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Original article

The impact of laparoscopic Roux-en-Y gastric bypass on sleep quality and duration after one year of follow-up

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S U M M A R Y

Background and aims: Several studies have shown the association between obesity and sleep. Roux-en-Y gastric bypass (RYGB) surgery may improve sleep disturbances in patients with obesity by influencing a variety of factors. This study aims to evaluate the impact of bariatric surgery on sleep quality.
Methods: Patients with severe obesity referred to the obesity clinic of a center from September 2019 to October 2021 were collected. The patients were divided into two groups, depending on whether they underwent RYGB surgery. Medical comorbidities and self-report questionnaires regarding sleep quality, anxiety, and depression were collected at baseline and 1-year follow-up.
Results: 54 patients were included, including 25 in the bariatric surgery group and 29 in the control group. However, five patients in the RYGB surgery group and four patients in the control group were lost in the follow-up. Pittsburgh Sleep Quality Index (PSQI) was decreased from a mean of 7.7 to 3.8 in the bariatric surgery group (p-value<0.001). In contrast to the control group, the number of patients with obstructive sleep apnea was significantly reduced in the bariatric surgery group.
Conclusions: We showed a significant improvement in sleep quality following RYGB surgery. Obstructive sleep apnea, obesity/overweight, and depressive symptoms significantly improved in our study. There is a lack of a better understanding of the association between these factors and sleep quality following surgery. Therefore, further studies are recommended regarding this issue.

1. Introduction

Obesity is considered a worldwide health problem, and its prevalence has increased during the last decades [1,2]. Several co-morbid conditions, including diabetes mellitus, hypertension, obstructive sleep apnea, and psychological problems, have been related to obesity [3–5]. Alongside the association between obesity and obstructive sleep apnea, it has been shown that obesity is associated with short sleep duration [6]. However, sleep inadequacy in patients with obesity is not just due to sleep duration. Sleep quality may be an independent factor of sleep duration regarding sleep inadequacy in patients with obesity [7].

Although the relationship between sleep loss and obesity seems to cause a vicious cycle, as obesity worsens sleep loss and sleep loss worsens obesity, the exact mechanism of this issue is unclear [8]. However, it has been found that changes in hormones, such as reduction in leptin, elevation in ghrelin, and decrease in insulin sensitivity, are responsible for weight gain, and on the other hand, obesity affects sleep through physical and emotional conditions, which may change the sleep pattern [8–10].

As bariatric surgery is the most effective treatment approach for severe obesity [11,12], it may improve obesity-related morbidities, including sleep disturbances. This study aimed to evaluate the impact of bariatric surgery on sleep quality and duration as only a few studies have evaluated the impact of bariatric surgery on sleep quality and duration.

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2. Materials and methods

2.1. Participants

In this retrospective study, patients with severe obesity who were referred to the obesity clinic of Mother and Child Hospital, affiliated with Shiraz University of Medical Sciences, Shiraz, Iran, from September 2019 to October 2021 were collected. Patients between 18 and 60 years of age with a body mass index (BMI) above 40 kg/m^2 or above 35 kg/m^2 with at least a risk factor were included. We excluded the patients with a history of pulmonary diseases (e.g., asthma and chronic obstructive pulmonary disease), history of Roux-en-Y gastric bypass (RYGB) or laparoscopic sleeve gastrectomy (LSG) in the control group, cardiovascular and cerebrovascular diseases, unwillingness to continue participation, and loss to follow-up. Meanwhile, women who were pregnant or lactating were also excluded.

Then, the patients were divided into two groups, depending on whether they underwent laparoscopic RYGB. They were followed up for at least one year, and outcome measures were recorded during this period.

Based on the opinion of the treatment team, including a surgeon, a nutritionist, a psychologist, and an exercise physiologist, those who did not seem to adhere to a postoperative diet or did not have enough motivation to change their lifestyle were placed in the control group. All the patients who underwent RYGB had regular follow-ups for clinical assessment over 10 days, 1, 3, 6, 9, and 12 months after the surgery, and the control groups who did not undergo bariatric surgery were followed for 12 months. The control group was not under any obesity treatment, such as diet, exercise, and medication, and were excluded from the study if they changed their lifestyle.

