



EFFECTIVENESS OF EARLY SHORT-TERM NON-INVASIVE VENTILATION IN POSTOPERATIVE OBESE PATIENTS

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Abstract

Acute respiratory failure is a common postoperative complication, especially in obese patients who are prone to ventilation-perfusion mismatch and airway obstruction. This paper examines the results of the short-term non-invasive ventilation (NIV) administered in the first 24 hours of surgery on the obese population. Obese patients (BMI 30-45, ASA II-III) who were undergoing minor peripheral surgery were randomly selected (n=144) and divided into two groups (NIV n=60 and standard care (control) n=60). Postoperative spirometry and pulse oximetry measurements were taken at multiple intervals to assess respiratory function. Results showed that NIV significantly improved oxygen saturation and lung function in the initial 12 hours compared to the control group. Despite modest overall differences, NIV demonstrated a faster recovery of lung function and reduced risk of atelectasis in the PACU. This study suggests that early NIV can be beneficial in improving postoperative pulmonary outcomes, particularly in obese patients, and may offer a practical therapeutic approach in day surgery settings.

Keywords: Non-Invasive Ventilation, Obesity, Postoperative Respiratory Failure, Day Surgery, Pulse Oximetry, Spirometry, Atelectasis, Postoperative Care

Introduction

It is a typical acute respiratory failure which is a complication during the postoperative period. NIV is proven to decrease the mode of intubation, morbidity, death, and the hospitalization in the intensive care unit of patients with non-hypercapnic and hypercapnic respiratory failure [1,2]. Despite the frequent use of NIV in intensive care unit, few studies have investigated the application of NIV in the first 24 and hence optimal treatment time and setting parameter are not clearly defined. Early NIV after surgery can be beneficial, particularly in obese individuals, whose lungs volumes are reduced significantly [3,4], and whose risk of atelectasis, ventilation-perfusion mismatch, and airway obstruction is high. Since the majority of respiratory complications are revealed during the post-anesthesia care unit (PACU) and patients with obesity tend to be patients with day-surgery, it is necessary to facilitate a quick pulmonary recovery [5]. The study under consideration works on the evaluation of the 24-hour outcomes of early short-term pressure-support NIV as the PACU stay of day-surgery obese patients.

Methodology

The research involved 144 obese adults (BMI 30-45, ASA II-III) who were to undergo minor peripheral surgery. Patients who had abdominal surgery or were subject to head-down tilt procedures were not allowed. Its length of surgery was between 45 and 120 minutes. Other conditions that would exclude them were pregnancy, asthma, severe renal failure, cardiac disease NYHA greater than II, severe psychiatric disorders, or problems with cooperation during measurements. The NIV technique was discussed with all the participants in the pre-anesthetic visit, and informed consent was signed. An independent study nurse randomly allocated the patients to non-invasive ventilation group (NIV group) (n = 60) or the control group (n = 60). The patients who failed to satisfy fast track requirements within 20 minutes after surgery or who showed adverse events throughout the study were withdrawn.

Post operative pain

Both were given normal non-opioid analgesic treatment that involved intravenous paracetamol 1 g and metamizol 1 g. A visual analogue scale (VAS) was used to determine the level of pain every 15 minutes. Further analgesia using intravenous piritramide was done when the VAS scores were higher than 4. The total intake of piritramide was recorded on the initial 24 hours.

Spirometry and pulse oximetry

Spirometry and pulse oximetry records were standardized when the patients were seated in 30 head-up position after the breathings of ambient air of five minutes. The baseline spirometry and the pulse oximetry (Tbase) of the lungs during the pre-anesthetic visit were performed after the appropriate education regarding the correct procedure. They included vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), mid-expiratory flow (MEF 2575), peak expiratory flow (PEF) [6,7], peak inspiratory flow (PIF), and forced inspiratory vital capacity (FIVC). At each time point, at least six spirometries were completed to address the European Respiratory Society (ERS) guidelines and the best one was retained. Spirometry was repeated again (T0) during the recovery period (around five to ten minutes after extubation), when the patients were awake and fully cooperative (fast-track score >10). The pain and dyspnea, during coughing were also measured before and in case of necessity, after administration of analgesic; all the patients met this requirement in forty minutes after extubation [8]. The supplementary spirometric and pulse oximetric specimens were conducted in the post-anesthesia care unit (PACU) after two hours (T1), four hours (T2), and further measurements using twelve hours (T3) and forty-eight hours (T4) after the extubation to track the course of the postoperative pulmonary functions. The use of Piritramide was documented before each examination when the patients were pain-free in terms of coughing. Respiratory measurements could be affected by factors like pain and shivering and thus minimized to ensure reliability of the measurements.

