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ORIGINAL CONTRIBUTIONS

Can We Predict the Perioperative Pulmonary Complications Before Laparoscopic Sleeve Gastrectomy: Original Research

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Abstract
Background The increasing prevalence of obesity in worldwide is one of the most serious chronic public health problems and is considered to be a global epidemic. Bariatric surgical procedures have also been applied more often with increased prevalence of obesity. As a result, the incidence of surgical complications has increased. Preoperative evaluation is quite important for these patients.
Aims The aim of our study is to determine the predictors of perioperative pulmonary complications of laparoscopic sleeve gastrectomy.
Study Design The study is a cross-sectional study.
Methods One hundred eighty-three consecutive patients who received laparoscopic bariatric surgery were followed up during 3 months. Patients were divided into two groups A and B. Group A being the patients who had perioperative pulmonary complications (n = 28) and group B being patients who had not (n = 155). Pulmonary function test (PFT), body mass index (BMI), preoperative oxygen saturation, age, gender, comorbid diseases, and smoking history were compared between these groups.
Results Mean age, size, weight, BMI, PFT parameters of groups A and B were close to each other. The strongest predictors of perioperative pulmonary complications were duration of smoking in current smokers and low baseline oxygen saturation.
Conclusions Preoperative oxygen saturation and smoking history may help to predict perioperative complications of laparoscopic sleeve gastrectomy.

Keywords Obesity · Pulmonary function test · Saturation · Perioperative · Complication

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Introduction

Morbid obesity is acknowledged as one of the most significant health problems throughout developed countries during the last 30 years, and bariatric surgery is considered its most effective means of treatment [1].

Types of bariatric surgery include the following procedures: sleeve gastrectomy, gastric band, gastric by-pass, and biliopancreatic diversion with duodenal switch. The surgical techniques can vary considerably in their level of difficulty and can accordingly have variable immediate post-operative and long-term results [2]. The use of laparoscopic sleeve gastrectomy (LSG) for the treatment of super morbid obesity was

first reported back in 2003 by Regan et al. as the first step of a two-stage surgical strategy [3]. Since then, it has evolved as a safe and effective independent surgical option for the treatment of morbid obesity, characteristics that have made it popular both among patients and surgeons [4].

It is known that obesity already in itself increases the risk of perioperative complications. In order to minimize these risks, detailed preoperative evaluation is usually performed. Chest X-ray and pulmonary function tests (PFTs) are routinely performed before major surgeries especially in the obese for bariatric operations, but their predictive value is unknown.

In our surgery department, our surgeons have been mostly using LSG for the treatment of morbid obesity since 2008. The aim of our study was to investigate the predictors of perioperative pulmonary complications in laparoscopic sleeve gastrectomy patients.

Methods

The study population consisted of 183 consecutive morbidly obese patients who had a LSG operation performed between 2008 and 2015. Age, gender, BMI, and preoperative oxygen saturation were recorded for all patients. Smoking history and comorbid diseases were also sought. Perioperative pulmonary complications including postoperative 3 months were recorded.

Spirometry was performed in a sitting position using a dry rolling spirometer (PFT 2450 system; Spire, Zan). FVC, FEV1, FEF 25–75, PEF and MEF 25–75 were measured. The pulse oximeter used was a wireless Philips M1020A pulse oximetry module.

Analysis

Patients were divided into two groups: those who developed perioperative pulmonary complications (group A) and those who did not (group B). Continuous variables were compared between these groups using the *t* test, and categorical variables were compared using the chi-squared test.

Results

Twenty-eight patients had one or more pulmonary complications in the perioperative period. (Table 1). The most common pulmonary complication was atelectasis (n = 26, 14.2%), followed by pleural effusion (n = 20, 10.9%), type 1 acute respiratory failure (ARF) (n = 10, 5.4%), pneumonia (n = 8, 4.3%), and pulmonary embolism (n = 2, 1.09%). One patient died due to pulmonary embolism (0.54%) (Table 2).

Patients who had pulmonary complications were older (40 ± 11.4 versus 36.6 ± 11.5 years, P = 0.14) and had a higher BMI (47.33 ± 11.3 kg/m2 versus 46.56 ± 8.53 kg/m2, P = 0.67). Yet, there was no statistical significance in terms of age and BMI. They were also more likely to be female, although this difference was not significant. There were no significant differences between the two groups in prevalence of asthma, diabetes mellitus, sleep apnea, hypertension, hyperlipidemia, and gender. Although group A patients had lower FEV1, FVC, FEV1/FVC, MEF25/75, and PEF (2.71 ± 0.91 lt, 3.5 ± 1.06 lt, 78.14 ± 10.4, 7.79 ± 26.3, 75.18 ± 24) than those in group B (2.89 ± 0.74 lt, 3.6 ± 0.88 lt, 80.2 ± 7.7, 76.8 ± 22.6, 75.10 ± 18.5), these differences were not statistically significant.

