Original Article

Bariatric Surgery in an Effort to Resolve Obstructive Sleep Apnea

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Submission: January 25, 2026 Accepted: March 5, 2026 Published: March 31, 2026

Abstract

Background: Obstructive sleep apnea is correlated with obesity, and of weight loss, as such; it helps improve obstructive sleep apnea. **Objectives:** This study aims to assess if bariatric surgery as obesity continues to rise worldwide, the prevalence of obstructive sleep apnea is increasing as well. There are many ways to lose weight and among them, bariatric surgery is associated with a significant amount has a role in improving and perhaps resolving obstructive sleep apnea in the long run. **Materials and Method:** A cross-sectional study composed of quantitative methodology. A total of 143 patients who had previously undergone bariatric surgery were recruited and the data was collected by contacting the participants through the telephone to ask them questions based on an evidence-based questionnaire. **Result:** The average age of the patients was 36.63 ± 9.71 years and 51 (35.6%) patients were males whereas females accounted for the remaining 92 (64.4%) patients. The most common age group was the 39-48 years group with 54 patients. The average BMI after surgery was 30.28 kg/m2 while before surgery; the average was 44.86 kg/m2. **Conclusion:** Bariatric surgery is an efficient way of losing weight, especially a weight loss significant enough to resolve OSA. Majority of patients are satisfied with the results of the surgery and consider their first 6-month experience following the surgery a good experience.

Keyword: Obesity, Obstructive Sleep Apnea, Bariatric surgery, Weight loss

Introduction

Obstructive sleep apnea (OSA) is known as either a partial or a complete episodic collapse of the airway leading to a fall in oxygen saturation followed by a decreased sleep arousal [1]. The condition was found in 9% of women and 24% of men in a study of 602 middle-aged adults between the ages of 30 to 60 years [2]. It is usually suspected in individuals with a history of either snoring or daytime sleepiness or an enlarged neck circumference on physical examination. There are four main questionnaires for screening and assessing OSA which are (Berlin Questionnaire, STOP-BANG questionaire, Stop Questionnaire, and Epworth Sleepiness Scale). However, to confirm the diagnosis, overnight polysomnography is required [3,4]. Sleep apnea is a condition that is associated with many consequences and morbidities such as an increased risk of hypertension, cerebrovascular accidents, and cardiovascular events. Furthermore, patients suffering from sleep apnea are more likely to develop cognitive deterioration and excessive daytime sleepiness. Moreover, studies emphasizing on the neurocognitive effects of OSA have shown associations between

sleep apnea and depression [5]. As far as etiology goes, changes in hormone, large tonsils and obesity are all considered as a risk factor for obstructive sleep apnea [6]. Among these causes of OSA, obesity seems to be one of the most common risk factors. As far as management goes, bariatric surgery has been deemed an efficient approach for resolving obesity and the subsequent co-morbidities associated with the condition such as OSA [7]. There are many treatments for Obstructive sleep apnea. One of them is a device, referred to as continuous positive airway pressure (CPAP), which uses a positive pressure to aid breathing when the person is sleeping. Another treatment is a mouthpiece which thrusts the jaw forward allowing the person to breathe easily. Some people also see improvement from surgery [8]. Bariatric surgery which is also known as weight loss surgery or metabolic surgery is a type of surgery used for decreasing weight in obese people. It has been proven that it is a better way for managing obesity than lifestyle and dietary modification. It is also important to know that bariatric surgery is only a part of the solution. For the surgery to be deemed as successful, healthy lifestyle habits after the surgery must be developed [9,10]. A great percentage of patients undergoing bariatric surgery report either a complete recovery or at least a significant improvement in their sleep apnea symptoms [11]. The prevalence of OSA in a study decreased from 71% to 44% after just one year of follow-up of the patients after undergoing bariatric surgery [12]. In an effort to help settle this conflict, we conduct this study to shed light on the long-term implications of bariatric surgery for OSA. Bariatric surgery can be performed using different techniques. The surgery can be either performed through a large incision or it can be performed laparoscopically, with the latter being more common lately [13]. There are also multiple types of bariatric surgery. The three most common ones are Roux-en-Y gastric bypass, adjustable gastric banding, and sleeve gastrectomy. Each one of these types present with their own pros and cons [14]. The problem lies in patients who tend to have a relapse of OSA in the long-term following the surgery due to the possible regaining of the weight that was lost [15]. There seems to be a debate on whether or not the benefits from the surgery outweigh the risks. This is mainly due to the invasiveness of bariatric surgery when compared to the other modes of weight loss such as diet modification and exercise.