Analysis

The prospective power analysis indicated that a standard deviation of 20 would provide an over 80 percent power to demonstrate a 20 mmHg difference in arterial oxygen partial pressure on room air in each of the groups with 34 participants, with a Student t -test and a 5 -percent type I error rate. The null hypothesis of the equivalence was applied in order to compare the postoperative respiratory measures as well as the pulse oximetry level in the groups. The Kolmogorov Smirnov test was used to test normality, t-tests were used on normally distributed data but the Wilcoxon Mann Whitney was used on non-normally distributed data. A mixed ANOVA, repeated-measures, two-factor ANOVA was done to determine the interactions among and between groups. Adjusted p -value of less than 0.0025 was used to reject the null hypothesis to ensure that several comparisons are taken into consideration. Randomisation was done when all the criteria of inclusion in postoperative assessment were satisfied and all preliminary measurements in the PACU were through so that observer bias was avoided. The collection of the use of relevant data, converted into BIS-Index, remifentanyl, and propofol, was done via an online documentation system.

Results

Four hundred and forty-four patients were recruited; four of them refused to go on and measurements were not satisfactory in sixteen cases because they could not reach fast track criteria of less than 10 in 40 minutes after the surgery. There were four patients with the control group who had laryngo-bronchospasm, and they were eliminated. Thus, the results are presented in the form of the data of 120 patients (male/female), 60 people in each of the groups. The average length of the surgery was 158 (SD 52) minutes with a range of between 90 and 240. There was no significant difference between groups on baseline characteristics. Ventilation was performed as per the target values without any sudden intubation problems. Muscle relaxation antagonism was unnecessary in all cases. No severe desaturation events ($\text{SpO}_2 < 85\%$) occurred.

Table: 1 Baseline Characteristics and Intraoperative Data for NIV and Control Groups

Parameter	NIV Group (n=60)	Control Group (n=60)
Mean patient age (years)	53 $\pm$ 12	54 $\pm$ 14
Body Mass Index value	36 $\pm$ 4.3	36 $\pm$ 3.5
Operative procedure time (minutes)	79 $\pm$ 27	80 $\pm$ 25
Total remifentanyl administered (μg)	1316 $\pm$ 211	1280 $\pm$ 200
Total propofol administered (mg)	666 $\pm$ 123	680 $\pm$ 144
BIS measurement during surgical procedure	50 $\pm$ 6.9	47 $\pm$ 6.2
BIS measurement at anesthesia termination	63 $\pm$ 6.1	64 $\pm$ 7.7
Duration until tracheal extubation (minutes)	9.3 $\pm$ 5.9	10.2 $\pm$ 6.3
Time to achieve fast track score >10 (minutes)	12.2 $\pm$ 4.5	11.5 $\pm$ 4.9
Piritramide consumption post-surgery (mg, within first 24 hours)	8.5 $\pm$ 5.3	9.1 $\pm$ 6.8

Postoperative ventilation and oxygenation were monitored via arterial blood gas analyses at fixed intervals in the post-anesthesia care unit using radial arterial puncture. At the initial PACU assessment, both groups showed similar reductions in oxygen partial pressure without hypercapnia. The preoperative pulse oximetry parameters of baseline (preoperative) were in normal ranges (95-99 percent) and there were no differences between the inter-groups regarding baseline (preoperative) pulse oximetry. The PACU was associated with the lowest values in both groups immediately after they passed fast track requirements (>10). There were no differences between groups in the first PACU measuring, before NIV initiation. The saturation of overall pulse oximetry was between 99 to 85 percent (mean 94) at this time. In the PACU in the first 2 hours ($p < 0.0001$) the NIV group had an average pulse oximetry that was profoundly great in comparison with controls, and still higher at 12 and 48 hours post-surgery. The overall mean pulse oximetry difference between groups was approximately six percentage points.

