Effect of bariatric surgery on obstructive sleep apnea: using the STOP-Bang score as a screening tool

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Background
Obstructive sleep apnea (OSA), the most prevalent major sleep disorder in the world, has been associated with obesity. Besides reducing weight, bariatric surgery has been reported to improve OSA. Data on the effects of bariatric surgery on OSA are scarce in Egypt. This study aimed to evaluate the short-term effects of bariatric surgery on OSA.

Patients and methods
This is a prospective study that was conducted on patients who were candidates for bariatric surgery at our institution who completed the STOP-Bang questionnaire before the surgery with a score greater than or equal to 4 and underwent re-evaluation 6 months after surgery. All patients underwent a standardized clinical assessment. The 6-month follow-up data were recorded and analyzed.

Results
The present study included 30 patients, with a mean baseline BMI of 54.32±9.77 kg/m^2. The surgeries performed were Laparoscopic Sleeve Gastrectomy (LSG) (n=21, 70%) and Laparoscopic Roux en Y gastric bypass (LRYGB) (n=9, 30%). The mean baseline STOP-Bang score was 5.3±1.09. At the 6-month follow-up, the mean 6-month postoperative STOP-Bang score was 1.13±1.04 ($P<0.001$). No statistically significant differences were noted in the BMI or the STOP-Bang score before and after surgery according to the surgery type ($P>0.05$). There was a statistically significant positive correlation between the 6-month BMI reduction and the Snoring, Tiredness, Observed apnea, Pressure, BMI, Age, Neck, Gender (STOP-Bang) score improvement (r=0.397, P=0.0298).

Conclusion
This study demonstrated the bariatric surgery-initiated evident improvement and even complete resolution of OSA in patients with obesity, as measured by the STOP-Bang score.

Keywords:
bariatric surgery, obesity, obstructive sleep apnea, STOP-Bang score

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Introduction

Obesity is a global epidemic that is closely connected to several medical issues that have a significant negative impact on people's health [1]. Obstructive sleep apnea (OSA), the most prevalent major sleep disorder in the world with a frequency of between 9% and 38% in the general population, has been associated with obesity [2]. In patients with obesity, excess amounts of fat deposit in the upper respiratory tract and narrow it, resulting in a reduction in muscle activity. These alterations subsequently lead to episodes of hypoxia and apnea that ultimately progress to sleep apnea. Eventually, the oxygen amount that exists in the tissues and blood vessels of the body decreases, with a resultant tissue hypoxia that is a risk factor for atherosclerosis and cardiovascular disease [3].

For patients with clinically severe obesity who have not achieved acceptable weight loss through dietary changes and medication treatments, bariatric surgery is the most effective treatment [4]. Sleeve gastrectomy (SG) and Roux-en-Y gastric bypass (RYGB) have been recognized as the gold standard bariatric procedures [5]. Besides reducing weight, bariatric surgery helps a sizable percentage of individuals cure or improve their OSA [6]. Data on the effects of bariatric surgery on OSA, however, are scarce from Egypt. Therefore, this study aimed to evaluate the short-term effects of bariatric surgery on OSA.

Patients and methods

This is a prospective observational study that included patients who were recruited for bariatric surgery at our hospital during the period from February 2021 to July

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2022. The institutional review board approval was obtained before the initiation of the study. The study adhered to the Declaration of Helsinki.

The required sample size was calculated using the Clinical sample size calculator with a 0.05 alpha error and a power of 0.80. Based on the study of Ghiasi *et al.* [7], in which the STOP-Bang questionnaire score improved from 4.22±1.71 at baseline to 1.53±1.23 at the 6-month follow-up after surgery, the sample size calculation necessitated the inclusion of a minimum of 20 patients in the study.

All patients underwent the standardized clinical assessment, including detailed history-taking, anthropometric measurements, clinical examination by a multidisciplinary team, and routine laboratory investigations. The patients' eligibility for bariatric surgery at our institution was judged per the criteria proposed by the 1991 NIH consensus [8] and further established by the prominent organizations in the field of obesity and bariatric surgery [9–11].

Patients who completed the STOP-Bang questionnaire prior to surgery and had a score equal to or higher than 4 were included in the study if they underwent re-evaluation 6 months after surgery. Patients with chronic respiratory or cardiac diseases were excluded from the study. Each included patient provided an informed written consent.

In brief, the STOP-Bang questionnaire encompasses the assessment of whether the patients have an age greater than 50 years, male sex, a BMI greater than 35 kg/m^2, hypertension, snoring, tiredness, observed apnea, and a neck circumference greater than 40 cm. For each item, the patient scores 0 or 1 for the answer with 'no' or 'yes', respectively. The final score can range from 0 to 8. A cutoff score of greater than or equal to 3 has been used to diagnose OSA [12].

The bariatric procedure for each patient was selected according to the patients' choice after a dedicated discussion with the surgeon about the suitable options and the advantages and possible shortcomings of each choice.