Materials and Methods

Study design

This study is a cross-sectional study with both quantitative and qualitative data. It aims to determine whether bariatric surgery has a role in resolving obstructive sleep apnea. The data for this study was collected through phone calls by calling participants that had undergone bariatric surgery.

Setting of the study

This study was conducted from December 21st, 2023, to May 1st, 2024 in Sulaymaniyah, Iraq.

Participants

A total of 143 patients who had underwent bariatric surgery with the surgeon, had OSA based on the and were willing to participate in the study were included questionnaire

Eligibility criteria

Furthermore, patients who did not respond after repeated contact attempts were not included. Patients that did not have OSA based on a questionnaire were also excluded had undergone bariatric surgery were eligible for the study, that is if they understood the importance of the study and provided complete and reliable responses. Any patients with a BMI of less than 35 or those

that were under the age of 18 at the time of their surgery were excluded. This left 143 patients to be included in this study.

Methods

In the selection process, patients were selected that had undergone bariatric surgery to contact through the phone in order to collect data. A questionnaire was used to determine whether the participants had OSA before undergoing the surgery. The questionnaire used is mostly a modified version of the "STOP BANG" questionnnaire combined with the "Epworth Sleepiness Scale" and "Berlin questionnaire" used to determine the degree of fatigue [16-18]. Due to limited availability of polysomnography in our setting, objective sleep testing could not be performed. Therefore, OSA status was assessed using a structured questionnaire derived from established screening tools (STOP-BANG, Epworth Sleepiness Scale, and Berlin Questionnaire). Although these instruments are widely used for OSA risk assessment, questionnaire-based classification may be subject to misclassification and recall bias. The questionnaire was composed of age, gender, residence, occupation, height, weight before and after surgery, chronic illnesses before and after surgery, type of the surgery, side-effects of the surgery, and any other previous methods used for losing weight before the surgery. Furthermore, 3 more questions were asked on the symptoms of OSA in order to help with the diagnosis of OSA. Each question was based on a scale of 0-2 as the degree of severity of the symptoms with 0 representing absence of the symptoms, 1 indicating moderate severity and lastly, a score of 2 implied that the symptoms were severe. **The 3 questions were:**

1. If the participants had snoring before the surgery and whether it has resolved after the surgery.
2. If the patient has woken up before surgery in the middle of the night gasping for air or if someone had observed them. They were also asked if it had resolved following the surgery.
3. If the patient had experienced excessive daytime sleepiness before the surgery and if yes, whether or not it had remained after surgery.

A score of 1 or 2 was given to those who woke up gasping for air or if someone had observed them doing so prior to surgery. This was deemed enough to diagnose the patient with OSA. If the participant had memory of such symptoms nor was observed to experience it, then to diagnose the patients with OSA, an cumulative score of 3 and above in the snoring and daytime sleepiness before surgery question was required. Apart from the aforementioned variables, questions were also asked on the following variables: satisfaction with the surgery, patient's experience in first 6 months, and smoking status.

