Clinical Investigations

Respiration

Respiration 2007;74:647–652
DOI: 10.1159/000107736

Received: February 19, 2007
Accepted after revision: June 1, 2007
Published online: August 29, 2007

Bariatric Surgery in the Treatment of Obstructive Sleep Apnea in Morbidly Obese Patients

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Key Words
Bariatric surgery · Morbid obesity · Obstructive sleep apnea

Abstract
Background: Weight loss has been shown effective in the treatment of the obstructive sleep apnea-hypopnea syndrome. Regrettably, many obese patients are unable to achieve sustained and useful weight loss by dietary means. Recently, bariatric surgery has emerged as an alternative to treat obesity and many of its comorbidities, although its role for sleep apnea treatment is still not defined. ***Objectives:*** To evaluate the impact of bariatric surgery on obstructive sleep apnea in morbidly obese patients. ***Methods:*** In this cohort study, polysomnography, Epworth Sleepiness Scale questionnaire and clinical assessment were performed in 12 of 13 morbidly obese patients with moderate to severe obstructive sleep apnea treated with bariatric surgery through Roux-en-Y gastric bypass procedure after a minimum of 18 months post surgery. ***Results:*** The mean (±SD) loss of excess body weight was 70.5 ± 24%. The mean level obtained in the Epworth Scale was 4.8. There was a significant reduction in the apnea-hypopnea index, from a median of 46.5 (range: 33–140) to 16 (range: 0.9–87) events per hour ($p < 0.05$), an improvement in mean oxygen saturation from 85.7 ± 5.1 to 94.5 ± 3.6% ($p < 0.05$) and in minimum oxygen saturation from 64.7 ± 13.4 to 78.7 ± 13.7% ($p < 0.05$). The magnitude of the weight loss and the improvements in mean and minimum oxygen saturation were positively correlated, ($r = 0.76$; $p \leq 0.05$, and $r = 0.59$; $p \leq 0.05$, respectively). ***Conclusions:*** Weight loss achieved by bariatric surgery is associated with significant long-term improvements in obstructive respiratory event, oxygenation and resolution of daytime somnolence.

Introduction

The obstructive sleep apnea-hypopnea syndrome (OSAHS) is characterized by frequent partial or complete collapse of the upper airways during sleep. When moderate or severe, it is typically associated with excessive daytime somnolence [1]. In addition to its impact on sleep quality, there is growing evidence of its role in the pathogenesis of systemic diseases, particularly cardiovascular diseases [1–3].

Morbid obesity, defined by the presence of a body mass index (BMI) >40 kg/m^2, is thus designated because it is

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0025–7931/07/0746–0647$23.50/0

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related to a significant increase in morbidity and mortality. There is an important relationship between obesity and OSAHS; the prevalence of OSAHS can surpass 70% in patients with morbid obesity [4–6]. Several mechanisms have been postulated to explain this association. It is possible that there is a greater deposition of fat in or around the upper airway passages predisposing to their collapse. The decrease in functional residual capacity associated with obesity diminishes oxygen stores thereby increasing the likelihood of hypoxemia during apneic events. Alterations in the mechanisms of the central regulation of respiratory control or in the tone of airways may also be implicated in the development of the syndrome [2, 7].

The most effective treatment for OSAHS in adults is continuous positive pressure to the upper airways during sleep (CPAP – continuous positive airway pressure) via a nasal or oronasal mask. The objective is to prevent upper airway collapse [8, 9]. Unfortunately, compliance with this form of therapy is often poor, averaging at only 25–50% [10].

Weight loss has been shown to produce significant benefits in OSAHS. Peppard et al. [11] have shown that a 10% decrease in total body weight is associated with a 26% reduction in the apnea-hypopnea index (AHI).

