

The effect of bariatric anaesthesia on postoperative pulmonary functions

Özcan Piskin,¹ Bülent Altınsoy,² Murat Çimencan,³ Bengü Gülhan Aydın,⁴ Dilek Okyay,⁵ Gamze Küçükosman,⁶ Öge Taşçılar,⁷ Selda Sarıkaya,⁸ Hilal Ayoglu⁹

Abstract

Objective: To evaluate respiratory function in the post-operative early period of patients undergoing bariatric surgery using the sleeve gastrectomy technique.

Methods: This prospective, observational study was conducted at Bülent Ecevit University Health Application and Research Centre, Zonguldak, Turkey from June to December 2014, and comprised patients with planned bariatric sleeve gastrectomy under general anaesthesia. Participants were visited 12-24 hours before the operation to record accompanying diseases and demographic data. Before the operations, respiratory function test, maximum expiratory pressure, maximum inspiratory pressure and arterial blood gas assessment tests were done and recorded as T0. After one hour of the operation, Aldrete scores ≥ 9 and the above-mentioned tests were repeated and recorded as T1. SPSS 18 and MedCalc 12.2.1.0 were used for statistical analysis.

Results: Of the 76 participants, 60(78%) were women and 16(21%) were men. The overall median age was 39 years (inter-quartile range: 32-47 years). The mean and median values for forced expiratory volume in 1 second, forced vital capacity, maximum inspiratory pressure, maximum expiratory pressure and the ratio between partial pressure of oxygen in arterial blood and fraction of inspired oxygen at T0 were 101 ± 17 , 102 ± 17 , 66 (interquartile range: 59-74), 114 (interquartile range: 100-138) and 379 ± 49 , respectively, compared with 78 ± 18 , 76 ± 18 , 53 (interquartile range: 48-59), 85 (interquartile range: 73-95) and 331 ± 49 at T1 ($p < 0.001$ each). Also, 38(50%) participants were given sugammadex and 38(50%) were given neostigmine. At the end of the test, sugammadex (odds ratio: 5.80; 95% confidence interval: 1.26-26.69; $p = 0.024$) and pre-operative ratio between partial pressure of oxygen in arterial blood and fraction of inspired oxygen (odds ratio: 1.04, 95% confidence interval: 1.02-1.06; $p < 0.0001$) were found to correlate significantly.

Conclusion: Impairment of respiratory function was found during the early post-operative period.

Keywords: Bariatric surgery, Anaesthesia, Pulmonary functions, RFT, Sugammadex. (JPMA 67: 561; 2017)

Introduction

Obesity is one of the most significant health problems in the modern world. According to 2014 data from the World Health Organisation (WHO), there are 1.9 billion overweight and 600 million obese people over the age of 18 years worldwide.¹

Obesity affects many systems and, as a result, is known to cause diseases such as diabetes mellitus (DM), chronic kidney disease (CKD), cardiovascular disease, obesity hypoventilation syndrome (OHS), asthma and sleep apnoea-hypopnoea syndrome to occur more often.²⁻⁴ Obesity affects respiratory functions through mechanical pathways. Excess fat around the neck, upper airways, chest wall and abdomen forms a mechanical barrier around the lungs, reducing the normal compliance of the

diaphragm and chest cage. Additionally, collapse of alveoli linked to closure of the small airways, particularly in the basal sections of the lungs, and increased pulmonary blood volume leading to imbalanced ventilation perfusion, cause hypoxia.⁵

For treatment of obesity, methods involving diet, exercise, and behavioural changes, as well as pharmacotherapy, are primarily recommended. However, despite these methods being used for most patients, they are typically unsuccessful. Therefore, surgical techniques are important. Studies have shown that surgical techniques produce successful results for obesity treatment.⁶ Under bariatric anaesthesia, patients undergoing laparoscopic abdominal surgery may have disrupted respiratory functions in the early postoperative period.⁷ This disruption occurs as a result of reduced diaphragm compliance, linked to increased intra-abdominal pressure due to the gases used to expand the laparoscopic field of view, and the fact that muscle agents used in anaesthesia negatively affect respiratory muscles in the post-operative period.^{8,9} In recent years, sugammadex has been used in anaesthesia practice to antagonise the

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^{1,3-6,9}Department of Anesthesiology and Reanimation, ²Department of Chest Disease, ⁸Department of Physical Medicine and Rehabilitation, Bülent Ecevit University, ⁷Department of General Surgery, Yeditepe University, (Formerly: Bülent Ecevit University Department of General Surgery), Turkey.