Limitations

This study has several limitations. First, polysomnography—the gold standard for diagnosing and grading obstructive sleep apnea—was not available in our setting; consequently, OSA status and symptom severity were assessed using a structured questionnaire derived from established screening tools. Although these instruments are widely used for OSA risk assessment, questionnaire-based assessment cannot replace objective testing and may introduce misclassification bias. Second, data were collected via telephone interviews, which may be subject to recall and information bias. Third, participants were limited to individuals who underwent bariatric surgery with a single surgeon and were reachable by phone; non-response from some eligible patients may have introduced non-response bias and limited

representativeness. Finally, given the cross-sectional design, associations observed in this study should not be interpreted as causal effects of bariatric surgery on OSA outcomes.

Statistical analysis

The data collected was first recorded on an excel workbook sheet but it was then imported onto a statistical analysis (SPSS version 26.0). Since majority of the data were categorical, Chi-Squared test was conducted to determine the association between certain categorical variables. A p-value of less than 0.05 was considered significant.

Ethical consideration

This study was conducted according to the guidelines set by the ethical consideration team of University of Slemani, College of medicine and the Code of Ethics of the World Medical Association. The ethical code provided by university of Slemani is: 145.

Result

The total number of patients included in this study was 143 patients and the average age of the participants was 36.63 (SD). The most common age group was the 39-48 years age group with 54 (37.76%) patients whereas the 59 years and above group with 3 (2.09%) patients were the least common. Table 1. Highlights these as well as the residency of the patients showing that 113 (79%) of the patients resided in urban areas.

Table 1: Sociodemographic data of the participants.

Age (mean with SD)	Mean = 36.63 (9.71)
Age groups	**Total patients (143)**
18-28 years	31 (21.67%)
29-38 years	47 (32.86%)
39-48 years	54 (37.76%)
49-58 years	8 (5.59%)
59 years and above	3 (2.09%)
Gender	**Total patients (143)**
Male	51 (35.6%)
Female	92 (64.4%)
Residency	**Total patients (143)**
Urban	113(79%)
Rural	30(21%)

The most common side effect experienced by the patients was alopecia with either vitamin or iron deficiency present in 31 (21.6%) of the patients. Majority (57.3%) of the participants reported no side effects. The mean weight after surgery was 83.65 Kg, following a reduction from 123.8 Kg of prior surgery weight. Regarding BMI, it was grouped into 4 groups for the pre-surgery BMI's whereby the most common group came out to be the 40 – 44.9 group with 48 (33.56%) patients. The average BMI prior to surgery was 44.86 Kg while following surgery, the mean BMI had fallen to 30.28. Moreover, most (91.6%) of the patients had gastric sleeve as the type of surgery, with the remaining 12 (8.4%) undergoing gastric bypass. When asked about satisfaction, majority (78.3%) of the participants were very satisfied with their surgery outcome leaving only 3 patients unsatisfied. All of these are shown in table 2. Furthermore, 90 (62.93%) of the patients complained of severe snoring prior to surgery, 27 (18.88%) complained of moderate snoring and 26 (18.18%) reported no snoring. No patient had severe snoring after surgery and only 19 (13.3%) patients had moderate snoring. Severe apnea was reported in 84 (58.74%) of the patients prior to surgery whereas only 4 (2.79%) patients had it following surgery. When it comes to daytime sleepiness, most (87.41%) of the participants complained of severe daytime sleepiness whilst 9 (6.29%) had moderate sleepiness and 9 (6.29%) had none. This changed to only 4 (2.79%) out of the total 143 participants with severe daytime sleepiness and 11 (7.69%) with moderate. Out of the total 143 patients, 118 (82.51%) had a good experience within they first 6 months following surgery. The number of chronic illnesses changed from 48 (33.56%) participants prior to

surgery to 22 (15.37%) after surgery. Among the total 143 patients, 112 (78.33%) reported no smoking history.

Table 2: Frequencies and percentages of the included variables.

