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Effect of Low-Dose Propofol on Post-Operative Nausea and Vomiting in Laparoscopic Surgery Under General Anesthesia

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HIGHLIGHTS

1. Low-dose propofol reduces post-operative nausea.
2. Effective in minimizing vomiting post-surgery.
3. Enhances patient comfort after anesthesia.
4. Improves recovery by controlling nausea.
5. Beneficial for laparoscopic surgery patients.

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ABSTRACT

Introduction: Post-operative nausea and vomiting (PONV) are common complications following laparoscopic surgery under general anesthesia, particularly due to the use of volatile anaesthetics and the creation of pneumoperitoneum. Propofol, an intravenous aesthetic, has shown promise in reducing PONV due to its antiemetic properties. This study aims to evaluate the effectiveness of low-dose propofol infusion in minimizing PONV in laparoscopic surgery. **Objective:** To assess the impact of continuous low-dose propofol infusion (1 mg/kg/hr) on the incidence and severity of PONV in patients undergoing laparoscopic surgery under general anesthesia, and to compare it with standard anesthesia practices. **Methods:** This prospective, randomized, double-blind study was conducted on 80 patients scheduled for elective laparoscopic surgeries. Patients were randomly assigned to receive either low-dose propofol infusion (n=40) or normal saline (n=40) after anesthesia induction. Data on the incidence of PONV, the need for rescue antiemetics, and post-operative recovery parameters were collected. Statistical analysis was performed to compare the outcomes between the two groups. **Results:** The propofol group exhibited a significantly lower incidence of PONV (12.5%) compared to the normal saline group (40%) (p=0.007). The need for rescue antiemetics was also reduced in the propofol group (15% vs. 45%). Additionally, propofol infusion resulted in lower scores on the Bellville scale at 1-, 3-, 6-, and 12-hours post-surgery, indicating reduced nausea and vomiting. **Conclusion:** Continuous low-dose propofol infusion significantly reduces the incidence and severity of PONV in patients undergoing laparoscopic surgery. It also decreases the need for rescue antiemetics, improving patient comfort and recovery outcomes. This approach presents a viable strategy for PONV management in high-risk patients undergoing laparoscopic procedures.

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INTRODUCTION

Post-operative nausea and vomiting (PONV) are frequent and distressing complications for patients undergoing laparoscopic surgery under general anesthesia. The incidence of PONV varies widely, ranging from 20% to 80%, depending on several factors, including the type of surgery, the aesthetic agents used, and individual patient risk factors[1]. Women, non-smokers, and patients with a history of motion sickness are at particularly high risk. Laparoscopic procedures, which involve creating a pneumoperitoneum by insufflating the abdomen with carbon dioxide, further exacerbate the risk of PONV. This insufflation increases intra-abdominal pressure and stimulates the vagus nerve, leading to higher rates of nausea and vomiting compared to open surgeries[2].

The aesthetic approach significantly influences the occurrence of PONV. Volatile anaesthetics and opioids, both of which are commonly used in general anesthesia, are strongly associated with an increased risk of PONV[3]. These agents are essential in many surgeries but come with the trade-off of higher rates of post-operative nausea and vomiting. In contrast, propofol, a widely used intravenous aesthetic, has emerged as a favourable alternative due to its antiemetic properties when used in higher doses for the induction and maintenance of anesthesia[4]. It has a rapid onset of action and a short half-life, which makes it an ideal agent for total intravenous anesthesia (TIVA). However, its potential use at lower doses as a continuous infusion during surgery to mitigate PONV without compromising the depth of anesthesia has sparked increasing interest in recent years[5].

Laparoscopic surgery presents unique challenges when managing PONV due to the physiological effects of pneumoperitoneum and the use of inhalational anaesthetics. The increased intra-abdominal pressure can irritate the peritoneum and trigger the emetic response through vagal stimulation[6]. Additionally, prolonged exposure to inhalational agents and opioids further increases the likelihood of PONV. Therefore, minimizing PONV is crucial in enhancing patient comfort and improving post-operative recovery outcomes. Propofol's antiemetic potential offers a promising solution, particularly when used in low-dose continuous infusion during laparoscopic surgery[7].