Correspondence: Özcan Piskin. Email: drozcanp@gmail.com

effects of muscle-relaxing agents like rocuronium and vecuronium.¹⁰ Compared with neostigmine, sugammadex is associated with early waking and a more rapid recovery by patients.¹¹

The current study was planned to evaluate respiratory function in the post-operative early period of patients undergoing bariatric surgery using the sleeve gastrectomy technique, and to determine the factors that could negatively affect respiratory functions.

Patients and Methods

This prospective, observational study was conducted at Bülent Ecevit University Health Application and Research Centre, Zonguldak, Turkey from June to December 2014, and comprised patients with planned bariatric sleeve gastrectomy under general anaesthesia. Ethical approval was obtained from the institutional ethics committee. Written informed consent was obtained from all participants. All procedures involving human participants were in accordance with 1964 Helsinki declaration and its later amendments. Patients having a body mass index (BMI) ≥ 40 kg/m² and aged between 18 and 60 years were included. Patients who had a previous history of obesity surgery or chronic respiratory disease, renal and/or hepatic dysfunction, malignant hyperthermia, were pregnant, or had an allergy or contraindication to narcotics, neuromuscular blockade agents, sugammadex, neostigmine, or other medications used during general anaesthesia were excluded.

To measure the respiratory function of the patients in the study, the respiratory function test (RFT) and arterial blood gas (ABG) analysis were conducted, and maximum expiratory pressure (MEP) and maximum inspiratory pressure (MIP) were assessed. For all patients, RFT measurements and evaluations were completed by a pulmonologist, while MIP and MEP measurements were completed by a physical therapy and rehabilitation expert. Patients were visited 12-24 hours before the operation to record accompanying diseases and demographic data. Before the operations, RFT, MEP, MIP and ABG assessment tests were completed and recorded as T₀. One hour after the operation, Aldrete scores ≥ 9 , RFT, MEP, MIP and ABG assessment tests were repeated and recorded as T₁. RFT measurements were obtained using a SpirolabIII® (MIR, Rome, Italy) device. Spirometry was completed in accordance with the guidelines of the American Thoracic Society (ATS).¹² All of the tests followed a standardised procedure, with the patients sitting upright, and involved use of a nose clip with a minimum forced exhalation time of 6 seconds after maximum inhalation. The best values of each forced expiratory

volume in 1 second (FEV1) and the forced vital capacity (FVC) from at least three acceptable forced expiration manoeuvres were used for analysis. The FEV1 and FVC values were expressed in litres. Respiratory muscle strength was measured by the maximal respiratory pressures, MIP and MEP,¹³ using an analogue manovacuometer Micro RPM® (CareFusion, San Diego, California, United States). The MIP and MEP values were expressed in centimetre of water (cmH₂O).

No patient was given premedication. During the operation, mean arterial pressure, heart rate, peripheral oxygen saturation, bispectral index (BIS) values and adductor muscle and nasopharyngeal temperatures were monitored and recorded. For neuromuscular conduction monitoring, a train-of-four (TOF)-Watch® SX device (Organon Teknika BV, Boxtel, Netherlands) was used. The temperature of the operating room was adjusted to 21-25°C. Patients were covered and care was taken that the skin temperature of the thenar region did not fall below 32°C.

All of the patients were administered the routine bariatric anaesthesia protocol of our clinic. While muscle relaxant agents were administered according to ideal body weight (IBW), all of the other anaesthetic agents were administered according to corrected body weight (CBW). IBW was calculated according to the formula¹⁴ — $22 \times \text{height (m)}^2$ — while CBW was calculated using the formula $\text{IBW} + 40\% \times \text{IBW}$. All of the patients had anaesthesia induction with 1 mcg/kg (CBW) intravenous (IV) fentanyl and 2 mg/kg (CBW) propofol. When BIS values were 40-60, TOF-Watch device calibration was completed, and three consecutive single twitch control values were recorded. Rocuronium [IV; 0.6 mg/kg (IBW)] was administered, and the TOF value was allowed to reach 0 (TOF₀). After TOF₀, the patients were intubated. Anaesthesia maintenance for all patients was 50:50% oxygen and nitrous oxide (O₂/N₂O), and 2% sevoflurane was titrated to ensure the BIS values were between 40 and 60. During the operation, when the TOF value was 25% (TOF₂₅), one-fourth of the induction dose of rocuronium was repeated. At the end of the operation, patients were left until TOF₂₅ was reached. When TOF₂₅ was reached, sugammadex [IV; 2 mg/kg (current body weight (CBW))] or neostigmine (IV; 0.03 mg/kg) and atropine [0.01 mg/kg; CBW] were administered. When the TOF values of all of the patients were 90% (TOF₉₀), they were extubated. The time between TOF₂₅ and TOF₉₀ was recorded in seconds (TOF₂₅₋₉₀). The time from the beginning of surgical incision to the last skin suture was termed the surgical duration and was recorded. After the skin sutures were completed, anaesthetic gases were terminated in both groups. The time from anaesthesia induction to cessation

