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Improvement of Associated Respiratory Problems in Morbidly Obese Patients after Open Roux-en-Y Gastric Bypass

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Background: Obstructive sleep apnea syndrome (OSAS) is present in 44% of patients scheduled for bariatric surgery. Respiratory dysfunction associated with this syndrome is attributable to chronic obstructive pulmonary disease (COPD) and/or obesity hypoventilation syndrome (OHS). We studied the long-term effect of bariatric surgery on weight loss, on the respiratory co-morbidities associated with obesity, and on the need for non-invasive positive pressure ventilation.

Methods: We followed a sample of patients with respiratory co-morbidity scheduled for open Capella Roux-en-Y gastric bypass (RYGBP) over 5-years. Patients who were positive for polysomnographic studies and required continous positive airway pressure (CPAP) before surgery were included. All patients were subjected to the same anesthetic and surgical protocols. At 1 year after surgery, polysomnographic studies were performed and arterial blood gases and pulmonary function were tested.

Results: Of the 209 patients scheduled for bariatric surgery during the study period, 105 had respiratory co-morbidity. Of these, 30 required CPAP-BiPAP treatment before surgery and were included in our study. Surgery took 128 minutes (range 70 to 210 minutes). Tracheal extubation in the operating theater was possible for 26 patients (86.7%). During the early postoperative period, 7 patients (23.3%) presented respiratory complications. Length of hospitalization was 6.87 days (range 4 to 11 days). At 1 year after RYGBP, patients presented significant weight loss and improvement of hypoxemia (from 73.3±10.6 to 90.5±11.5, *P*=0.000), hypercarbia (from 44.5±5.7 to 40.6±4.9, *P*=0.005), and in spirometric (*P*=0.004) and polysomnographic results (*P*=0.001). CPAP-BiPAP treatment after weight loss was necessary in only 14% of patients (*P*=0.001).

Conclusions: Weight loss after RYGBP improved arterial blood gases, respiratory tests and polysomnographic studies. CPAP treatment can be withdrawn in most patients.

Key words: Morbid obesity, bariatric surgery, Roux-en-Y gastric bypass, respiratory function, sleep apnea, anesthesia

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Introduction

Morbid obesity is associated with body mass index (BMI) >40 kg/m^2 or >35 kg/m^2 if accompanied by serious co-morbidity;[1] ~2% of the adult population in western countries suffer from this condition.[2] Co-morbidities of morbid obesity consist of arterial hypertension, heart disease, gastroesophageal reflux, diabetes mellitus, respiratory diseases, etc.[3,4]

Mortality rate for bariatric surgery is higher in patients with respiratory co-morbidities.[5] Moreover, patients with these secondary disorders tend to be super-obese (BMI > 50 kg/m^2), which can make the surgical procedure more difficult.[5] About 50% of patients scheduled for bariatric surgery have associated chronic respiratory co-morbidities,[3,6-8] such as obstructive sleep apnea syndrome (OSAS), obesity hypoventilation syndrome (OHS) and overlapping chronic obstructive pulmonary disease (COPD). Non-invasive ventilation has been used successfully to treat several of these respiratory conditions.[9-11]

The long-term effect of bariatric surgery was studied on weight loss, associated respiratory co-morbidities and need for non-invasive positive pressure ventilation (NIPPV).

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Methods

After obtaining institutional approval and written informed consent, data was collected on all patients scheduled for bariatric surgery in our hospital from January 1998 to June 2002. Participants in this study met the following criteria:

1) underwent an open Capella[12] Roux-en-Y gastric bypass (RYGBP);
2) presence of respiratory co-morbidity associated with obesity;
3) patients requiring positive pressure ventilation before surgery;

Patients who underwent surgical procedures other than RYGBP or who were subjected to a laparoscopic approach were excluded.

