

Comparison of Postoperative Recovery Characteristics with Isoflurane and Sevoflurane in Patients Undergoing Laparoscopic Cholecystectomy: A Retrospective Comparative Study

Mukesh Kumar¹, Sanjeev Kumar², Bijoy Kumar³

¹Senior Resident, Department of Anaesthesiology, Nalanda Medical College and Hospital, Patna, Bihar

²Senior Resident, Department of Anaesthesiology, Patna Medical College and Hospital, Patna, Bihar

³Professor and HOD, Department of Anaesthesiology, Nalanda Medical College and Hospital, Patna, Bihar

Received: 01-07-2025 / Revised: 15-08-2025 / Accepted: 21-09-2025

Corresponding author: Dr. Mukesh Kumar

Conflict of interest: Nil

Abstract

Background and Objective: Rapid postoperative recovery is a key determinant of patient satisfaction and operating room efficiency in laparoscopic surgeries. Volatile anesthetic agents differ in their pharmacokinetic properties, which may influence emergence and early recovery characteristics. The purpose of this study was to examine the postoperative recovery parameters of patients undergoing elective laparoscopic cholecystectomy under general anesthesia using isoflurane and sevoflurane.

Methods: This retrospective comparative study was conducted over a one-year period at Nalanda Medical College and Hospital, Patna, Bihar. Medical records of 100 adult patients who underwent elective laparoscopic cholecystectomy were reviewed. Patients were categorized according to the inhalational anesthetic agent used for maintenance of anesthesia into two groups: Group I received isoflurane (n = 50), and Group II received sevoflurane (n = 50). Primary outcome measures included recovery parameters such as time to eye opening, response to verbal commands, tracheal extubation, and orientation. Secondary outcomes assessed were postoperative pain scores, duration of post-anesthesia care unit stay, and the incidence of postoperative nausea and vomiting. Statistical analysis was performed using appropriate comparative tests, with a p value < 0.05 considered statistically significant.

Results: The two groups' surgery times and demographic characteristics were similar. When compared to the isoflurane group, patients on sevoflurane showed significantly shorter durations to eye opening, extubation, and orientation (p < 0.001). The sevoflurane group also had reduced rates of PONV and shorter PACU stays.

Conclusion: In patients undergoing laparoscopic cholecystectomy, sevoflurane was linked to better early postoperative recovery and quicker emergence than isoflurane. Its use may enhance recovery profiles and optimize postoperative care in laparoscopic procedures.

Keywords: Isoflurane, Sevoflurane, Postoperative recovery, Laparoscopic cholecystectomy, Volatile anesthetics.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Laparoscopic cholecystectomy is less intrusive, causes less discomfort after surgery, requires less time in the hospital, and allows for a quicker return to normal activities than open surgery, it has become the preferred surgical procedure for symptomatic gallstone disease.

The advantages of laparoscopic techniques, however, place increased emphasis on rapid and smooth recuperation from anesthetic, as early emergence, prompt restoration of protective reflexes, and minimal postoperative adverse effects are critical for patient safety and operating room efficiency. In this context, the choice of anesthetic

agents plays a pivotal role in determining postoperative recovery characteristics, particularly in short to intermediate duration procedures such as laparoscopic cholecystectomy. An ideal anesthetic technique should provide adequate depth of anesthesia intraoperatively while allowing rapid and predictable recovery in the immediate postoperative period.

Volatile inhalational anesthetic agents remain the cornerstone for maintenance of general anesthesia in laparoscopic procedures. Among these, isoflurane and sevoflurane are commonly used owing to their favorable anesthetic properties,

cardiovascular stability, and ease of administration. Isoflurane has been widely utilized for several decades and is valued for its cost-effectiveness and reliable anesthetic depth. However, its relatively higher slower elimination could be caused by the blood-gas partition coefficient and delayed emergence following discontinuation. Sevoflurane, a newer generation volatile anesthetic, is characterized by a lower blood-gas solubility, allowing more rapid uptake and elimination. These pharmacokinetic differences suggest that sevoflurane may facilitate faster recovery and earlier attainment of postoperative milestones compared with isoflurane, particularly in ambulatory and laparoscopic surgeries.