of gas was termed the anaesthesia duration and was recorded. The time from the cessation of anaesthetic gases until a modified Aldrete score (MAS) ≥ 9 was reached was recorded as the recovery time. After the operation, the patients were transferred to the post-anaesthesia care unit (PACU). All of the patients were administered 1 mg/kg tramadol IV for post-operative pain control at the end of skin incision. For 24 hours, post-operative tramadol was administered by patient-controlled analgesia. Visual analogue scale (VAS) scores of pain were recorded; when VAS >4 , a non-steroidal anti-inflammatory analgesic agent was added and recorded.

The FVC, FEV₁, MIP, MEP and ABG parameters were compared during the early post-operative period with the basal values before the operation.

Descriptive statistics of the categorical variables were given as numbers or percentages; continuous variables were provided as means \pm standard deviation (SD) or as medians (minimum-maximum). Chi-square test was used to evaluate categorical variables. The paired t-test or Wilcoxon signed-rank test was used to compare the means/medians of variables as appropriate. Predictors of post-operative normoxemia among the post-operative patients were identified using univariate and multivariate logistic regression analyses. SPSS 18 and MedCalc 12.2.1.0 were used for statistical analysis. P-values were two-sided; $p < 0.05$ was considered statistically significant.

Results

Of the 84 patients, 76(%) were included. Of them, there were 60(78%) women and 16(21%) men. The overall median age was 39 years (inter-quartile range [IQR]: 32-47 years). The mean or median values for FEV₁, FVC, MIP, MEP and the ratio between partial pressure of oxygen in arterial blood (PaO₂) and fraction of inspired oxygen (FiO₂) were 101 \pm 17, 102 \pm 17, 66 (IQR: 59-74), 114 (IQR: 100-138) and 379 \pm 49, respectively, before operation compared to 78 \pm 18, 76 \pm 18, 53 (IQR: 48-59), 85 (IQR: 73-95) and 331 \pm 49 after operation ($p < 0.001$) (Table-1).

Besides, 38(50%) were given sugammadex and 38(50%) were given neostigmine.

When the age, gender and BMI values of patients who were administered sugammadex were compared with those of patients who were administered neostigmine, no significant difference was found ($p > 0.05$).

The values of FEV₁ at T₀ and T₁ were 3.15 \pm 0.63 l and 2.40 \pm 0.63 l, respectively, in the patients who were administered sugammadex, compared to respective values of 3.04 \pm 0.75 l and 2.34 \pm 0.61 l in the patients who were administered neostigmine ($p = 0.890$). The FVC values

Table-1: Physical characteristics and pre-operative and post-operative patient's data.

n=76	T ₀	T ₁	p*
Age, median, IQR	39 (32-47)	-	-
Gender (female), n%	60 (78.9)	-	-
BMI, median, IQR	46 (42-48)	-	-
Smoking, n	35(43)	-	-
FEV ₁ , (%)	101 \pm 17	78 \pm 18	$p < 0.001$
FVC, (%)	102 \pm 17	76 \pm 18	$p < 0.001$
MIP, (cmH ₂ O), median, IQR	66 (59-74)	53 (48-59)	$p < 0.001$
MEP, (cmH ₂ O), median, IQR	114 (100-138)	85 (73-95)	$p < 0.001$
PaO ₂ /FiO ₂ ratio	379 \pm 49	331 \pm 49	$p < 0.001$
PaCO ₂ , (mmHg), median, IQR	36 (35-40)	37 (36-40)	$P = 0.238$

BMI: Body mass index

FEV₁: Forced expiratory volume (1 second)

FVC: Forced vital capacity

MIP: Maximal inspiratory pressure

MEP: Maximal expiratory pressure

PaO₂: Partial arterial oxygen pressure

PaCO₂: Partial arterial carbon dioxide pressure

IQR: Inter-quartile range

cmH₂O: Centimetre of water.

at T₀ and T₁ were 3.79 \pm 0.9 l and 2.86 \pm 0.8 l, respectively, for the sugammadex patients and 3.59 \pm 0.9 l and 2.63 \pm 0.8 l, respectively, for the neostigmine patients ($p = 0.515$).

