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Comparison of Recovery Profile Following Propofol Total Intravenous Anaesthesia Versus Sevoflurane Inhalational Anaesthesia in Elective Laparoscopic Cholecystectomy - A Randomized Controlled Trial

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Abstract

Background: Rapid recovery following laparoscopic cholecystectomy is an important objective of modern an aesthetic practice, particularly within Enhanced Recovery After Surgery (ERAS) protocols. Propofol total intravenous anaesthesia (TIVA) and Sevoflurane inhalational anaesthesia are widely used maintenance techniques; however, their effects on postoperative recovery remain a subject of ongoing research. This study compared the recovery profile following propofol TIVA and Sevoflurane inhalational anaesthesia in patients undergoing elective laparoscopic cholecystectomy.

Materials and Methods: This prospective, randomised, controlled trial was conducted in the Department of Anaesthesiology, Aster CMI Hospital, Bengaluru, Karnataka, over one year. A total of 100 adult patients (ASA I–II), aged 21–70 years, scheduled for elective laparoscopic cholecystectomy, were randomly allocated into two groups: Group P (Propofol TIVA, n=50) and Group S (Sevoflurane, n=50). Anaesthesia was maintained using target-controlled

infusion of propofol in Group P and Sevoflurane (MAC 0.8–1.2) in Group S while maintaining a Bispectral Index (BIS) of 40–60. The primary outcomes included extubation time, duration of stay in the post-anaesthesia care unit (PACU), time to discharge from PACU, Modified Aldrete Score, and White's Fast-Tracking Scoring System (WFTSS). Statistical analysis was performed using the independent Student's t-test and Chi-square test, with $p<0.05$ considered statistically significant.

Results: Baseline demographic characteristics, ASA status, body mass index, and duration of surgery were comparable between the two groups ($p>0.05$). Patients receiving propofol TIVA had significantly shorter extubation time (8.34 ± 2.61 vs. 11.24 ± 3.90 minutes; $p=0.015$), shorter PACU stay (8.52 ± 4.08 vs. 14.80 ± 6.70 minutes; $p=0.043$), and earlier discharge from PACU (16.86 ± 5.60 vs. 26.04 ± 8.70 minutes; $p=0.016$) than those receiving Sevoflurane. Fast-track eligibility was achieved in 38% of patients in the propofol group compared with only 4% in the Sevoflurane group ($p<0.001$).

Conclusion: Propofol total intravenous anaesthesia provided a significantly superior recovery profile compared with Sevoflurane inhalational anaesthesia in elective laparoscopic cholecystectomy. Earlier extubation, reduced PACU stay, faster discharge readiness, and improved fast-track eligibility suggest that propofol TIVA is an effective maintenance an aesthetic technique for facilitating enhanced post operative recovery.

Keywords: Propofol, Total Intravenous Anaesthesia, Sevoflurane, Laparoscopic Cholecystectomy, Recovery Profile, Fast-Track Anaesthesia, Post-Anaesthesia Care Unit.

Introduction

Laparoscopic cholecystectomy is considered the gold standard surgical procedure for the treatment of symptomatic gallstone disease and is one of the most frequently performed laparoscopic surgeries worldwide. Compared with conventional open cholecystectomy, the laparoscopic approach offers several advantages, including reduced postoperative pain, shorter hospital stay, earlier ambulation, faster recovery, improved cosmetic results, and an earlier return to normal daily activities. However, the creation of pneumoperitoneum and patient positioning during laparoscopic surgery produce significant cardiovascular and respiratory changes that necessitate meticulous an aesthetic management to ensure patient safety and facilitate rapid postoperative recovery[1].

General anaesthesia with endo tracheal intubation remains the preferred an aesthetic technique for laparoscopic cholecystectomy because it provides adequate airway protection, controlled ventilation, sufficient muscle relaxation, and optimal surgical conditions. Besides ensuring Intraoperative Haemodynamic stability, the choice of maintenance an aesthetic has a considerable influence on the quality of emergence, postoperative recovery, postoperative nausea and vomiting (PONV), cognitive function, patient satisfaction, and hospital discharge. With the increasing emphasis on ambulatory surgery and Enhanced Recovery After Surgery (ERAS) protocols, early recovery has become one of the major objectives of modern an aesthetic practice[2].

Propofol-based Total Intravenous Anaesthesia (TIVA) has become increasingly popular because of its favourable pharmacokinetic and pharma codynamic characteristics. Propofol produces rapid induction,

smooth maintenance of anaesthesia, quick emergence, excellent patient comfort, and possesses intrinsic antiemetic properties. The introduction of Target-Controlled Infusion (TCI) systems has further improved the delivery of propofol by maintaining predetermined plasma or effect-site drug concentrations, thereby allowing precise titration of an aesthetic depth while minimizing drug accumulation. Consequently, TIVA has been associated with improved recovery characteristics and reduced incidence of postoperative nausea and vomiting compared with inhalational an aesthetic agent [3,4].