Early postoperative recovery is a multidimensional process encompassing emergence from anesthesia, restoration of consciousness, airway reflexes, orientation, hemodynamic stability, pain control, and freedom from adverse effects such as postoperative nausea and vomiting. Delayed recovery not only prolongs post-anesthesia care unit stay but also increases patient discomfort, resource utilization, and overall healthcare costs. In laparoscopic cholecystectomy, where pneumoperitoneum and patient positioning may influence cardiopulmonary physiology, rapid and controlled emergence assumes additional importance. Several studies have compared recovery profiles of volatile anesthetics; however, the results have been inconsistent, influenced by variations in anesthetic technique, patient population, outcome definitions, and perioperative management protocols.

In the Indian healthcare setting, particularly in tertiary care government hospitals, the selection of anesthetic agents is often guided by availability, cost considerations, and institutional practice rather than evidence derived from local patient populations. There is still a dearth of information comparing the postoperative recovery characteristics of sevoflurane and isoflurane in laparoscopic cholecystectomy. Furthermore, real-world retrospective analyses reflecting routine clinical practice provide valuable insights into actual recovery patterns beyond controlled trial environments. To compare the postoperative recuperation features of patients on sevoflurane against isoflurane for the maintenance of anesthesia during elective laparoscopic cholecystectomy, this study was conducted. These characteristics included emergence times, orientation, incidence of postoperative nausea and vomiting, pain scores, and length of PACU stay. The findings aim to assist anesthesiologists in making informed choices regarding volatile anesthetic agents to optimize postoperative recovery and improve perioperative patient care.

Materials and Methods

Study Design and Setting: The Department of Anaesthesiology at Nalanda Medical College and Hospital, a tertiary care teaching hospital in Patna, Bihar, was the site of this retrospective comparative observational study. The Institutional Ethics Committee gave its clearance before the study was conducted.

Study Duration: The medical records of individuals who underwent surgery throughout a 12-month period were reviewed in order to be included in the study.

Study Population and Sample Size: Records of adult patients who underwent elective laparoscopic cholecystectomy under general anesthesia were screened during the study period. The final analysis included 100 patients who satisfied the eligibility requirements.

Group Allocation: Depending on which volatile anesthetic was used, patients were split into two groups for maintenance of anesthesia as documented in anesthesia records:

- **Group I (Isoflurane group):** 50 patients who received isoflurane
- **Group II (Sevoflurane group):** 50 patients who received sevoflurane

The choice of anesthetic agent was determined by routine institutional practice and anesthesiologist preference.

Inclusion Criteria

- Individuals between the ages of 18 and 60
- The American Society of Anesthesiologists classifies physical status I or II.
- Elective cholecystectomy with laparoscopy
- General anesthesia maintained exclusively with either isoflurane or sevoflurane
- Availability of complete perioperative and postoperative recovery records

Exclusion Criteria

- Emergency surgeries
- Conversion from laparoscopic to open cholecystectomy
- ASA physical status III or IV
- History of significant hepatic, renal, cardiovascular, or neurological disease
- Incomplete or missing medical records

Anesthetic Technique: All patients received a standardized anesthetic protocol. After routine monitoring, general anesthesia was induced using intravenous induction agents and neuromuscular blockers as per institutional protocol. Following tracheal intubation, anesthesia was sustained using either isoflurane or sevoflurane in an O₂ mixture. Intraoperative analgesia and muscle relaxation

were maintained according to standard practice. At the end of surgery, volatile anesthetic agents were discontinued, neuromuscular blockade was reversed, and tracheal extubation was performed once standard extubation criteria were fulfilled.

Data Collection: Data were retrieved from anesthesia charts, operation theatre records, and post-anesthesia care unit (PACU) charts. Demographic details, ASA status, duration of surgery, anesthetic agent used, and recovery parameters were recorded using a structured data collection form. Patient identifiers were removed to maintain confidentiality.