In accordance with other authors,[13] respiratory co-morbidity was defined as:

1) OSAS, when recurrent episodes of upper glottic airway obstruction during sleep were associated with a positive polysomnographic apnea study (tidal volume absent for >10 seconds, with paradoxical movement of chest and abdomen, with hypoventilation >50% and arterial oxygen saturation <90%). Polysomnographic studies were considered positive when >30 apnea episodes per night and/or >5 apnea episodes per hour of sleep were detected.

2) OHS, when, in addition to nocturnal hypoventilation, chronic daytime hypercapnia ($PaCO_2$ >43 mmHg), polycythemia, and hypoxemia (PaO_2 <75 mmHg or alveolar-arterial oxygen difference in room air of >20 mmHg) were detected.

3) COPD, when symptoms of chronic pulmonary disease (such as bronchitis, emphysema or asthma), chest X-ray images and low spirometric values were present, associated with OSAS or OHS.

NIPPV treatment with nocturnal nasal continuous positive airway pressure (CPAP) was started before surgery in patients with sleep apnea. In patients with acute clinical symptoms of respiratory failure or with severe hypercapnia ($PaCO_2$ >45 mmHg) bilevel positive airway pressure (BiPAP) treatment was prescribed.[14] In patients with COPD, optimizing their medication was done in order to improve their respiratory problem before surgery and non-invasive nasal ventilation was started if indicated.

Preoperative Evaluation and Protocol

Preoperative evaluation consisted of laboratory tests that included liver and kidney function, ECG, abdominal ultrasound, chest X-ray, room air arterial blood gases and spirometry tests. Moreover, predictors of difficult intubation were recorded (Figure 1). Polysomnographic studies were performed in patients with a clinical history of nocturnal snoring, restless sleep, morning headache, excessive daytime sleepiness, intellectual deterioration or a large neck circumference. We recorded the following using a Somte, Compumedics, Australia Computer: nasal flow by nasal canula, respiratory and abdominal movements (piezoelectric sensors), oxygen saturation by pulse-oximetry, snoring, ECG, position of patients and leg movements.

Patients who had been prescribed treatment with two or more antihypertensive drugs were considered to have severe arterial hypertension. Subjects who had been prescribed treatment with insulin or anti-diabetic drugs were included as diabetes mellitus patients.

In order to improve the basal situation of patients, the following recommendations were made to all patients before surgery:

1) stop smoking at least 1 month before surgery;
2) lose weight (especially in patients with BMI >60 kg/m^2): patients with BMI >55 kg/m^2 were admitted hospital 15 days before the operation in order to obtain weight loss before the surgical procedure;
3) respiratory physiotherapy: during pre-anesthesic evaluation, patients learn and practice respiratory physiotherapy exercises in order to use them during the immediate postoperative period;
4) increase exercise: we instruct patients to walk 30-60 minutes per day before the surgery.

Patients were admitted hospital the night before the operation and premedicated with 300 mg of ranitidine po every 12 hours and 3500 IU of low molecular weight heparin (bemiparin) SC every 24 hours.

Once in the operating theater, routine non-invasive monitors were applied and a peripheral intravenous route was established. Patients were placed in reverse Trendelenburg position and received 100% oxygen delivered by mask for 5 minutes. Anesthesia was induced by rapid sequence with 1 mg of atropine, 3 mcg/kg of fentanyl (maximum dose 450 mcg), 1.5 mg/kg of propofol (maximum dose 300

VARIABLE	LOW RISK		HIGH RISK	
1. Mallampati classification*	grade I	grade II	grade III	grade IV
2. Tiromentonian distance	>6 cm		<6 cm	
3. Cervical mobility	>35 grades		<35 grades	
4. Neck circumference Incisivos mandibulares	<60 cm		>60 cm	
5. OSAS	negative		positive	

Figure 1. Predictors of difficult intubation. (*Adapted from Mallampatti SR, Gatt SP, Guigino LD et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J 1985; 32: 429.)

