

ORIGINAL ARTICLE

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Retrospective evaluation of anesthesia experience of patients who underwent sleeve gastrectomy

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Abstract

In this study, we aimed to present our anesthesia experience in patients who underwent laparoscopic sleeve gastrectomy in our hospital and review the literature. 116 patients with ASA (American Society of Anesthesiology) risk classification II-III who underwent laparoscopic sleeve gastrectomy were evaluated retrospectively. The patients were divided into groups according to gender and the anesthetic agent used, and the lengths of stay in the recovery unit, intensive care unit and hospital were compared. The age of the patients ranged from 19 to 62, and 61% of them were women. We did not find a statistically significant difference between the total length of hospitalization, intensive care unit stay and recovery time of the gender groups ($p>0.05$). We found a statistically significant difference in recovery times between the Thiopental and Propofol groups ($p<0.001$). In laparoscopic bariatric surgery, a complete preoperative evaluation, strict perioperative follow-up, taking the necessary precautions, choosing the appropriate anesthetic agent and being alert for postoperative complications are very important.

Keywords: Obesity, laparoscopic sleeve gastrectomy, anesthetic agents

Introduction

Obesity can be described as a proinflammatory multisystemic disease. It is characterized by hypertrophy or hyperplasia of adipose tissue [1]. Obesity is one of the most important health problems encountered in western countries. Endocrine, cardiovascular, pulmonary and metabolic problems are common due to obesity. Hypertension, sudden cardiac death, hyperlipidemia, diabetes, coronary artery disease, restrictive lung disease, psychiatric diseases and some cancers (breast, gynecological, etc.) are associated with obesity [2].

Sleeve gastrectomy was first performed in 1993 by Marceau et al. It was defined as an alternative to distal gastrectomy, which is the restrictive part of malabsorptive duodenal switch surgery [3].

Obesity affects all systems anatomically and functionally. These factors, which may cause breathing and intubation difficulties, are critical for anesthesia management [4].

The increase of obese cases in the community has led to an increase in bariatric surgery. Anesthesia management is specific in obese cases. It is essential to be prepared for perioperative and as well as postoperative complications. In this article, we aimed to share our bariatric surgery experience in our operating room.

Materials and Methods

The records of 116 patients who experienced sleeve gastrectomy were assessed retrospectively with the permission of the Malatya Training and Research Hospital Clinical Research Ethics Committee (approval number: 2021/47). These participants had a Body Mass Index (BMI) of over 40 or 35-40 and had comorbidities. Morbidly obese patients between the ages of 19-62 with a BMI $>40 \text{ kg/m}^2$ and/or BMI >35 accompanied by significant comorbidities including hypertension, type 2 diabetes, obstructive sleep apnea syndrome (OSAS) were included in this present study. Patients with BMI ≥ 40 without any co-morbidity, patients with

