Change of respiratory functions, the STOP-Bang questionnaire, and Epworth sleepiness scale after bariatric surgery

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INTRODUCTION AND OBJECTIVE: *Obesity is a highly morbid and fatal syndrome that reduces respiratory function. Obstructive sleep apnea syndrome (OSAS) is a common sleep disorder in morbid obesity. Herein, we aimed to determine how respiratory function tests changed over time after bariatric surgery and to assess non-PSG (polysomnography) tests, namely STOP-Bang questionnaire and Epworth sleepiness tests, for predicting OSAS risk.*
METHOD: *This retrospectively conducted study enrolled 35 patients who underwent bariatric surgery. Patients were divided into three groups formed on the basis of time passed after surgery (1, 2, or 3 years). Preoperative and postoperative respiratory function test parameters assessed by spirometry, body mass index (BMI), STOP-Bang questionnaire, and Epworth sleepiness test scores were recorded.*
RESULTS: *Twenty-four (68.6%) patients were female, 11 (31.4%) male. The mean age was 36.5±10.5 years. Postoperative weight loss of the study groups was 26% p=0.001, 23.6% p=0.002 and 25.9% p=0.005. Reductions in BMI were 32 kg/m^2 p=0.001, 34.5 kg/m^2 p=0.002, 35.8 kg/m^2 p=0.005 respectively. Postoperative FVC (440 ml, 390 ml, 430 ml p = 0.005) and FEV1 (220 ml p = 0.005, 250 ml p = 0.004, 214 ml p = 0.005) increased in all three groups. STOP-Bang questionnaire and Epworth sleepiness scale scores significantly decreased after weight loss compared to preoperative period in all the study groups.*
CONCLUSION: *We showed that FVC and FEV1 increased in the short and long term after weight loss by bariatric surgery; we also found that STOP-Bang questionnaire and Epworth sleepiness scale scores decreased postoperatively. These tests may be helpful to assess OSAS risk before and after surgery.*

KEY WORDS: Bariatric surgery, Obesity, Respiratory functions, STOP-Bang questionnaire and Epworth sleepiness test

Introduction

World Health Organization defines obesity as an abnormal and excessive fat accumulation that impairs health. Obesity prevalence has doubled between 1980 and 2014 to become a major global health problem. As of 2014, approximately 13% of whole world population was obese (11% of men and 15% of women [1]. In the United States, obesity prevalence is 32% in men and 34% in women; in the United Kingdom it is 25% in both genders [2].
According to 2013 data of the Ministry of Health of Turkey, obesity prevalence is 30.3% among persons aged 19 years or older (20.5% in men, 41% in women) [3].
It is well known that obesity is linked to a number of conditions associated with morbidity and mortality, such as hypertension, diabetes mellitus, coronary heart disease, hyperlipidemia, obstructive sleep apnea, obesity hypoventilation syndrome, and asthma. Conditions with disordered sleep (e.g. OSAS and sleep associated hypoventilation) are very prevalent in morbid obesity [4,5].

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In obese persons, fat tissue that accumulates over the chest wall, abdominal region, and upper airway increases thoracic wall thickness resulting in an increased intrathoracic pressure and an upward diaphragm shift that reduces pulmonary compliance, which impair pulmonary functions. Additionally, systemic inflammation caused by adipose tissue leads to impaired respiratory function [6-8]. Studies in obese persons have shown improvements in respiratory functions following weight loss [9-13]. Obesity surgery has been performed by many centers using different techniques for weight loss. Among these techniques, laparoscopic sleeve gastrectomy is associated with a low mortality and morbidity risk and successful outcomes in terms of weight loss [14]. A sustainable and significant weight loss typically occurs after obesity surgery, with body weight being typically lowest in the first 1-2 years Postoperatively [15,16].

The aim of this study was to determine the changes in respiratory functions over time, and to assess non-polysomnography (PSG) methods, namely STOP-Bang questionnaire and Epworth sleepiness test for assessing OSAS risk in patients who underwent bariatric surgery at our center.

Methods

This study was designed in a retrospective fashion. A total of 58 patients were enrolled, who were operated with bariatric surgery with the "laparoscopic sleeve gastrectomy" technique between February 2012 and October 2015. A total of 35 patients remained in the final analysis (13 in 2013; 12 in 2014; and 10 in 2015) due to a change of address or city of residence.

Measurements and Recordings

Patient information was obtained from face-to-face questionnaires and medical records. Age, sex, height, operation date, time from operation, preoperative and postoperative weight, body mass index (BMI), total weight loss, smoking history (year packs), changes in symptoms in the preoperative and postoperative periods among patients with asthma obstructive sleep apnea syndrome (OSAS), medications, and changes in the use of noninvasive mechanical ventilation (NIV; CPAP or BIPAP) were recorded.

