid-based group experienced this side effect, with a statistically significant p-value of 0.003. This finding shows the role of opioids in triggering itching, likely due to their action on histamine release or specific opioid receptors in the central nervous system. The absence of itching in the opioid-free group emphasizes the potential advantage of this regimen in reducing opioid-related side effects, contributing to greater postoperative comfort and patient satisfaction. These results reinforce the importance of considering alternative pain management strategies, particularly for patients prone to opioid-induced pruritus.

Discussion

The present study compared the effects of opioid-free anesthesia (OFA) versus opioid-based anesthesia (OBA) in patients undergoing laparoscopic cholecystectomy, focusing on postoperative pain management, opioid consumption, adverse effects, and recovery outcomes. The findings indicate that the opioid-free regimen, using lignocaine and ketamine, was associated with superior pain control, reduced postoperative opioid requirements, and a lower incidence of opioid-related adverse effects.

Postoperative fentanyl consumption was significantly lower in the OFA group, particularly in the early postoperative period (first 6 hours). This suggests that the multimodal analgesic approach in OFA effectively reduced pain perception and opioid requirements, leading to better analgesic outcomes. Similar findings were reported by Ibrahim *et al*. (2019) [12], where ketamine-lignocaine-based anesthesia resulted in reduced opioid consumption postoperatively. The Numerical Rating Scale (NRS) scores were also significantly lower in the OFA group at all time points, reinforcing the analgesic benefits of opioid-free techniques. Studies by Martinez *et al*. (2021) [13] also demonstrated that opioid-free regimens could achieve comparable or superior pain relief while minimizing opioid-related side effects.

The OFA group had a significantly lower incidence of postoperative nausea and vomiting (PONV) and opioid-induced pruritus. Opioids are well-known for causing PONV due to their action on the chemoreceptor trigger zone, and our results align with previous studies, such as that by Mulier (2018) [16], which reported lower PONV rates with opioid-free anesthesia. The absence of itching in the OFA group further supports the safety of this approach.

The findings of this study suggest that opioid-free anesthesia with lignocaine and ketamine is a viable alternative for laparoscopic cholecystectomy, providing effective analgesia while reducing opioid-related complications [17, 18, 19].

Conclusion

The findings of this study demonstrate that opioid-free anaesthesia (OFA) using a combination of lignocaine and ketamine in laparoscopic cholecystectomy offers significant advantages over opioid-based anaesthesia (OBA). Patients in the OFA group experienced lower postoperative pain scores, reduced opioid consumption, and a lower incidence of opioid-related adverse effects such as postoperative nausea and vomiting (PONV) and itching. These results highlight the potential of opioid-free regimens in improving postoperative recovery, minimizing opioid-related complications, and enhancing overall patient comfort. The comparable ASA physical status distribution between the two groups ensures that these benefits were not influenced by preoperative health differences, reinforcing the efficacy of opioid-free anaesthesia.

This study shows the growing need for alternative analgesic strategies to reduce opioid dependence in perioperative care. By demonstrating effective pain control and improved recovery outcomes, opioid-free anaesthesia presents itself as a viable and safe alternative, particularly for patients at higher risk of opioid-related complications. Future large-scale, multi-centre studies can be done for validation of these findings and refine protocols for the broader implementation of opioid-free anaesthesia in various

surgical settings. Adopting such strategies could contribute to enhanced patient outcomes, reduced healthcare costs, and a shift toward more sustainable anaesthetic practices.

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