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BMI ≥ 35 and with one or more co-morbidities (hyperlipidemia, type-2 diabetes, sleep apnea, hypertension, obesity hypoventilation syndrome, fatty liver disease) steatohepatitis, venous stasis disease pseudotumor cerebri, reflux, arthritis, asthma, urinary incontinence, decrease in quality of life) were excluded in this present study. Anesthetic drugs administered to our patients and the period of recovery unit stay, hospital and intensive care unit stays were examined by dividing them into groups in terms of gender. From the pre-operative records; demographic characteristics of the patients, ASA score and co-morbidities were recorded. From the records during the operation; the type of monitorization applied, anesthesia and analgesia management, and complications during the operation were recorded. From the postoperative period records; intensive care requirement, duration of hospital stay, and causes of postoperative mortality and morbidity were examined in detail. It was determined that after the patients were taken to the operating room, they were monitored in a semi-sitting position with 100% oxygenation. In anesthesia management, it was determined that standard anesthesia monitoring (ECG, pulse oximetry, non-invasive blood pressure monitoring, end tidal carbon dioxide) was applied and all patients were dressed with antiembolic stockings. Before anesthesia induction, histamine receptor blockers, proton pump inhibitors, and metoclopramide were administered to reduce the aspiration risk. The dose of anesthetic drugs and the fluid infusion rate were obtained according to the "ideal body weight". 5 minutes of preoxygenation maintained at 100% oxygen concentration in a head up position. General anesthesia was induced with lidocaine (1mg/kg) propofol (2-2.5mg/kg), or thiopental (4-6mg/kg), rocuronium (0.6-1mg/kg) and fentanyl (1 μ g/kg) to ease tracheal intubation. The patients were given the appropriate lithotomy position for surgery. During the maintenance of anesthesia, 2 lt/min oxygen in 2% sevoflurane was administered, 2 lt/min air 4 lt/min. Respiratory frequency was adjusted 12-16/min to provide normocarbida, tidal volume was 6-8 ml/kg, ETCO_2 was between 30-35 mmHg, and positive end-expiratory pressure (PEEP) was 5 cmH₂O. A strict hemodynamic and bleeding follow-up was performed during the anesthesia application. Sugamadex 2g/kg IV was administered at the end of the surgery. Patients with adequate respiratory effort were extubated in a semi-sitting position and conscious. Multimodal postoperative analgesia was including tenoxicam (20mg), tramadol (50-100mg), meperidine (50-100 mg) and paracetamol (1 g), administered 30 minutes before the end of the surgery.

Statistical Analysis

Data analysis was carried out using the IBM SPSS version 26.0 statistical program (Chicago, IL, USA). A p value of <0.05 was accepted as statistically significant. Skewness and Kurtosis values were used to test the normality of the distribution of the data. Mann-Whitney U test was used to test for significant differences between groups. Descriptive statistics data were given as mean, median, standard deviation and quartiles for quantitative variables. In the Mann-Whitney U test performed with 116 patients included in the study, the effect size was calculated as $d=0.50950$. In the power analysis performed with the G*POWER 3.1.9.7 (Dusseldorf, Germany) program, when $d=0.50950$ and alpha error probability = 0.05, the power of the study was calculated as 0.80 in this sample of 116 people.

Results

A total of 116 patients were included to this present study. Laparoscopic Sleeve Gastrectomy (LSG) was performed in all our patients. Demographic data were shown in Table 1. The age of our patients ranged from 19 to 62. 71 of our patients were female and 45 were male. Our patients had ASA scores ranging from 2-3. BMI ranged from 38.2 to 48.8. Additional chronic diseases of our patients were classified in Table 2. Diabetes mellitus type II was present at a rate of 5%. In Table 3, the preoperative laboratory results were indicated according to gender and the values were found to be similar. Postoperative data were evaluated according to gender and no statistical difference was found between genders. Postoperative data were evaluated according to the type of anesthetic agent applied in induction, and it was observed that there was a statistically significant difference in terms of length of stay in recovery units (Table 4). When the analgesic treatment agents were examined, it was observed that 81% tramadol, 31% Tenoxicam, 18% paracetamol, 10% pethidine, 9% morphine were used. Paracetamol and tenoxicam were given in addition to the other analgesic agent. When the peroperative treatments were examined, Dexamethasone (8 mg iv.) was administered to 8 patients, methylprednisolone (average 109 mg iv.) to 46 patients, and theophylline ethylenediamine (average 227 mg iv.) to 16 patients. Peroperative hypertension was observed in 5 patients, bradycardia in 2 patients, desaturation and bronchospasm in 16 patients. Postoperative respiratory distress was observed in 33 patients, bleeding in 1 patient, and pulmonary embolism in 1 patient.

