The effect of massive weight loss on pulmonary function of morbid obese patients


Pulmonary Division, University of São Paulo Medical School, São Paulo, SP, Brazil
Endocrinology Division, University of São Paulo Medical School, São Paulo, SP, Brazil

Summary

Study objectives: To test if morbid obesity causes pulmonary function changes and if massive weight loss have effect on pulmonary function (especially in subjects with BMI ≥ 60 kg/m²).

Participants: Thirty-nine morbid obese subjects before and after massive weight loss.

Measurements and results: Patients had baseline BMI ≥ 40 kg/m², pulmonary function test (PFT) before and after surgery for gastric volume reduction and massive weight loss, and presented no complaints unrelated to obesity. Based on initial BMI, the patients were divided in groups A (BMI 40–59.9 kg/m²) and B (BMI ≥ 60 kg/m²). Initially, group A (n = 28) had normal PFT, however group B (n = 11) presented FVC and FEV₁ measurements in the lowest limit of normality (with normal FEV₁/FVC), significantly different from group A. After massive weight loss, the group B compared to A had a significant improvement in FVC (23.7% vs. 9.7%, P = 0.012) and FEV₁ (25.6% vs. 9.1%, P = 0.006); thus the initial difference in FVC and FEV₁ between groups no longer existed after weight loss.

Conclusions: These results point out that the severe morbid obesity (BMI ≥ 60 kg/m²) may lead to pulmonary function impairment and presents more prominent pulmonary function gain after massive weight reduction. The possible clinical implications of these results are that PFT abnormalities in subjects with BMI < 60 kg/m² should probably be interpreted as consequence of intrinsic respiratory disease and that severe morbid obese patients may be encouraged to lose weight to improve their pulmonary function, especially those with concomitant pulmonary disorders.

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KEYWORDS
Massive weight loss; Morbid obesity; Pulmonary function
**Introduction**

Obesity is becoming more and more prevalent worldwide and can be defined by the presence of body mass index (BMI) \( \geq 30 \text{ kg/m}^2 \). In Brazil, there also is a trend of increasing prevalence, from 2.1% to 12.4% (1975–1997).\(^1\)\(^2\) This increase in the prevalence turns obesity into one of the most common disorders in medical practice, associated with a large number of other clinical conditions or diseases, such as cardiovascular disorders, diabetes mellitus, chronic arterial hypertension, hyperlipidemia, digestive diseases, sleep apnea, asthma and pulmonary function changes.\(^3\)\(^–\)\(^6\)

The influence of weight loss on different organ functions has been studied in malnourished, critically ill and obese subjects. Specifically in obese patients, weight reduction may improve diastolic cardiac function and affect the entire cluster of cardiovascular disease (CVD) risk factors, such as insulin resistance and type 2 diabetes mellitus, dyslipidemia, hypertension and inflammation.\(^7\)\(^–\)\(^9\) Therefore, weight-management strategies should be considered as primary therapy for obese patients with CVD.\(^7\)

Regarding changes in pulmonary function related to morbid obesity, it has been described a consequent decrease in functional residual capacity (FRC) and expiratory reserve volume (ERV). Although some studies have addressed the question about the impact of massive weight reduction on respiratory function of patients with morbid obesity (BMI \( \geq 40 \text{ kg/m}^2 \)), this has never been specifically addressed in severe morbid obesity (BMI \( \geq 60 \text{ kg/m}^2 \)).\(^10\)\(^–\)\(^13\) The aim of this study was to analyse the pulmonary function patterns related to morbid obesity, and the effect of massive weight loss on pulmonary function testing (PFT), emphasizing on subjects with BMI \( \geq 60 \text{ kg/m}^2 \).

**Methods**

**Selection of Subjects**

Morbid obese patients from the Endocrinology Division of our tertiary hospital in São Paulo, Brazil that underwent surgery for gastric volume reduction (bariatric surgery) from 2000 to 2002, were studied retrospectively by their medical records, performing a total of 99 subjects. Thirty-nine of these patients had pulmonary function testing (PFT) before and after the surgery. They were stratified according to their BMI prior to surgery into group A (morbid obese—BMI 40–59.9 kg/m\(^2\)) and B (severe morbid obese—BMI \( \geq 60 \text{ kg/m}^2 \)). The BMI was computed as the ratio between body weight (kg) and squared height (m). Clinical data and smoking history were achieved from medical records and demographic data concerning age, sex, weight and height were obtained from PFT datasheet. Height and weight, as standard of PFT lab, were measured in the standing position, with subjects wearing soft clothes, without shoes.

