

Effects of Low-Flow Anesthesia on Hemodynamic Parameters and Oxygenation in Morbidly Obese Patients Undergoing Bariatric Surgery: A Prospective, Randomized Clinical Trial

***Sedat Akbas**, Asst. Prof. Department of Anesthesiology and Reanimation, Inonu University Medical Faculty, Malatya, Turkey

Ahmet Selim Ozkan, Asst. Prof. Department of Anesthesiology and Reanimation, Inonu University Medical Faculty, Malatya, Turkey

Mehmet Ridvan Yalin, Postgraduate student. Department of Anesthesiology and Reanimation, Inonu University Medical Faculty, Malatya, Turkey

Address all correspondence to:

Sedat Akbas, Asst. Prof. Department of Anesthesiology and Reanimation, Inonu University Medical Faculty, Malatya, Turkey

Mail: drsedatAkbas@gmail.com

Phone Number: +905058263912

Fax Number: +904223410728

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Conflict of Interest:

The authors declare that they have no conflict of interest.

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Study Protocol

Morbidly obese patients with American Society of Anesthesiology (ASA) scores of III-IV, who were aged 18–65 years old, and had a BMI >40 were included in our study. Patients were interviewed before surgery to obtain informed consent. Patients were excluded if they were pregnant or had uncontrolled diabetes mellitus, cardiovascular disease, pulmonary disease, cerebrovascular disease, or drug and alcohol addiction. Patients who refused informed consent were also excluded.

Patients were taken to the operating room without premedication. Standard monitoring procedures were used, including heart rate (HR), noninvasive blood pressure (NIBP), electrocardiogram (ECG), peripheral oxygen saturation (SpO_2), and body temperature. A general anesthesia protocol was administered in all patients by an experienced anesthesiologist. After preoxygenation (100% 4 L/min O_2 for 5 min), propofol (1–2 $\text{mg} \cdot \text{kg}^{-1}$), rocuronium (0.8–1 $\text{mg} \cdot \text{kg}^{-1}$) and fentanyl (0.1 $\mu \text{g} \cdot \text{kg}^{-1}$) were administered during the induction of anesthesia via intravenous (IV) route at doses calculated according to ideal body weights. Randomization was performed with the MedCalc for Windows (medcalc.com.tr.), version 16 statistical software. Forty-eight patients were randomly allocated to two study groups: a low-flow group (Group L, $n = 24$) and a normal-flow group (Group N, $n = 24$). Patients in Group L received a fresh gas flow of 4 L/min for the first 10 minutes and were then maintained with a fresh gas flow of 0.75 L/min. Patients in Group N received the same initial fresh gas flow of 4 L/min for the first 10 minutes but were then maintained with a fresh gas flow of 1.5 L/min. All patients were mechanically ventilated with a tidal volume of 8 mL/kg based on ideal body weight and a frequency of 12–16 breaths/min using a Dräger Primus ventilator (Dräger AG, Lübeck, Germany). End-tidal carbon dioxide (EtCO_2) was continuously monitored after intubation. Tidal volume and ventilation rate were adjusted to maintain EtCO_2 partial pressure

of arterial blood at 35–45 mmHg. Rocuronium was intermittently injected according to need based on Train of Four (TOF; Dräger AG, Lübeck, Germany) values. TOF responses were assessed by ulnar nerve stimulation and adductor muscle response. Anesthesia was maintained in both groups at desflurane inhalation in a 0.5 O₂ oxygen-air mixture. Desflurane was discontinued with the beginning of the skin sutures and the fresh gas flow was changed to 4 L/min of oxygen for both groups. In patients who did not experience complications during the surgery, sugammadex (IV, 2–4 mg/kg, Bridion®, MSD, Greenville, USA) was then administrated to reverse residual muscle relaxation at the end of surgery. All patients received the standard surgical procedures determined by the same team of surgeons with experience in gastroenterology surgery. Pneumoperitoneum pressure ranged between 10 – 12 mmHg. Surgical management of sleeve gastrectomy was not changed in any way. In all patients, postoperative analgesia was achieved IV analgesic medication using appropriate doses of tramadol (0.5-1 mg/kg, IV) and paracetamol (1 gr, IV) at the time of beginning skin sutures (16).

Hemodynamic parameters such as HR, SpO₂, EtCO₂, MAP and values of arterial blood gas were recorded before anesthesia (T₀), 5 min before insufflation of CO₂ (T₁) and 15 min after awakening from anesthesia (T₂). In addition to anesthesia and surgery times, perioperative and postoperative complications were recorded.

Statistical Analysis Plan

Using the power calculation method (OpenEpi, Version 3), assuming an alpha of 0.05 and a beta of 0.80, we calculated that 22 patients per group should be included in this study. Data were analyzed using the Statistical Package for the Social Sciences program (SPSS 22.0). As some pre and anesthetic characteristics of patients were distributed abnormally nonparametric statistics was used. Quantitative data are presented as mean or standard deviation and categorical data are shown as numbers or percentages. Continuous variables were compared between the groups using Mann-Whitney U-test. Categorical variables were summarized using frequencies and percentages (%) and compared between the groups using Chi-Squared Test. The results were evaluated at a 95% confidence interval at a significance level of $p<0.05$.