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Original Research Article

# RECOVERY PROFILE AFTER DESFLURANE, SEVOFLURANE, AND PROPOFOL INFUSION ANAESTHESIA FOR LAPAROSCOPIC CHOLECYSTECTOMY: A COMPARATIVE STUDY

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## ABSTRACT

**Background:** Rapid and predictable recovery is an important objective of modern general anaesthesia, particularly after laparoscopic surgery. Desflurane and sevoflurane are inhalational agents associated with relatively rapid emergence, whereas propofol infusion may provide favourable postoperative recovery and reduced postoperative nausea and vomiting. The present study compared early, intermediate, and late recovery profiles, postoperative nausea and vomiting (PONV), rescue antiemetic use, and adverse effects among patients receiving desflurane, sevoflurane, or propofol infusion for laparoscopic cholecystectomy. **Materials and Methods:** This comparative quasi-observational study was conducted over 18 months at Government Doon Medical College and Associated Doon Hospital, Dehradun. A total of 123 adult patients scheduled for laparoscopic cholecystectomy were allocated by computer randomisation into three groups of 41 patients each. Group D received desflurane, Group S received sevoflurane, and Group P received propofol infusion for maintenance of anaesthesia. Early recovery was assessed using time to extubation and eye opening. Intermediate recovery was assessed using orientation to time, place, date of birth, and whereabouts. Late recovery was assessed using the time required to sit and walk without assistance. PONV was recorded during the early postoperative period (0–4 hours) and late period (4–24 hours). **Results:** Baseline demographic characteristics were comparable among the groups. The mean extubation and eye-opening times were significantly longer in Group P than in Groups D and S. Extubation time was 17.93 ± 4.54 minutes in Group P, compared with 8.85 ± 2.17 minutes in Group D and 9.61 ± 5.22 minutes in Group S ($p < 0.01$). Eye opening occurred at 21.68 ± 7.06 minutes in Group P, compared with 10.29 ± 2.61 minutes in Group D and 11.12 ± 5.24 minutes in Group S ($p < 0.01$). Intermediate recovery was also delayed in Group P. Conversely, Group P showed faster late recovery, with shorter times to sitting and walking without help than the inhalational-agent groups. PONV incidence and rescue antiemetic use were low and comparable among groups. **Conclusion:** Desflurane and sevoflurane provided faster early and intermediate recovery than propofol infusion. Propofol was associated with faster late motor recovery. PONV and other adverse effects were uncommon and did not differ significantly among the three groups. Anaesthetic selection should therefore be individualised according to the desired phase of recovery, patient characteristics, and surgical requirements.

## INTRODUCTION

Laparoscopic surgery has become the standard of care for a wide range of abdominal procedures because of its advantages over open surgery, including reduced postoperative pain, shorter hospital stay, faster recovery, and improved cosmetic outcomes. However, the creation of carbon dioxide pneumoperitoneum and patient positioning during laparoscopic procedures produce significant cardiopulmonary and physiological alterations, necessitating optimal anaesthetic management to ensure hemodynamic stability and rapid postoperative recovery.[1-3]

Recovery characteristics and postoperative nausea and vomiting (PONV) remain important determinants of patient satisfaction, particularly in short-duration laparoscopic surgeries where early ambulation and discharge are desirable.[4-8]

Propofol has become the preferred intravenous anesthetic agent for laparoscopic surgeries and day care procedures due to its numerous benefits, including rapid recovery, clear-headedness, and inherent antiemetic properties.[9-11]

Among volatile anesthetics, sevoflurane and desflurane, owing to their low blood–gas partition coefficients, facilitate rapid emergence and early recovery while allowing precise titration of anesthetic depth. Although several studies have compared intravenous and inhalational anesthetics, limited evidence directly compares propofol, sevoflurane, and desflurane with respect to early recovery and PONV following laparoscopic cholecystectomy.[12-14] Therefore, the present study was undertaken to compare the recovery profile and incidence of postoperative nausea and vomiting among patients receiving propofol, sevoflurane, or desflurane for maintenance of anesthesia during elective laparoscopic cholecystectomy.

**Aim and Objectives**

The primary objective of this study was to evaluate & compare the effects of desflurane, sevoflurane & propofol on recovery profile of patients undergoing laparoscopic cholecystectomy while the secondary objective was to evaluate and compare the effects of these agents on Post operative nausea vomiting (PONV) and note any other side effects. After obtaining written informed consent from study participants, selected sample size of 123 patients were allocated with computer randomization method into 3 groups of 41 patients each. Patients in the age group 18years to 65 years; ASA I and ASA II posted for elective laparoscopic cholecystectomy; and patients willing to give informed written consent were included in the study.