During the application of the STOP-Bang questionnaire and Epworth sleepiness tests, the patients were asked to answer the questions by considering their preoperative and postoperative symptoms. STOP-Bang questionnaire is typically used to evaluate OSAS during the preoperative assessment. In this test questions about snoring, fatigue, breathing interruption during sleep, and hypertension are asked in addition to questions about demographic properties like sex, BMI>35 kg/m2, age>50 years, and neck circumference > 40 cm. When three of eight questions are answered "yes", then the person is considered high-risk for OSA.S [17]

Epworth sleepiness scale is a test used to rate daytime sleepiness where the likelihood of a person to doze in certain circumstances in an ordinary day when he/she is not exhausted is assessed. It consists of 8 questions, each of which is given 0 to 3 points. The scoring method is the same for all questions, where a zero point is given when the patient never dozes; 1 point when there is a slight chance of dozing; 2 points when there is a moderate chance of dozing; and 3 points when there is a high chance of dozing. A total of 10 points or greater is considered significant for daytime sleepiness [18].

Preoperative and postoperative weights were recorded using a digital weighing machine; BMI was also calculated by dividing a patient's weight by height's square and had a unit of kg/m^2. According to the international classification of World Health Organization (WHO), a BMI equal toor greater than 30 kg/m^2 was defined as obesity (19). The indications for obesity surgery are a BMI≥35 with one or more comorbidities, or a BMI≥40 kg/m^2 [20]. All patients underwent bariatric surgery using laparoscopic sleeve gastrectomy.

Respiratory Function Tests

Respiratory function tests (RFT) were performed with the spirometric method (Vitalograph spirometer Zan, Messgeraete GmbH Germany) in compliance with the American Thoracic Society criteria [21]. The spirometry was automatically calibrated twice daily, and all tests were done by the same technician. The test was performed with the patient sitting comfortably. After the nose was sealed by a clip, the mouthpiece was placed between the teeth and lips. The patients were asked to breath comfortably. Then, they were asked to take a deep breath, followed by exhaling as rapidly and as forceful as possible. This was followed by a deep inspiration and the spirometry test was completed. This sequence was repeated for three times, with the test that was the most appropriate one according to the spirometry standardization guide taken for analysis. Forced vital capacity (FVC) and forced expiration volume at one second (FEV1) were measured and recorded. Airflow limitation was assessed on the basis of FEV1-FVC ratio. A FEV1-FVC ratio below 70% was defined as obstruction and ratio above 80% was defined as restriction.

Statistical Analysis

Study data were analyzed using SPSS 17.0 software package. Categoric variables were reported as number and percentage, and the continuous variables as mean and standard deviation (median and minimum-maximum as

needed). Categoric variables were compared using the Chi Square test or Fisher's exact test. Comparison of preoperative and postoperative measurements was performed using the dependent samples t test when the parametric test assumptions were met, or with the Wilcoxon test otherwise. Statistical significance was set al $p<0.05$ for all analyses.

Results

Out of 35 patients, 24 (68.6%) were female and 11 (31.4%) were male. Thirteen (37.1%) patients underwent surgery 1 year ago (Group 1) 12 (34.3%) 2 years ago (Group 2); and 10 (28.6%) 3 years ago (Group 3). The mean age of the whole study group was 36.5±10.5 years. Each group had similar properties in terms of sex, age, weight, height, and BMI at the preoperative period (Table I). Twenty-four (65.7%) patients had never smoked, and 9 (25.7%) were active smokers,with the mean smoking exposure being 15 packs/year.

The mean weight loss was 31.3 kg (24.6% of total body weight) for the female subjects and 32.2 kg (31% of total body weight) for the male subjects ($p>0.05$).

The mean weight loss after bariatric surgery was 30 kg (26% of total body weight) after the first year; 32.5 kg (23.6%) after the second year; and 35 kg (25.9%). There was a significant reduction in weight and BMI compared to the preoperative period. No significant inter-group difference was observed (Table II).

A temporal analysis of the three groups revealed that FVC (440ml, 390ml, 430ml, respectively, FEV1 (320ml, 250ml, 254ml, respectively $p=0.005$) significantly increased in the postoperative period compared to the preoperative values. No significant difference was noted in the FEV/FVC ratio and FEV1 and FVC values between the study groups. In all three groups the preoperative STOP-Bang questionnaire score was 3-5 and Epworth sleepiness scale score was about 5-6. There were significant drops in both questionnaire scores compared to the preoperative values (Table III).

