

Relationship between Preoperative Pulmonary Function Test Parameters and Postoperative Pulmonary Complications in Laparoscopic Obesity Surgery

Laparoskopik Obezite Cerrahisinde Preoperatif Solunum Fonksiyon Testi Parametreleri ile Postoperatif Pulmoner Komplikasyonlar Arasındaki İlişki

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ÖZ

Amaç: Laparoskopik obezite cerrahisinde preoperatif spirometrinin değeri tartışmalı bir konudur. Çalışmamızın amacı, preoperatif solunum fonksiyon testleri (SFT) ile postoperatif pulmoner komplikasyonlar arasındaki ilişkiyi araştırmaktır.

Araçlar ve Yöntem: Çalışmaya İzmir'deki bir eğitim ve araştırma hastanesinde bariatrik cerrahi öncesinde göğüs hastalıkları bölümünde değerlendirilen 73 hasta dahil edildi. Demografik veriler, SFT verileri ve postoperatif pulmoner komplikasyonlar retrospektif olarak analiz edildi.

Bulgular: On yedi hastanın (%23.3) preoperatif SFT'sinde anormal pulmoner fonksiyon paterni saptandı ve 7 hastada ise (%9.6) postoperatif pulmoner komplikasyon izlendi. Yaş, cinsiyet, cerrahi süresi ve anormal pulmoner fonksiyon paternlerinin komplikasyon gelişiminde anlamlı faktörler olduğu bulundu (sırasıyla, $p=0.026$, 0.047 , 0.004 ve 0.024). Çok değişkenli analizde, cerrahi süresi komplikasyonlarla ilişkili bulundu ($p=0.009$).

Sonuç: Bu bulgular, preoperatif SFT'de anormal pulmoner fonksiyon paternine sahip hastaların postoperatif komplikasyon riskinin artabileceğini göstermektedir. Bu bağlamda, bariatrik cerrahide preoperatif SFT değerlendirmesi, özellikle komplikasyon riski daha yüksek olan hastalar için cerrahi ve postoperatif izleme kararlarını etkileyebilir.

Anahtar Kelimeler: laparoskopik bariatrik cerrah; pulmoner komplikasyonlar; preoperatif; spirometri

ABSTRACT

Purpose: The value of preoperative spirometry in laparoscopic obesity surgery is a subject of debate. The aim of our study is to investigate the relationship between preoperative pulmonary function tests (PFT) and postoperative pulmonary complications.

Materials and Methods: The study included 73 patients who were evaluated in the pulmonology department before bariatric surgery at a training and research hospital in Izmir, Turkey. Demographic data, pulmonary function, and postoperative complications were retrospectively analyzed.

Results: Seventeen patients (23.3%) had abnormal preoperative PFT results, while postoperative complications occurred in 7 patients (9.6%). Age, gender, surgery duration, and abnormal pulmonary function patterns were found to be significant factors in the development of complications ($p=0.026$, 0.047 , 0.004 , and 0.024 , respectively). In multivariate analysis, surgery duration was identified as statistically significant in relation to complications ($p=0.009$).

Conclusion: These findings suggest that patients with abnormalities in preoperative PFT may have an increased risk of postoperative complications. In this context, preoperative PFT assessment in bariatric surgery could influence surgical and postoperative monitoring decisions, especially for patients at higher risk of complications.

Keywords: laparoscopic bariatric surgery; preoperative; pulmonary complications; spirometry

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INTRODUCTION

Obesity is a significant public health concern and is linked to an elevated risk of cardiovascular diseases, diabetes, and other chronic conditions.¹ It is estimated that 600 million people worldwide have a Body Mass Index (BMI) over 30 kg/m².² As the global population increases, it grows by 2.5 people every second, and one of these 2.5 individuals is projected to be overweight or obese.³

Extensive research has confirmed the link between obesity and cardiovascular as well as metabolic diseases.^{4,5} Recently, however, there has been a heightened focus on the association between obesity and respiratory conditions, with evidence suggesting that obesity can lead to reduced lung function.⁶

Bariatric surgery is increasingly being performed, not only to control obesity but also to manage related comorbidities. In this context, bariatric surgery, while crucial in treatment, may contribute to increased mortality and morbidity in patients due to associated pulmonary function loss. The role of preoperative spirometry in laparoscopic bariatric surgery remains a subject of debate. Some studies have indicated that abnormal spirometric values may correlate with postoperative complications;^{7,8} while others suggest that spirometry findings are linked to complications predominantly in patients with obstructive sleep apnea syndrome (OSAS).⁹

Thus, the preoperative preparation of these patients should be approached with a multidisciplinary plan to anticipate potential complications. The goal of our study is to explore the relationship between respiratory function tests in preoperative preparation and their role in predicting postoperative mortality and complication risk.

