Original Article

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Hemodynamic Profile and Postoperative Pain Following Propofol-Remifentanil and Isoflurane-Remifentanil Anaesthesia in Laparoscopic Cholecystectomy

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ABSTRACT

Background: *Laparoscopic cholecystectomy is the standard approach for cholelithiasis, offering reduced postoperative pain and faster recovery compared to open surgery. General anaesthesia is routinely used, and the choice of technique plays a key role in ensuring haemodynamic stability and optimal perioperative outcomes.* ***Objective:*** *The aim of the study was to compare the hemodynamic profile and postoperative pain outcomes between propofol–remifentanil and isoflurane–remifentanil anesthesia in patients undergoing laparoscopic cholecystectomy.* ***Methods & Materials:*** *This quasi-experimental study was conducted in the operation theatre of the Department of General Surgery, Bangladesh Medical University, Dhaka, Bangladesh (October 2024–September 2025). Seventy-two patients undergoing elective laparoscopic cholecystectomy were purposively sampled and equally allocated to Group PR (propofol–remifentanil) and Group IR (isoflurane–remifentanil) to compare perioperative haemodynamic parameters and postoperative pain outcomes. Standardized anaesthetic protocols were applied, and data were analysed using SPSS version 29.0.* ***Results:*** *A total of 72 patients (36 per group) were included, with comparable baseline demographic and clinical characteristics between the PR and IR groups ($p > 0.05$). Heart rate remained similar throughout the perioperative period, while systolic and diastolic blood pressures were significantly lower in the PR group ($p < 0.01$). Postoperative pain was significantly reduced in the PR group at early time points, and opioid requirement was markedly lower (27.8% vs. 77.8%; 28.6 ± 12.3 vs. 46.9 ± 15.8 mg; $p < 0.001$), with differences resolving by 24 hours.* ***Conclusion:*** *Propofol–remifentanil anesthesia offers better hemodynamic stability and postoperative pain control than isoflurane–remifentanil anesthesia in laparoscopic cholecystectomy.*

Keywords: *Remifentanil, Propofol, Tracheal Intubation, Laparoscopic Surgery, Suxamethonium.*

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INTRODUCTION

Laparoscopic cholecystectomy is currently regarded as the standard surgical approach for the management of cholelithiasis. Compared with open cholecystectomy, this minimally invasive technique is associated with reduced postoperative pain, quicker mobilisation, earlier return to routine activities, and shorter hospital stay [1,2]. General anaesthesia remains the preferred anaesthetic technique for this type of procedure. Anaesthesia refers to a medically controlled and reversible state of loss of sensation and/or consciousness that is fundamental for performing surgical interventions. The selection of an appropriate anaesthetic technique is particularly important in patients undergoing complex surgical procedures, as it significantly influences perioperative outcomes, including haemodynamic stability and recovery profiles [3,4].

Laparoscopic surgical procedures involve the insufflation of gas, most commonly carbon dioxide (CO_2), into the peritoneal cavity under pressure to create working space by separating abdominal organs [5]. This pneumoperitoneum, together with patient positioning, leads to marked physiological alterations, particularly affecting haemodynamic parameters [6]. These changes associated with increased intra-abdominal pressure can contribute to cardiovascular and respiratory disturbances during surgery. In addition, CO_2 insufflation causes peritoneal stretching and irritation, which is strongly implicated in the development of postoperative nausea and vomiting (PONV). Certain laparoscopic procedures, such as those requiring steep Trendelenburg positioning and prolonged insufflation, further intensify intra-abdominal pressure and physiological stress responses [7].

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Remifentanil possesses a distinctive pharmacological profile and may serve as an alternative to nitrous oxide, providing effective intraoperative analgesia while enabling rapid emergence from anaesthesia without residual respiratory depression [8]. It is a potent opioid characterized by an exceptionally short half-life due to rapid metabolism by plasma and tissue esterases. Propofol demonstrates favourable pharmacokinetic properties when used in total intravenous anaesthesia (TIVA), offering faster recovery and a lower incidence of nausea and vomiting compared to conventional anaesthetic regimens. TIVA, most commonly based on propofol, has gained increasing acceptance due to its superior control over anaesthetic depth, reduced airway irritation, and decreased risk of postoperative nausea and vomiting (PONV) [9]. Isoflurane, a widely used inhalational anaesthetic agent, is valued for its rapid induction characteristics and stable haemodynamic profile during maintenance of anaesthesia.