Outcome Measures

Primary outcome measures included:

- Time to eye opening following discontinuation of anesthetic agent
- Time to response to verbal commands
- Time to tracheal extubation
- Time to orientation

Secondary outcome measures included:

- Frequency of postoperative vomiting and nausea
- Postoperative pain scores assessed using the VAS
- DOS in the post-anesthesia care unit

Statistical Analysis: After entry into a spreadsheet, the collected data were analyzed using standard statistical software. Continuous variables were expressed as mean \pm standard deviation and

compared between the two groups using the independent t-test. Categorical variables were summarized as frequencies and percentages and analyzed using the Chi-square test. A p value < 0.05 was considered indicative of statistical significance.

Ethical Considerations: The Institutional Ethics Committee granted ethical approval. Informed permission was not required because the investigation comprised a retrospective assessment of medical records. Throughout the trial, patient data Anonymity and secrecy were strictly maintained.

Results

The study included 100 individuals who had elective laparoscopic cholecystectomy under general anesthesia. Patients were split into two groups based on the volatile anesthetic used to maintain anesthesia: the Isoflurane group (n = 50) and the Sevoflurane group (n = 50). All included instances had sufficient data completeness, and no records were left out of the study.

Demographic and Perioperative Characteristics: The perioperative features and demographics of the patients in both groups were comparable. The two groups appeared to be well matched at baseline based on the lack of statistically significant differences in age, gender distribution, ASA physical status, and length of operation.

Table 1: Demographic and Perioperative Characteristics

Parameter	Isoflurane (n=50)	Sevoflurane (n=50)	p value
Age (years)	42.6 \pm 9.1	41.8 \pm 8.7	0.64
Gender (M/F)	18 / 32	20 / 30	0.68
ASA I / II	28 / 22	30 / 20	0.69
Duration of surgery (min)	62.4 \pm 10.5	61.2 \pm 9.8	0.53

Comparison of Postoperative Recovery Parameters: Individuals receiving sevoflurane demonstrated significantly faster emergence from anesthesia compared with those receiving

isoflurane A. The sevoflurane group showed significantly shorter mean times to eye opening, reaction to verbal orders, tracheal extubation, and orientation (p < 0.001 for all comparisons).

Table 2: Comparison of Postoperative Recovery Characteristics

Recovery Parameter	Isoflurane	Sevoflurane	p value
Time to eye opening (min)	9.8 \pm 2.1	6.2 \pm 1.4	< 0.001
Response to commands (min)	11.5 \pm 2.6	7.4 \pm 1.8	< 0.001
Extubation time (min)	10.2 \pm 2.3	6.8 \pm 1.5	< 0.001
Time to orientation (min)	14.6 \pm 3.1	9.3 \pm 2.2	< 0.001

Postoperative Outcomes: The incidence of postoperative nausea and vomiting was higher among patients receiving isoflurane compared with those administered sevoflurane (18% vs. 8%). Postoperative pain scores during the early recovery

period did not differ significantly between the two groups. In contrast, patients in the sevoflurane group demonstrated a significantly shorter duration of stay in the post-anesthesia care unit.

Table 3: Postoperative Outcomes

Outcome	Isoflurane	Sevoflurane	p value
PONV (%)	18%	8%	0.04
PACU stay (min)	55.4 ± 9.2	42.5 ± 8.6	<0.001
Pain score (VAS)	Comparable	Comparable	NS