The clinical treatment of obesity shows high rates of failure and relapse, with more than 90% of the patients unable to achieve and maintain a 5–10% decrease in body weight for a period of more than 5 years [12–14]. Bariatric surgery can produce sustained weight loss with corresponding improvements in the sequelae of morbid obesity, and modern surgical approaches have reduced perioperative complications [15].

The role of bariatric surgery in the treatment of OSAHS is not well defined. Although most published reports describe favorable results, patient numbers are small, and responses are not always measured objectively [16–27]. Given this dearth of information, some of the principal reviews dealing with OSAHS treatment do not even consider bariatric surgery as a therapeutic option for the treatment of the disease in obese patients [1–3].

Since most of such studies are confounded by large numbers of patients lost to follow-up and short follow-up intervals, the benefits described by such studies may not be found in typical patients and may not be sustained in the long term. In the present study, we have managed almost a 100% follow-up in our cohort of morbidly obese subjects undergoing bariatric surgery and reevaluated them no less than 18 months after surgical intervention.

Patients and Methods

A cohort study was conducted with patients submitted to bariatric surgery in the Center for Morbid Obesity at São Lucas Hospital (Pontifícia Universidade Católica do Rio Grande do Sul) between December 2002 and July 2004.

Patients scheduled to undergo bariatric surgery, the Roux-en-Y gastric bypass procedure according to Capella and Capella [28] and Fobi [29], were eligible for the study if they met the following entry criteria: age between 18 and 65 years; BMI $\geq$40 kg/m^2 or BMI $\geq$35 kg/m^2 with one or more severe comorbidities (diabetes mellitus, systemic arterial hypertension, coronary artery disease, OSAHS and/or severe degenerative arthropathy) [30–33]; coexisting moderate-severe OSAHS determined by polysomnography in the 6 months prior to surgery, combined with symptoms of excessive daytime somnolence, and at least one sustained non-surgical weight loss attempt with inadequate results. The patients were restudied 18 months after surgery. The study was reviewed and approved by the local institutional review board, and all subjects provided written consent.

Post-surgical polysomnography was performed in a single night by a specialized technician. Stages of sleep were defined using the criteria of Rechtschaffen and Kales [34]; the criteria of the American Sleep Disorders Association [35] were used to identify and score waking events.

Apnea and hypopnea events and the AHI were defined according to the recommendations of the American Academy of Sleep [36]. The severity of OSAHS was defined by AHI, where a frequency of 5–15 events per hour was considered mild, 15–30 as moderate and >30 events/h as severe [36].

OSAHS was considered absent when AHI was <5 events/h after the procedure. Improvement was defined as a decrease in AHI accompanied by a decrease in the severity of the disease. Failure was considered when there was no decrease in AHI or when it was not sufficient to decrease the level of severity.

Post-operative evaluation of somnolence was carried out according to the Epworth Sleepiness Scale, where excessive daytime somnolence was considered when the score was >10 [37, 38]. The questionnaire was not administered during the pre-operative period, because it was only introduced in our routine clinical evaluation in 2005.

Weight and weight changes were characterized by total body weight, BMI, excess weight and percentage of excess weight lost [39].

Statistical Analysis

Normally distributed variables were described as means and standard deviations. Non-normally distributed variables were described as medians with the minimum and maximum. Categorical variables were given in numbers and percentages. Quantitative data were compared using Student's t test for paired samples. Correlations were studied by Pearson's linear correlation coefficient and its respective significance. Fisher's exact test was used to compare categorical variables. The study was delineated for a statistical power of 90% to be able to detect a drop of 20 units in the AHI, considering the standard deviation of 20 units, for a significance level of α = 0.05. The data were analyzed with the help of SPSS (version 11.5) and SigmaPlot (version 8.0).

Table 1. Demographic data of the study patients

Characteristics	Patients (n = 12)
Age, years	44.6 ± 7.1
Females	3 (25%)
Height, cm	172.2 ± 9.2
Weight, kg	151.91 ± 22.6
Excess weight, kg	77.37 ± 17.4
BMI, kg/m^2	51.55 ± 10.1
Smokers	2 (16.6%)
Caucasians	12 (100%)

Means ± SD and numbers (%) are shown.

