NON-INVASIVE POSITIVE PRESSURE VENTILATION FACILITATES EARLY EXTUBATION IN POST OPERATIVE CARDIAC PATIENTS

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ABSTRACT

Objectives: *To assess the use of NIPPV (non-invasive positive pressure ventilation) during weaning from mechanical ventilation in post-op patients in an ICU and compared this procedure with intermittent mandatory ventilation (IMV) by analyzing cardiac and respiratory parameters and complications.*

Methodology: *A randomized clinical trial was conducted from June 2009 to July 2010 on Post-operative surgical patients that were on IMV for more than 48 hours, who failed at 30 minutes of spontaneous breathing T-piece trial (SBT). If failure occurred before the 30th minute, he/she was included in the group previously defined by random assignment. Patients in the experimental group were extubated and placed on NIPPV, whereas other patients (the control group) returned to IMV. Daily SBT was carried out thereafter in order to evaluate the possibility of extubation in control group.*

Results: *Of 60 patients who failed T-piece trials, 30 patients were placed on NIPPV & 30 on (IMV). The ages of patients in the NIPPV and IMV groups were 45.7± 18.11 and 47.10 ± 18.45 years respectively. In both groups, ventilation time before T-piece trial was 2-3 days. Patients of the NIPPV group had a shorter stay in the ICU and in the hospital i.e., 2.93 ±0.785 days versus 7.4+1.11 days for IMV group. No serious complications were observed in both groups.*

Conclusion: *The results of this study suggest that the combination of early extubation and NIPPV is a good alternative.*

Key Words: *Non-Invasive Positive Pressure Ventilation (NIPPV), Intermittent Mandatory Ventilation (IMV)*

This article may be cited as: Laiq N , Khan RA, Malik A. Non-Invasive Positive Pressure Ventilation facilitates early extubation in post operative cardiac patients. J Postgrad Med Inst 2013; 27(4):361-5.

INTRODUCTION

Atelectasis is frequently observed after open heart surgery. In addition to the effects of general anesthesia, cardiopulmonary bypass (CPB) may also contribute to postoperative atelectasis[1]. Cessation of pulmonary circulation and ventilation during extracorporeal circulation may lead to structural alterations of the lungs[2]. Pleural opening, phrenic nerve damage, pain and use of mammary arteries are other contributing factors. If atelectasis is persistent or progressive, it may lead to hypoxemia, increased shunt fraction, increased work of breathing, and pulmonary complications in the postoperative period. Chest physiotherapy, voluntary deep breaths, incentive spirometry, high positive end-expiratory pressure (PEEP), alveolar recruitment maneuvers (RM) during mechanical ventilation, and noninvasive ventilation (NIV) are the methods used to prevent postoperative atelectasis[3].

Non-invasive positive pressure ventilation (NIPPV) has been found to be as effective as conventional mechanical ventilation in improving gas exchange in patients with respiratory failure. It has also been shown to be associated with a shorter stay in the intensive care unit (ICU) compared to invasive ventilation. Postoperative respiratory failure due to atelectasis has also been treated with NIPPV[4].

Mechanical ventilation is often required in patients with respiratory failure to unload the respiratory muscles and support gas exchange in order to improve the pathophysiology leading to respiratory

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Date Received: January 03, 2013
Date Revised: July 19, 2013
Date Accepted: July 23, 2013

failure. Ventilator associated pneumonia is usually associated with invasive ventilation when used over a prolonged period of time although it maintains a patent airway. This in turn is associated with increased morbidity and trends towards increased mortality. For these reasons, clinicians strive to reduce the duration of invasive ventilation while optimizing the chance for successful extubation in patients who need invasive ventilation[5].

Patient's respiration is supported by providing an alternative method of Non-invasive ventilation i.e., by means of positive pressure ventilation with either an oronasal, nasal, or total face mask at the patient-ventilator interface. It also preserves the patient's ability to speak and cough and has been reported to reduce complications related to intubation, especially ventilator associated pneumonia[6]. Non-invasive ventilation has been reported to reduce the frequency of breathing, improve gas exchange, augment tidal volume, and rest the muscles of respiration similar to invasive ventilation and improve clinical outcomes in selected patients[7].