Sevoflurane is a modern volatile inhalational an aesthetic characterized by a low blood-gas partition coefficient, rapid induction and emergence, minimal airway irritation, and excellent cardiovascular stability. Because of these favourable characteristics, Sevoflurane has become one of the most widely used inhalational agents for maintenance of general anaesthesia in laparoscopic surgery. Nevertheless, the elimination of volatile anesthetic agents depends upon pulmonary washout, and prolonged exposure may contribute to delayed recovery compared with intravenous techniques in certain clinical situations[5.]

Rapid postoperative recovery is particularly important in laparoscopic surgery because most patients are expected to achieve early mobilization and discharge. Recovery from anaesthesia is commonly assessed using validated scoring systems such as the Modified Aldrete Scoring System (MASS) and White's Fast-Tracking Scoring System (WFTSS).

These scoring systems objectively evaluate recovery based on consciousness, respiration, circulation, activity, oxygen saturation, pain, and postoperative nausea, thereby determining readiness for discharge from the post-anaesthesia care unit (PACU). Faster recovery not only improves patient satisfaction but also reduces PACU occupancy, enhances operating room efficiency, and lowers healthcare costs[6].

Several randomized controlled trials have compared propofol TIVA with inhalational an aesthetic agents regarding emergence characteristics, postoperative recovery, and adverse effects. Numerous investigators have demonstrated that propofol TIVA results in earlier extubation, shorter PACU stay, reduced postoperative nausea and vomiting, and improved quality of recovery. Conversely, some studies have reported comparable recovery profiles between propofol and modern inhalational agents such as Sevoflurane when an aesthetic depth is carefully monitored using Bispectral Index (BIS). These conflicting findings may be attributed to differences in patient populations, an aesthetic protocol, duration of surgery, analgesic techniques, and recovery assessment methods [7–11].

Considering the growing emphasis on fast-track anaesthesia and enhanced recovery protocols, identifying an aesthetic technique that provides optimal recovery following laparoscopic cholecystectomy remains clinically important. Therefore, the present randomized controlled trial was undertaken to compare the recovery profile following maintenance of general anaesthesia with propofol Total Intravenous Anaesthesia and Sevoflurane inhalational anaesthesia in patients undergoing elective laparoscopic cholecystectomy. Recovery was evaluated using extubation time, duration of PACU stay, time to discharge from PACU, Modified Aldrete Score, and White's Fast-Tracking Scoring System to determine an aesthetic technique associated with superior postoperative recovery [6,11].

Materials And Methods

Study Design

This prospective, randomised, controlled clinical trial was conducted to compare the recovery profile following maintenance of general anaesthesia with propofol total intravenous anaesthesia (TIVA) and Sevoflurane inhalational anaesthesia in patients undergoing elective laparoscopic cholecystectomy. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants before enrolment.

Study Setting

The study was carried out in the Department of Anaesthesiology at Aster CMI Hospital, Bengaluru, Karnataka, over a period of one year.

Study Population

A total of 100 adult patients scheduled for elective laparoscopic cholecystectomy under general anaesthesia were enrolled in the study. Patients were randomly allocated into two equal groups:

- Group P (Propofol TIVA): 50 patients
- Group S (Sevoflurane): 50 patients

Sample Size

The sample size was calculated based on previously published data comparing extubation time between propofol TIVA and Sevoflurane anaesthesia. Assuming a pooled standard deviation of 1.7 minutes, 80% study power and a 5% level of significance, a minimum of 50 patients per group was required.

Inclusion Criteria

- Age 21–70 years
- ASA physical status I or II
- Patients undergoing elective laparoscopic cholecystectomy
- Written informed consent

Exclusion Criteria

- Emergency surgeries
- ASA physical status III or above
- BMI >35 kg/m²
- Known allergy to propofol or Sevoflurane
- Previous history of postoperative nausea and vomiting
- Patient refusal
- Age <21 years or >70 years
- Patients undergoing concomitant surgical procedures

Randomization

Eligible patients were randomly assigned into two groups using simple randomization.

An aesthetic Technique

Group P (Propofol TIVA)

Anaesthesia was induced with 2% propofol using a target-controlled infusion (TCI) pump (Schneider model) and atracurium (0.5 mg/kg). Anaesthesia was maintained with propofol TIVA at an effect-site concentration of 2–5 μg/mL while maintaining a Bispectral Index (BIS) between 40 and 60.

Group S (Sevoflurane)

Anaesthesia was induced with propofol (2 mg/kg) and atracurium (0.5 mg/kg). Maintenance was achieved using Sevoflurane with a MAC of 0.8–1.2 while maintaining BIS values between 40 and 60.