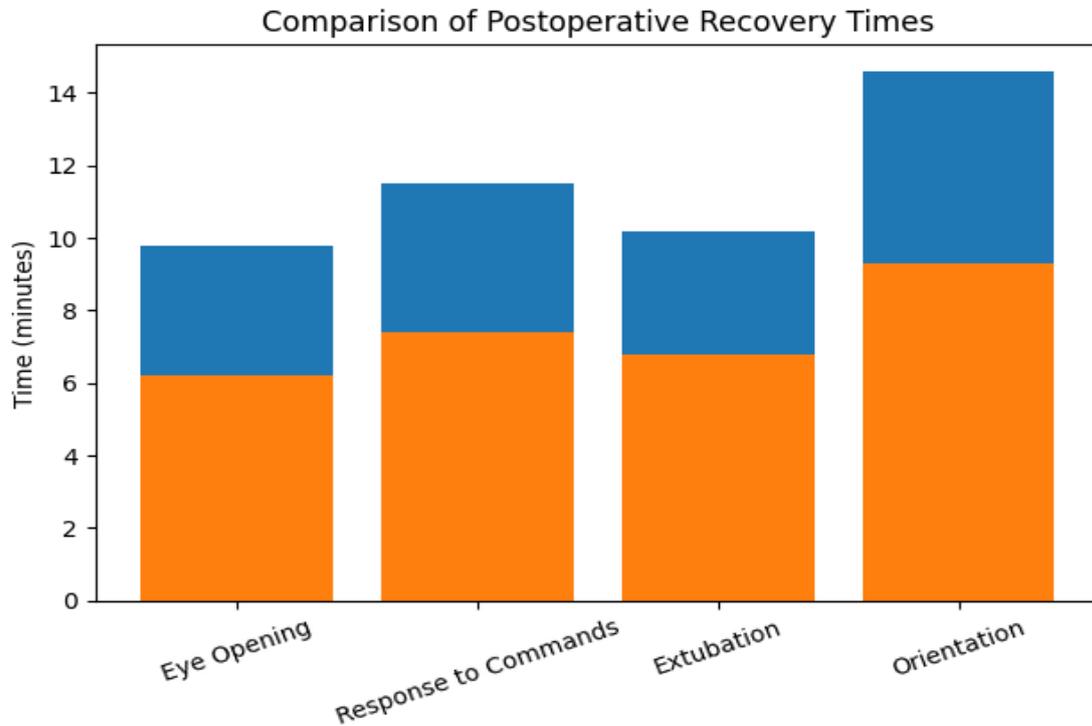


Figure 1: Comparison of postoperative outcomes

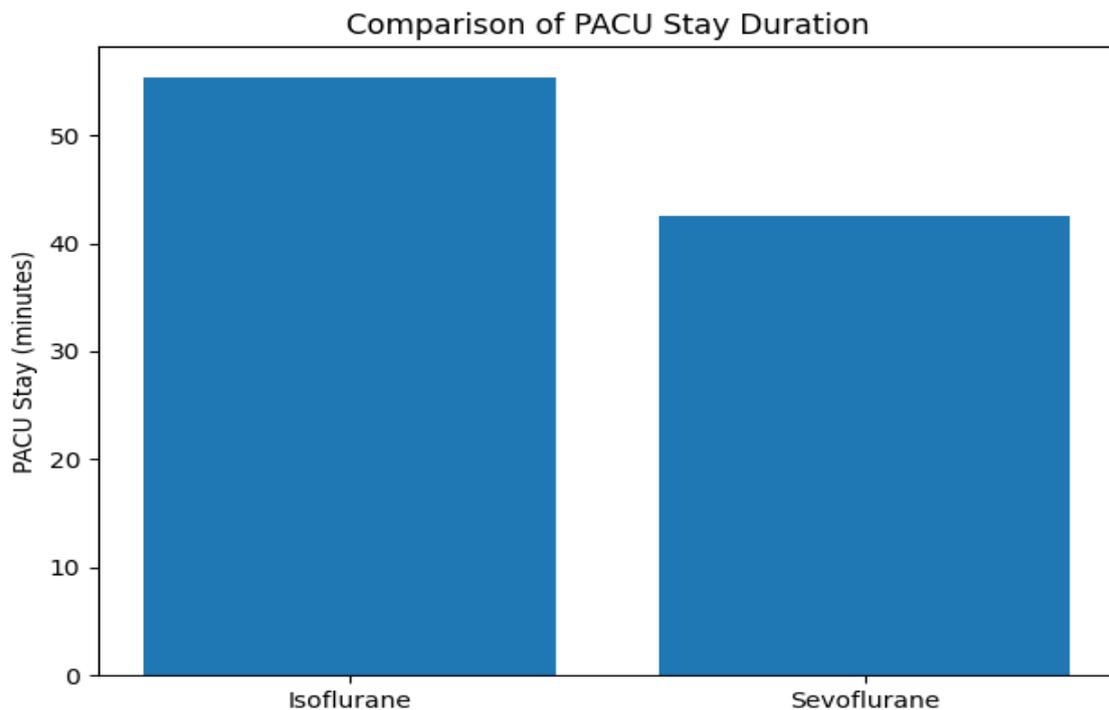


Figure 2: Comparison of PACU stay duration

Discussion

In this retrospective comparison study, Patients receiving general anesthesia for elective laparoscopic cholecystectomy maintained with either isoflurane or sevoflurane had their postoperative recovery features assessed. The main conclusion of this analysis was that, in comparison to isoflurane, sevoflurane was linked to noticeably quicker emergence and recovery, as seen by shorter durations to eye opening, responsiveness to verbal orders, extubation, and orientation. These findings indicate a clear difference in early postoperative recovery profiles between the two volatile anesthetic agents when used in routine clinical practice, despite comparable demographic characteristics, surgical duration, and anesthetic techniques across groups.