2.2. Data collection and outcome measurement

The demographic information of all patients, such as age and gender, was recorded at the beginning of the study. Anthropometric and obesity-related diseases were abstracted from the national obesity surgery database [13] at the beginning of the study and 1-year follow-up. BMI was calculated based on kilogram per meter squared (kg/m^2). Moreover, obesity-related diseases, including type 2 diabetes mellitus, hypertension, obstructive sleep apnea, and hyperlipidemia, were asked from patients. Remission rates of obesity-related diseases were defined by the standardized outcomes reporting in metabolic and bariatric surgery devised by the American Society for Metabolic and Bariatric Surgery (ASMBS) [14]. The sleep quality and psychological evaluation questionnaires used in the present study are described below.

Patients were followed up for at least one year, and all the variables mentioned above were recorded at one year of follow-up. As well as comparing the follow-up data with the baseline, a comparison between patients who underwent RYGB and those who were not was done to determine the impact of bariatric surgery.

2.2.1. Sleep quality status

The use of sleep medications was asked, and the Pittsburgh Sleep Quality Index (PSQI) was used as a self-assessment questionnaire for sleep quality. PSQI includes 19 items, which measure seven sleep components in the past month: sleep latency, disturbances, duration, and quality, habitual sleep efficiency, sleep pills use, and daytime dysfunction. Each item is scored from 0 to 3; zero shows good sleep quality, while three shows poor [15].

2.2.2. Psychological status

The Hospital Anxiety and Depression Scale (HADS) is used for the feeling of anxiety and depression. HADS includes seven questions for evaluating anxiety and seven for depression. Subjects answer the questions from 0 to 3. These scores result in two scores (anxiety and depression) from 0 to 21: 0–7 points show normal, 8–10 points demonstrate borderline abnormal, and 11–21 points show abnormal levels [16].

2.3. Statistical analysis

SPSS software, version 17, was used for data analysis. After determining whether the distribution of the variables was normal, an independent t-test/Mann–Whitney test or Chi-square/Fisher's exact test were used to compare the bariatric surgery group with the control group. Also, to compare baseline data to the follow-up, paired t-test/Wilcoxon signed-rank test was utilized for continuous variables and McNemar's test for dichotomous variables. A p-value under 0.05 was considered statistically significant.

2.3.1. Ethics

Ethical approval was obtained from the University's Ethics Committee (ethics code: IR. SUMS.REC.1398.1278).

3. Results

A total of 54 patients were included, including 25 in the bariatric surgery group and 29 in the control group. However, 20% ($n = 5$) of patients in the bariatric surgery group and 13.7% ($n = 4$) of patients in the control group were lost during the one-year follow-up. Table 1 shows the baseline demographic and anthropometric data and the history of comorbidities in our study population.

The existence of diabetes was reduced by 20% after the operation in the bariatric surgery group. Also, the presence of hypertension and hyperlipidemia decreased in comparison between the preoperative and postoperative groups by 19% and 24%, respectively. The incidence of obstructive sleep apnea decreased from 15 patients (60%) to only one (5%) postoperatively. The average BMI and weight were reduced from 44.15 kg/m^2 and 114.7 kg to 30.16 kg/m^2 and 83.3 kg, respectively, in the bariatric surgery group (Table 2).

Concerning sleep quality, PSQI decreased from a mean of 7.7 to 3.8 in the bariatric surgery group ($p\text{-value} < 0.001$), while no statistically significant difference was found in the control group. As mentioned before, the number of patients with obstructive sleep apnea significantly decreased in the bariatric surgery group. However, the number of patients with obstructive sleep apnea was not changed dramatically in the control group. Five patients (20%) used sleep medications before surgery, while none used sleeping pills postoperatively. In the control group, on the other hand, the number of patients using sleep medications increased from seven patients (24.1%) to nine patients (36.0%), which was statistically significant. In addition, the increase in sleep duration was not significant in both groups. Besides, HADS was decreased significantly in the bariatric surgery group ($p\text{-value} < 0.001$), demonstrating the impact of surgery on anxiety and depressive symptoms (Table 3) (Fig. 1).

