ISSN 1413-3555
Rev Bras Fisioter, São Carlos, v. 14, n. 4, p. 290-5, July/Aug. 2010
©Revista Brasileira de Fisioterapia

Noninvasive ventilation in the immediate postoperative of gastrojejunal derivation with Roux-en-Y gastric bypass

Ventilação não invasiva no pós-operatório imediato de derivação gastrojejunal com bypass em Y de Roux

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Abstract

Background: Morbidly obese patients develop more atelectasis during general anesthesia than non-obese ones, and these atelectasis persist for 24 hours after the end of the surgical procedure. **Objectives:** This study evaluated the effect of noninvasive ventilation with two pressure levels (BiPAP) in the pulmonary function, incidence of immediate postoperative pulmonary complications and the development of anastomotic dehiscence in morbid obese patients submitted to gastrojejunal derivation in Roux-en-Y (RYGB). **Methods:** It was an analytical and clinical study involving patients who were submitted to RYGB, had a body mass index (BMI) of at least 35 kg/cm^2, and were randomly chosen to receive BiPAP (experimental group) or standard oxygen therapy (control group), in the first four hours of the post-operation period. Patients with chronic or acute pulmonary disease were not included, and neither were the ones who needed invasive mechanical ventilation by the end of the surgery. Vital capacity, maximal inspiratory and expiratory pressure, and arterial blood gases were measured in the preoperative and in the first postoperative. Chest X-ray was performed in the third postoperative. **Results:** Eighteen patients were chosen for the study: ten received BiPAP and eight received standard oxygen therapy. The study group had better partial oxygen pressure and lower maximal expiratory pressure levels in the postoperative state than the control group. Anastomotic dehiscence was not observed in any group. There was no significant difference between the control group and the study group relating to the loss of vital capacity, maximal inspiratory pressure in the postoperative period or the incidence of atelectasis. **Conclusion:** The BiPAP in the postoperative period of gastroplasty was useful to improve oxygenation and did not increase the incidence of anastomotic dehiscence.
Article registered in the Australian New Zealand Clinical Trials Registry under the number ACTRN12609000979257.

Key words: morbid obesity; oxygenation; noninvasive ventilation.

Resumo

Contextualização: Pacientes obesos mórbidos desenvolvem mais atelectasias durante a anestesia geral que pacientes não obesos, e elas persistem 24 horas após o término do procedimento cirúrgico. **Objetivos:** Este estudo avaliou o efeito da ventilação não invasiva com dois níveis pressóricos (BiPAP) na função pulmonar, a incidência de complicações pulmonares no pós-operatório imediato e o desenvolvimento de deiscência de anastomoses em pacientes obesos mórbidos submetidos a derivação gastrojejunal em Y-de-Roux (RYGB). **Métodos:** Estudo analítico, ensaio clínico envolvendo pacientes submetidos à RYGB, com índice de massa corpórea (IMC) de pelo menos 35 kg/cm^2, randomizados para receber BiPAP (estudo) ou terapia padrão com oxigênio (controle), nas primeiras quatro horas de pós-operatório. Não foram incluídos pacientes com doença pulmonar aguda ou crônica ou que necessitaram de ventilação mecânica invasiva ao término da cirurgia. Capacidade vital, pressão inspiratória e expiratória máxima, gasometria arterial foram mensurados no pré-operatório e no 1º pós-operatório; radiografia de tórax foi realizada no 3º pós-operatório. **Resultados:** Dezoito pacientes foram incluídos no estudo, 10 receberam BiPAP e 8 terapia padrão com oxigênio. O grupo do estudo teve melhor pressão parcial de oxigênio e menor pressão expiratória máxima no pós-operatório que o controle. Não se observou deiscência de anastomose em nenhum grupo. Não houve diferença significante entre o grupo controle e o do estudo com relação à perda da capacidade vital, pressão inspiratória máxima no pós-operatório e incidência de atelectasias. **Conclusão:** O BiPAP no pós-operatório de gastroplastia foi útil para melhorar a oxigenação, não aumentando a incidência de deiscência de anastomose.
Artigo registrado no Australian New Zealand Clinical Trials Registry sob o número ACTRN12609000979257.

