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Boussignac CPAP in the Postoperative Period in Morbidly Obese Patients

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Background: In the postoperative period hypoventilation and hypoxia with hypercarbia may occur in morbidly obese patients due to the residual influence of general anesthesia drugs, postoperative atelectasis and postoperative pain. *Non-Invasive Ventilation* (NIV) is a method of improvement of respiratory efficiency in patients not requiring mechanical ventilation. The aim of the study was to compare NIV (Boussignac) CPAP and traditional oxygen delivery via nasal catheter in the postoperative acute care unit (PACU) in morbidly obese patients after open Roux-en-Y gastric bypass (RYGBP).

Methods: 19 morbidly obese patients scheduled for elective open RYGBP, were randomly divided into 2 groups: CPAP (10 patients) or control (nasal catheter - 9 patients). Patients consisted of: 8 male and 11 female, mean weight 127.76 ± 18.5 kg, height 173.41 ± 9.41 cm, BMI 42.43 ± 3.3 kg/m^2, age 35.84 ± 9.05 years. In the PACU, capillary blood gas measurements were taken at 3 Time Points: T1 - 30 min, T2 - 4 hours and T3 - 8 hours after admission. Sample T0 was taken before surgery. For management of postoperative pain, patients received morphine 2 mg/h intravenously and tramadol 100 mg.

Results: Mean blood gas measurements of all postoperative time points were: pO_2 81.0±16.0 (range 78.1-85.7) mmHg vs 65.9±4.9 (range 63.8-68.1) mmHg (*P*<0.05); pCO_2 40.6±2.4 (range 39.4-41.8) mmHg vs 41.5±4.0 (range 39.6-43.4) mmHg (*P*>0.05), in the CPAP and control groups respectively. In every case, pulse-oxymetry oxygenation was >94%.

Conclusion: Boussignac CPAP improved blood oxygenation compared to passive oxygenation with a nasal catheter but had no influence on CO_2 elimination in non-CO_2 retaining morbidly obese patients.

Key words: Morbid obesity, non-invasive ventilation, CPAP, postoperative period

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Introduction

Non-invasive ventilation (NIV) is a method for improvement respiratory efficiency in dyspneic patients not requiring mechanical ventilation and for prevention of respiratory failure. This method is also used for management of sleep apnea syndrome (SAS) and obesity hypoventilation syndrome (OHS) at home. NIV continuous positive airway pressure (Boussignac CPAP) is used in the postoperative period in obese patients with SAS and OHS. It is recommended that patients suffering from SAS and OHS should have in-hospital NIV CPAP for the perioperative period.[1] NIV CPAP may also be used for prevention of postoperative respiratory complications in patients not suffering from SAS or OHS but having other risk factors such as obesity itself. In the postoperative period, hypoventilation and hypoxia with hypercarbia may occur in morbidly obese patients due to the residual influence of general anesthetic drugs, postoperative atelectasis and postoperative pain.[2] The Boussignac method consists of a firmly applied mask connected to a CPAP device which is connected to an O_2-delivery catheter.

Obese patients are very sensitive to any drugs influencing the respiratory drive. However, after major abdominal surgery such as open Roux-en-Y gastric bypass (RYGBP), it is necessary to administer opioids for postoperative pain management. This may increase the incidence of Critical Respiratory Events (CRE). Oxygen support is absolutely necessary and often respiratory support is needed.

In the hospital setting, respirators are used to create CPAP. Outside the hospital and in emergency settings,

other devices that are smaller and easier to use are used. Boussignac CPAP is easy to use and is a cheap system for the emergency setting in patients requiring ventilatory support without the need for endotracheal intubation. The aim of this prospective randomized study was to compare the Boussignac CPAP system with traditional oxygen delivery via nasal catheter in the postoperative period in morbidly obese patients.

Materials and Methods

After obtaining institutional ethics board approval, 19 morbidly obese patients without a history of SAS or OHS scheduled for elective open RYGBP, were randomly divided into two groups: CPAP (10 patients) or controls (nasal catheter - 9 patients). There were: 8 male and 11 female patients, mean weight 127.76 ± 18.5 kg, height 173.41 ± 9.41 cm, BMI 42.43 ± 3.3 kg/m^2, and age 35.84 ± 9.05 years. Patients were asked about their sleep pattern, regarding snoring and recurrent arousal during the night, somnolence during the day. In both groups, snoring occurred in all patients. No patients had the other mentioned symptoms.