4. Discussion

In the present study, we assigned a RYGB group and a control group and compared the results of sleep quality and duration after a

Table 1
The baseline characteristic of the patients.

Variable	Bariatric surgery group (n = 25)	Control group (n = 29)	P-value	Hedges' *g*
Age, year; mean (SD)	38.5 (4.1)	35.8 (6.2)	0.09	0.506
Female sex; n (%)	18 (72)	22 (75.8)	0.26	–
Weight, kg; mean (SD)	114.7 (14.82)	119.51 (13.76)	0.11	0.337
BMI, kg/m2; mean (SD)	44.15 (5.68)	45.79 (5.12)	0.78	0.304
Comorbidities; n (%)				
Diabetes mellitus	5 (20.0)	6 (20.6)	0.77	–
Hypertension	6 (24.0)	8 (27.5)	0.20	–
Obstructive sleep apnea	15 (60.0)	14 (48.2)	0.66	–
Hyperlipidemia	6 (24.0)	7 (24.1)	0.54	–

SD: standard deviation, BMI: body mass index.

Table 2
Group comparison of weight and comorbidities.

Variable	Bariatric surgery group		P1	Control group		P1	P2	Hedges' *g*
	Baseline (n = 25)	1 year (n = 20)		Baseline (n = 29)	1 year (n = 25)			
Weight, kg; mean (SD)	114.7 (14.82)	83.3 (13.88)	**<0.001**	119.51 (13.76)	118.8 (12.11)	0.12	**0.002**	2.747
BMI, kg/m2; mean (SD)	44.15 (5.68)	30.16 (3.5)	**<0.001**	45.79 (5.12)	44.11 (5.99)	0.45	**<0.001**	2.765
Obstructive sleep apnea; n (%)	15 (60.0)	1 (5.0)	**<0.001**	14 (48.2)	14 (56.0)	0.33	**<0.001**	–
Diabetes mellitus, n (%)	5 (20.0)	0 (0.0)	**<0.001**	6 (20.6)	6 (24.0)	0.66	**<0.001**	–
Hypertension, n (%)	6 (24.0)	1 (5.0)	**<0.001**	8 (27.5)	8 (32.0)	0.44	**<0.001**	–
Hyperlipidemia, n (%)	6 (24.0)	0 (0.0)	**<0.001**	7 (24.1)	6 (24.0)	0.77	**<0.001**	–

P1 is the p-value regarding the comparison of baseline and one-year follow-up data in each group, and P2 is the p-value regarding the comparison between follow-up data of the bariatric and control groups; SD: standard deviation, BMI: body mass index.

Table 3
Group comparison of psychological and sleep quality status.

Variable	Bariatric surgery group		P1	Control group		P1	P2	Hedges' *g*
	Baseline (n = 25)	1 year (n = 20)		Baseline (n = 29)	1 year (n = 25)			
Sleep onset latency, minute; mean (SD)	33.53 (32.52)	30.88 (34.50)	0.11	32.87 (31.05)	32.66 (32.15)	0.87	0.11	0.053
Total sleep time, hour; mean (SD)	6.03 (1.87)	6.55 (1.45)	0.12	6.21 (2.12)	6.46 (1.70)	0.22	0.55	0.056
PSQI; mean (SD)	7.7 (3.5)	3.8 (2.6)	**<0.001**	7.25 (4.7)	8.55 (4.5)	0.66	**<0.001**	1.256
Habitual sleep efficiency, %; mean (SD)	78.94% (15.16%)	89.55% (12.1%)	0.55	78.01% (22.5%)	77.35% (14.1%)	0.21	**0.004**	0.920
Use of sleep medication; n (%)	5 (20.0)	0 (0.0)	**<0.001**	7 (24.1)	9 (36.0)	**0.01**	**<0.001**	–
HADS; mean (SD)	8.91 (5.32)	3.3 (3.5)	**<0.001**	9.12 (4.95)	8.94 (4.51)	0.77	**<0.001**	1.377

P1 is the p-value regarding the comparison of baseline and one-year follow-up data in each group, and P2 is the p-value regarding the comparison between follow-up data of the bariatric and control groups; SD: standard deviation PSQI: Pittsburgh Sleep Quality Index, HADS: Hospital Anxiety and Depression Scale.

year of follow-up. We observed that PSQI, habitual sleep efficiency, and the rates of obstructive sleep apnea and use of sleep medications were improved in the bariatric surgery group compared to the control; however, the improvements of total sleep time and sleep onset latency were not significant.