Variable	Number of patients (143)
Side effects	Number of patients (143)
None	82 (57.3%)
Alopecia and vitamin/iron deficiency	31(21.6%)
Nausea, vomiting and stomach pain	7 (4.89%)
Weakness	8 (5.59%)
Weakness and vitamin deficiency	8 (5.58%)
Others	7 (4.89%)
Weight before surgery	Mean = 123.8 Minimum = 80 Maximum = 209 SD = 23.12
Weight after surgery	Mean = 83.65 Minimum = 54 Maximum = 128 SD= 14.25
Height	Mean = 1.66 meters SD = 0.09
BMI before surgery	Number of patients (143)
35-39.9	39 (27.27%)
40-44.9	48 (33.56%)
45-49.9	24 (16.78%)
50 and above	32 (22.37%)
Mean BMI	44.86 kg/m2
Minimum BMI	35.2 kg/m2
Maximum BMI	64.5 kg/m2
SD	6.73 kg/m2
BMI after surgery	Number of patients (143)
Mean BMI	30.28 kg/m2
Minimum BMI	19.3 kg/m2
Maximum BMI	43.3 kg/m2
SD	4.41 kg/m2
Type of surgery	Number of patients (143)
Gastric sleeve	131 (91.6%)
Gastric bypass	12 (8.4%)
Patient satisfaction with the surgery	Number of patients (143)
Not satisfied	1 (0.7%)
Slight unsatisfaction	2 (1.4%)
Neutral	3 (2.09%)
Slight satisfaction	25 (17.48%)
Very satisfied	112 (78.3%)
Snoring before surgery	Number of patients (143)
No snoring	26 (18.18%)
Moderate snoring	27 (18.88%)
severe snoring	90 (62.93%)
Snoring after surgery	Number of patients (143)
No snoring	124 (86.7%)
Moderate snoring	19 (13.3%)
Severe snoring	0 (0%)
Apnea noticed or observed before surgery	Number of patients (143)
No apnea	21 (14.68%)
Moderate apnea	38 (26.57%)
Severe apnea	84 (58.74%)
Apnea noticed or observed after surgery	Number of patients (143)
No apnea	130 (90.9%)
Moderate apnea	9 (6.29%)
Severe apnea	4 (2.79%)
Daytime sleepiness before surgery	Number of patients (143)
No sleepiness	9 (6.29%)
Moderate sleepiness	9 (6.29%)
Severe sleepiness	125 (87.41%)
Daytime sleepiness after surgery	Number of patients (143)
No sleepiness	128 (89.51%)
Moderate sleepiness	11 (7.69%)
Severe sleepiness	4 (2.79%)
Patient's experience in first 6 months after surgery	Number of patients (143)
Bad	25 (17.49%)
Good	118 (82.51%)
Chronic illnesses before the surgery	Number of patients (143)
Yes	48 (33.56%)
No	95 (66.44%)
Chronic illnesses after the surgery	Number of patients (143)
Yes	22 (15.38%)
No	121 (84.61%)
Smoking status	Number of patients (143)
Smoker	31 (21.67%)
Non-smoker	112 (78.33%)

Table 3. emphasizes on the statistically significant association between both satisfaction with surgery and experience of patients in the months after surgery with apnea noticed or observed after surgery. Among the 112 patients with who were satisfied with the surgery, 102 of them reported no apnea after surgery while only 10 of them reported apnea of any kind. Similar results were seen regarding post-operative

experience as most of the patients who had a good experience where patients with no apnea after surgery.

Table 3: Association of both surgery satisfaction and patient experience in the 6 months after surgery with presence of apnea after surgery.

Variables		Apnea noticed or observed after surgery			
		Negative	Moderate	Severe	P-Value
With satisfaction surgery	Bad	0 (0%)	0 (0%)	1 (25%)	<0.001
	Slightly bad	2 (1.5%)	0 (0%)	0 (0%)	
	Moderate	3 (2.3%)	0 (0%)	0 (0%)	
	Slightly good	23 (17.7%)	2 (22.2%)	0 (0%)	
	Good	102 (78.5%)	7 (77.8%)	3 (75%)	
	Total	130 (100%)	9 (100%)	4 (100%)	
How was your experience in the first 6 months	Good	110 (84.6%)	4 (44.4%)	4 (100%)	0.006
	Bad	20 (15.4%)	5 (55.6%)	0 (0%)	
	Total	130 (100%)	9 (100%)	4 (100%)	

Table 4 highlights a statistically significant relationship (p-value <0.05) between snoring prior and following surgery. Out of the 124 patients who reported no snoring after surgery, 73 of them complained of severe snoring prior to it.