Comparison of respiratory muscle strength according to the median values of MIP and MEP revealed that the values of MIP at T₀ and T₁ for patients who were administered sugammadex were 68 (IQR: 60-77) cmH₂O and 54 (IQR: 50-60) cmH₂O, respectively, while these values were 64 (IQR: 56-73) cmH₂O and 52 (IQR: 47-58) cmH₂O for patients who were administered neostigmine ($p = 0.912$).

Comparison of ABG revealed that for patients who were administered sugammadex, the PaO₂/FiO₂ ratio at T₀ was 379 (IQR: 300-400) compared with 333 (IQR: 300-371) at T₁. Among the patients who were administered neostigmine, this ratio was 388 (329-429) at T₀, while it was 319 (IQR: 286-348) at T₁. Comparing the PaO₂/FiO₂ ratios of sugammadex and neostigmine patients, a statistically significant difference was observed ($p = 0.031$) (Table-2).

When the amounts of medication used were compared between patients who were administered sugammadex and those who were administered neostigmine, there was no statistically significant difference identified in terms of total propofol, remifentanyl, tramadol, desflurane, oxygen or N₂O consumption ($p > 0.05$). However, the amount of vecuronium consumed by patients who were administered sugammadex was identified as 56 (IQR: 48-63) mg, while the amount of vecuronium consumed by

Table-2: Physical characteristics and respiratory variables following injection of sugammadex or neostigmine.

	Sugammadex, n=38		Neostigmin, n=38		p value		
	T ₀	% difference T ₁	T ₀	% difference T ₁	T ₀	T ₁	
Age, (year)	40±8		39±9			0.521	
Female, n (%)	27 (71)		33 (85)			0.179	
BMI	46 (43-49)		44 (42-48)			0.285	
Smoking	19 (49)		16 (41)			0.247	
Duration of the surgery, (min)	59 (50-64)		54 (45-70)			0.760	
Duration of the anaesthesiology, (min)	78 (69-86)		74 (70-90)			0.671	
FEV ₁ , (lt)	3.15±0.82	2.40±0.63	22±18	3.04±0.75	2.34±0.61	22±14	0.890
FEV ₁ , (%)	100±19	79±18	20±17	102±16	78±18	23±15	0.425
FVC, (lt)	3.79±0.9	2.86±0.8	23±18	3.59±0.9	2.63±0.8	26±16	0.515
FVC, (%)	102±17	78±18	23±17	103±17	74±19	27±17	0.225
MIP, (mmHg)	68 (60-77)	54 (50-60)	16(13-26)	64 (56-73)	52 (47-58)	20(11-25)	0.912
MEP, (mmHg)	124 (104-145)	89 (77-101)	25 (18-36)	107 (94-135)	84 (70-91)	26 (16-37)	0.893
pH	7.43 (7.41-7.44)	7.40 (7.35-7.41)	0.5 (0-0.9)	7.43(7.41-7.44)	7.39 (7.37-7.42)	0.4 (0-0.8)	0.576
pO ₂ /FiO ₂ ratio	379 (300-400)	333 (300-371)	8 (5-14)	388 (329-429)	319 (286-348)	13 (7-21)	0.031
PaCO ₂ (mmHg)	36 (35-41)	38 (36-40)	3 (-2-14)	37 (36-40)	37 (35-40)	0 (-7-7)	0.076
SaO ₂ , (%)	96 (95-98)	95 (93-97)	2 (0-3)	96 (95-98)	94 (91-96)	3 (1-5)	0.136

BMI: Body mass index

FEV₁: Forced expiratory volume (1 second)

FVC: Forced vital capacity

MIP: Maximal inspiratory pressure

MEP: Maximal expiratory pressure

PaO₂: Partial arterial oxygen pressurePaCO₂: Partial arterial carbon dioxide pressure

IQR: Inter-quartile range

cmH₂O: Centimetre of waterSaO₂: Percentage of haemoglobin saturated with oxygen in arterial blood.**Table-3:** Time to recovery of TOF ratio to 0.9 and time to recovery of Aldrete ?9.

	Sugammadex	Neostigmin	P*
Time to recovery of TOF ratio to 0.9, sec	180 (108-250)	268 (240-360)	p<0.001
Time to recovery of Aldrete ≥9, min	11(11-15)	26 (18-29)	p<0.001

TOF: Train of four.

patients who were administered neostigmine was identified as 50 (IQR: 47-55) mg. The difference between the two patient groups was statistically significant (p=0.012).

