Submitted: 14 April, 2025 Accepted: 25 July, 2025 Published: 08 September, 2025 DOI:10.22514/sv.2025.135

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ORIGINAL RESEARCH

Hemodynamic effects of desflurane and sevoflurane low-flow anesthesia for laparoscopic sleeve gastrectomy

Hatice Kaya Özdoğan[1,*], Uğur Serkan Çitilcioğlu[1], Oktay Cunetoğlu[1], Barış Arslan[1]

[1] Department of Anesthesiology and Reanimation, Adana City and Training Hospital, University of Health Sciences, 010650 Adana, Turkey

***Correspondence**
hatice.kayaozdogan@sbu.edu.tr
(Hatice Kaya Özdoğan)

Abstract

Background: This study aimed to evaluate the hemodynamic effects of sevoflurane and desflurane in low-flow anesthesia during laparoscopic sleeve gastrectomy (LSG). Despite their increasing use, their hemodynamic effects in low-flow anesthesia for this high-risk population remain underexplored. **Methods**: This retrospective comparative study analyzed 79 patients who underwent LSG between 2022 and 2025. Patients were divided into two groups: 37 received low-flow sevoflurane, and 42 received low-flow desflurane. Hemodynamic parameters, including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and peripheral oxygen saturation (SpO_2), were recorded at predefined time points. Groups were statistically compared in terms of hemodynamic stability. **Results**: Both anesthetic agents maintained overall hemodynamic stability throughout the surgery, with no significant differences in SBP, DBP, HR or SpO_2 at any time point ($p > 0.05$). **Conclusions**: Both sevoflurane and desflurane provide stable hemodynamic conditions in low-flow anesthesia for laparoscopic bariatric surgery. These findings support the safety and feasibility of low-flow anesthesia in this patient population. Future prospective studies with larger sample sizes and diverse patient cohorts are needed to further validate these results and strengthen their clinical applicability.

Keywords

Low-flow anesthesia; Obesity; Bariatric surgery; Sevoflurane; Desflurane; Hemodynamic stability

1. Introduction

Obesity has become a significant global health issue due to its rapidly increasing prevalence, posing substantial challenges to healthcare systems worldwide [1]. It is associated with a range of comorbidities, including hypertension, type 2 diabetes mellitus, atrial fibrillation, asthma, and coronary artery disease [2, 3]. For patients undergoing surgery, obesity also presents unique challenges for anesthesiologists, such as difficult airway management, altered pharmacokinetics of anesthetic agents, and an increased risk of perioperative and postoperative complications, all of which significantly complicate perioperative management [4].

With the increasing prevalence of obesity, the demand for bariatric surgery is also rising. This has led to anesthesiologists becoming more involved in the care of obese patients [5]. Laparoscopic sleeve gastrectomy (LSG), one of the most common bariatric procedures, presents unique anesthetic and hemodynamic challenges. The pneumoperitoneum and reverse Trendelenburg position required for laparoscopic surgery can exacerbate hemodynamic instability due to increased intra-abdominal pressure, decreased venous return, and alterations in cardiac output [6]. Maintaining intraoperative hemodynamic stability, particularly in this vulnerable patient population, is critical as these patients are often less tolerant of fluctuations in blood pressure, heart rate, and oxygenation [7].

Low-flow anesthesia has become increasingly popular in recent years due to its numerous advantages. These include reduced waste of inhaled anesthetic agents, cost efficiency, and a smaller environmental footprint through decreased greenhouse gas emissions [8]. Additionally, low-flow techniques help maintain humidity in the respiratory system and minimize heat loss [8]. Although concerns such as inadequate anesthetic and oxygen delivery and the accumulation of CO_2 within the circuit, it has been demonstrated that low-flow anesthesia can be safely administered with the use of modern anesthesia machines and monitoring equipment, utilizing anesthetic gases like sevoflurane and desflurane, which have low blood and tissue solubility [9, 10]. While some studies have investigated the effects of these two gases in low-flow anesthesia [11, 12], their specific hemodynamic effects in patients undergoing laparoscopic bariatric surgery remain underexplored.