Palavras-chave: obesidade mórbida; oxigenação; ventilação não-invasiva.

Received: 08/01/2009 – **Revised:** 08/06/2009 – **Accepted:** 21/10/2009

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Introduction

Mortality in bariatric surgery is more common in patients with respiratory comorbidities. Approximately 50% of the patients in need of such surgery have associated chronic respiratory comorbidities, such as Obstructive Sleep Apnea (OSA), Obesity Hypoventilation Syndrome (OHS) and Chronic Obstructive Pulmonary Disease (COPD)[1]. The OSA is a common condition in morbidly obese patients, with prevalence ranging from 12 to 78%, however most patients are not diagnosed before the surgery[2]. Consequently, the combination of preexisting OSA and laparotomy significantly increases the morbidity and mortality of obese patients by respiratory complications[3].

The acute respiratory insufficiency is a frequent complication after abdominal surgery and is associated with the increase in morbidity and mortality[4]. General anesthesia and some types of surgery that affect the abdominal or thoracic muscles cause a negative effect on pulmonary mechanics by altering gas exchange and favoring the emergence of pulmonary complications in the immediate postoperative (PO) period[5]. Pulmonary atelectasis is the main cause of these negative effects and can occur in 85 to 90% of healthy adult subjects during the first minutes after the anesthesia. Morbidly obese patients develop more atelectasis during general anesthesia than non-obese patients, and this condition persists for 24 hours after the end of the surgical procedure[6].

Oxygen administration and the use of incentive spirometers are efficient in the treatment of the majority of hypoxemia cases. Despite this, respiratory insufficiency might occur in the PO period of abdominal surgery, and so the performance of tracheal intubation and mechanical ventilation is necessary in 8 to 10% of the patients[7]. Noninvasive ventilation (NIV) is considered the therapy of choice for patients with COPD exacerbation, but has also been used successfully in patients with hypoxemic respiratory insufficiency of several sources, including PO abdominal surgeries[4,8,9]. In the PO period, the use of continuous positive airway pressure (CPAP) improves the gas exchange in obese patients without compromising the integrity of the upper gastrointestinal anastomosis[10].

The NIV uses two levels of pressure (BiPAP) and has shown itself to be effective in preventing respiratory insufficiency in morbidly obese subjects if performed within 48 hours of extubation[11]. The effects of BiPAP on pulmonary function of the patients were assessed, and so was the incidence of pulmonary complications and dehiscence of gastrojejunal anastomosis in the PO period of gastric derivation in RYGB.

Methods

An analytical study was performed, consisting of a clinical trial with 20 patients at the University Hospital of Presidente Dutra, São Luis (MA), Brazil, from July 2005 to August 2006. A convenience sample was used and the selected patients were over 18 years old and had body mass index (BMI) equal or superior to 35 kg/m^2. The participants were submitted to a gastrojejunal derivation with Roux-en-Y gastric bypass in the Bariatric Surgery Service of the hospital. Patients with chronic or acute pulmonary disease were not included, and neither were the ones who needed invasive mechanical ventilation by the end of the surgery. The patients were randomly divided into two groups by a draw using sealed envelopes. The first group (experimental) received NIV four hours into the immediate PO period, right after the extubation, and while they were at the post-anesthetic recovery room. The second group (control) received oxygen support after the extubation, with a flow of 4 L per minute through a nasal catheter (type glasses), as described in the hospital protocol.

The pulmonary function test and the chest X-ray were performed in the preoperative period during evaluation by a pulmonologist to determine the surgical risk. According to the American Thoracic Society guidelines, obstructive pulmonary disease was defined as a reduction in the ratio between forced expiratory volume in the first second and forced vital capacity (FEV1/FVC), and restrictive ventilatory defect was defined as a reduction of the FVC with an increased ratio FEV1/FVC (>85-90%). The degree of gravity of the respiratory disorders was based on the predicted FEV1 percentage: low when FEV1>70%, moderate when 60≤FEV1≤69, moderately high when 50≤FEV1≤59, high when 35≤FEV1≤49 and very high when FEV1<35%[12].