Obstructive sleep apnea decreased by 55% in the postoperative group compared to the preoperative group. However, it was approximately unchanged in the control group after one year and even increased by 8%. This shows the tremendously beneficial effect of bariatric surgery on the incidence of sleep apnea. On the other hand, PSQI, as a representative of sleep quality, was significantly reduced in the bariatric surgery group in contrast with the control group. Therefore, it may be postulated that the reduction of obstructive sleep apnea may contribute to the improvement of sleep quality in the study group. We did not evaluate the direct association of these two variables; however, in a study by O'Halloran et al., although sleep quality was inversely associated with BMI, it was not affected by the presence or absence of obstructive sleep apnea. The authors of the mentioned study concluded that low sleep quality might be associated with obesity itself rather than sleep apnea [17].

In a similar study by Toor et al., the authors studied the effect of bariatric surgery on sleep quality and duration. It was shown that the mean PSQI was significantly higher in the preoperative patients who were planning to undergo bariatric surgery than in non-obese patients. Also, the use of sleep medications was more in the former group. On the other hand, when comparing the preoperative and postoperative data in patients who underwent surgery, PSQI decreased following the operation. This result was in line with the results of our study. It is noteworthy that, surprisingly, the authors reported that the decrease in PSQI was not statistically associated with surgery-induced weight loss [8]. It should be taken into consideration that in our study, sleep quality and duration were assessed at one-year follow-up, similar to the mentioned study be Toor et al., which determined the sleep quality and duration three months to one year after the surgery. This issue is important as a recent study by Lodewijks et al. reported that although the PSQI was improved in patients who underwent surgery under 1.5 years ago (6.1 versus 4.8), the improvement was disappeared in patients who underwent surgery more than 1.5 years ago [18].

As we discussed that sleep apnea and surgery-induced weight loss, contrary to our expectations, may not be the leading causes of improved sleep quality based on some studies, other factors may be more prominent leading to this improvement. Since our analysis does not evaluate the possible predictable factors, we suggest more studies to determine the associated factors correlated with the changes in sleep quality in the follow-up following the operation.