This study aims to address this gap in the literature by comparing the hemodynamic effects of sevoflurane and desflurane during low-flow anesthesia in laparoscopic bariatric surgeries. We believe that the findings of this study will provide valuable insights into optimizing anesthesia management and enhancing patient safety in this growing and high-risk patient population.

2. Methods

2.1 Study design and patient selection

This retrospective comparative study evaluated the archived records of 79 patients who underwent laparoscopic sleeve gastrectomy between 2022 and 2025 at our institution. Ethical approval was obtained from the SBU Adana City Education and Research Hospital institutional review board prior to the study (Approval Number: 06.02.2025 10-354). Informed consents were obtained from all patients. Patients aged between 18 and 60 years were included in the analysis. The study population was divided into two groups: 37 patients received low-flow sevoflurane anesthesia, while 42 patients received low-flow desflurane anesthesia.

Exclusion criteria were as follows:

Patients with known comorbidities such as hypertension, diabetes mellitus, coronary artery disease, and pulmonary diseases were excluded from the study. Additionally, patients with incomplete anesthesia records and those who developed perioperative complications due to surgery were not included in the final analysis.

2.2 Anesthesia protocol

All patients received premedication with intravenous midazolam (0.02 mg/kg) before the induction of anesthesia. Induction was performed using propofol (2.0–3.0 mg/kg), fentanyl (2 mcg/kg), and rocuronium (0.6 mg/kg). Induction agents (propofol and fentanyl) were dosed according to actual body weight, whereas rocuronium was administered based on adjusted body weight to optimize dosing in obese patients. Endotracheal intubation was achieved using an appropriately sized endotracheal tube with direct laryngoscopy.

For maintenance anesthesia, fresh gas flow was initially set at 4 L/min with a mixture of 50% air and 50% oxygen for the first five minutes. After this period, the gas flow was reduced to 1 L/min. In both groups, anesthesia was maintained at a minimum alveolar concentration (MAC) of approximately 1, using sevoflurane or desflurane according to group allocation. The MAC values were titrated between 0.8 and 1.2 based on the patient's clinical response, and anesthetic depth was monitored using bispectral index (BIS). Neuromuscular blockade was maintained with intermittent doses of rocuronium (0.1–0.2 mg/kg) administered approximately every 30 minutes. Mechanical ventilation was adjusted to maintain an endtidal CO_2 ($ETCO_2$) level between 30–40 mmHg. The tidal volume was set at 6–8 mL/kg, and the respiratory rate was adjusted to 12–16 breaths per minute. At the end of the procedure, the fresh gas flow was increased to 6–8 L/min, and the inhalation anesthetic was discontinued. Patients were then manually ventilated with 100% oxygen until they were extubated.

2.3 Perioperative measurements and monitoring

Throughout the operative period, standard monitoring protocols were followed. Patients were continuously monitored using electrocardiography (ECG), pulse oximetry (SpO_2), capnography ($ETCO_2$), and non-invasive arterial blood pressure (NIBP). Hemodynamic parameters were recorded at predefined time points: Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and peripheral oxygen saturation (SpO_2) were recorded before anesthesia induction (T0, in the supine position). Additional measurements were taken at 5, 10, and 15 minutes after intubation (T5, T10, T15), and every 15 minutes thereafter until the end of the surgery.

Since the average duration of the surgeries was 69 $\pm$ 3 minutes, and the final 5–7 minutes involved fresh gas flow increase and extubation, hemodynamic parameters were analyzed and compared up to the 60th minute of surgery. In addition to hemodynamic parameters, age, BMI (Body Mass Index), gender, and operation duration were recorded and statistically compared between the two groups.