mg) and 100 mg of succinylcholine; tracheal intubation (8.0-mm inner-diameter endotracheal tube) was done within 1 minute, and confirmation of correct endotracheal tube placement was achieved by auscultation and end-tidal CO_2 monitoring. Nasotracheal intubation by fibroscopic technique was done when a difficult intubation was suspected. Atracurium was administered to ensure complete muscle relaxation throughout surgery, which was monitored by the train-of-four ratio on cubital nerve (four stimuli of 2 Hz [0.5 seconds interval], 60 mA; grade of blockade no lower than 75%). Lungs were ventilated with air and oxygen inspired fraction of 0.5; the initial ventilator setting was set at a frequency of 13 breaths/min and a tidal volume of 12 ml/kg ideal body weight (Julian-Drägger; Lübeck, Germany), and adjustments were made to obtain an end-tidal CO_2 >35 mmHg assuming that in normoventilated and hemodynamic stable patients the difference between end-tidal CO_2 and arterial pCO_2 is ~10 mmHg. Peak inspiratory pressures was maintained below 30 cmH_20. Anesthesia was maintained by the administration of Sevoflurane at an end-tidal concentration adjusted to keep the bispectral index score (BIS) between 40 and 60 (Aspect Medical Systems, Inc., Natick, MA); fentanyl boluses of 50-100 mcg were administered in accordance with hemodynamic responses; warmed fluid replacement was performed with Ringers lactate solution (10 ml/kg ideal body weight). In addition to standard anesthesia monitors, arterial blood pressure was measured directly from a left radial artery catheter (20 G) if it could not be measured with a non-invasive system and in patients with severe arterial hypertension or respiratory co-morbidity. Central venous pressure was monitored from a double-lumen catheter inserted in the right internal jugular vein. Urinary catheter was used to monitor urine output. During surgery, patients were covered with a thermal convector air blanket (WarmTouch®, Tyco Healthcare, Pleasanton, CA, USA).

Surgical techniques were identical in all patients. By means of an open laparotomy, a 20-cc gastric pouch was constructed by sequential applications of a linear stapler. A retrogastric, retrocolic Roux-en-Y hand-sewn gastrojejunostomy with absorbable monofilament suture was performed. Patients with a BMI <50 kg/m^2 received a 100-cm Roux limb, those with BMI 50-60 kg/m^2 received a 150-cm limb, and those with BMI >60 kg/m^2 received a 200-cm Roux limb. When the bypass was finished, an intraoperative leak test was done by administration of methylene blue transorally.

After surgery, anesthesia was stopped and patients were ventilated with 100% oxygen. Neostigmine and atropine were administered to reverse neuromuscular blockade according to train-of-four ratio (when at least three responses were observed). When patients regained consciousness (good response to sample orders) and adequate respiratory parameters were observed (adequate respiratory rate with good spontaneous tidal volume and end-tidal CO_2 <43 mmHg), the tracheal tube was removed. Patients were then transferred to the intensive care unit and received 35% oxygen by face-mask. Patients who did not meet tracheal extubation criteria were transferred to the intensive care unit, and mechanical ventilation was started until the criteria were met.

All patients remained in intensive care for the first 24 hours after surgery. A chest X-ray and blood analysis were done every 12 hours, and prophylaxis of deep venous thrombosis was maintained for 3 days. Patients received respiratory physiotherapy, and NIPPV was re-started during the first postoperative day with a low pressure (not higher than 10 cm H_2O) in order to avoid aerophagia and induced leaks.

Pain relief was started during surgery by administration of 2 g of metamizole plus 2 g of propacetamol immediately after anesthetic induction. In the intensive care unit, pain was relieved with PCA-morphine-IV (bolus 0.5 mg, locked-time 5 minutes). Arterial oxygen saturation, respiratory rate and level of consciousness were monitored, and additionally multi-modal analgesia was used by administering 2 g of metamizole plus 2 g of propacetamol every 8 hours. Visual analogic score (VAS) was used to evaluate pain. The goal of treatment was to maintain a VAS score <4 during active physiotherapy. Once on the ward, pain was relieved by intravenous administration of 2 g of metamizole every 8 hours, 2 g of propacetamol IV every 8 hours and 75 mg of meperidine IM every 4 hours.