The median time it took patients to reach a TOF ratio of 0.9 was 180 (IQR: 108-250) seconds for those who were administered sugammadex and 268 (IQR: 240-360) seconds for those who were administered neostigmine (p<0.0001). The recovery time was 11(IQR: 11-15) minutes for patients who were administered sugammadex and 26 (IQR: 18-29) minutes for those who were administered neostigmine (p<0.0001) (Table-3).

Logistic regression analysis (enter method) tested the ability of the independent factors of age, gender, FVC value before the operation, total amount of muscle

relaxant consumed, neuromuscular blockade reversal agents (sugammadex or neostigmine) and mean BMI to predict post-operative oxygenation (PaO₂/FiO₂ > 350). At the end of the test, sugammadex (odds ratio [OR], 5.80; 95% confidence interval [CI]: 1.26-26.69; p=0.024) and pre-operative PaO₂/FiO₂ (OR: 1.04; 95% CI: 1.02-1.06; p < 0.0001) were found to correlate significantly. In this model, age, gender, FVC value before the operation, total amount of muscle relaxant consumed, neostigmine and mean BMI were not significant predictors of post-operative oxygenation (p>0.05).

Discussion

This study evaluated the pulmonary function, respiratory muscle strength and arterial blood gas of patients undergoing bariatric surgery. The study showed that, in the early period after patients underwent sleeve gastrectomy, there was a disruption in the FEV₁, FVC, MIP, MEP and arterial blood gas parameters. The results of regression analysis showed that oxygenation was significantly better in patients who were administered sugammadex.

Many methods, such as diet, exercise, and behavioural changes, pharmacotherapy and surgical procedures, can

be used for the treatment of obesity. However, the most successful and satisfactory results may be provided by surgical procedures.⁶ A study by Angrisani et al.¹⁵ determined that 468,609 people underwent bariatric procedures globally in 2013. The same study reported that 171,191 of these procedures were sleeve gastrectomies. The most important reason for the procedure being so common and popular is developments in laparoscopic techniques and technology and the frequency of its use worldwide.^{6,7} All of the cases in this study underwent laparoscopic sleeve gastrectomy. Cases with open surgery or additional operations were excluded.

In bariatric anaesthesia administration, muscle tone is lost on induction. As a result, a reduction in lung volume and functional residual capacity (FRC) occurs. Hedenstierna et al.¹⁶ reported a 16-20% reduction in FRC immediately after the induction of anaesthesia and placing of the patient in the supine position. The result of this reduction in FRC is initial airway closure, followed by alveolar collapse. Immediately after induction, the collapse rate at the base of the lungs can reach 20%.¹⁷ For this reason, the present study aimed to reveal the effect of bariatric anaesthesia on post-operative respiratory function, eliminating independent risk factors that may affect post-operative respiratory function by excluding patients with chronic respiratory disease and those with previous bariatric surgery.

To evaluate respiratory functions, RFT, MIP, MEP and ABG were measured in our study. Spirometry is a very useful, non-invasive, globally accepted method. It is known that during the early period after obesity surgery, there is a significant reduction in spirometric values.¹⁸⁻²¹ Ungern-Sternberg et al.¹⁹ performed spirometric measurements 3 hours after extubation of patients with a BMI of 25 kg/m². Additionally, laparotomy was performed in a study that reported a 17% reduction in FEV₁ and FVC compared to pre-operative values. Another study by Ungern-Sternberg et al.²⁰ reported that the risk of disruption to spirometry values increased according to BMI in patients who were administered general anaesthesia. Joris et al.²¹ compared spirometric values in obese patients with a BMI \geq 40 kg/m², who were undergoing gastroplasty, with those from another period. They reported that 4 hours after the operation, the FEV₁ value was reduced by 16% compared with basal values, while FVC was reduced by 14%. In our study, 4 hours after extubation, significant reductions were observed in the measured FEV₁ and FVC values, which accords with the literature.