2.4 Statistical analysis

The statistical analysis was performed using IBM SPSS Statistics software (version 30.0.0, IBM Corp., Armonk, NY, USA). Descriptive statistics (mean, standard deviation, minimum, and maximum values) were calculated for continuous variables. The normality of data distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Normally distributed variables were analyzed using the Independent Samples *t*-test, while non-normally distributed variables were evaluated with the Mann-Whitney U test. Demographic and baseline characteristics, including age, BMI, and operative duration, were analyzed with the appropriate statistical tests based on their distribution. Gender distribution was assessed using the chi-square (χ^2) test, with Fisher's exact test applied when necessary. A p-value < 0.05 was considered statistically significant in all analyses.

3. Results

3.1 Demographic and baseline characteristics

The demographic characteristics, including age, BMI, gender distribution, and operation duration, were compared between the two groups (Table 1). There was no statistically significant difference in age (p = 0.567), BMI (p = 0.302), gender distribution (p = 0.561), or operation duration (p = 0.761) between the sevoflurane and desflurane groups.

3.2 Hemodynamic parameters over time

Table 2 shows the mean $\pm$ SD values of SpO_2 at different time points. No statistically significant differences were observed between the two groups at any time point ($p >$ 0.05). The changes in systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) over time are presented in Figs. 1,2 for the sevoflurane and desflurane groups,

TABLE 1. Comparison of age, BMI, gender, and operative duration between groups.

Variable	Sevoflurane Group	Desflurane Group	*p*-Value
Age (yr)	33.97 ± 10.15	35.31 ± 10.43	0.567
BMI	42.86 ± 2.57	43.64 ± 3.86	0.302
Gender (Female/Male)	27/10	33/9	0.561
Operation duration (min)	69.64 ± 3.25	69.42 ± 3.16	0.761

Values are presented as mean ± standard deviation (SD).
Gender distribution is presented as absolute numbers (Female/Male).
p-values were calculated to assess statistical differences between groups.
BMI: Body mass index.

TABLE 2. Peripheral Oxygen Saturation (SpO_2) values over time in sevoflurane and desflurane groups.

Time (min)	Desflurane	Sevoflurane	*p*-Value
0	96.95 ± 0.96	97.19 ± 1.35	0.488
5	98.50 ± 1.11	98.46 ± 0.90	0.739
10	97.26 ± 1.56	97.86 ± 1.40	0.076
15	97.57 ± 1.48	97.24 ± 1.38	0.329
30	97.81 ± 1.50	97.86 ± 1.57	0.818
45	97.71 ± 1.35	97.59 ± 1.67	0.849
60	97.81 ± 1.50	97.86 ± 1.57	0.677

Values are presented as mean ± standard deviation (SD).
p-values were calculated to assess statistical differences between groups.