Table 1. Characteristics of the patients

	Mean $\pm$ SD	Min/Max
Age (years)	36 $\pm$ 10.2 n116	19/62
Gender (F/M)	71/45	
BMI (kg/m ²)	42.1 $\pm$ 3.3	38.2/48.8
ASA (II/III)	84/32	
Mallampati I/II/III/IV	31/51/31/3	
Duration of Anesthesia	122.8 $\pm$ 25.4	72/195
Duration of Surgery	109.2 $\pm$ 25.6	60/181

BMI: Body Mass Index, ASA: American Society of Anesthesiologists score

Table 2. Distributions of comorbidities

Comorbidities	n (%)
Diabetes mellitus type II	6 (5)
Hypertension	2 (1)
Asthma	3 (2)
Obstructive Sleep Apnea Syndrome	4 (3)
Hypothyroidism	4 (3)
Smoking	16 (13)

Table 3. Preoperative laboratory examinations

	Glucose	Albumin	HGBA1C
Male(n=45)	103.5(302)	4.3(1.4)	6.02(3.25)
Median(Range)(IQR)	(95.0-122.0)	(4.0-4.4)	(5.7-6.45)
Mean±Std.Deviation	116±48.264	4.24±0.382	6.1291±0.73961
Female(n=71)	100(233)	3.9(1.2)	5.7(9.22)
Median(Range)(IQR)	(91.5-112.0)	(3.8-4.1)	(5.35-6.09)
Mean±Std.Deviation	108.95±35.260	3.938±0.2815	5.6268±1.47337
Total(n=116)	101(366)	4(1.8)	5.8(9.22)
Median(Range)(IQR)	(92.0-117.0)	(3.8-4.3)	(5.425-6.215)
Mean±Std.Deviation	111.8±40.916	4.059±0.3557	5.8193±1.26064

Table 4. Postoperative characteristics associated with the anesthesia induction agent and gender

	Day of Hospitalization Median (Range)(IQR) Mean±Std.Deviation	Intensive Care Hospitalization Median (Range) (IQR) Mean±Std.Deviation	Duration in recovery room Median (Range) (IQR) Mean±Std.Deviation
Thiopental	n(58)	n(29)	n(58)
	7(8)(5.0-8.0)	1(1)(1.0-1.0)	26(16)(24.0-28.0)
	7.1±2.289	1.03±0.186	26.55±3.366
Propofol	n(58)	n(5)	n(58)
	9(6)(7.0-11.0)	1(0)(1.0-1.0)	23(2)(23.0-24.0)
	9±2.550	1±0	23.2±0.837
PValue	0.380	0.678	<0.001
Male	n(45)	n(18)	n(45)
	7(8)(6.00-10.00)	1(0)(1.0-1.0)	26(16)(24.0-28.0)
	7.94±2.485	1±0	26.72±3.968
Female	n(71)	n(16)	n(58)
	6(7)(5.0-7.0)	1(1)(1.0-1.0)	23(2)(23.0-24.0)
	6.75±2.176	1.06±0.250	23.2±0.837
PValue	0.175	0.289	0.171

Discussion

Obesity can be defined as the current body weight being more than the ideal body weight. BMI has been used to assess obesity. BMI is found by dividing the body weight in meters by the square of the height (BMI= Weight kg/Height (m)²) and a value above 30 kg/m² is in favor of obesity [5]. Obesity is mostly observed in the United States of America (USA), and it was reported with a frequency of 35.3% in women and 33.3% in men, according to the USA National Nutrition and Health Survey [6]. In Turkey, the incidence of obesity is reported as 41.5% in women and 21.2% in men. Obesity has emerged as an important health problem in our country and in the World recently [7].

Obesity has a high mortality and morbidity rate due to the respiratory system, cardiovascular system, endocrinological or metabolic disorders. Bariatric surgery is an important advance in the treatment method of obese patients, however anesthesia management is critical in these patients due to changes in both anatomical and obesity-related or accompanying organ functions. For such complex cases, detailed preoperative evaluation is essential, as well as intraoperative and postoperative treatment, in order to minimize surgical and anesthetic complications [8]. It is expected from bariatric surgery is to get rid of excess body weight to a large extent, to maintain it for a long time and to have positive effects on obesity-related morbidities. Sleeve gastrectomy is one of the volume-limiting surgeries. Complications including bleeding,

organ injury, respiratory problems and embolism that may occur in all laparoscopic surgeries after sleeve gastrectomy surgery can be observed at very low rates [9].