Table 1 Features of patients with/without pulmonary complications

Features	Patients without pulmonary complications (n = 155) mean ± SD	Patients with pulmonary complications (n = 28) mean ± SD	P
FVC LT	3.6 ± 0.88	3.5 ± 1.06	0.57
FVC%	98.32 ± 14.9	97.39 ± 16	0.76
FEV1 LT	2.89 ± 0.74	2.71 ± 0.91	0.24
FEV1%	92.11 ± 14.6	89.71 ± 20.8	0.45
FEV1/FVC	80.2 ± 7.7	78.14 ± 10.4	0.20
PEF	75.10 ± 18.5	75.18 ± 24	0.98
MEF25/75	76.8 ± 22.6	71.79 ± 26.3	0.29
BMI	46.56 ± 8.53	47.33 ± 11.3	0.67
Age	36.6 ± 11.5	40 ± 11.4	0.14
Gender (female/male)	113/42	21/7	0.8
Smoking history (p/y)			
Current	2.4 ± 6.8	6 ± 11.3	0.02
Ex-smoker	5.4 ± 2.1	7.2 ± 3.8	0.09
Saturation	97.27 ± 1.5	95.89 ± 2.2	0.00
Comorbidities			
Asthma	16.0%	19.4%	0.43
Diabetes Mellitus	29.3%	30.1%	0.82
Hypertension	31.2%	32.4%	0.75
Hyperlipidemia	32.5%	34.8%	0.50
OSAS	21.1%	23.6%	0.12

OSAS obstructive sleep apnea syndrome

Table 2 Postoperative pulmonary complications

Complications	Number	Percent
Atelectasis	26	14.2
Pleural effusion	20	10.9
Pneumonia	8	4.3
Pulmonary embolism	2	1.09
Death	1	0.005

Preoperative oxygen saturation was significantly lower in group A, compared to group B (95.89 ± 2.2 versus 97.27 ± 1.5, $P = 0.00$), while current pack year smoking was significantly higher in group A (6 ± 11.3 versus 2.4 ± 6.8, $P = 0.02$).

Discussion

To our knowledge, this is the first study which has investigated the predictors of perioperative pulmonary complications of laparoscopic bariatric surgery. Previous studies have investigated complications in open procedures [5] or both open and laparoscopic [6].

In our study, we found the prevalence of all respiratory complications and ARF was 15.3 and 5.4%, respectively. Respiratory complications were more common in those with BMI over 47.33 kg/m2. Blouw et al. found the rates of respiratory failure and total postoperative complications as 8% in the group with a BMI of 43 or less and 14% in the group with a BMI of more than 43. Blouw et al. used Roux-en-Y gastric bypass procedure, while ours was LSG. Because of longer surgery time and more complicated procedure, complication rates are also higher in Roux-en-Y compared to LSG. In a retrospective review of the the National Inpatient Sample database that included 304,515 patients undergoing a bariatric operation, the overall rate of ARF was 1.35% [7]. The incidence was higher with an open procedure compared with a laparoscopic procedure (3.87 versus 0.94%). The incidence of ARF in our study was higher compared with this review. In our clinic, LSG has been applied to a small number of patients compared to these studies. The reason for this may be high clinical experience of these centers.

We found no correlation between perioperative pulmonary complications and preoperative PFT. Huisstede et al. found a relationship between airway obstruction (FEV1/FVC < 70%) and subsequent complication [8]. It should be noted that Huisstede et al. had evaluated not only pulmonary complications but also surgical complications.

Cawley and coworkers in a large cohort study showed that subjects with obesity-related comorbidities prior to bariatric surgery were at significantly elevated risk of postsurgery complications [9]. In contrast, in our study, presurgical obesity-related comorbidities such as diabetes mellitus, hypertension, hyperlipidemia, or obstructive sleep apnea syndrome (OSAS) were unrelated with complications. But in our study, we have evaluated only pulmonary complications. This may be the reason for these differences.