We applied a clinical pathway that included: mobilization on the first postoperative day, water tolerance and radiological contrast evaluation of anastomosis at day 3, and discharge from hospital on day 4.

Postoperative respiratory complications were noted. These were defined as clinical signs (tachypnea, arterial oxygen desaturation measured by pulse-oximetry) and findings on chest X-ray (atelectasis, pneumonia, etc.) or on the arterial gasometric results (hypoxemia or hypercapnia) that indicated respiratory disturbances. We also recorded length of hospital stay.

At 1 year after the RYGBP, we performed polysomnographic studies, arterial blood gases and pulmonary function tests on all patients. Given that our study aimed to determine the long-term effect of RYGBP on weight loss, associated respiratory co-morbidities and the need for NIPPV, the main variables were:

1) changes in arterial blood gases on room air;
2) index of respiratory disturbances per hour (RDI/h) and time and length of oxygen saturation <90% in polysomnographic analyses;
3) positive pressure ventilation requirement 1 year after surgery.

In addition, demographic variables and co-morbidities were recorded 1 year after surgery. The results were analyzed with a SPSS statistical program. Student's *t*-test was used for continuous variables and Chi-square for discontinuous variables. Statistical significance was set at $P<0.05$.

Results

During the study period, 209 patients were scheduled for bariatric surgery. Patients selected for study are shown in Figure 2. Twenty-five patients were excluded because they had been scheduled for other surgical procedures (eight for laparoscopic techniques and 17 for gastric bands). In 184 patients, an open Capella RYGBP was performed.[12] Of these, 79 did not present respiratory co-morbidities associated with obesity and were therefore excluded from the study. Of the 105 patients with respiratory co-morbidity, only 30 required NIPPV before surgery; thus, data for these 30 patients were analyzed.

Demographic data are shown in Table 1, while

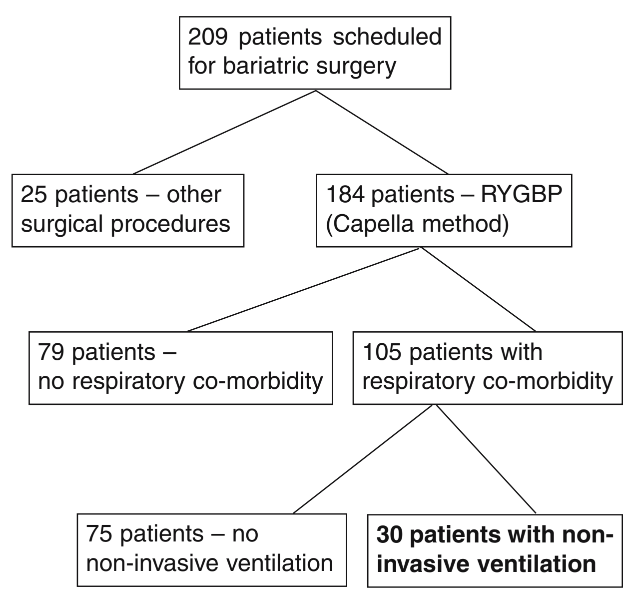

Figure 2. Course of the 209 patients selected for bariatric surgery (Jan 1998 - June 2002).

Table 2 shows preoperative findings and associated co-morbidites. Before surgery, 12 patients (40%) were reported to be smokers, and 16 patients (53%) presented arterial hypertension. Chronic renal failure was present in one patient (3.4%). Liver dysfunction was observed in 5 patients (17.9%). Seventeen patients (56.7%) presented chest X-ray alterations before surgery: of these, 9 (30%) showed increased cardiothoracic index, 7 (23.3%) a bilateral interstitial pattern and 1 (3.4%) an elevated diaphragm.