On arrival in the operating theater, standard anesthesia monitoring was instituted. At this moment, SpO_2 was >94% in every patient breathing room air. General anesthesia was administered with sevoflurane, fentanyl and atracurium.

After recovery from anesthesia, patients were transferred to the postoperative acute care unit (PACU) where capillary blood gas measurements were taken at Time points: T1 - 30 minutes after admission to the PACU, T2 - 4 hours after admission to the PACU, T3 - 8 hours after admission to the PACU. To compare results with initial values a sample was taken before surgery – T0. In the CPAP group, patients received oxygen support through the CPAP Boussignac device with a mean pressure of 9.4 cmH_2O confirmed by measurement. We used the device for measurement of cerebrospinal fluid pressure with a special connector.

In the control group, patients were breathing with oxygen delivery through a nasal catheter, with oxygen flow 4 l/min. In both groups, pure oxygen was delivered but patients were breathing a mixture of air and oxygen. Therefore, the FiO_2 was difficult to estimate because it was dependant on many factors, i.e. depth of breathing and respiratory rate.

Patients were observed for findings associated with increased work of breathing such as substernal retraction, sternocleidomastoid activity, and abdominal paradoxical movement. Evaluation also included patient activity, arousal, and tolerance to the method of oxygen delivery used. Continuous SpO_2 measurement was used in every case. If a patient was tired of the CPAP mask, he/she was allowed to take it off for several minutes but no longer than for 30 minutes. It was explained to the patients that this method of ventilatory support is necessary to increase their safety.

For management of postoperative pain, patients received continuous infusion of morphine 2 mg/h intravenously and repeated doses of tramadol 100 mg every 8 hours. As "rescue" pain medication, metamizol was used if the patient required an additional dose of analgesic. Pain was estimated using the visual analogue score (VAS). The patient received "rescue" medication if the VAS was >4. If the VAS was <4, the patient received standard treatment.

Statistical analysis was performed between groups using independent samples *t*-test with double samples assuming unequal variations, and *t*-test for connected pairs with double samples for means within groups to compare changes in parameters. Statistical significance was set at $P<.05$. All statistical tests were performed with Microsoft Office Excel.

Results

Patients in the CPAP group had to get used to the face mask firmly attached to the face. They had to learn how to breathe through it and tolerate it. Although they had satisfactory blood gas parameters, 4 of 10 patients felt dyspnea at the beginning. None of the patients in control group complained.

Mean blood gas measurements are presented in Table 1. In every case pulse-oxymetry oxygenation was >94%. In the CPAP group, patients were breathing deeper but no symptoms of increased respiratory work were observed. Also in the control group, these symptoms were not observed. In both groups, oxygen support improved the blood oxygenation significantly (P=0.04). Blood oxygenation was signifi-

Table 1. Blood gas results: T0 - before surgery, T1 - 30 min after admitted to PACU, T2 - 4 hours, T3 - 8 hours after admitted to PACU (Mean ± SD)

	T0		T1		T2		T3	
	CPAP	Control	CPAP	Control	CPAP	Control	CPAP	Control
pCO_2 (mmHg)	39.8±5.6	39.7±2.7	41.8±2.3	41.4±5.3	39.4±2.3	43.4±3.3	40.6±2.5	39.6±3.3
pO_2 (mmHg)	58.8±9.4	58.8±7.1	85.7±8.2 *	68.1±5.6	79.2±8.4 *	63.8±6.7	78.1±5.6 *	65.7±0.5

*P<0.05 compared to control group.

cantly higher in the CPAP group at all Time points (P=0.01). Boussignac CPAP improved blood oxygenation, but had no important influence on CO_2 elimination compared to passive oxygenation with the nasal catheter (T1: P=0.17, T2: P=0.06, T3: P=0.3). In the control group, slight hypercarbia was observed, but with no clinical relevance.