Postoperative atelectasis was detected in a total of 26 patients (14.2%); 20 patients had atelectasis associated with an adjacent pleural effusion. The remaining six were simple and resolved with respiratory physiotherapy. Eight of the 20 patients identified with pleural effusions were secondary to abdominal complications. Subphrenic abscess was seen in three patients and anastomosis leak was seen in five patients. The remaining 12 pleural effusions were left-sided, simple, and secondary to diaphragm irritation due to abdominal surgery. Pleural effusion is frequently seen following elective abdominal surgery and has no clinical significance in most patients. Most of the cases of postoperative pleural effusions are self-limited, resolving without symptoms. Thoracentesis was performed on four of the patients with pleural effusion. Bronchoscopy was performed to one patient because of secretions. Chest X-ray is being performed only for symptomatic postoperative patients in our clinic. Some studies have reported that atelectasis arises at the time of induction of anesthesia in all patients but only persists in the postoperative period in obese [10]. Baltieri L et al. found that the prevalence of postoperative atelectasis after bariatric surgery was 25% [11]. In this study, laparotomic bariatric surgery was analyzed and postoperative chest radiograph was performed on all patients, potentially resulting in a higher prevalence compared to our study. For patients without abundant secretions, continuous positive airway pressure may be beneficial for coping with atelectasis. For patients with abundant secretions, chest physiotherapy and suctioning are appropriate. Some patients with abundant secretions may also benefit from bronchoscopy.

A total of three patients died postoperatively (1.64%). One of them died due to leakage in the anastomotic region, one of them died due to sepsis secondary to intraabdominal abscess, and one of them died due to pulmonary embolism; even though, we routinely provide DVT prophylaxis to our patients. None of them had smoking history, but all of them were diabetic. Our mortality rate of 3/183 (1.64%) is high; it is generally regarded as 0.08–0.3% [12, 13]. This may be associated with clinical experience. PE occurred in two of our patients and one of them died. PE remains the most common cause of mortality in the perioperative period after bariatric surgery and accounts for approximately 30 to 50% of deaths [14, 15]. The mortality rate of a pulmonary embolism is dependent upon the severity of presentation and time to diagnosis/treatment and widely varies from 1 to 95% [16]. The majority of deaths occur within the first one to 2 h after the embolism. For patients undergoing bariatric surgery, perioperative pharmacologic (e.g., low molecular-weight heparin, unfractionated heparin) and mechanical thromboprophylaxis to prevent venous thromboembolism should be recommended and patients should be encouraged to ambulate as soon as possible.

All patients attended our chest diseases outpatient clinic for preoperative assessment by physical examination, specific questioning on respiratory symptoms, PFT, chest X-Ray, and oxygen saturation. We stratify as high risk to surgery in

the presence of the following situations: any complaints associated with respiratory system, abnormal physical examination, oxygen saturation under 90%, FEV1 under 70%, or current heavy smoker. Bronchodilator therapy is initiated to patients with airway obstruction, diagnostic polysomnography is recommended to patients with sleep apnea symptoms, and heavy smokers are directed to smoking cessation clinics. Two weeks later, patients are reassessed for preoperative evaluation and being granted for surgery if conditions became suitable. On failure of improvement, final decision is left to the patient after being fully informed about relevant risks and possible complications. Only a minority of patients withdraw from surgery because of the perceived. Treatment to reduce the risk of postoperative pulmonary complications begins prior to surgery. Potential preoperative strategies include cigarette cessation, optimization of underlying chronic lung disease, and patient education. Antibiotics may be indicated for patients with lower respiratory tract infection as evidenced by purulent sputum or a change in the character of the sputum.

Current cigarette smokers have an increased risk of postoperative pulmonary complications, smoking cessation at least 4 weeks prior to surgery reduces the risk of postoperative complications, and longer periods of smoking cessation may be even more effective [17]. In a 2014 meta-analysis of 107 cohort and case-control studies, preoperative smoking was associated with an increased risk of postoperative complications, including pulmonary complications [18]. Smokers with a greater than 20-pack-year smoking history have a higher incidence of postoperative pulmonary complications than those with a lesser pack-year history [19]. In morbid obesity, fat accumulation around the abdomen and chest wall contributes to reduced lung volumes and respiratory system compliance. Breathing at lower lung volumes increases airway resistance, reduces respiratory system compliance, and promotes premature small airway closure, all of which increase work of breathing [20]. As a consequence, obesity may exacerbate the harmful effects of smoking on the lungs. In our study, an average of 6-pack-years current smokers had significantly higher respiratory complications. As a result, smoking history should be detailed in obese patients.

Arterial oxygen saturation assessed by pulse oximetry is now in such ubiquitous use that it has been called the "fifth vital sign" [21]. There are several studies investigating the reliability of this technique. The high accuracy of one widely used type of pulse oximeter at SaO2 values ranging from 82 to 94% was confirmed in a study of 100 patients; although, the accuracy of the instrument deteriorated at values outside these parameters [22].

Our study demonstrates that oxygen saturation and smoking history do predict perioperative pulmonary risk in morbidly obese patients undergoing laparoscopic sleeve gastrectomy. Knowing that a patient has a high risk preoperatively may alert the surgeon to take the necessary precautions.