Perioperative date are shown in Table 3. Surgery took 128 minutes (SD 27.81), with a range of 70 to 210 minutes; in 1 patient (3.3%) nasotracheal intubation with fibroscopy was necessary. Tracheal extubation was performed in the operating theater in 26 patients (86.7%), while four patients (13.3%) were extubated in the intensive care unit, without showing any complications. All patients were moved to the ward 24 hours after surgery.

During the early postoperative period, 7 patients (23.3%) presented respiratory complications. Of these, 5 (16.6%) presented postoperative atelectasis that was diagnosed by chest X-ray, which responded to medical procedures, and tracheal intubation was not necessary. Two presented arterial desaturation during the first hours after surgery, at the same time as PCA administration of morphine and without other symptoms added, suggesting a severe complication such as pulmonary embolus. Administration of oxygen by mask was sufficient treatment, and tracheal reintubation was not required in either case.

Length of hospitalization was 6.87 days (SD 1.68), ranging from 4 to 11 days.

At 1 year after the RYGBP, 6 patients showed arterial hypertension (20% vs 53.3% before surgery). Patients became less hypoxemic, had less hypercapnia and showed improved spirometric and polysomnographic results (Table 4). NIPPV was withdrawn in all but 4 patients. At 1 year after surgery, the mean BMI of our sample was 36.69 kg/m^2

Table 1. Demographic data

	General population before surgery (n=209)	Study sample before surgery (n=30)	Study sample after surgery (n=30)
Age (years)	42±9.5	44±9	45±9*
Weight (kg)	127.35±24.34	144.5±27.12	82.67±19.51*
BMI (kg/m^2)	49.69±8.52	56.53±8.39	32.12±59*
Male/Female (%)	13/87	27 / 73	

Values are mean ± standard deviation. *P<0.05 (t-test).

Table 2. Associated co-morbidities and preoperative findings

	Study sample before surgery (n=30)	Study sample after surgery (n=30)	P-value
Chest X-ray alterations (%):	17 (57)		
cardiothoracic index	9 (30)		
bilateral interstitial pattern	7 (23)		
elevated diaphragm	1 (3)		
Respiratory co-morbidity:			
OSAS (%)	14 (47)		
OHS (%)	9 (30)		
COPD (%)	7 (23)		
HTA (%)	53	20	0.0017*
Diabetes mellitus (%)	7	–	0.000*

*P<0.05 (Chi-square). HTA = systemic arterial hypertension.

Table 3. Perioperative data

	Study Sample (n=30)
Surgery length (min) (SD, range)	128 (27.81, 70-210)
Operating room extubation (%)	26 (87)
Respiratory complications (%):	7 (23)
atelectasis (%)	5 (17)
arterial desaturation (%)	2 (7)
tracheal reintubation (%)	0 (0)
Length of hospitalization (days) (SD, range)	6.87 (1.68, 4-11)

SD = standard deviation

(SD 7.94 kg/m^2). NIPPV was withdrawn a mean of 10.52 months (SD 6.65) after the operation; at this time-point, patients had a mean weight loss of 34.09% (SD 14.6).

Following the New York Heart Association classification, before surgery 15.4% of patients presented grade II of dyspnea, 50% grade III and 34.6% grade IV. At 1 year after the operation, 96.2% of patients presented grade I and 3.8% grade II; no cases of grade III and IV were detected.