Table 4: Relationship between snoring prior to surgery and snoring following surgery.

Variables		Any snoring after surgery?		
		Negative	Moderate	P-Value
Any snoring prior to surgery?	Negative	26 (21%)	0 (0%)	0.027
	Moderate	25 (20.2%)	2 (10.5%)	
	Severe	73 (58.9%)	17 (89.5%)	
	Total	124 (100%)	19 (100%)	

A statistically significant relationship was observed between daytime sleepiness before and after surgery. Out of the 113 patients with severe daytime sleepiness prior to operation, only 1 patient was left with the complaint after surgery.

Table 5: Association between daytime sleepiness prior to surgery and daytime sleepiness after surgery.

Variables		Daytime sleepiness after surgery			
		Negative	Moderate	Severe	P-Value
Daytime sleepiness prior to surgery	Negative	6 (4.7%)	0 (0%)	3 (75%)	< 0.001
	Moderate	9 (7%)	0 (0%)	0 (%)	
	Severe	113 (88.3%)	11 (100%)	1 (25%)	
	Total	128 (100%)	11 (100%)	4 (100%)	

Discussion

Obesity is a disease of excess fat that can result in many morbidities and mortalities due to the complications caused by the excessive amount of weight [19]. For adults, a BMI of 25.0 to 29.9 kg/m2 is considered overweight whereas a BMI of 30 kg/m2 or higher is categorized as being obese [20]. Nowadays, obesity is one of the most common diseases worldwide. The World Health Organization (WHO) estimates that more than one billion people are overweight and, of these, 300 million can be considered obese [21]. This increase in obesity has obvious effects on many aspects of an individual's health such as a rise in the incidence of cardiovascular disease, type 2 diabetes mellitus, cancer, osteoarthritis, work disability, and obstructive sleep apnea (OSA) [22]. Among the complications, obstructive sleep apnea is a disease is of great importance due to the complications it's associated with [23]. In a study that consisted of 602 men and woman between the ages of 30 to 60 years, the incidence of OSA was 9% for women and 24% for men [2]. In another study that was conducted in