Associated pulmonary diseases were considered absent when test results for pulmonary function and chest X-ray were normal and when there were no respiratory symptoms, such as cough, mucus production, dyspnea or bronchospasm.

The procedures performed in both groups were: quantification of the risk of pulmonary complications in the PO period by the Torrington & Henderson scale, and measurement of the vital capacity (VC), maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP) and arterial blood gas (ABG). These evaluations were performed preoperatively and during the first PO period. The preoperative period was considered as the day before the surgery, and first PO period as the first day after the surgery. The same examiner performed all the measurements.

As in other studies[13-16], the VC was measured by use of an analogue ventilometer (Ohmeda Respirometer®, model RM 121, Japan). During this procedure, the patients sat down

with their feet supported and nostrils occluded by a nose clip. Three measurements were performed from the total lung capacity (TLC) to the residual volume (RV), with an interval of one minute between them and adopting the greatest measure as the result.

The MIP and the MEP were measured by use of a manovacuometer (Suporte®, class B, Brazil) with scale varying from 0 to 159 cmH_2O, connected to the patients through a hard plastic mouthpiece. The MIP was obtained through the RV value and the MEP through the TLC value, and was measured at all times with the patients in the sitting position with their nostrils occluded by a nose clip. A small hole was made in the mouthpiece to prevent glottal closure during the procedure and the patients' cheeks were held by one of their hands. Each effort was sustained for at least one second. The procedure was repeated three to five times, with intervals of one minute, until three values with a difference between them of less than 10% were obtained. The greatest measure was adopted as the result, except for the last procedure[17]. Reference equations for maximal respiratory pressures proposed by Pereira[18] were used.

The ABG was collected from the radial artery during the preoperative and first PO period, using a 1 ml syringe lubricated with sodium heparin and needle size of 4.5 x 13 mm. The patient was in the supine position, breathing ambient air. The examination was performed using a blood gas analyzer (ABL 700® Series, Radiometer Medical). The variables assessed were partial pressure of oxygen in arterial blood (PaO_2) and oxyhemoglobin saturation of arterial blood (SaO_2)[19].

The NIV was performed by a noninvasive ventilator (BiPAP synchrony ST®, Respironics, Murrysville, USA), which was set in the spontaneous-timed (S-T) mode. Inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) were adjusted to 12 cmH_2O[20] and 8 cmH_2O[21], respectively. The inspiratory time was 0.8 seconds, the breathing frequency was 8 bpm, the rise time was 1 second, the ramp was 0.5 cmH_2O and the oxygen flow rate was 4 L per minute. A nasal mask with headgear was used as a patient-ventilator interface.

All the participants were submitted to daily respiratory physical therapy in the preoperative and PO periods under the guidance of the physical therapist, who had no knowledge about which patient had used the NIV. In the preoperative period, the subjects were guided in terms of the surgical incision, importance of coughing, early ambulation and respiratory patterns. Respiratory physical therapy was initiated in the first PO period and consisted of the performance of respiratory exercises associated to free global active exercises, assisted cough, incentive spirometry and ambulation.

The surgeon in charge assessed the integrity of the gastrojejunal anastomosis before starting a meal and during the second PO period. The methylene blue test was used for the procedure, as follows: 5 ml of the solution were diluted into 100 ml of saline solution; the solution was then taken orally in portions of 20 ml every 20 minutes until the solution was finished. The result was assessed by the abdominal cavity drain tube, which was placed next to the gastrojejunal anastomosis[22]. The chest X-ray was performed during the third PO period. For pain control in the PO period, Tramadol 100 mg 12/12h and Dipirona 2 g 6/6h were provided via intravenous injection.

The study was approved by the Research Ethics Committee of the University Hospital of Presidente Dutra, Universidade Federal do Maranhão (UFMA), São Luís (MA), Brazil (Record: 162/05), under the number 104/06, following the provisions of resolution 196/06. The informed consent was obtained from all participants.