Results

Between December 2002 and July 2004, 128 bariatric surgeries were performed in this hospital. Twenty patients were pre-operatively tested with polysomnography due to subjective symptoms of daytime somnolence, and 18 patients were identified with OSAHS. One patient was excluded from this study for having only a polysomnography performed 3 years before the surgery, and 4 patients were excluded because they had mild apnea (AHI <15). Therefore, 13 patients fulfilled the inclusion and exclusion criteria; 1 of them declined to repeat the post-operative polysomnography.

Table 1 presents the baseline characteristics of the 12 patients evaluated in the study. Obstructive sleep apnea was no longer present in 25% of the patients (n = 3), and a significant improvement (as indicated by a reduction in AHI) was noted in another 50% (n = 6). Four of these patients improved from severe to moderate disease and 2 from severe to mild. Those who did not improve were more often the most obese with BMI >40 kg/m², but this difference was not statistically significant.

The patients were reevaluated after 24.2 ± 6.4 months. The mean weight changed from 151.9 ± 22.6 to 100.7 ± 18.9 kg; the BMI fell from 55.5 ± 10.1 to 34.1 ± 8.1 kg/m^2, signifying a mean loss of excess weight of 70.5 ± 24%; 10 of the 12 patients lost more than 50% of the excess weight. There was a significant reduction in AHI, which changed from a median (range) of 46.5 (33–140) to 16 (0.9–87) events per hour ($p < 0.05$; fig. 1). There was also a significant improvement in mean oxygen saturation during the night, showing an increase from 85.7 ± 5.1 to 94.5 ± 3.6% ($p < 0.05$; fig. 2). A significant improvement in the minimum oxygen saturation was detected, which increased from 64.7 ± 13.4 to 78.7 ± 13.7% ($p < 0.05$).

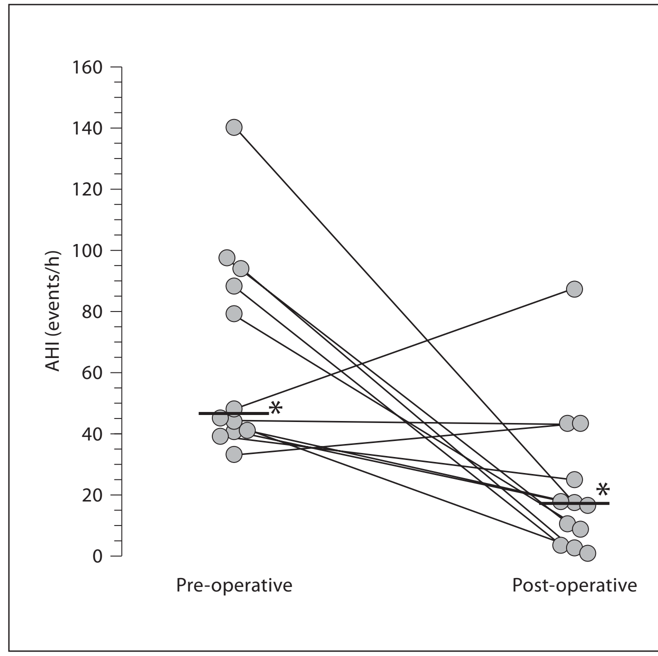

Fig. 1. AHI before and after bariatric surgery. $p < 0.05$. Asterisks indicate median values.