We noted that 2 of 3 (5.7%) patients with a preoperative diagnosis of asthma had their asthma symptoms completely resolved and their need for inhaler medications completely eliminated while in one patient the number of medications was reduced. Similarly, 2 (8.5%) of OSAS patients (diagnosed by polysomnography) had their need for NIMV use eliminated after surgery.

Discussion

In the present study we detected a significant increase in respiratory function and drops in STOP-Bang questionnaire and Epworth sleepiness scale scores after weight loss by bariatric surgery (1, 2, and 3 years). There was no significant change in postoperative FEV/FVC ratio or inter-group FEV1 and FVC differences. Studies examining changes in pulmonary function within 2 years after bariatric surgery have reported 5-15% increase in FEV1

TABLE I - *Characteristics of obese patients prior to bariatric surgery*

	Total patients (n =35)		**Female (n=24)**		**Male (n=11)**	
Age (years)	34,7	± 10.5	37,2	± 10.2	37.7	± 11,7
Height (cm)	167.0	± 9.4	163.4	± 7.8	174.9	± 7.8
Weight (kg)	131,7	± 19.3	126.1	± 18.5	143	± 14.6
BMI (kg /m^2)	47.7	± 7.5	47.1	± 7,8	49.1	± 7.1

BMI: Body mass index, n=number of patients

TABLE II - Weight loss, body mass index (BMI) prior to and after bariatric surgery

Postoperative time (years)	**Group 1 (n =13)**		**Group 2 (N=12)**		**Group 3 (n=10)**		
	Median	**Min-Max**	**Median**	**Min-Max**	**Median**	**Min-Max**	**p**
Preoperativeweight(kg)	124	102-177	134	108-155	137	110-170	0.784
Postoperativeweight (kg)	88	114-142	97.5	80-144	97.5	75-132	0.413
p		0.000		0.002		0.005	
Postoperative weight loss (%)	26	3-42	23.6	1-31	25.9	13.3-36	0.525
p		0.001		0.002		0.005	
Preoperative BMI (kg/ m^2)	43	40-65	45.3	40-59.7	46.8	39-58	0.335
Postoperative BMI (kg/ m^2)	32	27-44	34.5	29-57.6	35.8	26.5-44.8	0.699
PostoperativeBMI(kg/m^2)loss%	25.5	27-65	23.8	29-60	23.5	26-58	
p		0.001		0.002		0.005	

BMI: Body mass index, n=number of patients, Min-Max: Minimum-Maximum

TABLE III - *Changes of respiratory function test parameters, STOP-Bang questionnaire score, and Epworth sleepiness test score (mean ±SD) prior to and after bariatric surgery in the whole study population (n=35)*

Postoperative time(years)	Group 1 (n =13)		Group 2 (n=12)		Group 3 (n=10)		
	Median	Min-Max	Median	Min-Max	Median	Min-Max	p
Preoperative FVC (L)	3.49	2-4.37	3.20	2.05-5.43	3.91	2.84-4.89	0.553
Postoperative FVC (L)	3.93	2.5-4.71	3.59	1.91-5.65	4.48	3.21-5.73	0.389
p		0.005		0,005		0,005	
Preoperative FEV1 (L)	3	1.78-4.00	2.75	1.31-4,41	2.96	2.07-3.84	0.920
Postoperative FEV1 (L)	3.32	2.17-4.36	3.09	1.24-4.8	3.25	2.54-4.59	0.595
p		0.005		0.004		0,005	
Preoperative FEV/FVC %	81	69-89	81.5	64-88	80	76-92	0.937
Postoperative FEV/FVC %	82	69-94	80.0	64-90	80	74-105	0.629
p		0.786		0.751		0.646	
Preoperative STOP-Bang score	4	2-7	3	2-6	5	2-7	2.76
Postoperative STOP-Bang score	0	0-3	0	0-3	1	0-4	0.547
p		0.001		0.002		0.005	
Preoperative Epworthsleepiness scale score	6	1-12	5	0-14	5.5	0-24	0.952
Postoperative Epworth sleepiness scale score	0	0-2	0	0-4	1	0-8	0.084
p		0.001		0.002		0.005	

FVC: Forced vital capacity, FEV 1: Forced expiratory volume at one second

and FVC; 190-330 ml increase in FEV1; and 280-700 ml increase in FVC [22-25]. Hewitt et al, in a study where long-term changes in pulmonary functions following bariatric surgery were studied, reported significant increase in FVC and FEV1 [26]. We also found significant increases in FVC and FEV1 three years after surgery.