The surgery was performed under general anesthesia. After the patient's preoperative preparation, the bariatric procedures were performed laparoscopically while the patient was lying in the reverse Trendelenburg position. The four-trocar and five-trocar techniques were followed when performing SG and RYGB, respectively. A Veress needle was used to achieve pneumoperitoneum (with 15 mmHg intra-abdominal pressure). A 10 mm laparoscopic liver retractor was routinely used to retract the left hepatic lobe.

For dissection and coagulation, an ultrasonic shear or sealer/divider was employed. The gastric sleeve was calibrated using a 36-French gastric bougie. With continually inserted linear staples directed directly at the angle of His, the gastric pouch creation began 4–5 cm proximal to the pylorus. A running suture was used to reinforce the staple line. During LSG and through the left flank trocar site, the resected stomach section was expelled from the peritoneal cavity.

To create a pouch for LRYGB, a horizontal 45 mm stapler had to be used first, then vertical staples had to be placed at the His angel until the gastric pouch was completely cut off from the remainder of the stomach. Using a linear stapler (The Covidien Endo GIA Universal Stapler. Medtronic, Irland), a gastrojejunal anastomosis was created, and the remaining defect was closed by manual sewing. All patients had typical lengths for the alimentary and bilio-pancreatic limbs of 150 and 100 cm, respectively. A linear stapler was used to make a jejunojejunal anastomosis. To avoid herniation, a standard 10- or 12 mm port site closure was carried out.

Given the potential respiratory challenges associated with OSA, especially in the postoperative period, we deemed it prudent not to apply the early recovery after bariatric surgery protocols for patients. Patients with OSA required vigilant intensive care unit postoperative monitoring to prioritize patient safety and optimal recovery.

After surgery, the study patients were motivated for early mobilization and received routine instructions concerning the diet, supplementation, and required medications. The state of OSA was re-evaluated using the STOP-Bang score [12]. â

Study outcomes

The primary outcome was the change in the STOP-Bang score at the 6-month follow-up after surgery, and the secondary outcome was the potential difference in the STOP-Bang score according to the type of surgery.

Statistical analysis

The data of the included patients were analyzed using version 28 of the SPSS statistical software (IBM Corp., Armonk, NY, USA). Numerical data were compared

using an independent *t*-test or a paired *t*-test, as appropriate. The paired comparison of categorical values (before and after surgery) was done using the McNemar test. A Pearson correlation test was used to test the correlation between the BMI and STOP-Bang score differences after surgery. A *P* value less than 0.05 was considered statistically significant.

Results

The present study included 30 patients who fulfilled the eligibility criteria during the study period. The patients had ages ranging from 24 to 61 years, with a mean of 37.4±11.3. The majority were females (*n*=25, 83.3%). The baseline BMI ranged from 40.3 to 81.9 kg/m^2, with a mean of 54.32±9.77. The surgeries performed were LSG (*n*=21, 70%) and LRYGB (*n*=9, 30%).

Evaluation of the baseline STOP-Bang score items revealed that five (16.7%) patients aged above 50 years, five (16.7%) patients were males, all the patients (100%) had a BMI higher than 35 kg/m^2, 12 (40%) patients had hypertension, 29 (96.7%) patients had snoring, all the patients (100%) had tiredness, 26 (86.7%) patients had observed apnea, and 25 (83.3%) patients had a neck circumference larger than 40 cm. The baseline STOP-Bang score ranged from 4 to 8, with a mean of 5.3±1.09.

At the 6-month follow-up, there was a statistically significant reduction in the BMI ($P<0.001$), ranging from 25.6 to 58.8 kg/m^2, with a mean of 37.98±7.76. The percentage of all positive items in the STOP-Bang score, apart from age and sex, showed a statistically significant reduction (Table 1). The 6-month postoperative STOP-Bang score ranged from 1 to 4, with a mean of 1.13±1.04, denoting a statistically significant improvement ($P<0.001$).

No statistically significant differences were noted in the BMI or the STOP-Bang score before and after surgery according to the surgery type ($P>0.05$) (Table 2).

Table 1 Comparison between items of STOP BANG score before and 6 months after surgery in all patients

	Before		After		
Item	Count	%	Count	%	*P*-value
Age>50 years					
Yes	5	16.7%	6	20.0%	1
No	25	83.3%	24	80.0%	
Sex (male)					
Yes	5	16.7%	5	16.7%	1
No	25	83.3%	25	83.3%	
BMI >35 kg/m^2					
Yes	30	100.0%	18	60.0%	< 0.001*
No	0	0	12	40.0%	
Hypertension					
Yes	12	40.0%	1	3.3%	0.001*
No	18	60.0%	29	96.7%	
Snoring					
Yes	29	96.7%	2	6.7%	< 0.001*
No	1	3.3%	28	93.3%	
Day tiredness					
Yes	30	100.0%	0	0	< 0.001*
No	0	0	30	100.0%	
Observed apnea					
Yes	26	86.7%	0	0	< 0.001*
No	4	13.3%	30	100.0%	
Neck circumference>40 cm					
Yes	25	83.3%	1	3.3%	< 0.001*
No	5	16.7%	29	96.7%	

There was a statistically significant positive correlation between the 6-month BMI difference and the STOP-Bang score difference (r=0.397, P=0.0298) (Fig. 1).