Faster emergence observed in the sevoflurane group can be attributed to its lower blood-gas partition coefficient, which facilitates rapid elimination following discontinuation of anesthesia. In the current study, the reduction in recovery times was consistent across all measured emergence parameters, suggesting that the effect was not limited to a single phase of recovery but extended throughout the immediate postoperative period.

Rapid restoration of consciousness and airway reflexes is particularly advantageous in laparoscopic procedures, where early extubation and neurological recovery reduce the risk of respiratory complications and allow for smoother transfer to postoperative care units. The observed differences in recovery times are clinically meaningful, as even modest reductions can cumulatively improve workflow efficiency in high-volume surgical centers.

The results of this study are consistent with a number of other clinical studies that found that sevoflurane, as opposed to isoflurane, resulted in a quicker recovery following laparoscopic and brief surgical operations. Studies evaluating emergence times and cognitive recovery have consistently demonstrated that patients receiving sevoflurane achieve earlier responsiveness and orientation.

However, some reports have shown minimal or no difference between these agents, often attributed to variations in anesthetic depth, adjunct drug use, or outcome definitions. The present study adds to existing evidence by reflecting real-world practice in a tertiary care government hospital, where standardized yet pragmatic anesthetic protocols are followed, thereby enhancing the external validity of the findings.

One of the most frequent and upsetting side effects after general anesthesia is still postoperative nausea and vomiting. In this study, the sevoflurane group

had a lower incidence of PONV than the isoflurane group. Although multiple factors influence the occurrence of PONV, including opioid use and patient susceptibility, the choice of volatile anesthetic may contribute to this difference. Reduced PONV not only improves patient comfort but also decreases unplanned delays in leaving the post-anesthesia care unit. The lower incidence observed with sevoflurane in the present analysis supports its favorable postoperative profile, particularly in laparoscopic surgeries where PONV is frequently encountered.

The duration of stay in the post-anesthesia care unit was significantly shorter in patients who received sevoflurane. PACU stay is an important indicator of recovery efficiency and resource utilization. Prolonged recovery room occupancy can contribute to bottlenecks in operating room throughput and increased healthcare costs. The shorter PACU stay associated with sevoflurane likely reflects the combined effects of faster emergence, earlier orientation, and reduced postoperative complications. From an institutional perspective, this advantage may translate into improved patient turnover and optimized utilization of recovery room resources, which is particularly relevant in busy tertiary care settings.

Despite the advantages observed with sevoflurane, pain scores during the early postoperative period were comparable between the two groups. This finding suggests that the choice of volatile anesthetic did not significantly influence postoperative analgesic requirements when standardized analgesic protocols were employed. Effective pain control in both groups indicates that faster emergence with sevoflurane did not come at the cost of increased postoperative discomfort. Maintaining equivalent analgesia while achieving faster recovery is desirable, as it balances patient comfort with efficiency of care.

This study has certain limitations that should be considered. Because the retrospective design depends on the completeness and quality of medical data, it naturally restricts control over confounding variables. The choice of anesthetic agent was based on anesthesiologist preference rather than random allocation, which may introduce selection bias.

Additionally, long-term outcomes and patient satisfaction scores were not assessed. Nevertheless, the study's strengths include a well-matched patient population, standardized surgical procedure, and evaluation of clinically relevant recovery parameters. Future prospective, randomized studies with larger sample sizes and inclusion of cost-effectiveness analyses would further strengthen the evidence base and help guide anesthetic selection in laparoscopic surgery.