Patients in the control group were more obtunded, sedated, and when they fell asleep pulse-oxymetry oxygenation decreased. In the CPAP group, patients were alert and at all times pulse-oxymetry oxygenation was higher than in the control group. No respiratory complications were observed in both groups, nor surgical complications associated with the use of CPAP in that study group.

Discussion

Non-invasive CPAP is the delivery of positive pressure via a tight-fitting mask that covers the nose or both the nose and mouth in spontaneously breathing patients. Because the airway is unprotected, aspiration may occur, so that patients must have an adequate level of consciousness and airway protective reflexes. NIV CPAP should be avoided in patients who are not hemodynamically stable or have evidence of impaired gastric emptying. In those patients, the swallowing of a significant amount of air may result in regurgitation and life-threatening aspiration. Because of the physiology of the lower esophageal sphincter, the pressure used for NIV CPAP must be set below esophageal opening pressure (20 cmH_2O) to avoid gastric insufflation.[3]

Acute respiratory failure (ARF) is a common complication after abdominal surgery and is associated with significant morbidity and mortality.[4] Patients undergoing abdominal surgery, especially of the upper abdomen, commonly have reductions in lung volumes, elevation of both hemidiaphragms, and lower-lobe atelectasis. Dysfunction of the respiratory muscles due to surgery may lead to a reduction in the vital capacity, tidal volume, and total lung capacity and, thus, insufficient cough. This may cause atelectasis in the basal lung segments and a decrease in functional residual capacity that, in turn, affects the gas exchange properties of the lung by increasing ventilation/perfusion mismatch. The use of NIV with Pressure Support and Positive End-Expiratory Pressure (PEEP) allows for decreased work of breathing, reduced pulmonary extravascular water, and increased lung volume with reexpansion of atelectasis.[4] Atelectasis is more common in obese than in non-obese postsurgical patients, and Eichenberger et al[5] call atelectasis "the underestimated problem".

Morbid obesity is often associated with respiratory complications such as sleep apnea syndrome, Pickwickian syndrome, obesity hypoventilation syndrome, and respiratory drive disturbances. CPAP is a well known and advocated treatment for those illnesses, and prevents postoperative atelectasis from worsening.[1] Patients with a medical history of respiratory disturbances require assisted ventilation in the postoperative period, and the CPAP device should be brought to PACU.[6] However, even obese patients without a history of SAS or OHS are sensitive to the residual effect of anesthetics on respiratory function in the PACU. In this group of patients, Critical Respiratory Events occur more often than in the non-obese.[7] The rationale for the acute use of CPAP in postoperative obese patients is increased functional residual capacity (FRC), improved lung compliance, ventilation and oxygenation, and decreased upper airway obstruction and work of breathing.

There are a few studies that specifically evaluate

the feasibility and efficiency of NIV after abdominal surgery that is prophylactic (ie., immediately following extubation, not waiting for respiratory distress to develop) or curative.[4] Joris et al[8] reported that prophylactic NIV at an inspiratory pressure of 12 cmH_2O and PEEP of 4 cmH_2O used during the first 24 hours following surgery allows a significant reduction in the magnitude of the postoperative pulmonary restrictive syndrome in morbidly obese patients undergoing gastroplasty.[8] In the study of Jaber et al,[4] only 11 obese patients were included: 5 were intubated and 6 were not intubated. No significant difference was observed between obese and non-obese patients for NIV success and clinical outcomes. The small number of studied obese patients limits conclusions about the benefits of NIV in this population after abdominal surgery.

The use of NIV in the postoperative period in morbidly obese patients improves respiratory function and prevents complications.[9] It stimulates patients to breath deeply and decreases respiratory load.[10] This should prevent hypoxia and possible respiratory failure in the postoperative period.