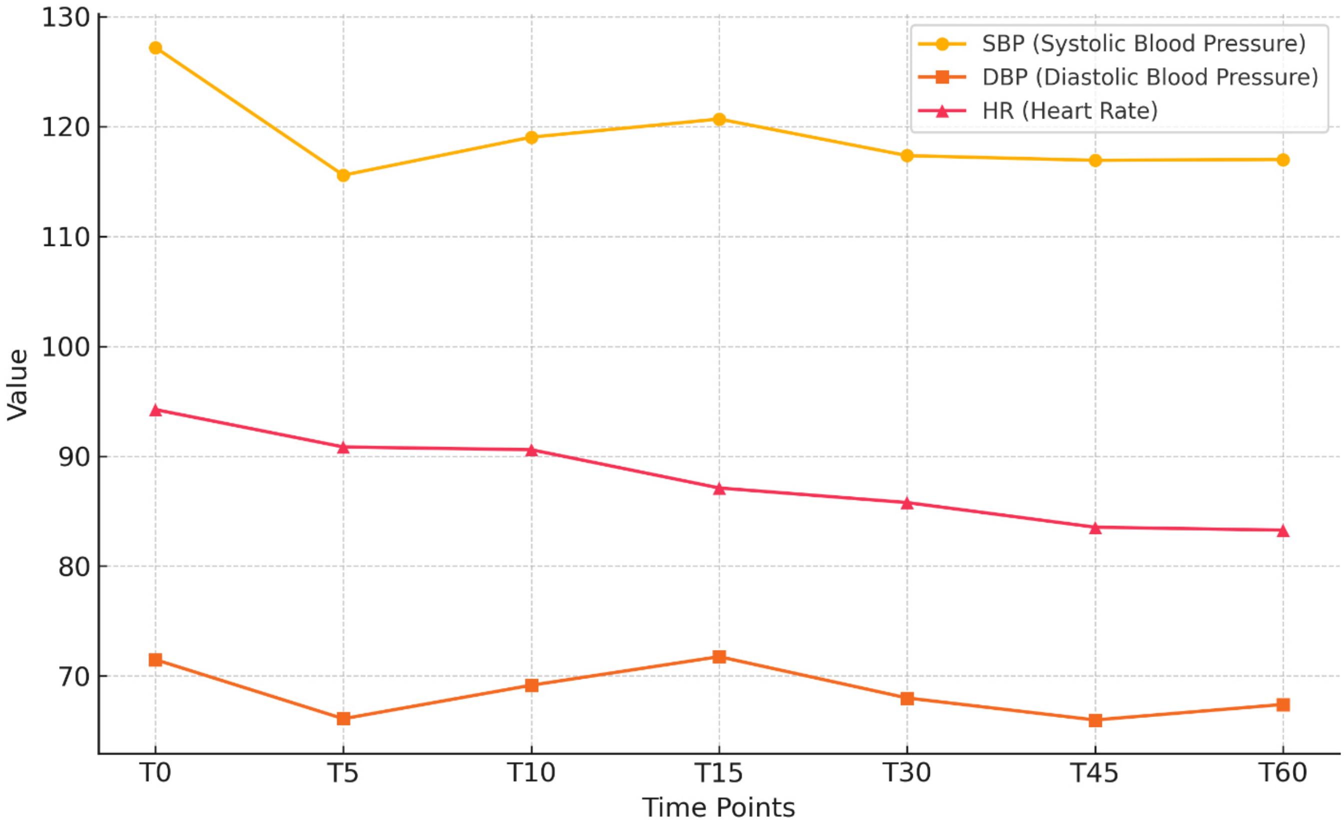

FIGURE 1. The changes in systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) over time for the Sevoflurane group.