The software used for statistical analyses was Bioestat 3.0[23]. The quantitative variables were presented in terms of means and standard deviations, and qualitative variables in terms of frequencies and percentages. The Shapiro-Wilk test was used to test the normality of the variables. Differences between the groups were assessed by the Student's *t*-test for independent samples ((normally distributed variables), or by the Mann-Whittney test (non-normal variables). The significance level of 5% was adopted.

Results

Twenty patients participated in the study: 18 women (90%) and 2 men (10%). Two of the selected patients were excluded from the study: one patient did not accept noninvasive ventilatory support in the immediate PO period, and one patient was not able to perform the evaluation during the first PO period. Of the 18 patients included, 10 were randomized to the experimental group (EG) and 8 to the control group (CG). The demographic variables, vital capacity values, respiratory pressures and arterial blood gases in the preoperative period were similar between the groups (Table 1). Two patients in the EG were ex-smokers and had stopped smoking about 10 years ago. In the CG, there was one ex-smoker, which had not smoked for a year.

The pulmonary function test demonstrated the following means and percentages of the predicted values, respectivelly: FVC 2.98±0.56 L, 95.05±16.01%; FEV1 2.46±0.51 L, 94.89±15.05%; FEV^1/FVC 82.62±6.48%, 99.26±7.43%. These data were within the established limits based on age, gender and height. All the patients demonstrated normal chest X-rays in the preoperative period, with low risk of developing pulmonary complications in the PO period, according to the Torrington & Henderson scale.

Table 2 presents the partial pressure of oxygen, the oxyhemoglobin saturation, and the loss of vital capacity, respiratory pressures and PaO_2 for each group in the first PO period. No statistically significant difference was detected between the

groups on the losses of VC and MIP (p=0.62 and p=0.53, respectively). The EG showed a greater loss of MEP (p=0.01), whereas the CG showed lower PaO_2 and SaO_2 values (p=0.04 and p=0.02, respectively) (Table 2).

Abdominal distension and/or anastomotic dehiscence were not observed among the participants of this study. Three patients in the CG demonstrated radiological alterations in the chest X-ray performed in the third PO period: two patients demonstrated right lower lobe atelectasis, and one patient demonstrated bilateral pneumoperitoneum. One patient in the EG demonstrated right lower lobe atelectasis. All the patients remained in the hospital for five days.

Table 1. Patient demographic variables, vital capacity, respiratory pressures and arterial blood gases in the preoperative period.

Variables	NIV (n=10)	Control (n=8)	p value
Age (years)	36.7±10.7	43.1±7.5	0.13
Gender (M/F)	2/8	0/8	—
BMI (kg/cm^2)	48.5±8.2	46.3±5.7	0.50
VC (ml)	3.037±864	2.576±492	0.14
MIP (cmH_2O)	-110.5±21.7	-102.7±13.7	0.33
MEP (cmH_2O)	102.3±28.1	92.7±23.4	0.39
pH	7.41±0.02	7.42±0.01	0.44
PCO_2 (mmHg)	38.2±3	38.3±3	0.94
PaO_2 (mmHg)	77.03±7.32	73.99±7.66	0.46
HCO_3 (mEq/L)	24.1±1.9	24.8±1.6	0.38

Data presented as mean and standard deviation. BMI=body mass index; VC=vital capacity; MIP=maximal inspiratory pressure; MEP=maximal expiratory pressure; PaCO2=partial pressure of carbon dioxide in arterial blood; PaO2=partial pressure of oxygen in arterial blood; HCO3=bicarbonate concentration in arterial blood.

Table 2. Partial pressure of oxygen and oxyhemoglobin saturation in the 1st postoperative, and loss of vital capacity, respiratory pressures and partial pressure of oxygen in the postoperative period.