Compliance with Ethical Standards

Financial Disclosure The authors declared that this study has received no financial support.

Conflict of Interest The authors declare that they have no conflict of interests.

Informed Consent Not applicable.

Ethics Committee Approval Ethics committee approval was received for this study from the local ethics committee of Kahramanmaraş Sutcu Imam University Faculty of Medicine.

References

1. Buchwald H, Oien DM. Metabolic/bariatric surgery worldwide 2011. Obes Surg. 2013;23(4):427–36.
2. Benedix F, Westphal S, Patschke R, et al. Weight loss and changes in salivary ghrelin and adiponectin: comparison between sleeve gastrectomy and roux-en-Y gastric bypass and gastric banding. Obes Surg. 2011;21(5):616–24.
3. Regan JP, Inabnet WB, Gagner M, et al. Early experience with two-stage laparoscopic Roux-en-Y gastric bypass as an alternative in the super-super obese patient. Obes Surg. 2003;13(6):861–4.
4. Menenakos E, Stamou KM, Albanopoulos K, et al. Laparoscopic sleeve gastrectomy performed with intent to treat morbid obesity: a prospective single-center study of 261 patients with a median follow-up of 1 year. Obes Surg. 2010;20(3):276–82.
5. Ogunnaike BO, Jones SB, Jones DB, et al. Anesthetic considerations for bariatric surgery. Anesth Analg. 2002;95:1793.
6. Al-Khyatt W, Thomas JD, Humes DJ, et al. Intestinal ischemia following laparoscopic surgery: a case series. J Med Case Rep. 2013;7:25.
7. Masoomi H, Reavis KM, Smith BR, et al. Risk factors for acute respiratory failure in bariatric surgery: data from the Nationwide Inpatient Sample, 2006-2008. Surg Obes Relat Dis. 2013;9:277.
8. Huisstede A, Ulas Biter L, Luitwieler R, et al. Pulmonary function testing and complications of laparoscopic bariatric surgery. Obes Surg. 2013;23:1596–603.
9. Cawley J, Sweeney MJ, Kurian M, et al. Predicting complications after bariatric surgery using obesity-related co-morbidities. Obes Surg. 2007;17(11):1451–6.
10. Eichenberger AS, Proietti S, Wicky S, et al. Morbid obesity and postoperative pulmonary atelectasis: an underestimated problem. Anesth Analg. 2002;95(6):1788–92.
11. Baltieri L, Santos LA, Rasere-Junior I, et al. Use of positive pressure in the bariatric surgery and effects on pulmonary function and prevalence of atelectasis: randomized and blinded clinical trial. Arg Bras Cir Dig. 2014;27(1):26–30.
12. Sanchez-Santos R, Masdevall C, Baltasar A, et al. Short- and mid-term outcomes of sleeve gastrectomy for morbid obesity: the experience of the Spanish National Registry. Obes Surg. 2009;19:1203–10.
13. Rosenthal RJ, International Sleeve Gastrectomy Expert Panel, Diaz AA, et al. International sleeve gastrectomy expert panel consensus statement: best practice guidelines based on experience of >12,000 cases. Surg Obes Relat Dis. 2012;8:19.

14. Melinek J, Livingston E, Cortina G, et al. Autopsy findings following gastric bypass surgery for morbid obesity. Arch Pathol Lab Med. 2002;126:1091.
15. Podnos YD, Jimenez JC, Wilson SE, et al. Complications after laparoscopic gastric bypass: a review of 3464 cases. Arch Surg. 2003;138:957.
16. Janata K, Holzer M, Domanovits H, et al. Mortality of patients with pulmonary embolism. Wien Klin Wochenschr. 2002;114:766.
17. Wightman JA. A prospective survey of the incidence of postoperative pulmonary complications. Br J Surg. 1968;55:85.
18. Grønkjær M, Eliasen M, Skov-Ettrup LS, et al. Preoperative smoking status and postoperative complications: a systematic review and meta-analysis. Ann Surg. 2014;259:52.
19. Warner MA, Divertie MB, Tinker JH. Preoperative cessation of smoking and pulmonary complications in coronary artery bypass patients. Anesthesiology. 1984;60:380.
20. Behazin N, Jones SB, Cohen RI, et al. Respiratory restriction and elevated pleural and esophageal pressures in morbid obesity. J Appl Physiol. 1985;108:212.
21. Neff TA. Routine oximetry. A fifth vital sign? Chest. 1988;94:227.
22. Chiappini F, Fuso L, Pistelli R. Accuracy of a pulse oximeter in the measurement of the oxyhaemoglobin saturation. Eur Respir J. 1998;11:716.