The most important mechanism of weight loss following LSG is the severe reduction of gastric capacity. Another factor that affects the weight loss after LSG is the marked decrease in serum ghrelin levels [10].

Factors that may cause breathing and intubation difficulties are important for anesthesia management. In these patients, the neck is short and thick, with the larynx displaced anteriorly and upwards. The amount of pharyngeal and palatal soft tissue is increased and the tongue is large. Difficulty should be expected in providing airway management such as mask ventilation, direct laryngoscopy and tracheostomy, as a result of the enlargement of the face, neck, chest and abdomen circumferences with a high Mallampati score. The difficult intubation incidence of cases with BMI>35 kg/m² has been reported as 15.5% [4].

Previous experiences in anesthesia planning is important in predicting possible complications. A Mallampati score of 3 or higher, a sternomental distance of 12.5 cm or a thyromental distance of smaller than 6 cm are indicators of difficult intubation [11]. While the probability of difficult intubation was 5% in those with a neck circumference of 40 cm, it was 35% in those with a neck circumference of 60 cm [12]. There are studies reported in the literature stating that the incidence of difficult airway is 6% and above in morbidly obese patients [13]. In the study of Dohrn et al. including 539 patients who experienced laparoscopic gastric bypass surgery, it was reported that the rate of difficult intubation was 3.5% and it was more common in male patients [14]. Difficult intubation was found in 5% of our patients. Direct laryngoscopy procedure in obese cases, intubation is facilitated by raising the upper part of the body so that the sternal notch and the external auditory canal are aligned with the head and neck with the ramped position. In addition, this position ensures that the lung reserves are filled during preoxygenation [15].

In our study, we observed that intubation was carried out in the ramped position, that emphasized in the literature. In morbidly obese patients, in many publications reported in the literature that the head in a 30° upward position during anesthesia induction improves the laryngoscopic appearance, as well as the abdominal contents relieve the diaphragm pressure and increase oxygenation [16].

Patients should be evaluated for OSAS and obesity hypoventilation syndrome (OHS). OSAS is present in 90% of patients with obesity hypoventilation syndrome. Particularly in patients with OSAS, intensive care support and reintubation may be necessary due to postoperative hypoxia. There is chronic daytime hypoxemia (PaO₂<65 mmHg) and hypercapnia (PaCO₂>45 mmHg) in OSAS. Respiratory response to hypoxemia and hypercapnia is also impaired. Hypoventilation worsens during sleep, particularly in REM, and is associated with severe arterial oxygen desaturation [17].

As a result of obesity, peripheral resistance and blood volume increase; and also a hyperkinetic circulation and an increase in renal blood flow exist. Myocardial infarction, congestive heart failure, hypertension, pulmonary hypertension and cor pulmonale, arrhythmias, cerebrovascular events are common [18-19].

In obese patients, splanchnic blood flow increases by 20%. Additionally ventricular workload, blood volume, cardiac output and oxygen consumption are increased in obese [19]. Systemic and cor pulmonale, pulmonary hypertension and right heart failure may develop. Systemic vascular resistance is increased. Developing systemic hypertension can lead to left heart failure. Cardiac conduction disturbances and arrhythmias may occur [20].

We found that 2 of our patients developed arrhythmia and there was no need for peroperative treatment for this clinical condition. Respiratory dysfunction is common in obese patients. Ventilation/perfusion disorders, chronic respiratory diseases and increased intrapulmonary shunts cause hypoxemia [21].