MATERIALS and METHODS

Study Population

Approval for this study was obtained from the Health Research Ethics Committee of S. B. Ü. İzmir Bozyaka Training and Research Hospital (dated 03.04.2024 and numbered 2024/09). All procedures performed in studies involving human participants were carried out in accord-

ance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study included consecutive patients who underwent a preoperative screening program for bariatric surgery at a training and research hospital in İzmir, Turkey, between July 2021 and June 2024. Prior to surgery, all patients scheduled for bariatric surgery were referred to the pulmonology department. Patients who underwent a pulmonary function test within 30 days before surgery were included, whereas those with incomplete clinical data or invalid spirometry results were excluded.

Clinical records were retrospectively reviewed at a single center, analyzing demographic characteristics such as age, gender, and BMI; smoking history; chronic diseases; respiratory symptoms; preoperative pulse oximetry values, ARISCAT risk score, spirometry results (FEV1, FVC, and FEV1/FVC); and postoperative complications and in-hospital mortality.

Height and weight were measured with light clothing and without shoes. BMI was calculated by dividing weight (in kilograms) by height (in meters squared).¹⁰

Spirometry was conducted for all patients by a certified spirometry technician in the pulmonology clinic. The results were interpreted according to the American Thoracic Society criteria as follows:¹¹ an FEV1/FVC ratio of less than 70% of the predicted value was classified as an obstructive pattern. A restrictive pattern was defined as an FVC of less than 80% of the predicted value with a normal FEV1/FVC ratio, and a mixed pattern was defined as the combination of both. The impact of spirometry abnormalities on the development of postoperative pulmonary complications was subsequently evaluated.

The ARISCAT Score for postoperative pulmonary complications was calculated using age, preoperative saturation, respiratory infection in the last month, preoperative anemia (Hgb ≤ 10 g/dL), surgical incision, duration of surgery, and emergency procedure.¹²

In our seven cases with complications, major and minor complications were classified as follows: prolonged

oxygen requirement (n=2) and post-operative atelectasis (n=2) were classified as minor complications, while respiratory failure requiring non-invasive (n=1) or invasive mechanical ventilation (n=2) and cases requiring intensive care unit admission were defined as major complications.

All patients were monitored for complications throughout their hospital stay, upon discharge, and at the postoperative follow-up visit 30 days after surgery.

Statistical Analysis

Statistical analysis was conducted based on variable scaling using IBM SPSS® Statistics version 23.0 (Chicago, IL) and MedCalc version 22.018. G-power analysis estimated a minimum sample size of 58 with a power of 0.90, a margin of error of 0.10, and an effect size of 0.45 in the G-Power 3.1.9.2. program. The Kolmogorov-Smirnov test was used to assess the normality of continuous data. Patient characteristics were presented as mean (SD), median (IQR), or as counts and percentages of the total. Multiple logistic regression analysis was used to assess the relationship between factors and the postoperative complications. The relationship between spirometry variables (%FEV1, FVC, and FEV1/FVC) and complications was investigated using ROC analysis, with the optimal cut-off value determined by the Youden index. Area under the ROC curve (AUC) values for the curves that were statistically different from the null line were then compared. A p-value of ≤ 0.05 (5%) was considered significant for a two-tailed comparison (type I error). A 95% confidence interval (CI) was calculated for all odds ratios.

RESULTS

A total of 73 patients who underwent bariatric surgery were analyzed. The mean age of the patients was 42 ± 10.55 years, and the majority were female (n=56, 76.7%). The median duration of surgery for the patients was 129 [29] minutes. The majority of patients had at least one comorbid disease (n=54, 74%). In six patients (8.2%), the accompanying disease was OSAS. In the

evaluation of respiratory function tests, 17 patients (23.3%) displayed abnormalities in preoperative testing. Specifically, an obstructive pattern was observed in 5 patients (6.8%), a restrictive pattern in 8 patients (11%), and a mixed pattern in 4 patients (5.5%). Complications were noted in 7 patients (9.6%), including 3 (4.1%) classified as major and 4 (5.5%) as minor. In-hospital mortality was reported in 2 patients (2.7%).

In univariate analysis, age, gender, duration of surgery, and the presence of an abnormal respiratory function pattern (obstructive, restrictive, or mixed) were found to be associated with complications ($p=0.026$, 0.047 , 0.004 , and 0.024 , respectively). The characteristics of the patients and their association with complications are summarized in Table 1.