**Pulmonary function testing**

PFT was performed with the patient in sitting position, with nose clips in place, using a flow sensor pneumotachograph (Pulmonary Data Service—Koko—Colorado, USA). Patients performed 3 acceptable FVC maneuvers according to American Thoracic Society guidelines, meeting repeatability criteria.\(^14\) The largest FVC and FEV\(_1\) values were reported, regardless of the maneuver. FEV\(_1\)/FVC ratio was also calculated.

**Statistical analysis**

All statistical analysis was done using SPSS statistical package program (SPSS Inc., Chicago, IL, USA). Data are expressed as mean \( \pm SD \), and statistical significance was set at \( P < 0.05 \). We tested normal distribution of the data within the groups with Kolmogorov–Smirnov test, and then we used unpaired \( t \)-test for the comparison between groups. Pearson correlation coefficients were calculated to describe the relationship between BMI and baseline FVC, and between BMI reduction and absolute changes in FVC and FEV\(_1\) in the entire group (\( n = 39 \)). We also calculated the effect of weight loss and BMI reduction, through linear regression models, on absolute changes in FVC and FEV\(_1\), and on relative changes in FVC and FEV\(_1\) (calculated by the ratio of post-surgery minus baseline value over baseline; values in liters).

**Results**

Thirty-nine patients were enrolled and divided into groups A (BMI 40–59.9 kg/m\(^2\)) and B (BMI \( \geq 60 \text{ kg/m}^2 \)). The group A had 28 patients (25 women) and group B had 11 subjects (7 women). The baseline demographic and PFT characteristics are outlined in Table 1. We found a significant correlation between baseline FVC and BMI (\( r = -0.35 ; P = 0.02 \)) (Fig. 1).

The proportion of smokers and/or ex-smokers was 39% in group A and 45% in group B, without any
clinical complain suggestive of obstructive disease. There was no change in smoking habit after surgery.

Data after massive weight loss are shown in Table 2 for the entire population and for groups A and B. The mean time between surgery and post-operative PFT was of 12.74 months with a mean weight loss of 35.87 9.9% of their initial weight, without difference between groups (\(P=0.749\)). For the entire population (9 = 39), there was a significant correlation between absolute weight loss and absolute changes in FVC (\(r=0.526, P = 0.001\)) and in FEV\(_1\) (\(r=0.568, P<0.001\)). These correlations were maintained between absolute change in BMI and absolute changes in FVC (\(r=0.414, P = 0.009\)) and FEV\(_1\) (\(r=0.433, P = 0.006\)), and also between absolute change in BMI and relative changes in FVC and FEV\(_1\) (Figs. 2 and 3). Based on these findings, for every change of 10 kg/m\(^2\) in BMI, the FVC improved by 150 mL, and the FEV\(_1\) by 105 mL.

We found a significant difference between the two groups when considering the changes in FVC and FEV\(_1\) after weight loss. While FVC and FEV\(_1\) increased, respectively, 0.301 (9.7%) and 0.229 L (9.1%) in group A, group B presented a marked increase of 0.632 L (23.7%) in FVC (\(P=0.012\)) and of 0.556 L (25.6%) in FEV\(_1\) (\(P=0.006\)). Because of this marked gain in pulmonary function presented in the group B, the initial, statistically significant difference in FVC and FEV\(_1\) between groups A and B disappeared after weight loss (\(P=0.078\) and 0.156, respectively).

Discussion

The major finding of the present study was that severe morbid obese subjects presented a marked and significantly higher gain in FVC and in FEV\(_1\) despite the same degree of relative weight loss than morbid obese patients with lower BMI.

Obesity may induce restrictive disturbance of respiratory function, related to reduced compliance of chest wall and/or pulmonary parenchyma. The chest mechanics in morbid obese are altered due to the subcutaneous adipose tissue and the splinting of diaphragm by intraabdominal fat, and the decreased lung compliance has been related to increased pulmonary blood volume.\(^4\) In our study, in agreement with data previously published, severe morbid obese subjects (group B) with no complaints other than obesity initially had FVC and FEV\(_1\) in the lowest limits of normality, with normal FEV\(_1\)/FVC.\(^4,15\) In contrast, group A had normal values of FVC, FEV\(_1\) and FEV\(_1\)/FVC at baseline, suggesting that the impairment at pulmonary function can be associated only to severe morbid obesity.
Consequently, in subjects with BMI $< 60\, \text{kg/m}^2$, the finding of abnormal FVC and/or FEV$_1$ should not prevent the investigation of other clinical situations that lead to lung function abnormalities, such as pulmonary or chest wall diseases.