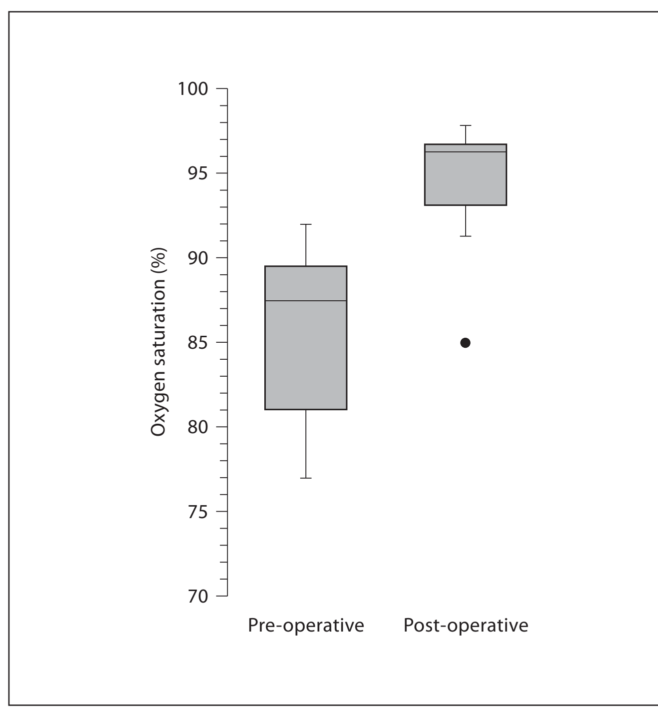

Fig. 2. Mean oxygen saturation before and after bariatric surgery. $p < 0.05$.

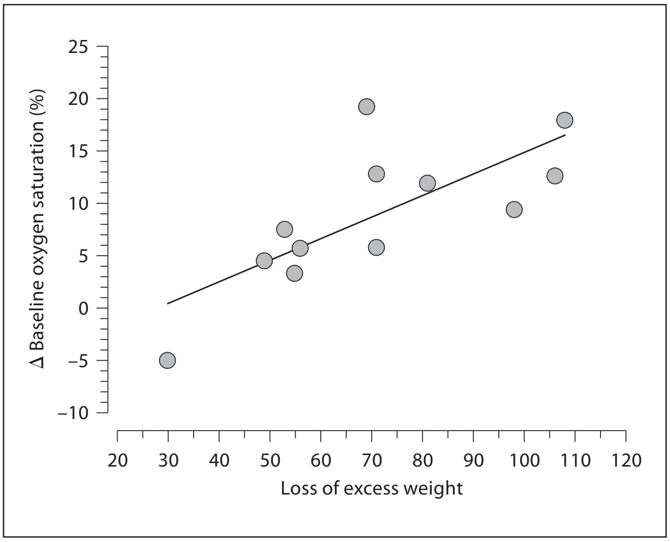

Fig. 3. Correlation between loss of excess weight and variation in mean oxygen saturation. $p < 0.01$, $r = 0.76$.

In the pre-operative period, 5 patients were treated with CPAP for OSAHS, while none used such a device at the time of reevaluation. In relation to comorbidities, there was a significant decrease in the prevalence of diabetes mellitus (25–8.3%), systemic arterial hypertension (83.3–50%), dyslipidemia (58.3–16.7%) and hyperuricemia (41.7–8.3%).

The determination of daytime somnolence according to the Epworth Sleepiness Scale indicated a mean score of 4.8. Only 1 patient showed a score >10, suggesting excessive daytime somnolence.

There was a strong positive correlation between loss of excess weight and improvement in minimum and mean oxygen saturation (fig. 3). There was no significant correlation between excess weight loss and change in AHI ($r = 0.283$; $p = 0.37$).

There were no early complications during the post-operative follow-up of these patients. Late complications included severe anxiety in 1 patient and iron malabsorption in another.

Discussion

The data presented here are consistent with those of the few available studies in the literature [27], where in nearly all cases great benefit was observed. However, most of those studies present several biases, as patients were often lost to follow-up and follow-up was short so that final weight was not achieved and stabilized. The small proportion of patients with obstructive sleep apnea submitted to bariatric surgery who are later reevaluated is perhaps the greatest limitation of these earlier studies. This can generate bias, since patients who are not reevaluated may correspond to patients who do not improve, thereby overestimating the actual effect of surgery.