Especially fat accumulation on the anterior surface of the body reduces chest wall compliance. Total lung capacity, expiratory reserve volume and functional residual capacity decrease, while airway resistance increases [22]. The expiratory reserve volume functions as an oxygen reserve in the possible development of apnea in obese cases. Therefore, the efficiency of preoxygenation is low in obese and the susceptibility to hypoxemia is increased [23].

In our patients, hypoxemia was prevented by preoxygenation of all patients before anesthesia induction. Respiratory workload increased due to decreased lung compliance, high intra-abdominal pressure, and increased metabolic demand [24].

Deep breathing and coughing exercises should be taught preoperatively, they should be practiced every 1.5-2 hours postoperatively, and the patient should be given the opportunity to complete the 90-minute sleep cycle. In addition, it should be explained that deep breathing and coughing exercises should be performed 10 times per hour in morbidly obese patients, especially in the preoperative period, due to decreased expansion of the lungs and chest wall due to excess weight [25].

Edema and venous stasis, increased fibrinogen and plasminogen activator inhibitor, decreased fibrinolysis and antithrombin III deficiency predispose to the development of deep vein thrombosis in obese. Since the thromboembolism risk originating from arterial and deep veins is high, the use of antiembolic stockings or intermittent pneumatic compression devices is recommended for thromboembolism prophylaxis [18, 26]. As reported in the literature, our patients were routinely put on antiembolic stockings in the perioperative and postoperative periods. Pulmonary embolism developed in only 1 patient and clinical improvement was achieved with treatment. The incidence of gastroesophageal reflux is high in obese patients. Gastroesophageal reflux is caused by increased intra-abdominal pressure and decreased esophageal lower sphincter pressure. Before induction of anesthesia, drugs such as histamine receptor blockers, proton pump inhibitors, metoclopramide can be used for prophylactic purposes to reduce the aspiration risk [27].

Proton pump inhibitors and metoclopramide were administered in our patient group. Dose for induction drugs and opioids should be calculated based on lean body weight (LBW), for neuromuscular agents except succinylcholine, dose should be obtained according to the ideal body weight (IBW), and for the agents reversing neuromuscular block, dose should be obtained based on Total body weight (TBW). Recovery is slow in obese patients due to

the highly lipid soluble characteristic of inhalation agents. Since the blood flow in the adipose tissue is reduced, the release of inhalation agents from the adipose tissue is limited [28]. Rapid recovery, rapid induction, perioperative hemodynamic stability and are prerequisites for anesthesia management of these patients. For this purpose, while propofol is the commonly used intravenous anesthetic, sevoflurane has been found to be the most commonly preferred inhalation anesthetic [29].

50% of our patients received propofol, while the other half received thiopental. Maintenance was continued with sevoflurane in all patients. Theoretically, excess fat stores increase the volume of distribution of fat-soluble drugs (eg, benzodiazepines, opioids). This results in the need for a larger loading dose to achieve the same plasma concentration. Less frequent maintenance doses are required as a result of a larger volume of distribution slowing clearance. It is also important to regulate the doses of water-soluble drugs according to the exact body weight in obese [30].

Propofol is preferred in many studies because of its rapid recovery properties and low adhesion rate in adipose tissue. Jung et al. administered thiopental to seven obese and eight thin patients experienced abdominal surgery and found that the elimination half-life of thiopental was 27.8 hours in obese patients and 6.33 hours in lean patients. They stated that this was due to the increased volume of distribution in obese patients [31]. Similarly, Servin et al reported the elimination half-life of propofol to be 29.1 minutes in obese subjects and 24.2 minutes in non-obese subjects [32].

When the follow-up times in the recovery unit were compared, it was found to be significantly higher in the thiopental group. Neuromuscular blockers are water-soluble drugs and have a more limited volume of distribution that is not affected by fat stores. Therefore, IBW should be considered when adjusting the dose of these drugs to prevent overdose [30]. Rocuronium is used in bariatric surgery due to its low lipophilicity, but it is suggested to be given based on IBW in anesthesia induction [33].