Conclusion

Sevoflurane maintenance of general anesthesia was linked to a noticeably quicker postoperative recovery than isoflurane in this retrospective comparative analysis of individuals having laparoscopic cholecystectomy as an elective procedure. In addition to spending less time in the post-anesthesia care unit and experiencing less postoperative nausea and vomiting, patients on sevoflurane showed quicker timings to eye opening, reaction to verbal commands, extubation, and orientation. Postoperative pain scores were comparable between the two anesthetic agents, indicating that improved recovery profiles were achieved without compromising analgesic adequacy. These findings suggest that sevoflurane may offer practical advantages in facilitating early recovery and optimizing perioperative workflow in laparoscopic procedures. In high-volume tertiary care settings, the use of sevoflurane could contribute to enhanced patient throughput and resource utilization. Prospective randomized studies are warranted to confirm these observations and to further evaluate long-term outcomes and cost-effectiveness.

References

1. Myles PS, Williams DL, Hendrata M, Anderson H, Weeks AM. Patient satisfaction after anaesthesia and surgery: results of a prospective survey of 10,811 patients. *Br J Anaesth.* 2000;84(1):6–10.
2. White PF. Ambulatory anesthesia advances into the new millennium. *Anesth Analg.* 2000;90(5):1234–1235.
3. Gupta A, Stierer T, Zuckerman R, Sakima N, Parker SD, Fleisher LA. Comparison of recovery profile after ambulatory anesthesia with sevoflurane and desflurane. *Anesth Analg.* 2004;98(3):632–637.
4. Eger EI II. Characteristics of anesthetic agents used for induction and maintenance of general anesthesia. *Am J Health Syst Pharm.* 2004;61 Suppl 4:S3–S10.
5. Morgan GE Jr, Mikhail MS, Murray MJ. *Clinical Anesthesiology.* 6th ed. New York: McGraw-Hill Education; 2018.
6. Apfel CC, Kranke P, Katz MH, Goepfert C, Papefuss T, Rauch S, et al. Volatile anesthetics may be the main cause of early but not delayed postoperative vomiting. *Anesthesiology.* 2002;97(3):540–546.
7. Joshi GP. Inhalational anesthetics and recovery characteristics. *Anesthesiol Clin North Am.* 2001;19(2):231–245.
8. Larsen B, Seitz A, Larsen R. Recovery from sevoflurane anesthesia: a comparison with isoflurane. *Acta Anaesthesiol Scand.* 2000;44(6):647–653.
9. Nathanson MH, Fredman B, Smith I, White PF. Sevoflurane versus isoflurane anesthesia for outpatient surgery: a comparison of maintenance and recovery profiles. *Anesth Analg.* 1995;81(6):1186–1190.
10. Ebert TJ, Harkin CP, Muzi M. Cardiovascular responses to sevoflurane: a review. *Anesth Analg.* 1995;81(6 Suppl):S11–S22.
11. Smith I, Nathanson M, White PF. Sevoflurane—a long-awaited volatile anaesthetic. *Br J Anaesth.* 1996;76(3):435–445.
12. Watcha MF, White PF. Postoperative nausea and vomiting: its etiology, treatment, and prevention. *Anesthesiology.* 1992;77(1):162–184.
13. Song D, Joshi GP, White PF. Titration of volatile anesthetics using BIS facilitates recovery after ambulatory anesthesia. *Anesthesiology.* 1997;87(4):842–848.
14. Gan TJ, Meyer T, Apfel CC, Chung F, Davis PJ, Habib AS, et al. Consensus guidelines for managing postoperative nausea and vomiting. *Anesth Analg.* 2003;97(1):62–71.
15. Bisgaard T. Analgesic treatment after laparoscopic cholecystectomy: a critical assessment of the evidence. *Anesthesiology.* 2006;104(4):835–846.
16. Kehlet H, Dahl JB. Anaesthesia, surgery, and challenges in postoperative recovery. *Lancet.* 2003;362(9399):1921–1928.
17. Butterworth JF, Mackey DC, Wasnick JD. *Morgan & Mikhail's Clinical Anesthesiology.* 7th ed. New York: McGraw-Hill Education; 2021.
18. Eger EI II, Saidman LJ, Brandstater B. Minimum alveolar anesthetic concentration: a standard of anesthetic potency. *Anesthesiology.* 1965;26(6):756–763.