The relationship between spirometry parameters and complications was examined using ROC analysis, yielding AUC (95% CI) values as follows: %FEV1, 0.69 (0.57-0.79); %FVC, 0.70 (0.58-0.80); FEV1/FVC, 0.55 (0.43-0.67); and duration of surgery, 0.83 (0.72-0.91) (Figure 1).

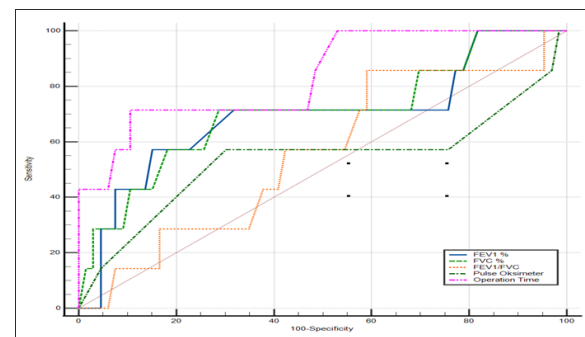


Figure 1. Comparison of ROC curves on postoperative mortality

Variables identified as statistically significant in univariate analysis were further assessed in multivariate analysis. When examining the relationship between age, duration of surgery, spirometry, and complications, only the duration of surgery remained statistically significant in multivariate analysis ($p=0.92$, 0.009 , and 0.092 , respectively) (Table 1).

Table 1. Characteristics of patients and association with complications by univariate and multivariate analysis.

Characteristic		Univariate analysis	Multivariate analysis	
		p value	HR(CI)	p value
Age	42 ±10.55	0.026	0.99 (0.90-1.09)	0.93
Gender				
Female	56 (76.7)	0.047		
Smoking History				
Current smoker	33 (45.2)	0.54		
Never smoked	28 (38.4)			
Former smoker	12 (16.4)			
Smoking (pack/year)	7.5 [5]	0.94		
Comorbidity				
Yes	54 (74)	0.59		
OSAS	6 (8.2)	0.099		
Respiratory Function Test				
Normal	56 (76.7)	0.024	6.39 (0.73- 55.36)	0.092
Obstructive	5 (6.8)			
Restrictive	8 (11)			
Mixed	4 (5.5)			
Pulse Oximeter (%)	97 [3]	0.75		
ARISCAT Risk Score	31 [0]	0.093		
FVC (L)	2.99 [1.08]	0.64		
FVC (%)	90 [15]	0.076		
FEV1 (L)	2.63 (0.70)	0.40		
FEV1 (%)	88 [17]	0.095		
FEV1/FVC	84 [7.5]	0.63		
Duration of Surgery	129 [29]	0.004	0.94 (0.91-0.98)	0.009
Complication	7 (9.6)			
Major	3 (4.1)			
Minor	4 (5.5)			
In-hospital mortality	2 (2.7)			

*If the data show a normal distribution, they are presented as mean (SD); if not, as median [25-75]. Categorical variables are presented as counts (percentage of the total).

*OSAS: obstructive sleep apnea syndrome, FVC: forced vital capacity, FEV1: Forced Expiratory Volume in 1 second.

DISCUSSION

This study indicates that abnormalities in pulmonary function tests (PFT) may be linked to a higher risk of postoperative complications in morbidly obese patients undergoing laparoscopic bariatric surgery. Although our findings weren't confirmed in multivariate analysis due to the limited sample size, there is a potential association between preoperative PFT abnormalities and postoperative complications.

Obesity is closely connected to various respiratory issues, including effort dyspnea, OSAS, obesity hypoventilation syndrome, chronic obstructive pulmonary disease (COPD), asthma, pulmonary embolism, and aspiration pneumonia.¹³ These conditions increase the likelihood of pulmonary complications after surgery, such as atelectasis, pneumonia, and acute respiratory failure.¹⁴ While bariatric surgery remains the most effective long-term treatment for severe obesity, obesity's link with respiratory diseases can lead to serious complications. Accurately predicting postoperative pulmonary risks would enable high-risk patients to receive specialized monitoring and care. For this reason, it's essential to identify predictors of pulmonary complications.

During the era of open bariatric surgery, pulmonary function tests were valuable in predicting postoperative complications. Various studies have shown that values such as FEV1 < 80% and FEV1/FVC < 70% may increase the risk of postoperative complications.^{8,9,15} However, the American College of Physicians guidelines do not recommend the routine use of preoperative spirometry.¹⁶ Although studies on preoperative spirometry have yielded varied results, the accessibility of spirometry as a test and the strong association observed between abnormal spirometry results and pulmonary complications suggest that spirometry could serve as a predictor for pulmonary complications. More comprehensive reviews and meta-analyses are needed to confirm spirometry's predictive value.

