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Hypoxemia and Hypoventilation Syndrome Improvement after Laparoscopic Bariatric Surgery in Patients with Morbid Obesity

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Abstract. *Background: The objective of this study was to evaluate the relationship between oxygen partial pressure (pO_2), awake oxymetric saturation (SpO_2), body mass index (BMI), and percentage of excess weight loss (EWL) in extremely severe obesity (BMI >50 kg m^{-2}) and hypoxemia, before and after laparoscopic Roux-en-Y gastric bypass. Patients and Methods: A group of 11 obese patients aged 41.2±10.2 years (4 men, 7 women, median BMI=52.3 kg/m^2, range 50.2-57.1) were prospectively enrolled in the study. BMI, arterial blood gas measurements, and spirometry were obtained before and after (6 and 12 months) surgery. Results: The main preoperative parameters were SpO_2=88.3±3.9%, predicted forced vital capacity (FVC)=84.5±8.3%, predicted forced expiratory volume exhaled in one second (FEV1)=79.9±10.1%. No relationship (p>0.01) was found between BMI, SpO_2, and FEV1. A significant correlation between SpO_2 and both paO_2 (R=0.74, p=0.009) and EWL (R=–0.75, p=0.008) was found. Three, 6, and 12 months after surgery EWL was 18.9%, 26.4%, and 39.6% (p<0.001), respectively. At one-year follow-up SpO_2, FVC, and FEV1 were 96.2±3.2% (p<0.001), 112.3±9.9% (p<0.001), and 101.6±18.8% (p=0.003), respectively. Conclusion: In patients with extremely severe obesity, bariatric surgery may improve significantly both SpO_2 and spirometric parameters, and EWL represents the factor that impacted the results.*

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Obesity is a disorder of body composition, defined by a relative or absolute excess of body fat (1).

The prevalence of obesity has increased dramatically in the last decades, occuring in about 25% of adult men and 30% of adult women in the USA (1, 2). Respiratory co-morbidity (*i.e.* obesity-hypoventilation syndrome (OHS)) represents a common complication in morbidly obese patients, and when patients lose weight a rise in oxygen partial pressure (pO_2), and a fall in dioxide partial pressure (pCO_2) are usually observed.

The aim of this study was to evaluate the relationship between baseline and postoperative pO_2, awake pulse oxymetric saturation (SpO_2), body mass index (BMI), and percentage of excess weight loss (EWL) in patients with extremely severe obesity and hypoxemia (pO_2<75 mm Hg), before and after bariatric surgery.

Patients and Methods

Eleven extremely obese patients (BMI>50) undergoing laparoscopic Roux-en-Y gastric bypass were enrolled in the study. The gastric bypass combines the creation of a small gastric pouch with bypassing a portion of the upper small intestine (3). Additional modifications resulted in the Roux-en-Y gastric bypass, a now common operation that involves stapling the upper stomach into a 30-mL pouch and creating an outlet to the downstream small intestine (4).

There were 4 men and 7 women (median BMI=52.3 kg/m^2, range 50.2-57.1) aged 41.2±10.2 years. In all patients, preoperative and postoperative measurements of BMI, SpO_2, predicted forced vital capacity (FVC), and predicted forced expiratory volume exhaled in one second (FEV1) were performed. Informed consent was obtained from all participants, in accordance with institutional review board approval.

The reported data are expressed as mean±standard deviation (SD). The Pearson's correlation coefficient (R) calculation was used to evaluate the linear relationship between pairs of variables. Comparisons between groups were performed using the Mann-

Whitney *U*-test and the Student's *t*-test. A *p*-value <0.01 was considered statistically significant.

Results

The main preoperative parameters were the following: SpO_2=88.3±3.9%, FVC=84.5±8.3%, FEV1=79.9±10.1%. No relationship was found between BMI and SpO_2 (R=0.06, *p*=0.86), FVC (R=0.26, *p*=0.43), or FEV1 (R=0.18, *p*=0.59). A significant correlation between age, SpO_2 (R=0.75, *p*=0.007), FVC (R=–0.95, *p*<0.001), and FEV1 (R=–0.96, *p*<0.001), and between SpO_2 and both pO_2 (R=0.74, *p*=0.009) and EWL (R=–0.75, *p*=0.008) was found.