After bariatric anaesthesia, respiratory muscle strength

causes respiratory impairment as a result of surgery and/or anaesthetic medications. Studies evaluating respiratory muscle strength have shown significant fall in MIP and MEP values measured in the early period after the operation. A study by Barbalho-Moulim et al.²² reported a reduction in MIP of 23%, and in MEP of 27%, after laparoscopic bariatric surgery. Similarly, Llorens et al.,²³ in a study investigating changes in MIP and MEP values in patients undergoing bariatric surgery, measured pre-operative MIP as 76.5 \pm 17.0 mmHg, and MEP as 106.8 \pm 3.27 mmHg, while post-operative values were 53.3 \pm 27.7 mmHg for MIP and 63.3 \pm 37.4 mmHg for MEP. In our study, a significant decrease in both MIP and MEP values was observed compared with pre-operative values.

Although patients undergoing bariatric surgery are given supplemental oxygen, there is a risk of hypoxia persisting into the post-operative period.²⁴ A study by Llorens et al.²³ identified a PaO₂/FiO₂ ratio of <300 mmHg in 17/21 patients. In our study, while the PaO₂/FiO₂ ratio was 379 \pm 49 at T₀, the PaO₂/FiO₂ ratio was 331 \pm 49 at T₁.

In our logistic regression analysis, we tested the predictive value of the independent factors of age, sex, pre-operative FVC, total amount of muscle relaxant consumed, neuromuscular blockade reversal agents (sugammadex or neostigmine) and BMI for post-operative oxygenation (PaO₂ /FiO₂ > 350, Horowitz index). The results showed that although the mean rocuronium amount used by patients who were administered sugammadex was higher, oxygenation was better for them than neostigmine.

In literature, we found no randomised, controlled study on the effect of sugammadex on post-operative oxygenation. Sugammadex has recently entered anaesthetic practice and is an agent that very rapidly and reliably reverses neuromuscular blockade caused by rocuronium and vecuronium. Comparison studies with neostigmine showed that the time taken to reach a TOF of 0.9 was much shorter in patients who were administered sugammadex.^{25,26} In our study, the time taken to reach a TOF of 0.9 was 180 and 268 seconds in the sugammadex and neostigmine groups, respectively, while the recovery durations were measured 11 and 26 minutes, respectively. However, even if the reversal of the muscle-relaxing effect is clinically identified in patients, there may be partial blockage of receptors at the nerve muscle junction by muscle relaxant agents. This situation is known as post-operative residual curarisation (PORC). Although in previous years, values of the TOF response below 0.7 were accepted as the threshold value for PORC, with the publication of studies showing that this level may not

fully reverse the protective reflexes in the upper airway (such that the aspiration risk is high), the threshold value for TOF has been accepted as 0.9.²⁷ Gaszynski et al.,^[28] in a study on sugammadex and neostigmine use in obese patients, measured the times taken to reach a TOF of 0.9 as 2 minutes 44 seconds and 9 minutes 37 seconds, respectively, while the TOF values of the same patients in the PACU were measured as 109.8% and 85.5%, respectively. They stated that these results showed that neostigmine use does not prevent the occurrence of PORC in obese patients and may cause some side effects. As a result, we believe that the better oxygenation achieved in patients who were administered sugammadex in our study may be due to the occurrence of PORC in patients who were administered neostigmine.

In our study, most of the patients (78.9%) were women, which may be due to morbid obesity generally being observed at higher rates among women.²⁹ A study by Kolutkin et al.³⁰ showed that there is a higher rate of female patients undergoing obesity surgery. They considered that this situation may be due to more women applying for surgery to resolve obesity, or to the fact that morbid obesity is observed at higher rates in women.

During the post-operative period, for the measurement of spirometry or respiratory muscle strength, it is necessary that patients have full palliation of pain. In our study, in the first 72 hours, post-operative consumption of tramadol [mean IV dose, 424 mg (range: 258-522 mg)] occurred. Despite tramadol infusion, patients with VAS pain scores > 4 were given 10 mg/kg paracetamol IV according to CBW. In all patients, spirometric and muscle strength measurements were completed in accordance with ATS criteria.

The current study had its limitations as well. Due to high cost, radiologic tests were not completed on these patients for post-operative atelectasis and other respiratory complications. This represented the most significant limitation of our study. Another limitation was that TOF monitoring was not used to check post-operative PORC.

However, the most important feature of our study was that it was novel as a literature search identified no study showing the effect of sugammadex on post-operative respiratory function.

Conclusion

Impairment of respiratory function was found during the early post-operative period in patients undergoing laparoscopic bariatric surgery. In these patients, early awakening and recovery from anaesthesia may be

beneficial for respiratory function. Sugammadex is a very new agent. More randomised, controlled studies using different doses of sugammadex, and including larger samples, are required in the future to illustrate the effects of this agent on post-operative respiratory function.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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