The comparative advantages of intravenous anaesthesia using propofol versus inhalational anaesthesia have been widely explored in literature, though findings remain inconsistent. Some clinical studies have reported that propofol-based TIVA is associated with a significantly lower incidence of PONV compared to inhalational agents [10]. In contrast, other investigations have recommended TIVA with propofol primarily in patients at high risk of PONV, indicating selective rather than universal superiority. Although several cost-related and outcome-based analyses have evaluated remifentanil-based TIVA techniques, robust comparative evidence remains limited [11]. Furthermore, there is a lack of studies that comprehensively compare anaesthetic techniques with respect to both haemodynamic stability and postoperative recovery outcomes in specific surgical populations.

Laparoscopic cholecystectomy is commonly performed under general anaesthesia, where maintaining stable haemodynamics and ensuring optimal postoperative recovery are key priorities. However, pneumoperitoneum-related physiological stress and postoperative pain remain important challenges despite advances in anaesthetic techniques. Although both propofol–remifentanil total intravenous anaesthesia and isoflurane–remifentanil anaesthesia are widely used, existing literature shows inconsistent findings regarding their comparative effects on haemodynamic stability and postoperative recovery, particularly pain outcomes. In this context, the present study was designed to compare the perioperative haemodynamic profile and postoperative pain outcomes between propofol–remifentanil and isoflurane–remifentanil anaesthesia in patients undergoing elective laparoscopic cholecystectomy.

OBJECTIVE

To compare the hemodynamic profile and postoperative pain outcomes between propofol–remifentanil and isoflurane–remifentanil anesthesia in patients undergoing laparoscopic cholecystectomy.

METHODS & MATERIALS

This quasi-experimental study was conducted in the operation theatre of the Department of General Surgery, Bangladesh Medical University, Dhaka, Bangladesh, between October 2024 and September 2025. A total of 72 patients undergoing elective laparoscopic cholecystectomy under general anaesthesia were included in the study, who were selected by purposive sampling according to predefined inclusion and exclusion criteria for the evaluation of perioperative hemodynamic parameters and postoperative pain outcomes, and were allocated into two equal groups: Group PR (propofol–remifentanil anesthesia) and Group IR (isoflurane–remifentanil anesthesia), with 36 patients in each group.

Inclusion criteria:

- Patients scheduled for elective laparoscopic cholecystectomy.
- Patients aged 20–64 years.
- Expected duration of surgery ≤ 3 hours.
- Patients with American Society of Anesthesiologists (ASA) physical status I–II.

Exclusion criteria:

- Patients with known hypersensitivity to propofol, isoflurane, or remifentanil.
- Patients currently receiving sedative, opioid, or sleep-aid medications.
- Emergency surgical cases.
- Obese patients (BMI >30 kg/m^2).
- Patients with pre-existing cardiac, respiratory, renal, or hepatic disease.
- Patients with diagnosed psychiatric disorders.

After 8 hours of fasting for solids, 6 hours for liquids, and 2 hours for water, all patients received intravenous omeprazole (40 mg) and metoclopramide (10 mg) 30 minutes before induction. Standard monitoring with electrocardiography, non-invasive blood pressure, and pulse oximetry was established, and baseline haemodynamic parameters were recorded. Anaesthesia was induced with remifentanil infusion (0.5 μg/kg/min) followed by propofol (0.5 mg/kg) titrated to loss of consciousness, and tracheal intubation was facilitated with suxamethonium (1.5 mg/kg). Maintenance anaesthesia consisted of either propofol infusion (75 μg/kg/min) with remifentanil (0.1 μg/kg/min) in Group PR or isoflurane (0.8 MAC) with remifentanil (0.1 μg/kg/min) in Group IR, with vecuronium for muscle relaxation and mechanical ventilation using 33% oxygen in 66% nitrous oxide, targeting end-tidal CO_2 of 35–45 mmHg. Haemodynamic variables (heart rate, systolic and diastolic blood pressure) were recorded at baseline, 10 minutes after induction, 30 minutes during maintenance, after cessation of anaesthesia, and in the recovery room. At the end of surgery, anaesthesia was discontinued and neuromuscular blockade was reversed with neostigmine and atropine, followed by extubation and transfer to the recovery room. Postoperatively, all patients received paracetamol and ketorolac, with rescue intramuscular pethidine (1 mg/kg) administered when VAS ≥4, and discharge from recovery room occurred at Modified Aldrete Score ≥9. The primary outcomes included VAS pain score, haemodynamic parameters, total 24-hour opioid consumption, and recovery room stay. Data were analysed using SPSS version 29.0; continuous variables were compared using independent t-test and categorical variables using Chi-square or Fisher's exact test, with $p<0.05$ considered significant. Ethical approval was obtained from the Institutional Review Board of Bangladesh Medical University, and written informed consent was taken from all participants in accordance with the Declaration of Helsinki.