United States for individuals aged from 30-70 years, the prevalence of mild OSA was 17.4% for women and 33.9% for men, while 5.6% of women and 13% of men had moderate or severe OSA [24]. Within the 143 individuals in this study, all with OSA, only 51(35.6%) patients of them were male whereas 92 (64.4%) patients were female. The gold standard for the diagnosis of OSA is polysomnography [25]. With this being said, questionnaires such as (Berlin questionnaire, STOP-BANG and Epworth sleep-iness scale) are also available for assessing the risk of OSA; however, they cannot provide a definitive diagnosis [24]. Since polysomnog-raphy was not available, a combination of the aforementioned questionnaires has been used in this study. This is since the questions from no single questionnaire were sufficient alone to assess the patients. Among the total 143 participants included in this study, a total of 31 (21.6%) of them had alopecia as a postoperative complication. This is in contrast to results yielded in other studies where among the 103 participants included, 82 (79.6%) of them had alopecia as a postoperative complication [26]. Although with different percentages, this complication was found to be the most common postoperative complication in both studies. Regarding satisfaction with surgery, 137 (95.8%) of the participants were either very satisfied or slightly satisfied with the surgery. This high satisfaction rate with bariatric surgery is not limited to our study since other studies have also shown that majority of the participants were satisfied as 82%) of a total of 261 participants reported high satisfaction after the surgery [27]. As previously mentioned, since bariatric surgery performed for OSA is usually, but not always, in people that are considered obese, it is very essential to evaluate patient BMI both preoperatively as a possible indication and postoperatively as a surgical outcome evaluation. Within this study, the mean BMI calculated was 44.79 kg/m2 with 72 (50.3%) individuals falling within the high 40-49.9kg/m2 range. Similarly, other studies have also a great number of patients such as 45.8% of their total patient population in the (40-49.9 kg/m2) range [28]. Satisfaction with the surgery is one of the variables that were asked of the participants. It was grouped into 5 categories. Out of the 143 participants, 112 (78.3%) of them fell into the very satisfied group. 25 (17.48%) of them were slightly satisfied. 3 (2.09%) of them were neutral for the satisfaction. 2 (1.4%) participants were slightly not satisfied and there was only 1 (0.7%) participant that was very unsatisfied with the surgery. Another question presented to the participants was their experience in the first 6 month first 6 months after the surgery. The answers to this question were either the patient had a good experience or a bad one. Out of the total participants 118 (82.51%) of them had a good experience and the remaining 25 (17.49%) of them had a bad experience in the regarding OSA treatment, continuous positive airway pressure (CPAP) is the best therapeutic option recommended for patients with moderate to severe OSA and has shown success in reducing the symptoms of the condition [29]. Nonetheless, other therapeutically options are available for those who may not want to or cannot tolerate CPAP. These include the likes of Oral appliance therapy, life-style modifications, surgical procedures, and weight loss [30]. There are several ways to reduce weight such as exercise, diet, and drugs. However, these weight loss methods have a role in management of only mild to moderate OSA as has been shown in small studies [31]. Another way to decrease weight, especially significant amounts, is Bariatric surgery, an operation that alters your digestive system and limits the amount an individual can intake [32]. There are four types of bariatric

surgery that surgeons uses which are gastric sleeve, gastric bypass, adjustable gastric banding, and biliopancreatic diversion with duodenal switch [33]. A study in the US shows that among the types of bariatric surgery, gastric bypass was the most common type of surgery accounting for (58.4%) of all bariatric surgeries performed in 2010. Fast-forward a couple years to 2014, sleeve gastrectomy became more frequent accounting for (58.2%) of the surgeries [34, 35]. In this study, 131 (91.6%) individuals have had sleeve gastrectomy while only 12 (8.4%) had underwent gastric bypass surgery. Another study yields results that further support these where in a total of 2190 participants, 1023 (46.7%) of them had sleeve gastrectomy while only 140 (6.3%) participants had gastric bypass [36]. This shows that in both studies sleeve gastrectomy was the predominant type of surgery. In this study, statistically significant relationships (p-value = <0.001) were found between presence of apnea either noticed by the patient or by their surroundings after surgery with the patient satisfaction after surgery. The results showed that the lower the rates of apnea either felt or observed, the higher the rates of patient satisfaction with their surgery. Out of the total, 102 participants fell into this category of no apnea sensed and satisfaction with the surgery. Furthermore, presence of apnea either noticed by the patient or by their surroundings after surgery was also found to have a statistically significant (p-value = 0.006) association with the patient's experience in first 6 months following surgery. As expected, the lower the rate of apnea, the better the experience of the patient within this.

Conclusion

Obesity is associated with many complications, one of them being OSA. Bariatric surgery is an efficient way of losing weight, especially significant weight loss, enough to resolve OSA. Majority of patients are satisfied with the results of the surgery and consider their first 6-month experience following the surgery a good experience. Many variables, among them, severity of snoring before surgery and daytime sleepiness before surgery are significantly associated with the outcome of the surgery.

List of abbreviations:

OSA = Obstructive Sleep Apnea; SPSS = Statistical Package for Social Sciences; SD = Standard Deviation.

Consent for publication.

This study is yet to be published.

Competing interests and Funding

None exists.

Author contribution

All of the authors equally contributed to the literature review, data extraction, analysis and writing of the manuscript.

Acknowledgements

The authors would like to express their appreciation for medical student Aland S. Abdulla, as he helped with this study. All four authors have read and approved the final manuscript.

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