Variable	Group NIV	Control Group	p value
PaO_2 (mmHg) 1st PO	71.6±6.69	64.03±6.1	0.04
SaO_2 (%) 1st PO	95.5±1.6	93.4±1.8	0.02
VC (ml)	32.28±9.81	30.03±9.15	0.62
MEP (cmH_2O)	39.32±15.24	22.93±10.20	0.01
MIP (cmH_2O)	32.87±4.87	31.78±10.97	0.53
Loss of PaO_2 (%)	6.96±3.52	13.31±5.30	0.02

Data presented as mean and standard deviation; PaO2=partial pressure of oxygen in arterial blood; SaO2=oxyhemoglobin saturation in arterial blood; MEP=maximal expiratory pressure; MIP=maximal inspiratory pressure; VC=vital capacity. P>0.05.

Discussion

Obesity might cause damages to pulmonary function due to its effects on mechanical ventilation, air resistance, lung volumes and respiratory mucles[24]. This condition is considered an independent risk factor for PO pulmonary complications[25]. The prophylactic use of the NIV during the PO period of lung resections and gastroplasty has been shown to be effective in improving gas exchange and pulmonary function, when compared to treatments using nothing but oxygen[8].

A convenience sample was recruited in the present study, including all the subjects submitted to the gastrojejunal derivation in RYGB during the period in which the study was performed. The sample size was similar to that of other studies that also used a convenience sample to evaluate surgical procedures or procedures applied postoperatively in patients with morbid obesity[6,20,26-29].

In this study, the Torrington & Henderson scale was used to estimate the risks of pulmonary complications in the PO period. This scale was validated for use in a Brazilian population in 2000, and it was shown to be an appropriate measure to identify patients with low, medium or high risks of pulmonary complications, or death by pulmonary cause, during the PO period of elective general surgery[31]. All the patients demonstrated low risks of pulmonary complications in the PO period.

Previous studies have shown that the prophylactic use of BiPAP in the first 12 to 24 hours following a gastric bypass surgery in morbidly obese patients significantly increases the pulmonary function, when compared to a control group[20,32]. In the present study, BiPAP was applied to patients submitted to gastroplasty four hours into the immediate PO period, while they were in the post-anesthetic recovery room. The measurement of the pulmonary function was performed 24 hours later. No statistically significant difference was detected between the group that received BiPAP and the control group in terms of VC reduction during the first PO period. Joris et al.[32] and Ebeo et al.[20] used BiPAP during 12 to 24 hours, in periods from 3 to 4 hours. They observed an increase in the FVC and FEV[1] from 24 to 30% in the group that used NIV in comparison to the control group during the measurement of the pulmonary function in the PO period. The absence of difference observed in the present study can be justified by the use of NIV for a smaller amount of time, as the subjects remained in the post-anesthetic recovery room for about 5 hours, and were then sent to a ward. Joris et al.[32] reported a dose-dependent effect of the IPAP in restrictive lung disease, as the group that used BiPAP of 8/4 cmH_2O did not demonstrate a statistically significant reduction in disease intensity when compared to the control group. Therefore, this effect would be considered dependent of dosage and time.

The dysfunction of respiratory muscles after upper abdominal surgery (UAS) is well established, as are the reductions in

MIP and MEP values after laparotomy. This is due to several factors such as irritation and inflammation, or trauma next to the diaphragm, which lead to local mechanical failure, reflex inhibition and pain[33]. Few studies have evaluated the alterations in respiratory pressures of morbidly obese patients during the PO period of UAS. Paisani, Chiavegato and Faresin[13] found a 51% reduction in the mean MIP and a 39% reduction in the mean MEP during the first day of the PO period in patients submitted to Fobi-Capella gastroplasty surgery. In the present study, the group that used the NIV (EG) demonstrated a greater loss of expiratory pressure in the preoperative period than the group that did not use the NIV (CG). No statistically significant difference was detected between the groups in terms of the inspiratory pressure.