Propofol's antiemetic effects have been recognized for several decades, although the exact mechanisms remain not fully understood. It is believed to act on neurotransmitter pathways involved in nausea and vomiting, such as the gamma-aminobutyric acid (GABA) and dopamine systems[8]. Additionally, propofol's ability to suppress vagal nerve activity, which is implicated in the genesis of PONV, may further contribute to its effectiveness. Traditionally, propofol has been administered in higher doses for induction and maintenance of anesthesia, especially in TIVA, where it significantly reduces the incidence of PONV compared to volatile anaesthetics[9]. However, recent research has focused on exploring whether propofol can exert similar antiemetic benefits when administered in lower doses as a continuous infusion throughout the surgical procedure[10].

Administering low-dose propofol as a continuous infusion during surgery has emerged as a potentially effective strategy to mitigate PONV, especially in patients undergoing laparoscopic procedures[11]. Typically, the doses range between 10-20 mg/hour, which is low enough to avoid affecting the depth of anesthesia but sufficient to provide antiemetic effects. This strategy is especially useful in high-risk populations, such as women, non-smokers, and patients with a history of motion sickness, who are more susceptible to PONV. Studies have shown that in these patient groups, low-dose propofol infusion during surgery can significantly reduce the incidence and severity of PONV[12].

Traditional antiemetic strategies for managing PONV involve pharmacological agents like 5-hydroxytryptamine (5-HT3) receptor antagonists, corticosteroids, and antihistamines. While effective, these medications can come with side effects and varying degrees of efficacy[13]. Moreover, some patients may be at risk for adverse reactions or drug interactions. The potential for propofol to reduce reliance on these conventional antiemetics is of great interest in modern aesthetic practice. By incorporating low-dose propofol infusion as part of a multimodal approach to PONV prevention, anaesthesiologists may offer patients improved outcomes with fewer side effects[14].

One of the main advantages of low-dose propofol infusion is that it can be seamlessly integrated into standard aesthetic practice without altering the overall anesthesia management plan. It can be combined with inhalational anaesthetics, which are commonly used in laparoscopic surgery, to provide effective anesthesia while reducing PONV [15]. This allows for a tailored approach that meets the specific needs of the patient while mitigating one of the most common and uncomfortable post-operative complications 16. Furthermore, the use of low-dose propofol does not significantly alter the hemodynamic profile of patients, meaning that it can be safely administered without increasing the risk of adverse cardiovascular events, a concern often associated with higher doses of propofol[17].

Further research is needed to establish the optimal dosing regimen for low-dose propofol infusion, including precise dosage and timing for maximum antiemetic effect. Questions remain about its long-term use, particularly interactions with other aesthetic agents and potential side effects[18]. Nevertheless, current evidence suggests that low-dose propofol infusion is a safe, well-tolerated approach that holds promise in managing post-operative nausea and vomiting (PONV) in laparoscopic surgery. This strategy offers the potential to reduce PONV incidence and severity without compromising anesthesia quality, enhancing patient recovery, minimizing discomfort, and improving overall surgical outcomes[19]. As more studies refine the best use of propofol in this setting, low-dose infusion is poised to become an important tool in modern perioperative care, offering an effective and patient-centred approach to PONV management, particularly for those at high risk[20].

The study aims to evaluate the effect of low-dose propofol infusion on post-operative nausea and vomiting (PONV) in

patients undergoing laparoscopic surgery under general anesthesia. Specifically, it seeks to assess the effectiveness of administering propofol at 1 mg/kg/hr after anesthesia induction in reducing the incidence and severity of PONV. Additionally, the study will evaluate the safety and tolerability of this infusion protocol, comparing its impact on patient recovery and comfort against standard anesthesia practices. The goal is to determine whether low-dose propofol can improve post-operative outcomes in laparoscopic surgery patients.