Table: 2 Early Short-Term Non-Invasive Ventilation in Obese Day-Surgery Patients

Measurement	NIV Group	Control Group	Statistical Significance
SpO_2 before premedication (%)	97.9 $\pm$ 2.0	98.0 $\pm$ 2.4	Not significant
SpO_2 after premedication (%)	96.8 $\pm$ 2.5	96.9 $\pm$ 2.9	Not significant
Forced Vital Capacity (liters)	4.81 $\pm$ 2.1	4.69 $\pm$ 2.0	Not significant
FEV1 - Forced expiratory volume at 1 second (liters)	4.05 $\pm$ 1.9	3.98 $\pm$ 1.7	Not significant
Peak Expiratory Flow (liters/second)	7.9 $\pm$ 2.9	7.8 $\pm$ 3.3	Not significant
Mid-expiratory flow rate (liters/second)	4.15 $\pm$ 2.2	4.09 $\pm$ 2.1	Not significant

All comparisons between groups showed no statistical significance (n.s.) at baseline.

Spirometry

The preoperative spirometry values of the inspiratory and expiratory measures were normal values existing between upper and lower limits of normal. Postoperative spirometry except peak inspiratory flow had a similar pattern of pulse oximetry. The NIV group showed a quicker restoration of lung function throughout the PACU stay which was almost reaching the preoperative baseline level whereas the control group had only an average change in lung volumes. This time-dependent effect within groups was significant during the initial postoperative period but diminished thereafter. The control group had a lung function up to 40 percent of baseline even after the first postoperative mobilization and the second day after the operation. Although the overall difference between groups lessened by 48 hours post-surgery, significant disparities in lung function persisted.

Discussion

Atelectasis and respiratory dysfunction frequently occur after general anesthesia, primarily due to lung compression and oxygen absorption related to high inspired oxygen fractions (FiO₂). Although high FiO₂ is commonly used when ending anesthesia, its negative impact on lung function is well documented. Additional factors such as hypoventilation and reduced postoperative vigilance may also contribute to early lung impairment.

Although many studies have established the advantages of non-invasive ventilation (NIV) in acute respiratory failure, most of them are in intensive care units whereby the trials have been conducted over a long period with continuous application to realize the desired results. Our results suggest that at least one hour of NIV started at the moment of extubation in the post-anesthesia care unit (PACU) may enhance the pulmonary functions at least over 24 hours. Even though the total differences were small and measurement bias in pulse oximetry and lung function does exist, this would have an equal impact on both samples. The lack of risk factor preselection, such as obstructive sleep apnea (OSA), might have influenced the observed effect size.

It is well established that NIV and continuous positive airway pressure (CPAP) enhance gas exchange, reduce atelectasis, and increase functional residual capacity [9]. Early, preventive use of these modalities has been shown to lower pulmonary complications, although treatment durations and objectives vary widely [10]. Conversely, late or short-term application often shows no benefit. Chest physiotherapy has also been effective but may not surpass NIV in efficacy and could incur higher staffing costs.

Additional factors may explain our results. Postoperative alertness is critical, but painful procedures like blood gas sampling might affect wakefulness [11], and fast track scores lack sensitivity to assess consciousness in detail. Residual effects of anesthetic drugs may increase upper airway collapsibility in obese patients [12]. Postoperative residual curarization (PORC), even with neuromuscular monitoring, could further impair respiratory function, supported by our findings of similar expiratory peak flow but limited inspiratory flow shortly after surgery. Drug effects are more pronounced after brief procedures and worsen with age, particularly affecting upper airway muscle tone [13].

Our study's early initiation of short-term NIV, compared to other research involving different surgeries and normal-weight populations, may explain its observed benefits. Obese patients are especially prone to respiratory changes from reduced functional residual capacity, which NIV with positive end-expiratory pressure (PEEP) can mitigate by enhancing alveolar ventilation and gas exchange. These were not dependent on supplemental oxygen since measurements were made at the conclusion of NIV and oxygen discontinuation.

Conclusion

Findings of this study indicate that it may be possible to find some benefits of early short-term non-invasive ventilation (NIV) in the improvement of pulmonary performance and oxygenation of obese patients in the first 24 hours after surgery. NIV showed significant improvements in pulse oximetry and lung function compared to the control group, particularly during the initial recovery phase in the post-anesthesia care unit (PACU). These findings suggest that NIV could be an effective strategy to

prevent atelectasis and enhance gas exchange in obese patients after general anesthesia. However, the clinical significance of these improvements requires further validation, and future studies should explore the long-term benefits and ideal patient selection criteria for NIV in different surgical contexts.

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