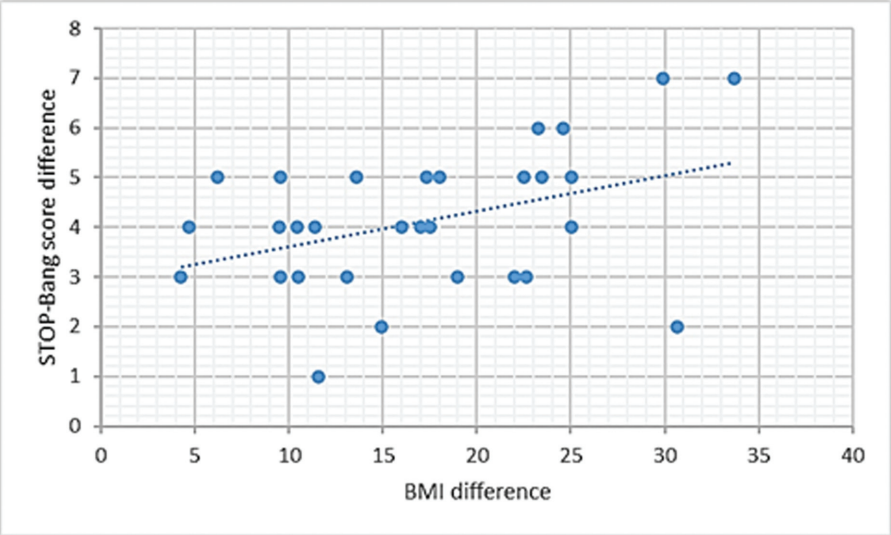
Discussion

Obstructive sleep apnea not only disrupts the quality of rest but also carries a substantial burden on overall health. Consequently, effective management strategies for OSA have garnered significant attention from the medical community. Being obviously linked with obesity, bariatric surgery has emerged as a potentially transformative intervention in the management of OSA. This surgical approach, which encompasses various procedures aimed at achieving substantial and sustained weight loss, has demonstrated profound effects on multiple comorbidities associated with obesity.

Table 2 Comparison of the BMI and total STOP-Bang score before and after surgery in according to the surgery type

	LSG Mean±SD	LRYGB Mean±SD	*P* value
BMI before	54.50±10.53	53.89±8.25	0.894
BMI after	38.52±8.38	36.73±6.32	0.594
P value	<0.001*	0.008*	
STOP-Bang score before	5.33±1.06	5.22±1.20	0.756
STOP-Bang score score after	1.14±1.06	1.11±1.05	1.000
P value	<0.001*	0.007*	

Figure 1



A significant positive correlation between the BMI reduction and the STOP-Bang score improvement.

Our findings emphasize the bariatric surgery effect on OSA, with remission or even complete resolution in all the included patients. This is consistent with the reported significant ameliorating effect of bariatric procedures on OSA symptoms [13–15]. Beyond weight loss, several bariatric surgery-related metabolic alterations have been related to OSA remission. These include surgery-induced glycemic control improvement and systemic inflammation suppression [16]. Fewer episodes of apnea have been reported three weeks after bariatric surgery, even without notable weight loss [17].

The present study could not find any significant difference between LSG and LRYGB in the postoperative STOP-Bang score, with significant improvement in patients who underwent either procedure. In line with our findings, Currie *et al.* [15] reported that both LSG and LRYGB have comparable effect sizes. LRYGB, however, had a marginally higher rate of OSA remission. Despite only including 309 individuals from 5 trials, a systematic evaluation addressing the same topic found that LSG may have a little higher OSA remission rate than LRYGB [14]. This variation can be attributed to factors such as differences in the study design, follow-up period, percentage of contribution by each bariatric procedure, and heterogeneity of the baseline patients' characteristics. Addressing these variations requires further investigation.

A key finding in the current study is the significant positive association between the BMI loss and the OSA improvement, as reflected in the STOP-Bang scores. In the same context, Nagendran *et al.* [18] and Magne *et al.* [19] found that the decrease in BMI was a predictor of OSA improvement after bariatric surgery. Also, Currie *et al.* [15] reported that higher weight loss was related to a tilted odds towards the remission of OSA.

Our findings signify that despite the other reported metabolic pathways [16,17], weight loss still poses a particular importance in the improvement of OSA after bariatric surgery.

This study is limited by the small sample size (particularly for the RYGB patients) and the short-term follow-up. However, the journey towards effectively managing OSA through bariatric surgery was shown to be a promising one, offering positive effects on OSA. It is crucial to recognize the need for larger studies with ongoing research to refine our understanding of the nuances surrounding different surgical approaches.

Conclusion

This study demonstrated the bariatric surgery-initiated evident improvement and even complete resolution of OSA in patients with obesity, as measured by the STOP-Bang score.

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Statements and declarations

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The authors declare that the manuscript has been read and approved by all the authors, the requirements for authorship have been met, and that each author believes that the manuscript represents honest work.

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Conflicts of interest
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