Discussion

Before surgery, patients had a mean BMI of 56.53 kg/m^2; this value exceeded the criteria for super-obesity[1] and is greater than the value in other bariatric surgery studies.[3,6,7,15] Super-obese patients had respiratory co-morbidity, defined as a breathing dysfunction due to fat accumulation in the respiratory system.[5,16] At 1 year after RYGBP, our patients showed weight in the low range of morbid obesity, consistent with the results of other studies.[5,17]

This large weight loss led to a clear improvement in arterial gasometric values, both hypoxemia and hypercapnia, thereby corroborating the findings of other studies.[5,18] Again, improvement of results from spirometric tests were also clear, mainly in the restrictive values (forced vital capacity) but not for the Tifeneau ratio. Expiratory reserve volume showed the most significant improvement after surgically-induced weight loss. The lack of improvement in the obstructive component of lung function may be due to the high percentage of smokers in our sample, which may have masked the results by opposing effects on residual volume and functional residual capacity.[19]

The improvement in the polysomnographic results 1 year after surgery are consistent with other

Table 4. Respiratory results before and 1 year after RYGBP

	Before surgery (n=30)	After surgery (n=30)	*P*-value
Arterial pO_2, mmHg	75.2±11.04	90.54±11.48	0.000*
Arterial pCO_2, mmHg	44.39±5.31	40.55±4.86	0.005*
Arterial bicarbonate, mmHg	28.25±3.22	27.2±2.7	0.054
Arterial pH	7.4±0.02	7.42±0.02	0.003*
A-a O_2 diference, mmHg	18.42±8.47	10.7±6.7	0.001*
Arterial sat. O_2 (%)	94.25±2.84	96.96±1.15	0.001*
FEV1, %predicted	77.58±14.39	104.19±29.53	0.001*
FVC, %predicted	81.99±12.67	114.6±15.36	0.000*
FEV1/FVC, %	83.22±7.2	80.98±7.39	0.151
RDI (/h)	63.59±38.39	17.45±16.64	0.004*
Time of saturation <90%	40.51±21.81	2.65±4.9	0.001*
Positive pressure ventilation (%) 100	13.8	0.001*	

FVC, % pred: percentage of forced vital capacity.
FEV1,% pred: percentage of forced expiratory volume during first second.
FEV1/FVC, %: percentage of ratio of forced expiratory volume in 1 second to forced vital capacity.
RDI: respiratory disturbance index. *P<0.05 (*t*-test).

reports.[5,16,18,20,21] In patients with acute clinical symptoms of respiratory failure or with severe hypercapnia ($PaCO_2$>45 mmHg), BiPAP treatment is indicated to improve gas exchange, and to keep respiratory mechanics stable and improve symptoms associated with chronic hypoventilation.[14] Furthermore, improvement in dyspnea after surgery was significant. Consequently, CPAP or BiPAP treatment was withdrawn in most patients. Most patients avoided CPAP or BiPAP treatment, but the success in avoiding non-invasive nasal ventilation in our study was higher than reported, although the weight reduction observed was similar to the other studies.[5,22,23] Although more studies are necessary to evaluate why in some patients avoidance of non-invasive ventilation is not possible after weight reduction, we believe that an anatomic factor of the upper airway exists in those patients, that could explain OSAS, independent of their obesity. When untreated, OSAS causes continued morbidity.[24] Therefore, weight-reducing operations are indicated even when other respiratory co-morbidities are diagnosed. However, follow-up >1 year may be necessary because worse figures may arise 5 years after surgery.[5]

In our study, the ratio of men to women was 2.75:1, which differs from other studies. This difference could be because sex distribution becomes more equal with extreme obesity values and because severe respiratory co-morbidity associated with obesity is more common in men,[5] thereby representing *per se* a risk factor of morbidity and mortality during the postoperative period.[25]

Respiratory co-morbidity was detected in 105 of 184 patients in our series (57%), which represents a higher prevalence than reported in other studies.[3,6,7] This prevalence could be attributed to the high BMI of our patients. Upper glottic airway obstruction caused by accumulation of fatty tissue at the hypopharynx produces apnea and nocturnal hypoventilation (OSAS) in 5% of morbidly obese patients;[3,20] the arterial oxygenation reduction that occurs during sleep leads to both pulmonary vasoconstriction and stimulation of the respiratory center to prevent hypercapnia.[26] The obstructive syndrome is established by the clinical manifestation of upper glottic airway obstruction, and definitive diagnoses required polysomnographic studies.[27-28] Untreated OSAS my lead to obesity-hypoventilation syndrome with chronic daytime hypercapnia (pCO_2>45 mmHg) and arterial hypoxemia with increased alveolar-arterial oxygen difference on room air.[26,29-31] The severity of both obstructive and hypoventilation syndrome are related to the degree of obesity; therefore, the prevalence of these conditions is increased in patients scheduled for bariatric surgery.[3,6,7]