However, some recent outcome papers on respiratory failure in postoperative surgical patients treated with CPAP bring other findings. Delclaux et al[11] conducted a study on acute hypoxemic, non-hypercapnic respiratory insufficiency treated with CPAP delivered by a face mask. This was a randomized, controlled, and unblinded trial of 123 consecutive adult patients who were admitted to 6 intensive care units between September 1997 and January 1999 with a PaO_2/FIO_2 ratio of 300 mmHg or less due to bilateral pulmonary edema. Patients were randomly assigned to receive oxygen therapy alone or oxygen therapy plus CPAP. In this study, despite early physiologic improvement, CPAP neither reduced the need for intubation nor improved outcomes in patients with acute hypoxemic non-hypercapnic respiratory insufficiency primarily due to acute lung injury.

The use of CPAP is still not widely accepted for obese patients following gastrointestinal surgery because of concerns that pressurized air may inflate the stomach and proximal intestine, resulting in anastomotic disruption. However, in a recent study, it was proved that CPAP is a safe method of respiratory support in the postoperative period in bariatric operations.[12] A total number of 1,067 patients undergoing the gastrojejunostomy as part of the RYGBP operation were prospectively evaluated for the risk of developing anastomotic leaks and pulmonary complications. There were only 15 major anastomotic leaks, two of which occurred in CPAP-treated patients. Despite the theoretical risk of anastomotic injury from pressurized air delivered by CPAP, no anastomotic leaks that occurred were attributable to CPAP. A more recent study confirmed that routine use of CPAP after RYGBP does not convey added risk of anastomotic disruption to morbidly obese patients in the postoperative period.[13]

Esophageal and gastric surgery are usually considered contraindications to the use of Non-invasive Positive Pressure Ventilation (NPPV). The study of Jaber et al[4] showed that NIV can be used without adverse effect in patients after esophageal surgery. In the study of Joris et al[8] no severe complications such as aspiration or gastric distension were observed. Gastric distension was successfully avoided by the placement of a nasogastric tube for regular decompression of the stomach, prior to the institution of NIV.

The Boussignac CPAP system is easy in use, cheap and effective, requiring only an oxygen source – not a special respirator. It is often used in emergency settings in cardiac and non-cardiac acute pulmonary edema, deterioration of lung illnesses like diffuse pulmonary infections, asthma and spastic chronic obstructive bronchopneumopathies.[14] It is also indicated for use in prevention of postoperative atelectasis, weaning off artificial ventilation and in patients with sleep apnea.

The Boussignac CPAP system consists of silicone mask firmly applied to the patient's face and a CPAP device connected to the mask. A typical oxygen delivery catheter is connected to a valve. High-flow gas injection through several capillaries with an angle of 45° creates over-pressure which acts like a virtual diaphragm and generates positive pressure in the patient's airway. This mechanism is compared to jet ventilation. Positive pressure should increase tidal volume and stimulate breathing. The pressure generated depends on gas flow: eg. oxygen flow of 15 l/min creates pressure of 10 cmH_2O. While this recently introduced open CPAP system has the advantage of being user-friendly and cheap, it may result in an unpredictable level of positive airway pressure. In fact, its successful use is highly dependant on the oxygen flow-rate provided. In our experience, we found that oxygen flow >15 l/min is difficult to achieve by standard equipment, so that the danger of over-pres-

sure that may cause some complications is low. However, one must check the inspiratory pressure by repeated measurement.

The face mask used in NIV may be not well-tolerated by the patients. From our experience, we suggest that patients should learn how to use the NIV system before operation. For example after admission to hospital the day before surgery, morbidly obese patients in whom it is planed to use the CPAP device may use it and learn how to breath with it.

Patients in our study in the CPAP group were more alert in the PACU compared to the control group, where patients were sleepier and clearly more obtunded. It is difficult to decide if this mental status difference was the result of better oxygenation in the CPAP group or lack of tolerance to the interface (mask). The difference in blood gas is barely statistically significant and, in our opinion, clinically non-significant in this group of morbidly obese patients (without SAS and OHS) to justify the mental status difference between the two groups. Thus, patients in the control group were probably not disturbed by the CPAP device and were sedated by morphine infusion. Boussignac CPAP is an effective and cheap NIV system compared to other NIV devices requiring a ventilator.

Conclusion

Boussignac CPAP improves blood oxygenation but has no important influence on CO_2 elimination compared to passive oxygenation with anasal catheter in morbidly obese patients (if they are a non-CO_2 retainer population) in the postoperative period.

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