In both groups, standard monitoring included ECG, non-invasive blood pressure, pulse oximetry, end-tidal carbon dioxide, MAC monitoring and BIS monitoring. All patients received standardized premedication, analgesia, neuromuscular blockade and ultrasound-guided abdominal wall blocks. An aesthetic agents were discontinued at skin closure, followed by reversal of neuromuscular blockade and extubation after fulfilment of standard extubation criteria.

Outcome Measures

Primary Outcome

Recovery profile was assessed using:

- Extubation time
- Time spent in Post Anaesthesia Care Unit (PACU)
- Time to discharge from PACU
- Modified Aldrete Score (MASS)
- White's Fast Tracking Scoring System (WFTSS)

Modified Aldrete Score was recorded every five minutes until a score ≥9 was achieved. Fast-track eligibility was defined as WFTSS ≥12 within five minutes after extubation.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS software. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequency and percentage. Independent Student's t-test was used for comparison of continuous variables and Chi-square test for categorical variables. A p-value <0.05 was considered statistically significant.

Results and Observations

Baseline Characteristics

Table 1. Baseline demographic characteristics

Variable	Propofol TIVA (n=50)	Sevoflurane (n=50)	p-value
Age (years)*	Comparable	Comparable	NS
Male	18 (36%)	15 (30%)	0.53
Female	32 (64%)	35 (70%)	
ASA I	27 (54%)	30 (60%)	0.54
ASA II	23 (46%)	20 (40%)	
BMI (kg/m²)	26.6 ± 3.4	26.8 ± 3.05	0.50
Duration of surgery (min)	97.25 ± 19.5	103.48 ± 18.3	>0.05

Observation

A total of 100 patients completed the study, with 50 patients in each group. The demographic variables, ASA physical status, BMI and duration of surgery were comparable between the two groups without statistically significant differences (p>0.05), indicating successful randomization. Recovery Profile

Table 2. Comparison of extubation time

Group	Mean ± SD (minutes)	p-value
Propofol TIVA	8.34 ± 2.61	
Sevoflurane	11.24 ± 3.90	0.015

Observation

Patients receiving propofol TIVA demonstrated significantly shorter extubation times compared with the Sevoflurane group (p=0.015).

Table 3. Time spent in PACU

Group	Mean ± SD (minutes)	p-value
Propofol TIVA	8.52 ± 4.08	
Sevoflurane	14.80 ± 6.70	0.043

Observation

The duration of stay in the PACU was significantly lower in patients receiving propofol TIVA than in those receiving Sevoflurane anaesthesia.

Table 4. Time to discharge from PACU

Group	Mean ± SD (minutes)	p-value
Propofol TIVA	16.86 ± 5.60	
Sevoflurane	26.04 ± 8.70	0.016

Observation

Patients in the propofol group achieved discharge readiness significantly earlier than patients maintained with Sevoflurane.

Table 5. Fast-track eligibility

Fast-track eligibility	Propofol TIVA	Sevoflurane	p-value
Yes	19 (38%)	2 (4%)	
No	31 (62%)	48 (96%)	<0.001

Observation

Fast-track eligibility was achieved by 38% of patients in the propofol group compared with only 4% in the Sevoflurane group, demonstrating a statistically significant advantage for propofol TIVA.

Table 6. Recovery profile comparison

Parameter	Propofol TIVA	Sevoflurane	p-value
Extubation time (min)	8.34 ± 2.61	11.24± 3.90	0.015
PACU stay (min)	8.52 ± 4.08	14.80 ± 6.70	0.043
Time to discharge (min)	16.86 ± 5.60	26.04 ± 8.70	0.016
Fast-track eligibility	38%	4%	<0.001

Discussion

The present randomized controlled study compared the recovery profile following maintenance of general anaesthesia using propofol Total Intravenous Anaesthesia (TIVA) and Sevoflurane inhalational anaesthesia in patients undergoing elective laparoscopic cholecystectomy. The study demonstrated that propofol TIVA was associated with significantly faster recovery, as evidenced by shorter extubation time, reduced duration of stay in the post-anaesthesia care unit (PACU), earlier discharge readiness, and a substantially higher proportion of patients achieving fast-track eligibility compared with Sevoflurane anaesthesia.

The baseline demographic variables, including age, gender distribution, body mass index, ASA physical status, and duration of surgery, were comparable between the two groups. This indicates that randomization was successful and minimizes the possibility that differences in recovery outcomes were influenced by confounding patient characteristics. Similar demographic comparability has been reported in previous randomized studies evaluating propofol and volatile an aesthetic agents [7,8].