MATERIALS AND METHODS

Data was collected from patients scheduled for elective laparoscopic surgeries under general anesthesia at ESIC Medical College-PGIMSR, Rajajinagar, Bangalore. Based on a previous study by Mine Celik et al. (2015), where PONV incidence was 40% in the propofol group and 75.5% in the control group, a sample size of 35 per group was calculated (with 5% alpha error and 80% power). To account for potential dropouts, 40 patients per group were included. This prospective randomized study, conducted from March 2021 to August 2022, included patients aged 18-60 years, ASA physical status I-II, and excluded those with PONV history, motion sickness, or organ dysfunction.

RESULTS

The mean age of patients undergoing laparoscopic surgeries in the propofol infusion group was 37.97±8.18 years, while in the normal saline group, it was 36.00±7.15 years. The difference between the two groups was not statistically significant (P=0.254). This indicates that there was no significant variation in the age distribution of patients between the propofol and normal saline groups, ensuring comparable baseline characteristics for age in the study population.

Table 1: Distribution of BMI According to the Study.

BMI	Propofol Infusion (N=40)	Normal Saline (N=40)	Total (N=80)
<18.5	0(0%)	0(0%)	0(0%)
18.5-24.9	26(65%)	31(77.5%)	57(71.3%)
25.0-29.9	14(35%)	9(22.5%)	23(28.8%)
>30.0	0(0%)	0(0%)	0(0%)
Total	40(100%)	40(100%)	80(100%)

In the propofol infusion group, 26 patients (65%) had a BMI between 18.5 and 24.9, while 14 patients (35%) had a BMI between 25 and 29.9. In the normal saline group, 31 patients (77.5%) had a BMI between 18.5 and 24.9, and 9 patients (22.5%) had a BMI between 25 and 29.9. There was no statistically significant difference in BMI distribution between the two groups (P=0.322), indicating similar baseline characteristics regarding BMI.

Table 2: ASA-Frequency Distribution in two Groups of Patients Studied

ASA	Propofol Infusion (N=40)	Normal Saline (N=40)	Total (N=80)
Class 1	26(65%)	29(72.5%)	55(68.8%)
Class 2	14(35%)	11(27.5%)	25(31.3%)
Total	40(100%)	40(100%)	80(100%)

In the propofol infusion group, 26 patients (65%) were classified as ASA class 1, and 14 patients (35%) were in ASA class 2. In the normal saline group, 29 patients (72.5%) were ASA class 1, and 11 patients (27.5%) were ASA class 2. There was no statistically significant difference in the ASA class distribution between the two groups (P=0.631), indicating comparable baseline physical status among patients in both the propofol infusion and normal saline groups.

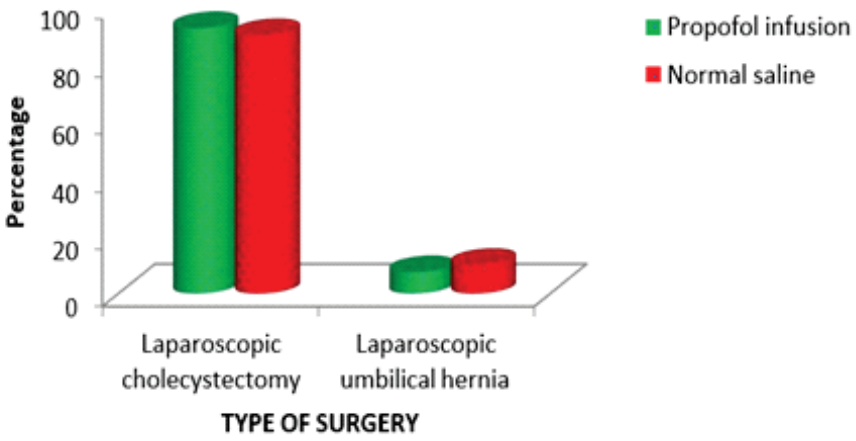

Figure 1: Type of Surgery-Frequency Distribution in Two Groups of Patients Studied.