In the preoperative evaluation, 56.7% of patients presented abnormal chest X-rays, mainly an increase in the cardiothoracic index, which has been reported elsewhere.[32] Alveolar hypoventilation syndrome has been detected in 12-20% of patients with OSAS and depended on the alteration of basal arterial blood gases, association of OSAS and obstructive problems, and the severity of obesity.[33-35] Pulmonary hypertension is not related to the severity of nocturnal apneas.[35]

Several authors consider that patients with OSAS should be extubated the day after surgery, while those with OHS should be extubated 1-5 days after surgery.[5] In our series, most patients were extubated in the operating theater. In our opinion, early tracheal extubation is crucial to avoid postoperative respiratory complications. Therefore, it is useful to administer multi-modal analgesia in order to prevent postoperative pain, which can impair respiratory mechanics. During the early postoperative period, 23.3% of our patient sample presented respiratory complications. Atelectasis was the most common, occurring in 16.6% of patients. The incidence of atelectasis during the early postoperative period after bariatric surgery is under-estimated when chest X-rays are used to diagnose this condition, compared to the incidence detected by means of tomography.[4] No patients were diagnosed with pulmonary embolism or died during the study. Mortality in bariatric surgery is associated with respiratory complications.[6,18,25] Further studies are necessary to determine the impact of laparoscopic surgery on postoperative respiratory complications in patients with respiratory co-morbidity scheduled for bariatric surgery.

Before surgery, systemic arterial hypertension was present in 53.3% of patients, a slightly higher percentage than values reported in previous studies.[7,8] In contrast, diabetes was detected in few patients, which contrasts with the findings of other authors.[3,7] We cannot explain this difference. The high prevalence of diabetes mellitus, liver dysfunction and arterial hypertension in the obese population is explained by the interaction of multiple factors.[36]

Morbidly obese patients show an increase in intraabdominal pressure, which could lead to a decrease in liver, pancreatic and kidney perfusion, and also have fatty infiltration of these tissues with liver fibrosis, insulin alteration and nephrosis;[36] in spite of this, a lineal proportion between grade of damage of these tissues and BMI does not exist. We observed that the weight loss after surgery decreased the incidence of both systemic arterial hypertension and diabetes.[37,38]

Although the number of patients can limit our analysis, we regressed our data to see if the immediate postoperative respiratory complications are related to sex, age, BMI, alteration of preoperative room-air arterial blood gases, respiratory co-morbidity, presence of arterial hypertension, presence of diabetes, smokers or ex-smokers, and the possibility of operating-room extubation after surgery. We considered statistical significance results when $P<0.05$. In general, no relationship existed between immediate postoperative respiratory complications and those variables. However, we found operating room extubation was less possible in patients who presented OHS or who were smokers. On the other hand, arterial desaturation was related to male and to smokers or ex-smoker patients. If we study the regression relationship with length of hospital stay (we considered hospital stay prolonged when >8 days, that was the 75th percentile), we found that length of stay was related to BMI and alteration of preoperative room-air arterial blood gases.

We conclude that weight loss obtained after bariatric surgery improves the values of arterial blood gases and respiratory and polysomnographic results. This improvement is related to the percentage of weight lost and occurs within the first year after RYGBP. Therefore, positive pressure ventilation treatment was able to be withdrawn in most patients. These improvements ameliorated the quality of life of these severely incapacitated individuals as dyspnea was reduced. However, long-term follow-up is required to confirm the weight loss and clinical improvement.

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