Patients with major cardiovascular, pulmonary, hepatic, renal, endocrine, metabolic, neurologic & psychiatric diseases, pregnant patients, those with history of allergic reactions and motion sickness and patient receiving sedative medication were excluded from the study.

## MATERIALS AND METHODS

**Study design and participants**

This comparative quasi-observational study was conducted in the Department of Anaesthesiology at Government Doon Medical College and Associated Doon Hospital, Dehradun, Uttarakhand, over a period of 18 months. The study included 123 patients scheduled for elective laparoscopic cholecystectomy. Written informed consent was obtained from all participants.

The sample size was calculated for an equivalence design, resulting in 41 participants per group. Patients were allocated using a computer randomisation method into three groups:

- Group D: Maintenance with desflurane.
- Group S: Maintenance with sevoflurane.
- Group P: Maintenance with propofol infusion.

The study population consisted of adult patients within the age range represented in the thesis data. Patients were evaluated during the pre-anaesthetic check-up, and baseline demographic and clinical information was recorded.

**Anaesthetic technique**

Patients were instructed to remain nil per oral for 6 hours before surgery. Standard monitoring included electrocardiography, non-invasive blood pressure, pulse oximetry, and temperature monitoring. After preoxygenation with 100% oxygen, patients received intravenous midazolam 0.03 mg/kg, glycopyrrolate 0.005 mg/kg, and fentanyl 2 µg/kg.

Anaesthesia was induced with intravenous propofol 2 mg/kg. Tracheal intubation was facilitated with vecuronium 0.1 mg/kg. Endotracheal tubes of 7.0 mm internal diameter for females and 7.5 mm for males were used. During maintenance, additional vecuronium 0.02 mg/kg was administered as required.

In Group P, anaesthesia was maintained with propofol infusion at 6 mg/kg/hour, together with 50% nitrous oxide in oxygen. In Groups D and S, anaesthesia was maintained with desflurane and sevoflurane, respectively, at concentrations providing an average of 1.3 minimum alveolar concentration, together with 50% nitrous oxide in oxygen.

During maintenance, anaesthetic concentrations and propofol infusion rates were adjusted when haemodynamic variables deviated by more than 15% from pre-induction values. The permitted ranges were 50–150 µg/kg/min for propofol, 2–8% for desflurane, and 0.5–3% for sevoflurane. The aim was to maintain haemodynamic variables within ±15% of baseline values.

Five minutes before anticipated extubation, all patients received ondansetron 4 mg intravenously and dexamethasone 8 mg intravenously for PONV prophylaxis. Neuromuscular blockade was reversed using neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. Patients were extubated after fulfilling clinical criteria for extubation. The time of


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discontinuation of the volatile agent or propofol infusion was used as the reference point for measuring recovery outcomes.

**Assessment of recovery**

**Recovery was divided into three phases**:

- Early recovery: Time to extubation and eye opening.
- Intermediate recovery: Time to orientation to time and place, followed by identification of date of birth and whereabouts.
- Late recovery: Time to sitting and walking without assistance.

All recovery times were recorded in minutes from discontinuation of the maintenance anaesthetic. Postoperatively, patients were monitored for heart rate, blood pressure, respiratory rate, oxygen saturation, and adverse effects for 24 hours.

PONV was recorded separately during the early period of 0–4 hours and the late period of 4–24 hours. Nausea was assessed using a visual analogue scale from 0 to 10, with a score greater than 4 considered clinically significant. Patients with significant nausea or vomiting were treated with intravenous metoclopramide. Rescue antiemetic requirements were documented.

**Statistical Analysis**

Data were entered into a Microsoft Excel spreadsheet and analysed using SPSS version 27.0 (IBM Inc., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as numbers and percentages. Normality was assessed using the Kolmogorov–Smirnov test. Intergroup comparisons of continuous variables were performed using Student's t-test or analysis of variance, as appropriate. The Mann–Whitney test was used for non-homogeneous variables, and categorical variables were compared using the chi-square test. A p value <0.05 was considered statistically significant.

## RESULTS

**Baseline characteristics**

Each group included 41 patients. The demographic characteristics were comparable. The mean age was 38.3 ± 10.6 years in Group D, 41.8 ± 11.9 years in Group P, and 37.5 ± 10.5 years in Group S. The difference was not statistically significant ($p$ = 0.171).