Considering PFT changes related to weight reduction, there was a significant correlation between absolute weight loss and absolute changes in FVC. Between groups A and B, the relative change in FVC and FEV$_1$ were significantly different for the same degree of relative weight loss ($\pm 35\%$). In addition, after massive weight reduction, the significant difference of FVC and FEV$_1$ between groups A and B, which initially existed, disappeared. These findings reinforce the data previously described that respiratory function decline related to weight gain is worse among subjects with higher baseline BMI.$^{16,17}$

A limitation of this study might be the selection of morbid obese subjects. We selected only those with complete data and PFT before and after bariatric surgery (39 from 99). Furthermore, measurements of total lung capacity and residual volume as well as other clinical variables like oxygen saturation or arterial blood gases, which would greatly improve the physiological understanding about the effects of weight loss in respiratory function, were not available for our analysis. However, pulmonary function reports did not mention any abnormality in oxygen saturation at baseline nor after weight loss. Nevertheless, the initial PFT measurements in groups A and B were in accordance with previously published data involving patients with BMI of $40-59.9\, \text{kg/m}^2$ and $\geq 60\, \text{kg/m}^2$, respectively.$^{4,10,15,18}$ Even though, a prospective study following these populations

### Table 2  Post-surgery data.

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentual weight loss</td>
<td>$35.8 \pm 9.1%$</td>
<td>$35.5 \pm 8.7%$</td>
<td>$36.6 \pm 10.4%$</td>
</tr>
<tr>
<td>FVC%</td>
<td>$105.4 \pm 13.1$</td>
<td>$107.7 \pm 13.4$</td>
<td>$99.5 \pm 10.8$</td>
</tr>
<tr>
<td>Relative change FVC (%)</td>
<td>$13.6 \pm 16.1$</td>
<td>$9.7 \pm 14$</td>
<td>$23.7 \pm 17.2^*$</td>
</tr>
<tr>
<td>FEV$_1$%</td>
<td>$104.4 \pm 13$</td>
<td>$106.3 \pm 13.2$</td>
<td>$99.6 \pm 11.8$</td>
</tr>
<tr>
<td>Relative change FEV$_1$ (%)</td>
<td>$13.8 \pm 17.4$</td>
<td>$9.1 \pm 13.4$</td>
<td>$25.6 \pm 21.3^*$</td>
</tr>
<tr>
<td>FEV$_1$/FVC</td>
<td>0.83</td>
<td>0.83</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Data presented as mean $\pm$ sd.

$^*$P $< 0.05$ for the comparison between groups A and B.

FVC%: FVC in percent of the predicted.

Relative change FVC: (post-surgery FVC/initial FVC)/initial FVC.

FEV$_1$%: FEV$_1$ in percent of the predicted.

Relative change FEV$_1$: (post-surgery FEV$_1$/initial FEV$_1$)/initial FEV$_1$.

**Figure 2** Correlation between relative change in FVC (post-surgery/initial FVC/initial FVC, presented in percentual) and absolute change in BMI ($r = 0.509$; $P = 0.001$).

**Figure 3** Correlation between relative change in FEV$_1$ (post-surgery/initial FEV$_1$/initial FEV$_1$, presented in percentual) and absolute change in BMI ($r = 0.513$; $P = 0.001$).
should be performed, with long term follow-up, to clarify the impact of these changes over daily activities and quality of life of morbid obese patients, mainly in subjects with BMI $\geq 60$ kg/m$^2$.

Previous data have shown that weight loss might have a positive repercussion in pulmonary function and even in respiratory symptoms of morbid obese patients.\textsuperscript{19,20} Specifically in asthmatic, weight loss was related to decreases variability in peak flow during the day.\textsuperscript{20} None of the studies, however, included patients with BMI greater than 60 kg/m$^2$. This population, according to our results, is of particular interest once, even without respiratory complains, pulmonary function is presented at the lowest limits of normality and completely normalized after massive weight loss.

In conclusion, the results presented here point out that the severe morbid obesity (BMI $\geq 60$ kg/m$^2$) may lead to pulmonary function impairment with all its potential complications. Furthermore, the severe morbid obese subjects had more prominent pulmonary function gain related to weight reduction. The possible clinical implications of these results are that PFT abnormalities in subjects with BMI < 60 kg/m$^2$ should be properly investigated and not immediately interpreted as consequence of respiratory impairment related to obesity, and that severe morbid obese patients should be encouraged to lose weight to improve their pulmonary function, what could probably have especial importance for those with concomitant pulmonary disorders.

References