In the propofol infusion group, 37 patients (92.5%) underwent laparoscopic cholecystectomy, while 3 patients (7.5%) had laparoscopic umbilical hernia repair. In the normal saline group, 36 patients (90%) had laparoscopic cholecystectomy, and 4 patients (10%) underwent laparoscopic umbilical hernia repair. No statistically significant difference was observed in the distribution of surgery types between the two groups (P=1.00), indicating that the types of surgeries were comparable across both groups in the study.

Table 3: Duration of Anesthesia (Mins)

Duration of Anesthesia (Mins)	Propofol Infusion (N=40)	Normal Saline (N=40)	Total (N=80)
45-65	11(27.5%)	10(25%)	21(26.3%)
66-85	22(55%)	25(62.5%)	47(58.8%)
>85	7(17.5%)	5(12.5%)	12(15%)
Total	40(100%)	40(100%)	80(100%)
Mean ± SD	74.03±12.09	72.1±13.2	73.06±12.62

The mean duration of anesthesia in the propofol infusion group was 74.03±12.09 minutes, while in the normal saline group, it was 72.1±13.2 minutes. No statistically significant difference was observed between the two groups (P=0.499), indicating that the duration of anesthesia was comparable across both groups. This similarity in anesthesia duration ensures that it did not influence the study outcomes related to post-operative nausea and vomiting (PONV) between the two groups.

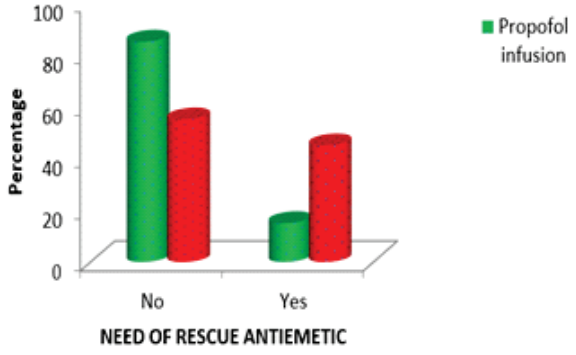

Figure 2: Need of Rescue Antiemetic

In the propofol infusion group, 6 participants (15%) required rescue antiemetics, while in the normal saline group, the need for rescue antiemetics was significantly higher, with 18 patients (45%) requiring them. This difference was statistically significant (P=0.007), indicating that patients in the propofol infusion group had a reduced need for additional antiemetic treatment compared to those in the normal saline group, suggesting the effectiveness of propofol in minimizing post-operative nausea and vomiting (PONV).

Table 4: Total Rescue Antiemetic

Total Rescue Antiemetic	Propofol Infusion (N=6)	Normal Saline (N=18)	Total (N=24)
1	6(100%)	13(72.2%)	19(79.2%)
2	0(0%)	5(27.8%)	5(20.8%)

In the propofol infusion group, 6 patients required one dose of rescue antiemetic, and none needed a second dose. In contrast, in the normal saline group, 13 patients (72.2%) out of 18 required one dose, while 5 patients (27.8%) needed two doses of rescue antiemetic. Although the normal saline group had a higher number of patients requiring multiple doses, the difference was not statistically significant (P=0.280), indicating comparable overall rescue antiemetic requirements between the two groups.