Three, 6, and 12 months after surgery, EWL was 18.9%, 26.4%, and 39.6% (*p*<0.001), respectively. At one-year follow-up SpO_2, FVC, and FEV1 were 96.2±3.2% (*p*<0.001), 112.3±9.9% (*p*<0.001), and 101.6±18.8% (*p*=0.003), respectively.

Discussion

OHS describes the hypoventilation observed in severe obese patients when other causes (*i.e.* chronic lung or respiratory muscle diseases) are absent (5). It represents a heterogeneous group of disorders with differing clinical manifestations, such as obstructive sleep apnea, and chronic daytime hypoventilation.

Ventilatory responsiveness is attenuated in patients with OHS (6, 7). Respiratory muscle strength is reduced in obese patients with OHS, and following significant weight loss, both respiratory muscle performance and lung volumes improve, along with normalization of hypoxemia (3, 8). Patients with OHS should have daytime hypoxia (PO_2<70 mm Hg) and hypercapnia (PCO_2>45 mm Hg) (9). Moreover, the severity of obesity and the associated changes in lung function play an important role in the pathogenesis of pulmonary hypertension (10, 11).

The mechanism of hypoxemia and hypercapnia in obese patients with OHS are shown in Figure 1. The role of leptin is unclear. Leptin is a hormone produced in adipose cells that suppresses appetite through interaction with its receptor in hypothalamus (12). Hypoxic suppression of leptin production, and a central nervous system leptin resistance in patients with OHS have been suggested, but leptin is more likely a respiratory modulator or an epiphenomenon of obesity (13-15).

About 50% of obese patients scheduled for bariatric surgery have associated respiratory comorbidity, such as obstructive sleep apnea syndrome, OHS, and overlapping chronic obstructive pulmonary disease (16-18). In our series, all patients had hypoxemia, and reduced FVC and FEV1. At one year follow-up, SpO_2, FEV and FEV1 improved significantly (*p*<0.01), and a relationship between EWL and both SpO_2 and pO_2 was found. In several studies, after Roux-en-Y gastric bypass patients presented significant weight loss, and improvement of hypoxemia, hypercarbia and in spirometric results (18-21). However, neither number of weight loss attempts nor the maximal preoperative weight loss correlate with the percentage of excess weight loss after laparoscopic Roux-en-Y gastric bypass surgery (22).

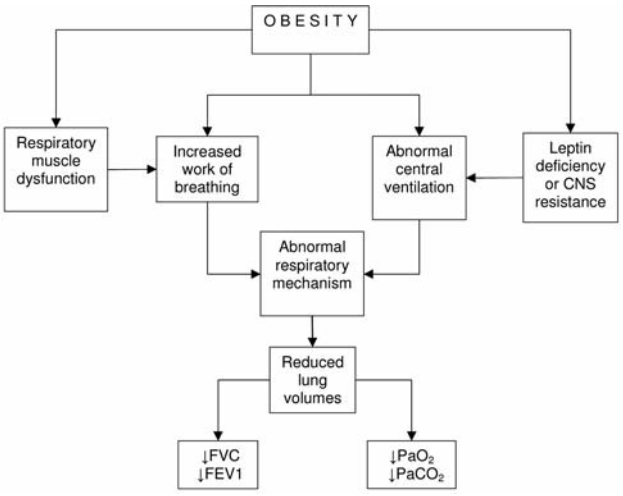

Figure 1. *Mechanism of hypoxemia and hypercapnia in obese patients with obesity hypoventilation syndrome. CNS=Central nervous system, FVC=predicted forced vital capacity, FEV1=predicted forced expiratory volume exhaled in one second, PaO_2=arterial oxygen partial pressure, $PaCO_2$=arterial carbon dioxide partial pressure.*

In conclusion, in patients with extremely severe obesity, bariatric surgery may improve significantly both SpO_2 and spirometric parameters, and EWL represents the factor that impacted results.

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