In open bariatric surgeries, the connection between preoperative spirometry and postoperative complications is more evident, while its necessity in laparoscopic procedures remains uncertain. This study explores this question. Although our study population is limited, it provides indications regarding the potential use of spirometry in assessing postoperative risk. Moreover, evidence suggests that individuals with abnormal spirometry test

results have a threefold increased risk of complications following laparoscopic bariatric surgery.⁷ Knowing that a patient is at high risk before surgery may influence the surgeon's choice of procedure (open/laparoscopic) or decision to extubate the patient and may also serve as a prompt to extend monitoring time in the intensive care unit.⁸

In our study, the postoperative complication rate was 9.6%, which is relatively high compared to other studies reporting rates between 1.35% and 4.6%.¹⁷⁻¹⁹ Of the three patients with major complications, two required intubations for respiratory failure, while one was managed with non-invasive ventilation. In comparison with the literature, the postoperative complication rate in our study appears relatively high, which may be attributed to the small sample size. In a large multicenter study involving bariatric surgery, no distinction was made between laparoscopic and open surgical techniques, and pneumonia and respiratory failure were observed in 18.6% of the cases during the postoperative period²⁰. In another study investigating laparoscopic surgery, the rate of postoperative pulmonary complications was reported as 5.4%.²¹ Postoperative pulmonary complication rates vary significantly across study populations. Notably, one study reported that postoperative pulmonary complications in bariatric surgery were associated with a 50-fold increase in 30-day mortality (OR 47.1; 95% CI, 38.6–57.5; $p < 0.0001$).²² Therefore, accurately predicting pulmonary complications in the preoperative period is crucial for preventing adverse outcomes and reducing both morbidity and mortality. Given that PFTs are easily accessible and straightforward to perform, their use in preoperative evaluation may represent a cost-effective strategy.

Several factors have been identified as being associated with respiratory failure, including congestive heart failure, open surgical technique, chronic kidney failure, gastric bypass, peripheral vascular disease, male gender, age >50, history of alcohol abuse, chronic lung disease, diabetes mellitus, and smoking.¹⁹ These factors play a significant role in determining postoperative outcomes and may contribute to an increased risk of pulmonary complications, particularly in patients undergoing bariatric surgery. Additionally, the duration of surgery was

independently associated with complications in our analysis. However, while age and impairment in PFT were found to be statistically significant in univariate analysis in relation to post-operative pulmonary complications, this relationship was not detected in multivariate analysis. Nonetheless, the presence of obstruction, restriction, or mixed impairment in PFT showed a p -value close to 0.05 in the multivariate analysis. This suggests that if the sample size is increased, this difference might also reach statistical significance in multivariate analysis. Therefore, it is thought that future multicenter studies could more clearly reveal this difference.

Our study has certain limitations. First, the single-center and retrospective design was a primary limitation. The retrospective nature may introduce selection bias and limit the ability to establish causality. Second, due to the small sample size, the results cannot be generalized to the entire population. Additionally, the low number of pulmonary complications in our study did not allow for specific subgroup comparisons. To address these limitations, prospective, multicenter studies are needed to validate our findings and provide more robust evidence. We hypothesize that increasing the sample size would more definitively elucidate the relationship between PFT and post-operative pulmonary complications.

In conclusion, our study highlights the potential role of preoperative pulmonary function tests in assessing the risk of postoperative pulmonary complications in patients undergoing laparoscopic bariatric surgery. Despite the limited sample size, our findings suggest that abnormal preoperative spirometry results may be associated with a higher risk of postoperative complications. The study underscores the importance of a multidisciplinary approach in managing patients with respiratory risk factors, emphasizing that personalized surgical planning and extended monitoring may help mitigate these risks. Future large-scale studies are essential to establish spirometry as a routine predictive tool, optimizing patient outcomes and enhancing safety in bariatric procedures.

Conflict of Interest

The author declare that there is not any conflict of interest regarding the publication of this manuscript.

Ethics Committee Permission

Approval for this study was obtained from the Health Research Ethics Committee of S. B. Ü. İzmir Bozyaka Training and Research Hospital (dated 03.04.2024 and numbered 2024/09).

Authors' Contributions

Concept/Design: MAT. Data Collection and/or Processing: MAT. Data analysis and interpretation: MAT. Literature Search: MAT. Drafting manuscript: MAT. Critical revision of manuscript: MAT. Supervisor: MAT.

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