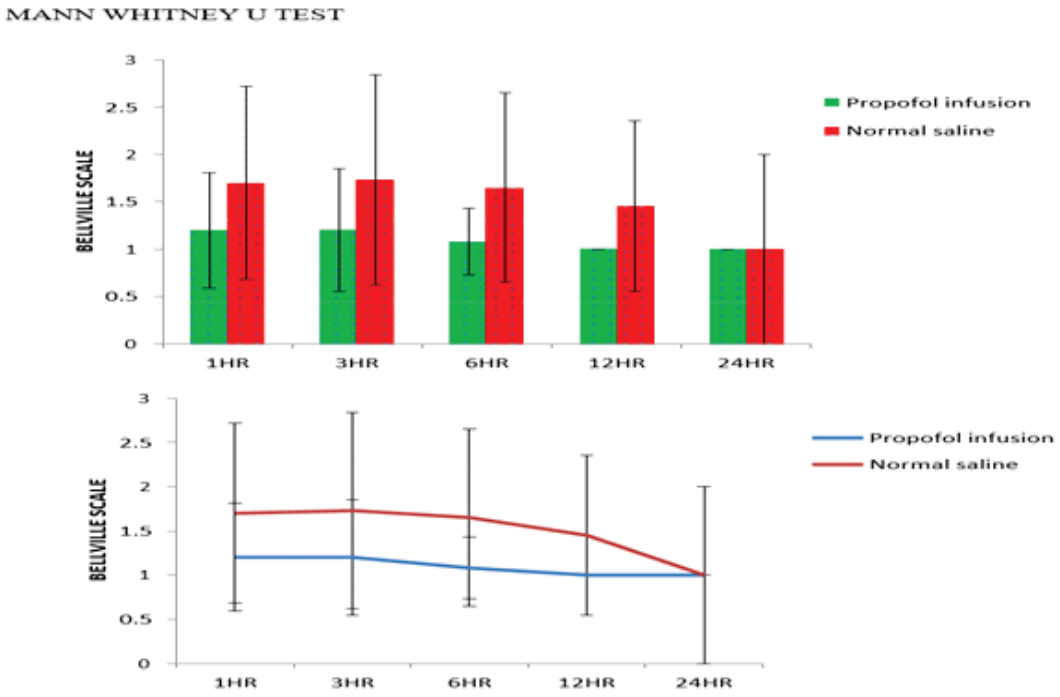

Figure 3: Bellville Scale According to Study Group

The Belville scale showed a lower incidence of PONV in the propofol infusion group compared to the normal saline group. The mean and standard deviation for the propofol group at 1, 3, 6, 12, and 24 hours were 1.2±0.61, 1.2±0.65, 1.08±0.35, 1±0, and 1±0, respectively. In contrast, the normal saline group had values of 1.7±1.02, 1.73±1.11, 1.65±1, 1.45±0.9, and 1±0. Statistically significant differences were observed at 1, 3, 6, and 12 hours (p=0.005, 0.005, <0.001, <0.001).

Table 5: Distribution of Gender According to the Study.

Gender	Propofol Infusion (N=40)	Normal Saline (N=40)	Total (N=80)
Female	23(57.5%)	22(55%)	45(56.3%)
Male	17(42.5%)	18(45%)	35(43.8%)
Total	40(100%)	40(100%)	80(100%)

In the propofol infusion group, there were 23 females (57.5%) and 17 males (42.5%), while the normal saline group had 22 females (55%) and 18 males (45%). No statistically significant difference was observed in the gender distribution between the two groups (P=1.00), indicating that the gender composition was comparable in both groups. This balance ensures that gender did not influence the outcomes of the study related to post-operative nausea and vomiting (PONV).

DISCUSSION

Laparoscopic surgeries have a high incidence of PONV, particularly in cholecystectomy, due to peritoneal irritation from carbon dioxide insufflation, with rates as high as 46-72%. Prolonged vomiting can cause complications like electrolyte imbalances, dehydration, and wound issues. Propofol, a short-acting hypnotic, reduces PONV by interacting with dopaminergic and 5HT3 receptors[21].