RESULTS

Table I presents the demographic and anthropometric characteristics of the study participants. The mean age was 44.6 ± 8.9 years in the Propofol-Remifentanil (PR) group and 43.1 ± 9.3 years in the Isoflurane-Remifentanil (IR) group. In the PR group, 4 (11.1%) patients were male and 32 (88.9%)

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were female, whereas in the IR group, 5 (13.9%) patients were male and 31 (86.1%) were female. The mean body weight was 64.7 ± 8.9 kg in the PR group and 65.5 ± 8.8 kg in the IR group. The mean height was 160.1 ± 1.4 cm and 160.5 ± 1.7 cm, respectively, while the mean BMI was 25.3 ± 3.6 kg/m^2 and 25.4 ± 3.4 kg/m^2. No statistically significant differences were observed between the groups in any of these variables ($p > 0.05$).

Table I: Demographic and Anthropometric Characteristics of the Study Groups (*n* = 72).

Variable	Group PR (n=36)	Group IR (n=36)	p-value
Age (years), Mean ± SD	44.6 ± 8.9	43.1 ± 9.3	0.26
Sex, Male, n (%)	4 (11.1%)	5 (13.9%)	1.00
Sex, Female, n (%)	32 (88.9%)	31 (86.1%)	
Weight (kg), Mean ± SD	64.7 ± 8.9	65.5 ± 8.8	0.36
Height (cm), Mean ± SD	160.1 ± 1.4	160.5 ± 1.7	0.16
BMI (kg/m^2), Mean ± SD	25.3 ± 3.6	25.4 ± 3.4	0.46

Table II presents the baseline clinical characteristics of the study participants. In the PR group, 19 (52.8%) patients were classified as ASA I and 17 (47.2%) as ASA II, whereas in the IR group, 21 (58.3%) and 15 (41.7%) patients were classified as ASA I and ASA II, respectively. Hypertension was present in 10 (27.8%) patients in the PR group and 9 (25.0%) patients in the IR group. Diabetes mellitus was observed in 7 (19.4%) patients in the PR group and 6 (16.7%) patients in the IR group. No statistically significant differences were found between the groups regarding ASA physical status or comorbidities ($p > 0.05$).

Table II: Clinical Characteristics of the Study Groups (*n* = 72).

Variable		Group PR (n=36)	Group IR (n=36)	p-value
ASA Physical Status	ASA I, n (%)	19 (52.8%)	21 (58.3%)	0.23
	ASA II, n (%)	17 (47.2%)	15 (41.7%)	
Comorbidity	Hypertension, n (%)	10 (27.8%)	9 (25.0%)	1.00
	Diabetes mellitus, n (%)	7 (19.4%)	6 (16.7%)	

Table III presents the perioperative hemodynamic parameters of the study participants. Baseline heart rate was comparable between the PR and IR groups (78.5 ± 12.0 vs. 78.9 ± 11.6 beats/min; $p = 0.44$), and no statistically significant differences in heart rate were observed at any perioperative time point ($p > 0.05$). Baseline systolic blood pressure (124.9 ± 9.1 vs. 126.0 ± 9.7 mmHg; $p = 0.62$) and diastolic blood pressure (80.4 ± 5.9 vs. 80.0 ± 5.5 mmHg; $p = 0.38$) were also similar between the groups. However, systolic and diastolic blood pressure values were significantly lower in the PR group at 10 minutes after induction, during maintenance, after cessation of anesthesia, and in the recovery room compared with the IR group (all $p < 0.01$).

Table III: Comparison of Perioperative Hemodynamic Parameters Between the Study Groups (*n* = 72).