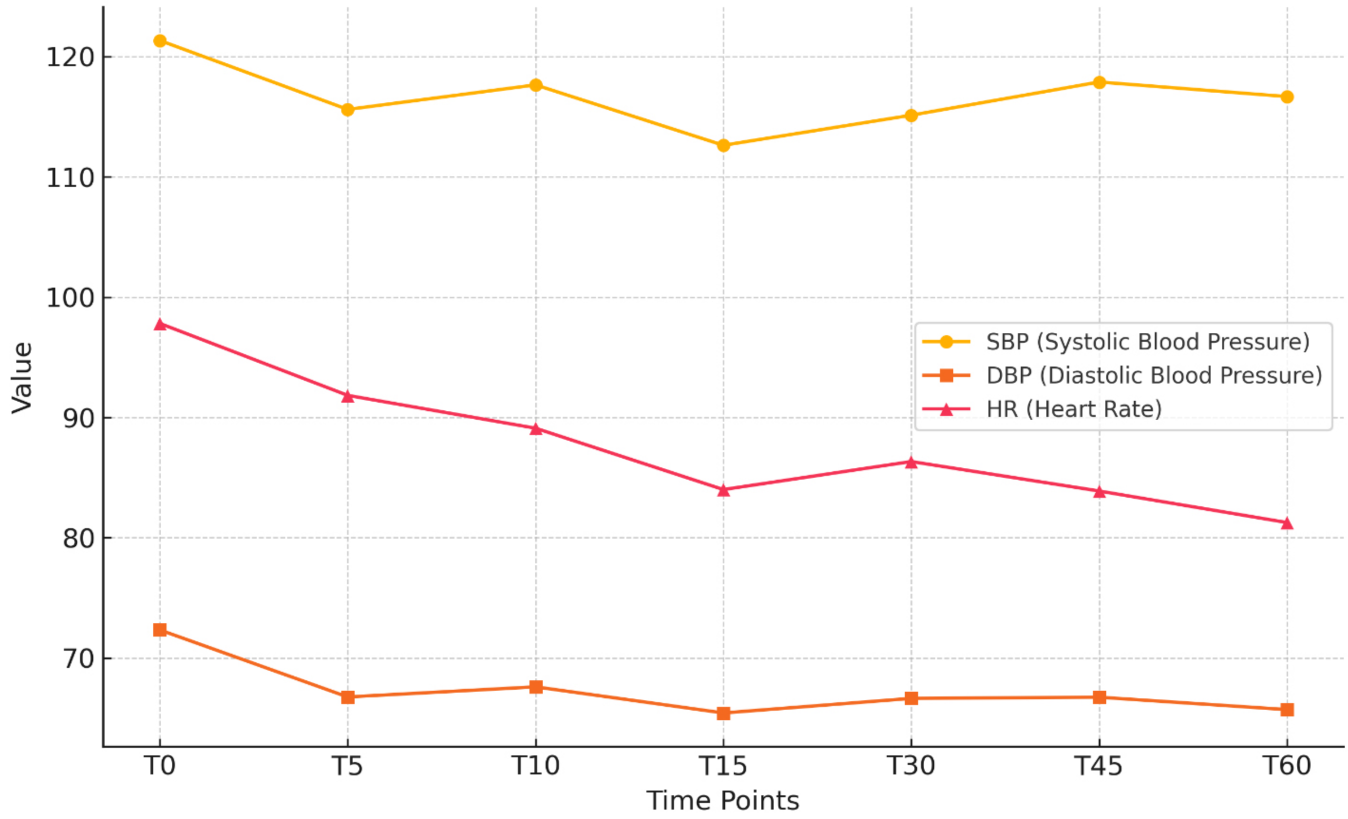

FIGURE 2. The changes in systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) over time for the Desflurane group.

respectively. Both groups demonstrated a general trend of hemodynamic stability throughout the intraoperative period.

3.3 Group comparisons

These results suggest that both anesthetic agents provide comparable and overall satisfactory hemodynamic stability in bariatric surgery patients under low-flow conditions.

4. Discussion

This study aimed to compare the hemodynamic effects of low-flow sevoflurane and desflurane anesthesia in obese patients undergoing laparoscopic sleeve gastrectomy. Our findings indicate that both anesthetic agents provided satisfactory hemodynamic stability.

Our results demonstrated no significant differences between the sevoflurane and desflurane groups in terms of systolic blood pressure (SBP) and diastolic blood pressure (DBP). In both groups, stable blood pressure was maintained throughout the surgery. A previous study investigating controlled hypotension under high-flow anesthesia reported no significant difference between the two agents [13]. Similarly, in a study by Taş *et al*. [11] (2022), minimal-flow applications of sevoflurane and desflurane were compared across various surgical procedures, and no significant differences in blood pressure outcomes were found. Our findings support these results, further demonstrating that both anesthetic agents provide satisfactory hemodynamic stability across a wide range of conditions.

Regarding oxygenation, peripheral oxygen saturation (SpO_2) levels remained stable in both groups, with no instances of hypoxia. The SpO_2 consistently stayed above 95%, in line with a previous study on low-flow anesthesia using a fresh gas flow of 0.5 L/min and an FiO_2 (Fraction of Inspired Oxygen) of 40% [14]. Likewise, a study on obese patients receiving low-flow anesthesia with 50% oxygen, as in our study, reported similar findings [15]. Together with our findings, these results further demonstrate that oxygenation in low-flow anesthesia is not a concern even in such a challenging surgical population. This reinforces the growing body of evidence suggesting that, with modern anesthesia machines and advanced monitoring techniques, low-flow anesthesia does not pose a significant risk in terms of oxygenation [16].