Gan TJ et al. demonstrated that a plasma concentration of 300-500 ng/ml is necessary to prevent nausea and vomiting. Various studies have examined both single bolus doses and sub-hypnotic propofol infusions for PONV prevention. A bolus dose leads to a rapid plasma level decline, with a redistribution time of 2-8 minutes and a clearance rate of 20-30 ml/kg/min, reducing propofol concentration within two hours. In contrast, low-dose propofol infusion remains effective for up to 24 hours postoperatively. Propofol infusion has also proven effective in conditions like chemotherapy-induced nausea and vomiting unresponsive to ondansetron and steroids, with an optimal infusion rate of 17 µg/kg/min (1 mg/kg/h). In our study, patients received a propofol infusion of 1 mg/kg/hr starting 10 minutes after induction and stopping 15 minutes before surgery ended. This dose significantly reduced the incidence of PONV (12.5%) compared to the control group (40%), with lower Bellville scale scores and less need for rescue antiemetics (15% vs. 45%)[22].

In a prospective, double-blind, randomized study by Kim et al., 107 women undergoing laparoscopy-assisted vaginal hysterectomy under general anesthesia were given two different doses of propofol (0.5 mg/kg and 1 mg/kg) 15 minutes before the end of surgery. The incidence of nausea in the first 2 hours was significantly lower in both the 0.5 mg/kg and 1 mg/kg propofol groups compared to the control group ($p<0.05$). However, no significant differences were observed between the groups during the 2-24 hour and 24-48-hour periods. These findings are consistent with our study's results[23].

Our findings are supported by Celik M et al., who demonstrated that a propofol infusion of 1 mg/kg/h effectively prevents PONV in patients undergoing laparoscopic surgery during the first 24 hours post-anesthesia. PONV incidence was significantly lower in the propofol group compared to the control group, with reduced rescue antiemetic and analgesic requirements. In our study, we used propofol alone as an infusion to prevent PONV. Arslan et al., in their double-blind study, found that combining propofol with dexamethasone (8 mg) provided better PONV control than with metoclopramide in patients undergoing laparoscopic surgery under general in patients undergoing laparoscopic surgery under general anesthesia. However, the dose of propofol used in their study was half of what was used in ours, highlighting a difference in dosing strategy and outcomes[24,25].

In our study, we used continuous propofol infusion based on findings by Gan TJ et al., who demonstrated that the protective effect of propofol against PONV was evident only when it was administered throughout the procedure. The mean plasma concentration associated with an antiemetic response was 343 ng/ml, while patients receiving continuous infusion had a concentration of 424 ng/ml. In contrast, patients who received propofol only during induction and at the end of surgery had a higher incidence of PONV, with a mean concentration of 178 ng/ml. The antiemetic effect is significantly lower than the concentration required for sedation (1-3 µg/ml)[22].

Borgeat et al. demonstrated that sub hypnotic doses of propofol have a direct antiemetic effect in minor elective surgeries. The area postrema, which has the highest concentration of 5HT3 receptors in the brain, plays a key role in this antiemetic action, with propofol reducing serotonin levels in this region. Propofol's weak serotonin antagonistic action also contributes to its antiemetic effects. In our study, intraoperative propofol infusion effectively reduced PONV with minimal side effects. Although the requirement for rescue antiemetics was lower in the propofol group, complete avoidance was not achieved. The optimal dose of propofol for preventing PONV remains undetermined. Additionally, we did not assess the reduction of the minimum alveolar concentration (MAC) of inhalational agents when using a 1 mg/kg/hr propofol infusion[26].

CONCLUSION

Intraoperative propofol infusion at a dose of 1 mg/kg/hr has been shown to effectively reduce postoperative nausea and vomiting (PONV) in patients undergoing laparoscopic surgeries under general anesthesia. This approach significantly lowers the incidence of PONV and the need for rescue antiemetics, making it a valuable option for improving patient comfort and outcomes in laparoscopic procedures, without introducing significant side effects.

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