Female patients predominated in all groups. The proportion of females was 82.9% in Group D and 87.8% in both Groups P and S. Male patients accounted for 17.1% of Group D and 12.2% of Groups P and S. There was no statistically significant difference in sex distribution ($p$ = 0.761).

Mean body mass index was also similar among the groups: 23.48 ± 4.95 kg/m² in Group D, 23.04 ± 3.75 kg/m² in Group P, and 23.06 ± 4.38 kg/m² in Group S ($p$ = 0.696). These findings indicate that the three groups were broadly comparable before the intervention.

**Early recovery**

Significant differences were observed in early recovery. The mean time to extubation was 8.85 ± 2.17 minutes in Group D, 17.93 ± 4.54 minutes in Group P, and 9.61 ± 5.22 minutes in Group S. Overall comparison showed a statistically significant difference among groups ($p$ < 0.01). Pairwise comparisons demonstrated significantly delayed extubation in Group P compared with both Groups D and S, whereas the difference between Groups D and S was not significant.

The mean time to eye opening was 10.29 ± 2.61 minutes in Group D, 21.68 ± 7.06 minutes in Group P, and 11.12 ± 5.24 minutes in Group S. The difference among groups was statistically significant ($p$ < 0.01). Similar to extubation, patients receiving propofol had significantly delayed eye opening compared with those receiving either volatile anaesthetic. Desflurane and sevoflurane produced comparable early recovery. (Table 1)

**Intermediate recovery**

Intermediate recovery was significantly slower in Group P. The mean time to orientation to time and place was 34.3 ± 11.53 minutes in Group D, 58.56 ± 19.29 minutes in Group P, and 36.63 ± 12.56 minutes in Group S ($p$ < 0.01). Group P differed significantly from Groups D and S, while no significant difference was observed between Groups D and S.

The time to correctly state the date of birth and identify whereabouts was 42.17 ± 12.24 minutes in Group D, 104.9 ± 42.71 minutes in Group P, and 45.9 ± 15.98 minutes in Group S ($p$ < 0.01). Thus, the propofol group required substantially more time to achieve higher levels of orientation. Recovery in the desflurane and sevoflurane groups remained similar. (Table 1)

**Late recovery**

The pattern changed during the late recovery phase. Patients in Group P reached the sitting milestone significantly earlier than patients in the volatile-agent groups. The mean time to sit was 255.66 ± 40.86 minutes in Group P, compared with 324.78 ± 73.13 minutes in Group D and 302.05 ± 57.98 minutes in Group S ($p$ < 0.01).

A similar difference was observed for walking without help. The mean time was 357.29 ± 41.39 minutes in Group P, 451.0 ± 90.43 minutes in Group D, and 436.32 ± 191.6 minutes in Group S. The overall difference was statistically significant ($p$ = 0.002). Group P therefore demonstrated faster late motor recovery than both inhalational-agent groups. (Table 1)

**PONV and adverse effects**

PONV was uncommon in all groups. During the first 4 postoperative hours, PONV was reported in one patient each in Groups D and S and in none of the patients in Group P. The corresponding proportions were 2.4%, 2.4%, and 0%, respectively. The difference was not statistically significant ($p$ = 0.601).

During the 4–24-hour period, PONV occurred in one patient each in Groups D and P and in none of the


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patients in Group S. Again, the difference was not statistically significant ($p$ = 0.601). Rescue antiemetic use was similarly limited. Most patients did not require additional medication: 95.2% in Group D and 97.6% in Groups P and S. No significant difference was observed among the groups ($p$ = 0.732).

No additional side effects were reported in any group during the observation period. All patients were free from recorded adverse effects, and no statistically significant difference was observed among the groups.

**Table 1: Comparison of early, intermediate, and late recovery profiles among the three groups**

| Recovery parameter | Group D (n=41) Mean ± SD | Group P (n=41) Mean ± SD | Group S (n=41) Mean ± SD | p value |
|---|---|---|---|---|
| **Early recovery** | | | | |
| Extubation (min) | 8.85 ± 2.17 | 17.93 ± 4.54 | 9.61 ± 5.22 | <0.01* |
| Eye opening (min) | 10.29 ± 2.61 | 21.68 ± 7.06 | 11.12 ± 5.24 | <0.01* |
| **Intermediate recovery** | | | | |
| Time and place orientation (min) | 34.30 ± 11.53 | 58.56 ± 19.29 | 36.63 ± 12.56 | <0.01* |
| Orientation—date of birth/whereabouts (min) | 42.17 ± 12.24 | 104.90 ± 42.71 | 45.90 ± 15.98 | <0.01* |
| **Late recovery** | | | | |
| Sitting without help (min) | 324.78 ± 73.13 | 255.66 ± 40.86 | 302.05 ± 57.98 | <0.01* |
| Walking without help (min) | 451.00 ± 90.43 | 357.29 ± 41.39 | 436.32 ± 191.60 | 0.002* |