Time Interval		Group PR (n=36) Mean ± SD	Group IR (n=36) Mean ± SD	p-value
Heart Rate (beats/min)	At Baseline	78.5 ± 12.0	78.9 ± 11.6	0.44
	10 min After Induction	61.8 ± 6.9	62.3 ± 8.8	0.80
	During Maintenance (30 min After Induction)	64.6 ± 8.5	65.7 ± 8.2	0.60
	After Cessation of Anaesthesia	75.0 ± 5.4	76.5 ± 7.2	0.35
	At Recovery Room	71.1 ± 7.6	73.7 ± 6.5	0.10
Systolic Blood Pressure (mmHg)	At Baseline	124.9 ± 9.1	126.0 ± 9.7	0.62
	10 min After Induction	96.7 ± 7.9	111.9 ± 7.5	<0.01
	During Maintenance (30 min After Induction)	107.1 ± 9.4	116.6 ± 8.4	<0.01
	After Cessation of Anaesthesia	113.4 ± 7.2	126.5 ± 10.0	<0.01
	At Recovery Room	112.9 ± 8.1	117.5 ± 8.2	<0.01
Diastolic Blood Pressure (mmHg)	At Baseline	80.4 ± 5.9	80.0 ± 5.5	0.38
	10 min After Induction	59.9 ± 6.7	68.3 ± 7.7	<0.01
	During Maintenance (30 min After Induction)	64.3 ± 6.1	70.4 ± 8.0	<0.01
	After Cessation of Anaesthesia	70.0 ± 5.6	92.6 ± 11.8	<0.01
	At Recovery Room	71.7 ± 8.1	76.8 ± 8.4	<0.01

Table IV presents the postoperative pain intensity of the study participants at different time points. On arrival at the postoperative ward, 25 (69.4%) patients in the PR group experienced mild pain and 11 (30.6%) experienced moderate pain, whereas all 36 (100%) patients in the IR group reported moderate pain ($p < 0.01$). At 12 hours postoperatively, all 36 (100%) patients in the PR group reported mild pain, while 20 (55.6%) patients in the IR group experienced moderate pain and 16 (44.4%) reported mild pain ($p < 0.01$). At 24 hours postoperatively, all 36 (100%) patients in both groups reported mild pain, and no statistically significant difference was observed between the groups ($p = 1.00$).

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Table IV: Comparison of Postoperative Pain Intensity Between the Study Groups (*n* = 72).

Time Point		Group PR (n=36)	Group IR (n=36)	p-value
On arrival at postoperative ward	Severe	0 (0%)	0 (0%)	<0.01
	Moderate	11 (30.6%)	36 (100%)	
	Mild	25 (69.4%)	0 (0%)	
At 12 hours	Severe	0 (0%)	0 (0%)	<0.01
	Moderate	0 (0%)	20 (55.6%)	
	Mild	36 (100%)	16 (44.4%)	
At 24 hours	Severe	0 (0%)	0 (0%)	1.00
	Moderate	0 (0%)	0 (0%)	
	Mild	36 (100%)	36 (100%)	

Table V presents the postoperative opioid analgesic requirements during the first 24 hours after surgery. Rescue opioid analgesia was required in 10 (27.8%) patients in the PR group compared with 28 (77.8%) patients in the IR group. The mean total opioid consumption was 28.6 ± 12.3 mg in the PR group and 46.9 ± 15.8 mg in the IR group. Both the proportion of patients requiring opioid analgesia and the total opioid consumption were significantly lower in the PR group than in the IR group ($p < 0.001$).

Table V: Postoperative Opioid Analgesic Requirement During the First 24 Hours (*n* = 72).

Variable	Group PR (n=36)	Group IR (n=36)	p-value
Number of Cases Required Opioid Analgesics	10 (27.78%)	28 (77.77%)	<0.001
Total Opioid Consumption (mg)	28.6 ± 12.3	46.9 ± 15.8	<0.001

DISCUSSION

This quasi-experimental study was conducted at Bangladesh Medical University, Dhaka, Bangladesh, and included seventy-two patients undergoing elective laparoscopic cholecystectomy under general anaesthesia. Patients were allocated into two groups: Group PR receiving propofol–remifentanil anaesthesia and Group IR receiving isoflurane–remifentanil anaesthesia. The study aimed to compare perioperative haemodynamic parameters and postoperative pain outcomes, including pain scores and opioid consumption, between the two anaesthetic techniques in patients undergoing laparoscopic cholecystectomy.

The two study groups were well matched in terms of baseline demographic and anthropometric characteristics, with no statistically significant differences observed in age, sex distribution, body weight, height, or BMI ($p > 0.05$). This confirms successful randomization and ensures that both groups were comparable prior to the intervention. Such baseline homogeneity is essential for minimizing confounding variables and strengthening the internal validity of comparative anesthesia studies, as it allows postoperative outcomes to be attributed more confidently to the anesthetic technique rather than pre-existing patient differences. Similar observations have been consistently reported in previous randomized studies on laparoscopic cholecystectomy. Deng et al. demonstrated comparable demographic profiles, including age, sex distribution, BMI, and ASA physical status, between propofol–remifentanil TCI and volatile anesthesia groups [12]. Likewise, Nadri et al. reported no significant differences in key demographic variables such as age, sex, weight, and BMI between patients receiving propofol-based TIVA and isoflurane-based anesthesia [13]. Collectively, these findings support the methodological strength of the present study and reinforce that observed differences in perioperative outcomes are unlikely to be confounded by demographic variability.