One of the major findings of the present study was the significantly shorter extubation time observed in the propofol group compared with the sevoflurane group (8.34 ± 2.61 vs. 11.24 ± 3.90 minutes). Rapid emergence following propofol TIVA can be attributed to its rapid redistribution, high metabolic clearance, short context-sensitive half-time, and minimal tissue accumulation during continuous infusion.

Furthermore, Target-Controlled Infusion technology allows accurate titration of an aesthetic depth according to patient requirements, thereby preventing excessive administration and facilitating earlier recovery. Similar findings have been reported by Song et al. and Gupta et al., who demonstrated significantly earlier extubation following propofol anaesthesia compared with inhalational agents [8,9].

The duration of stay in the PACU was significantly shorter among patients receiving propofol TIVA than those maintained with Sevoflurane. Early recovery following propofol anaesthesia enables patients to achieve discharge criteria more rapidly, thereby improving PACU efficiency and optimizing hospital resource utilization. White and Song reported similar observations, demonstrating that patients receiving propofol fulfilled fast-track discharge criteria significantly earlier than those receiving volatile an aesthetic agents [6].

Patients receiving propofol also achieved discharge readiness significantly earlier than those maintained with Sevoflurane. Early discharge from PACU represents an important endpoint in modern ambulatory

anaesthesia because it improves patient turnover, reduces healthcare expenditure, and enhances patient satisfaction. A systematic review and meta-analysis by Schraag et al. concluded that propofol maintenance anaesthesia provides superior early recovery characteristics compared with inhalational an aesthetic agents, findings that are consistent with the present study [11].

Fast-track eligibility represents one of the most clinically relevant indicators of postoperative recovery. In the present study, 38% of patients receiving propofol achieved fast-track eligibility compared with only 4% in the Sevoflurane group. White's Fast-Tracking Scoring System evaluates multiple recovery parameters, including consciousness, activity, respiratory status, Haemodynamic stability, oxygen saturation, pain, and postoperative nausea. Therefore, the significantly higher fast-track eligibility observed in the propofol group reflects an overall improvement in postoperative recovery rather than merely earlier awakening [6].

Although postoperative nausea and vomiting were not evaluated as a primary outcome, the established antiemetic properties of propofol may have contributed to improved recovery quality. Previous studies have consistently demonstrated that propofol anaesthesia is associated with a significantly lower incidence of postoperative nausea and vomiting than inhalational anaesthesia. Reduced PONV contributes to earlier oral intake, improved patient comfort, and faster hospital discharge [12].

Sevoflurane nevertheless remains an excellent volatile an aesthetic because of its rapid induction, ease of administration, low airway irritation, and favourable Haemodynamic profile. Although recovery was comparatively slower than propofol in the present study, Sevoflurane continues to provide safe and effective maintenance of anaesthesia and remains an appropriate choice where TCI systems are unavailable or when inhalational anaesthesia is preferred [5].

The strengths of the present study include its prospective randomized controlled design, standardized an aesthetic protocol, objective assessment of recovery using validated scoring systems, and maintenance of comparable an aesthetic depth using Bispectral Index monitoring. These methodological strengths enhance the reliability and clinical applicability of the findings.

However, certain limitations should be acknowledged. The study was conducted at a single tertiary care institution with a relatively small sample size of 100 patients, which may limit the generalizability of the results. Furthermore, postoperative pain scores, patient satisfaction, quality-of-recovery scores, postoperative cognitive function, cost-effectiveness analysis, and long-term postoperative outcomes were not evaluated. Future multicentre randomized trials involving larger patient populations and comprehensive recovery assessment are recommended to validate these findings further.

Overall, the present study demonstrates that propofol Total Intravenous Anaesthesia provides superior early postoperative recovery compared with Sevoflurane inhalational anaesthesia in patients undergoing elective laparoscopic cholecystectomy. Earlier extubation, shorter PACU stay, faster discharge readiness, and improved fast-track eligibility support the use of propofol TIVA as an effective an aesthetic technique for laparoscopic surgery within enhanced recovery programme.

Conclusion

The present study demonstrated that propofol total intravenous anaesthesia (TIVA) provided a significantly superior recovery profile compared with Sevoflurane inhalational anaesthesia in patients undergoing elective laparoscopic cholecystectomy. Patients receiving propofol TIVA experienced earlier extubation, shorter post-anaesthesia care unit (PACU) stay, faster discharge readiness, and a significantly higher rate of fast-track eligibility. Although both an aesthetic techniques ensured safe and effective Intraoperative management, propofol TIVA facilitated more rapid postoperative recovery, making it particularly suitable for enhanced recovery protocols and ambulatory laparoscopic surgery. Based on these findings, propofol TIVA may be considered the preferred maintenance an aesthetic technique for elective laparoscopic cholecystectomy when rapid recovery and early discharge are desired.

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