When analyzing the effects of NIV on the activity of inspiratory muscles in obese patients, Pankow et al.[34] found a 46% reduction in diaphragm's activity with the use of the BiPAP. The authors concluded that the assisted NIV can cause partial inactivation of the respiratory muscles in patients with severe obesity[34]. Cambonio et al.[35] assessed the effects of CPAP in children with severe acute viral bronchiolitis by monitoring the pressure x time product of the gastric pressure (GP) as an indicator of expiratory muscle activity. The authors concluded that the reduction in the GP wave could be related to alterations in the breathing pattern after the use of CPAP, such as the increase in expiratory time, which favors passive expiration with no expiratory muscle activity. The present study did not assess the respiratory muscle activity during the use of NIV. However, the greater loss of MEP in the EG might have been a consequence of the inactivation of the muscles due to ventilatory assistance. Considering expiratory muscles, this inactivation persisted for 24 hours after the NIV.

With respect to oxygenation, patients who used NIV demonstrated greater PaO_2 and SaO_2 during the PO period than those who did not use NIV. This indicates better oxygenation levels with the use of NIV, probably due to an increase in functional residual capacity (FRC). Several ventilation strategies have been assessed for their effect on improving arterial oxygenation during the intraoperative period in patients with morbid obesity[21]. The use of CPAP restores the FRC to preoperative levels, improving PO oxygenation[3].

The ideal levels of IPAP and EPAP for obese patients submitted to abdominal surgery are not yet established. Previous studies[20,32] suggest that an IPAP of 12 cmH_2O promotes lung inflation and an EPAP of 4 cmH_2O prevents alveolar collapse at the end of expiration. Erlandsson et al.[36] analyzed the optimization of the positive end-expiratory pressure (PEEP) using electrical impedance tomography during laparoscopic gastric bypass. The authors concluded that PEEP levels of around 15 cmH_2O were necessary to prevent lung collapse and to improve gas exchange in morbidly obese patients. Chalhoub et al.[21] assessed the effects of the vital capacity maneuver (VCM) in morbidly obese subjects submitted to open bariatric surgery and found that PEEP levels of 8 cmH_2O associated to VCM were sufficient to significantly improve arterial oxygenation and to avoid hemodynamic instability. The levels of IPAP and EPAP used in the present study were based on these previous findings.

The use of CPAP during the PO period potentially increases the risk of anastomotic dehiscence as a result of the increase in air pressurization in the stomach and proximal anastomosis[3]. However, anastomotic dehiscence was not observed in any participant of this study, suggesting that the procedure can be safely applied during the PO period of upper abdominal surgery, given that the appropriate pressures are used. The recommended lung inflation pressure is 20 cmH_2O or lower[10,27,29], in order to avoid the opening of the lower esophageal sphincter and consequent gastric insufflation, regurgitation and bronchoaspiration. Huerta et al.[3] assessed the safety and efficiency of CPAP after gatroplasty and concluded that it is safe for treating patients with risks of PO apnea. However, Jensen at al.[32] suggested that in patients with OSA the use of CPAP/BiPAP during the PO period of laparoscopic gastrojejunal derivation in RYGB, and also its previous use, can be safely suppressed once the patients are monitored and their pulmonary function is optimized by intensive incentive spirometry and early ambulation.

Two patients (onein the CG and one in the EG) demonstrated segmental atelectasis in the third PO period. The incidence of atelectasis during the early PO period of bariatric surgery is known to be underestimated when the diagnosis is performed by chest X-ray[1]. Chest tomography could not be used in the present study to diagnose atelectasis in the PO period because the capacity of the service's tomograph was 150 kg. The NIV has been successfully used to correct atelectasis in the PO period and thus restore the FRC, prevent the collapse of upper airways and increase the lung compilance[38]. On the other hand, inpatient treatment through breathing exercises has been shown to improve respiratory muscle strength, oxygenation, cough mechanisms, chest mobility and pulmonary ventilation. These exercises also appear to decrease the respiratory work and prevent pulmonary complications in the PO period[39]. In the present study, there was no difference in the incidence of atelectasis between the groups. This fact can be a consequence of the sample size or the period of application of the NIV.

It is concluded that the use of NIV in the PO period of gastrojejunal derivation with Roux-en-Y gastric bypass is effective in improving oxygenation, without increasing the incidence of fistulas or anastomotic dehiscence, once the appropriate levels of inflation pressure are applied.

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