In parallel with the literature, rocuronium was preferred in all of our patients. Pelosi et al. in the obese patient group, they recommended PEEP application with a tidal volume of 6-10 ml/kg according to IBW, a respiratory frequency of 35-45 cmH₂O, and a pressure of 10 cmH₂O [34].

In our study, it was determined that the mechanical ventilation strategy was adjusted by applying 3-5 cmH₂O PEEP under 10-15 mmHg pneumoperitoneum pressure. Cadi et al. reported that pressure-controlled ventilation (PCV) improved gas exchange better than volume-controlled ventilation (VCV) in obese cases underwent laparoscopic surgery [35]. In our patient group, VCV was chosen as the ventilation strategy. Almarakbi et al. declared an increase in intraoperative PaO₂, a decrease in PaCO₂, an increase in lung compliance and postoperative high saturation values with the application of PEEP after ten minutes of recruitment and suggested this practice as the best ventilator strategy in the obese patient group [36].

Vallenza et al. reported that the optimum PEEP value against pneumoperitoneum should be 10 cmH₂O for this surgery [37]. In our study, it was determined that the mechanical ventilation strategy was adjusted by applying 3-5 cmH₂O PEEP under 10-

15 mmHg pneumoperitoneum pressure. Volatile anesthetics may be metabolized more in obese due to increased metabolism and tendency to hypoxia. The distribution of volatile anesthetic agents into the adipose tissue is very slow, and the clinical effect of excess fat deposits on the recovery time is very low, even in long surgical procedures [19].

Rapid recovery, perioperative hemodynamic stability and rapid induction are prerequisites for anesthesia management of these patients. For this purpose, while propofol is the commonly used intravenous anesthetic, sevoflurane has been found to be the most commonly preferred inhalation anesthetic [29]. Two randomized studies have shown that sevoflurane has an advantage over isoflurane in bariatric surgery with rapid recovery, hemodynamic stability, and a low frequency of nausea and vomiting [38].

When non-invasive positive pressure ventilation implemented immediately following extubation in laparoscopic bariatric surgery in especially morbidly obese patients diagnosed with obstructive sleep apnea syndrome is compared with continuous positive airway pressure administered in the postoperative care unit; There are studies showing that it improves spirometric parameters in 1 hour and in one day postoperatively [39].

In obese patients, multimodal analgesia should be preferred to reduce opioid-associated side effects including nausea, respiratory depression, pruritus, and disruption of intestinal peristalsis [40]. Opioids and paracetamol or nonsteroidal anti-inflammatory agents may be preferred as a component of a multimodal regimen in the postoperative analgesia in especially morbidly obese patients. In our patients, a multimodal system was preferred for postoperative analgesia, and the contralateral paracetamol pair included in the literature recommendations was the most preferred. Although the amount of intraoperative bleeding varied between 60 ml and 350 ml, it was determined that no patient received blood or blood product transfusion during the intraoperative period. It was determined that the anesthesia induction and maintenance methods applied to our patients were compatible with the literature, and the complications that emerged were similar. We believe that our article is a retrospective study containing important information that can shed light on all periods of bariatric surgical anesthesia.

Conclusion

As a result, aspiration and thromboembolism prophylaxis and difficult airway preparation should be done in the preoperative period together with an experienced team to prevent complications that can develop in laparoscopic bariatric surgery. For a safe anesthesia, tight monitoring, selection of the ideal anesthetic agent in the induction and maintenance of anesthesia, ramp position in intubation, ventilator settings to prevent intraoperative and postoperative atelectasis, and prevention of residual block should be ensured. In addition, appropriate postoperative analgesia is important.

Conflict of interests

The authors declare that they have no competing interests.

Financial Disclosure

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Ethical approval

Malatya Clinical Research Ethics Committee (approval number: 2021/47).

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