It has been shown that fat mass accumulated in the upper part of the body and abdominal region in obese persons, resulting from an altered fat distribution, had a negative effect on airway function, mainly by exerting a mechanical pressure on the lungs; it has also been reported that lung function improved in persons with reduced BMI after weight loss [27,28]. Sütbeyazı et al showed a negative correlation between BMI and FVC, FEV1 values in obese individuals [29]. We showed a 23-26% weight loss and a reduction in BMI (24-26%, respectively) at the postoperative period in all three groups, and the amounts of weight loss and BMI reductions were statistically significant. There was, however, no significant differences between the groups in this regard (Table II). Sjöstrøm L, in a large-scale study, showed that maximum weight loss occurred in the first 1-2 years and plateaued after 10 years following obesity surgery [15]. We determined that weight loss continued in the patient group which was 3 years postoperative.

Nagappa M. et al showed that STOP-Bang questionnaire was a sensitive test for OSAS screening (likelihood of moderate-severe OSAS was proportional to higher scores) [30] .We showed a STOP-Bang score of at least 3 in all three groups. We also showed a significant drop in the postoperative score with weight loss. In two of our patients, whose OSAS diagnoses were confirmed by polysomnography, CPAP need was eliminated by weight loss. Therefore, we are of the opinion that STOP-Bang questionnaire may be useful for determining OSAS risk at the preoperative period and for risk monitoring after weight loss among obese persons.

Epworth sleepiness scale is a test used to rate daytime sleepiness. Its validity in Turkish language was tested, and its Turkish version was reported to be effective for rating daytime sleepiness thus offering a valuable method for clinical studies [31]. In our study each three groups had approximately 5-6 points in preoperative Epworth sleepiness scale and we found a statistically significant drop in these scores in the postoperative period. We can assume that our patients had not a high rate of daytime somnolence and that this was further eliminated after bariatric surgery. Epworth sleepiness scale can also be useful for determination OSAS risk and risk monitoring after weight loss.

Our study contributes to the existing literature by showing positive changes in respiratory functions after bariatric surgery, which has been more widely performed in Turkey in the last decade. Its limitations include its retrospective nature, the low sample size, and that OSAS diagnosis could not be verified by polysomnography. Despite these, our findings are in agreement with literature reports.

Conclusions

Our study showed that FEV1 and FVC levels increased in the short and long term following weight loss after bariatric surgery, which has been increasingly performed in our country and worldwide. STOP-Bang questionnaire and Epworth sleepiness test may be useful for the assessment of preoperative OSAS risk and its monitoring.

Riassunto

L'obesità è una sindrome altamente patologica e fatale che riduce la funzione respiratoria: l'apnea ostruttiva del sonno (OSAS) è un disturbo del sonno comune nell'obesità patologica. In questo studio sui è cercato di determinare come i test di funzionalità respiratoria sono cambiati dopo chirurgia bariatrica e di valutare i test non-PSG (polisonnografia), ovvero il questionario STOP-Bang e i test di sonnolenza Epworth, per prevedere il rischio di OSAS.

Nello studio retrospettivo sono stati arruolati 35 pazienti sottoposti a chirurgia bariatrica, suddivisi in tre gruppi formati sulla base del tempo trascorso dopo l'intervento chirurgico (1,2, o 3 anni). Sono stati registrati i parametri del test di funzionalità respiratoria preoperatoria e postoperatoria valutati mediante spirometria, indice di massa corporea (BMI), questionario STOP-Bang e punteggi del test di sonnolenza di Epworth.

Ventiquattro (68,6%) pazienti erano di sesso femminile, ed 11 uomini (31,4%). L'età media era di 36,5 ± 10,5 anni. La perdita di peso postoperatoria dei gruppi di studio è stata del 26% p = 0,001, del 23,6% p = 0,002 e del 25,9% p = 0,005 rispettivamente nei tre gruppi. Le riduzioni del BMI sono state di 32 kg / m2 (p= 0,001), 34,5 kg / m2 (p = 0,002), 35,8 kg / m2 (p = 0,005) rispettivamente. Il FVC postoperatorio (440 ml, 390 ml, 430 ml - p = 0,005) e FEV1 (220 ml p = 0,005; 250 ml - p = 0,004; 214 ml p = 0,005) è risultato aumentato in tutti e tre i gruppi. Il questionario STOP-Bang e il punteggio della scala di sonnolenza di Epworth sono diminuiti significativamente dopo la perdita di peso rispetto al periodo preoperatorio in tutti i gruppi di studio.

Si è così dimostrato che FVC e FEV1 sono aumentati nel breve e lungo termine dopo la perdita di peso mediante chirurgia bariatrica; abbiamo anche scoperto che il questionario STOP-Bang e il punteggio della scala di sonnolenza di Epworth sono diminuiti dopo l'intervento. Questi test possono essere utili per valutare il rischio di OSAS prima e dopo l'intervento chirurgico.

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