The clinical characteristics of the study participants further demonstrated that both groups were comparable with respect to ASA physical status and preoperative comorbid conditions, with no statistically significant differences observed between the Propofol-Remifentanil and Isoflurane-Remifentanil groups ($p > 0.05$). The distribution of ASA I and ASA II patients was similar between groups, indicating a comparable preoperative risk profile. In addition, common comorbidities such as hypertension and diabetes mellitus were evenly distributed, further confirming baseline clinical equivalence. This consistency in preoperative status is important because ASA classification and comorbid disease burden are known determinants of perioperative risk and postoperative outcomes. Similar findings have been reported by Ghani et al., who observed comparable ASA distribution across laparoscopic cholecystectomy cohorts [14]. Likewise, Boehme et al. reported that hypertension and diabetes mellitus were among the most common comorbidities in cholecystectomy patients and did not differ significantly between study groups at baseline [15]. Taken together, these findings, along with the present study, confirm that patients undergoing laparoscopic cholecystectomy are generally well matched in terms of ASA classification and comorbid disease burden.

The perioperative hemodynamic parameters demonstrated that heart rate remained comparable between the Propofol-Remifentanil and Isoflurane-Remifentanil groups throughout all measured time points, with no statistically significant differences observed ($p > 0.05$), indicating stable chronotropic responses under both anesthetic techniques. In contrast, systolic and diastolic blood pressures showed consistently lower values in the Propofol-Remifentanil group at multiple intraoperative and postoperative time points ($p < 0.01$), indicating better attenuation of sympathetic responses. Similar hemodynamic changes have been reported in previous studies. Umar et al. demonstrated significant blood pressure elevation associated with pneumoperitoneum during laparoscopic cholecystectomy [16]. Khare et al. also observed marked fluctuations in systolic and diastolic blood pressures during pneumoperitoneum and extubation phases [17]. Similarly, Stamate et al. reported significant increases in blood pressure during pneumoperitoneum, with relatively less consistent changes in heart rate [18]. Collectively, these findings support the present results, indicating that propofol–remifentanil provides superior control of perioperative blood pressure responses.

The postoperative pain profile demonstrated significantly better analgesic outcomes in the Propofol-Remifentanil group compared to the Isoflurane-Remifentanil group during the early postoperative period. This difference was most

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pronounced in the immediate postoperative phase and at 12 hours, while pain scores converged by 24 hours. Similar findings have been reported by Faiz et al., who demonstrated that deeper anesthesia levels were associated with lower postoperative pain scores and reduced analgesic requirements [19]. Likewise, Karcioglu et al. reported significantly lower VAS scores and reduced analgesic consumption in the intervention group across postoperative time points [20]. Collectively, these findings support the present results, confirming superior early postoperative pain control with propofol–remifentanil anesthesia.

The postoperative opioid analgesic requirement during the first 24 hours was significantly lower in the Propofol-Remifentanil group compared to the Isoflurane-Remifentanil group, both in terms of proportion of patients requiring rescue analgesia and total opioid consumption ($p < 0.001$). Similar findings have been reported by Chen et al., who observed reduced postoperative analgesic requirements and smoother recovery profiles with propofol–remifentanil anesthesia [21]. Likewise, Xiong et al. demonstrated significantly reduced postoperative opioid consumption with propofol-based anesthetic strategies compared to conventional approaches [22]. Collectively, these studies support the present findings, indicating that propofol–remifentanil anesthesia provides superior postoperative analgesia and reduces overall opioid requirements.

LIMITATIONS

Variations in surgical technique, anesthetic management, and perioperative care among healthcare providers may have influenced the hemodynamic responses and postoperative recovery outcomes observed in this study.

CONCLUSION

Both anesthetic regimens provided safe and effective perioperative management for laparoscopic cholecystectomy. However, propofol–remifentanil anesthesia was associated with better perioperative blood pressure control, reduced early postoperative pain, lower rescue opioid requirements, and decreased total opioid consumption compared with isoflurane–remifentanil anesthesia. Therefore, propofol–remifentanil appears to offer superior hemodynamic and postoperative analgesic outcomes in these patients.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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