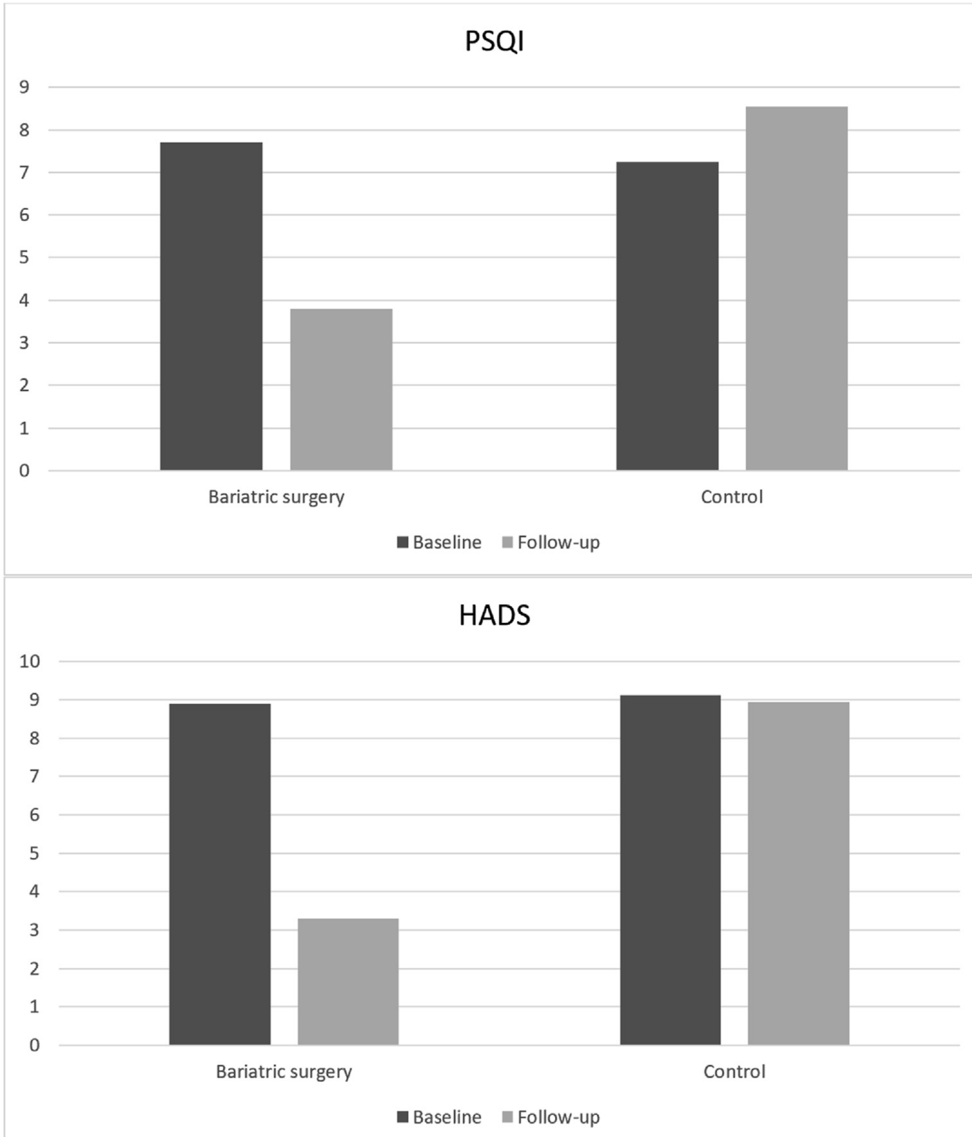

Fig. 1. Baseline and follow-up data of PSQI and HADS; PSQI: Pittsburgh Sleep Quality Index, HADS: Hospital Anxiety and Depression Scale.

In this study, anxiety and depressive symptoms were improved following the operation. This was also shown in the study by Pinto et al. [19]. As the relationship between sleep and obesity seems to be bi-directional, one of the factors associated with improved sleep quality following bariatric surgery may be the improvement of depressive symptoms [19].

Obesity is considered one of the main risk factors for hypertension, as, in a large study published in 2009, about 40% of new cases of hypertension were related to high BMI [20]. So, a strong association between obesity and hypertension has been proved [21]. Accordingly, bariatric surgeries decrease the number of patients with hypertension by reducing the mean BMI and weight, as indicated in this study. Also, as shown in previous studies that bariatric surgery improves dyslipidemia [22,23], we showed a 24% decrease in the number of patients with hyperlipidemia.

4.1. Limitations

As the control group included patients who were non-compliant with lifestyle changes and were not under any obesity treatment, they may not be fully comparable to the study group who underwent bariatric surgery. PSQI was used as a measure of subjective sleep quality in our study. In addition, this study represents a short-term follow-up of patients. So, we suggest further studies with longer follow-ups and using objective measures of sleep quality, which can lead to more reliable results. We also did not evaluate the correlation of sleep quality with probably associated factors, including sleep apnea, weight loss, and depressive symptoms, measured in the study. The related factors are suggested to be studied in future studies, leading to more desirable outcomes and better sleep quality following bariatric surgery when the factors are more precisely determined.

5. Conclusion

We showed a significant improvement in sleep quality following RYGB surgery. Obstructive sleep apnea, obesity/overweight, and depressive symptoms significantly improved in our study. There is a lack of a better understanding of the association between these factors and sleep quality following surgery. Therefore, further studies are recommended regarding this issue.

Author contribution

L.V, NH, SVH, and MA designed the study. F.J, Z. M, N.H, and K.L collected the data. H.K, P.K, and K.L drafted the manuscript. N.H and H.K revised the manuscript. All authors approved the final paper.

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Ethics

Ethical approval was obtained from the University's Ethics Committee (ethics code: IR. SUMS.REC.1398.1278).

Declaration of Competing Interest

None.

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