An important point to be considered is that results recorded after a short follow-up period may be under- or overestimating success rates. During the first 6 months following surgery, patients can adopt other habits that may contribute to temporary improvements of OSAHS, e.g. abstaining from alcohol. On the other hand, as a consequence of the short follow-up, they may still have significant weight to loose, contributing to future improvement in their disease. We followed the subjects for a more clinically relevant period.

Thus, the strengths of this study are its longer follow-up (24.2 ± 6.4 months) compared to other studies and the follow-up of nearly all the patients, which is in contrast to many publications where many patients were lost to follow-up. Here, 12 of 13 patients who were initially selected were reevaluated (92.3%).

Our data show that weight loss achieved by bariatric surgery provides substantial benefits to morbidly obese patients with severe obstructive sleep apnea. Benefits included significant AHI reductions with improvement in oxygenation, the latter correlating with the degree of weight loss. Following bariatric surgery, some patients no longer had sleep apnea; the majority markedly improved, and only a minority showed no change in AHI. Even when sleep apnea remained unchanged despite bariatric surgery, there was improvement in overnight oxygenation. This could be secondary to improvements in extrathoracic obstruction and lung mechanics, although postsurgical pulmonary function tests were not performed.

Although only 25% of the patients were considered cured of apnea, most of them (91.6%) did not show symptoms of excessive daytime somnolence according to the Epworth Sleepiness Scale. Even though objective measurement of baseline daytime somnolence is not available, the reason for the initial polysomnography was subjective complaints of excessive daytime somnolence, probably corresponding to high scores on the Epworth Scale. In addition, none of the patients were on CPAP treatment at the time of reevaluation, because they felt no longer daytime somnolence. Therefore, one of the objectives of the treatment of sleep apnea, to improve daytime somnolence, was achieved.

The second main objective of OSAHS treatment is to reduce the risk of developing diseases associated with apnea, especially cardiovascular diseases. Many of the deleterious consequences of OSAHS are a result of frequent episodes of hypoxemia that occur during the night [40]. Even though the pathophysiology of cardiovascular complications is multifactorial, involving sympathetic excitation, endothelial dysfunction, inflammation and insulin resistance, it is probable that intermittent episodes of hypoxia and, particularly, intermittent episodes of re-oxygenation play a central role in the process [41–44]. If so, the prevention of hypoxemia episodes and re-oxygenation in OSAHS could result in the prevention of inflammatory activation, and, thereby, this treatment facilitates, at least in part, a reduction in cardiovascular risks [40].

This study demonstrated that bariatric surgery affords substantial weight loss that is sustained over a long follow-up period. The majority of the patients studied achieved a weight reduction considered clinically important. Significant improvements in the frequencies of the main comorbidities were also observed. No surgical complications occurred in this group, which corroborates the data in the literature, indicating that it is a generally safe surgical intervention particularly if weighed against the morbidity of extreme obesity [15].

Some limitations to our study should be noted. The patients studied had very severe obesity with a mean BMI of 51.5 $\pm$ 10.1 kg/m^2. Therefore, the results cannot be extrapolated to a population of less obese patients, as those with a BMI between 35 and 40 kg/m^2, or to a non-morbidly obese population (BMI between 30 and 35 kg/m^2). Because of the design of this protocol, the study patients sought treatment for obesity, and not OSAHS per se. Therefore, they do not represent patients whose main problem is OSAHS, and the conclusions of this study cannot be appropriately extended to this group.

Based on these findings, which are consistent with the literature, we believe that surgical treatment for weight reduction should be considered as an important option in the care of morbidly obese patients with obstructive sleep apnea.

Acknowledgment

We thank Dr. A. Leyva for English language editing.

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