Low-flow anesthesia offers multiple benefits, including reduced anesthetic gas consumption, lower environmental impact, and cost-effectiveness [17, 18]. Furthermore, while both sevoflurane and desflurane are compatible with low-flow anesthesia and help reduce overall anesthetic gas consumption, sevoflurane has been reported to be more cost-effective in several comparative studies [19]. This advantage is attributed to its lower acquisition cost and reduced uptake at minimal flow rates. For instance, a randomized controlled trial by Taş *et al*. [11] demonstrated that minimal-flow sevoflurane anesthesia led to significantly lower total anesthetic costs than desflurane, without compromising intraoperative stability or recovery quality. This cost advantage, alongside its established hemodynamic safety, may influence anesthetic choice in settings where economic considerations are crucial.

Previous research has demonstrated that sevoflurane, desflurane, and isoflurane do not adversely affect renal or hepatic function when used in low-flow conditions. Previous studies have also demonstrated that low-flow anesthesia better preserves pulmonary functions and triggers the immune response to a lesser extent [20, 21]. The growing body of evidence supporting the hemodynamic safety and ecological advantages of low-flow anesthesia highlights its potential for broader adoption in clinical practice. To the best of our knowledge, this is the first study comparing the hemodynamic effects of these two anesthetic gases specifically in obese patients undergoing laparoscopic bariatric surgery using low-flow anesthesia. Therefore, our findings contribute significantly to the existing knowledge and highlight that hemodynamic stability can be maintained even in this high-risk population, reinforcing the safety of low-flow anesthesia and supporting its increasing adoption in clinical practice.

5. Limitations

This study has some limitations. First, its retrospective design inherently limits the control over potential confounding factors. Second, the sample size, although adequate for detecting major hemodynamic differences, may not be sufficient to assess less pronounced effects. Additionally, the study was conducted in a single center, which may limit the generalizability of the findings to different clinical settings. Lastly, while we analyzed key hemodynamic parameters, other physiological markers, such as inflammatory or oxidative stress biomarkers, were not included in our evaluation. Future prospective studies with larger, multicenter cohorts and additional physiological parameters could provide a more comprehensive understanding of the effects of low-flow anesthesia in this patient population.

6. Conclusions

In this study, we compared the hemodynamic effects of sevoflurane and desflurane in obese patients undergoing laparoscopic bariatric surgery with low-flow anesthesia. Our findings indicate that both anesthetic agents maintain stable hemodynamic parameters, supporting the safety of low-flow anesthesia in this high-risk patient population. Given the increasing emphasis on low-flow anesthesia due to its environmental and economic benefits, our results provide valuable evidence for its feasibility in obese patients. Future prospective studies with larger sample sizes and additional physiological parameters will be beneficial to further elucidate the impact of these volatile anesthetics in this setting.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this paper are available upon reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

HKÖ—development of methodology, conception and study design; data collection, analysis, interpretation, drafting of the manuscript, critical revision and final approval. USÇ—development of methodology, conception and study design, analysis, statistics critical revision and final approval. BA—development of methodology, analysis and final approval. OC—development of methodology, analysis and final approval. All the authors have read and approved the final version of this manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study complied with the principles of the 1964 Declaration of Helsinki and its amendments. Patient data were anonymized to ensure confidentiality. Ethical approval was obtained from the Institutional Review Board on 06 February 2025 (Approval Number: 06.02.2025 10-354) SBU Adana City Education and Research Hospital. Informed consents were obtained from all patients.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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How to cite this article: Hatice Kaya Özdoğan, Uğur Serkan Çitilcioğlu, Oktay Cunetoğlu, Barış Arslan. Hemodynamic effects of desflurane and sevoflurane low-flow anesthesia for laparoscopic sleeve gastrectomy. Signa Vitae. 2025; 21(9): 111-116. doi: 10.22514/sv.2025.135.