**Group D:** Desflurane
**Group P:** Propofol
**Group S:** Sevoflurane
*Statistically significant at $p < 0.05$.

## DISCUSSION

The present study compared the perioperative recovery profiles and postoperative outcomes of desflurane, sevoflurane, and propofol infusion in 123 patients undergoing laparoscopic cholecystectomy, with 41 patients in each group. The three groups were comparable with respect to age, sex, and BMI, thereby minimizing potential confounding and allowing a reliable comparison of recovery characteristics.

The principal finding was that desflurane and sevoflurane were associated with significantly faster early recovery than propofol. Mean extubation and eye-opening times were significantly longer in the propofol group (17.93 ± 4.54 and 21.68 ± 7.06 minutes, respectively) compared with desflurane (8.85 ± 2.17 and 10.29 ± 2.61 minutes) and sevoflurane (9.61 ± 5.22 and 11.12 ± 5.24 minutes) ($p < 0.01$). No significant difference was observed between desflurane and sevoflurane. These findings are consistent with previous studies demonstrating rapid emergence with desflurane and sevoflurane.[15-17] Gangakhedkar et al,[18] reported shorter extubation and eye-opening times with desflurane compared with sevoflurane, while Gupta et al,[16] demonstrated faster recovery with desflurane compared with propofol. Similar observations have been reported by Zaballos,[19] et al. and Dalal et al,[20] However, studies by Höcker et al.and Arar et al,[21,22] have reported comparable or faster emergence with propofol, highlighting the influence of patient characteristics, anesthetic techniques, and surgical duration on recovery.

Intermediate recovery parameters further supported the advantage of the inhalational agents. Time to orientation in time and place and orientation to date of birth and whereabouts was significantly longer with propofol than with desflurane and sevoflurane ($p < 0.01$), whereas no significant difference existed between the two volatile anesthetic groups. These findings are consistent with the rapid elimination characteristics of sevoflurane and previous observations by Singh et al. and Robinson et al,[15,23] who reported earlier response to verbal commands with sevoflurane than propofol.

Interestingly, the pattern was reversed for late recovery. Patients receiving propofol achieved sitting and walking without assistance significantly earlier than those receiving desflurane or sevoflurane. These findings suggest that propofol facilitates faster late recovery, particularly in motor function, compared to desflurane and sevoflurane.

A study by Larsen B et al,[24] demonstrated emergence and return of cognitive function was significantly faster after remifentanil-propofol compared with desflurane and sevoflurane up to 60 min after anaesthesia administration. Another study by White PF et al,[25] reported emergence from anaesthesia was faster with desflurane compared to sevoflurane.

Postoperative nausea and vomiting were uncommon in all three groups, with no statistically significant intergroup differences during either the early or late postoperative period. Rescue antiemetic requirements were also minimal and comparable between groups. These findings are broadly consistent with previous studies,[26-27] reporting similar postoperative tolerability with desflurane, sevoflurane, and propofol, although some studies have suggested a lower incidence of PONV with propofol.

Overall, the findings suggest that desflurane and sevoflurane provide more rapid early and intermediate emergence, whereas propofol may offer advantages during later functional recovery. All three


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techniques demonstrated comparable postoperative tolerability and minimal PONV, supporting their safe use for laparoscopic cholecystectomy.

**Limitations**

The present study has few limitations. Firstly, the sample size, although adequate for the primary objective, may not be sufficient to detect rare side effects or complications. Furthermore, the study only assessed recovery profiles and PONV up to 24 hours postoperatively.

## CONCLUSION

In patients undergoing laparoscopic cholecystectomy, desflurane and sevoflurane provided faster extubation, eye opening, and intermediate cognitive recovery than propofol infusion. Propofol was associated with faster late recovery, including earlier sitting and walking without assistance. PONV, rescue antiemetic use, and other recorded adverse effects were uncommon and comparable among the groups. Desflurane and sevoflurane may therefore be preferred when rapid early emergence is the primary objective, whereas propofol may offer advantages during later motor recovery. Anaesthetic selection should be individualised according to patient factors, operative requirements, and the desired recovery endpoint.

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