NIPPV has been tested in the last few years, Nava and colleagues [8] in a randomized clinical trial, compared NIPPV or IMV in 50 patients having failed spontaneous ventilation trials and observed shorter ventilation time and lower mortality with the use of NIPPV. Girault and colleagues[9] compared NIPPV with pressure support ventilation in 33 patients after a failed 2-hour T-piece trial and found a reduction in total mechanical ventilation time in the NIPPV group. In a later study, Ferrer and colleagues[10] suggested that NIV (noninvasive ventilation) be used as a means to facilitate IMV weaning for patients who failed spontaneous ventilation trials, regardless of the underlying disease. Later a meta-analysis revealed that NIPPV facilitates weaning and reduces mortality comparatively to IMV[11].

We assessed the use of NIPPV during weaning from mechanical ventilation in post cardiac surgery patients in an ICU in our own circumstances and setup and compared this mode of ventilation to IMV by analyzing cardiac and respiratory parameters, clinical course, and complications.

METHODOLOGY

This study was approved by the Institutional Research and Ethics Committee. A randomized clinical trial was conducted from June 2009 to July 2010 with patients in the cardiac ICU of Lady Reading Hospital Peshawar Sealed envelopes were used for random assignment (opened by the studying person unaware about the groups) Patients of both sexes and ages between 40-70 years, post cardiac surgeries and were on IMV for more than 48 hours, who failed at 30 minutes of spontaneous breathing T-piece trial (SBT) were included in the study.

The established weaning criteria was routinely followed in the ICU i-e improvement of the cause of Acute respiratory failure that led to the use of ventilation support, correction of arterial hypoxemia (arterial partial pressure of oxygen (PaO_2) of greater than 60 mm Hg, fraction of inspired oxygen (FiO_2) of less than or equal to 0.4, and positive end-expiratory pressure (PEEP) of less than or equal to 5 cm H_2O during pressure support ventilation. All patients were breathing at low levels of pressure support ventilation (less than 12 cm H_2O). Patients included in the study did not require vasoactive drugs, had an adequate consciousness level (Glasgow coma score of greater than or equal to 13) and cough reflex, and did not require sedation.

Failure or intolerance at 15 minutes of SBT was defined according to one of the following criteria: peripheral oxygen saturation (SpO_2) measured by pulse oximetry of less than 90% (80% in chronic respiratory failure), respiratory rate (f) of greater than 35 respirations per minute, heart rate (HR) of greater than 140 or less than 50 beats per minute (bpm) or increase or decrease of greater than 20% in previous mechanical ventilation, and systolic arterial blood pressure of greater than 180 mm Hg or less than 70 mm Hg or increase or decrease of greater than 20% in previous mechanical ventilation. Patients with tracheotomy, excessive respiratory secretion, agitation or noncooperative behavior were excluded from the study.

Patients were included in the study after an informed consent form was signed by a family member or guardian. Patients considered apt to undergo the weaning procedure were given spontaneous breathing trail (SBT) for at least 30 minutes. At that moment, if the patients had failed SBT, they will be put into one of the two studied groups i-e either NIPPV or IMV (control mode of ventilation). Sealed envelopes were used for random assignment.

Before SBT and after 30 min of SBT, the following measurements were carried out, arterial blood gases, parameters of ventilation such as f ,V_T, PEEP,-FiO_2, PaO_2/FiO_2 ratio, HR(Heart rate), systolic (SBP) diastolic (DBP) blood pressure and SpO_2. If the patient failed SBT, he/she was included in the group previously defined by random assignment. Patients in the experimental group were extubated and placed on NIPPV, whereas the other patients (the control group) returned to IMV, which was classified as the conventional treatment. The group on NIPPV (the experimental group) was extubated after having rested in the mechanical ventilation for 30 minutes in the experimental group. Immediately after tracheal extubation, spontaneous ventilation mode using a bi-level NIPPV support was used. Inspiratory posi-

tive airway pressure was delivered according to patient tolerance and varied from 10 to 30 cm H_2O.

Expiratory positive airway pressure was set at sufficient gas exchange maintenance level and FiO_2 was set according to a value of SpO_2 of greater than 90%, as measured by pulse oximetry. The interface chosen was facemask. Weaning from NIPPV was performed on a daily basis by gradually reducing pressure levels until adequate V_T levels could be reached and proper alveolar ventilation could be established. In the control group, invasive ventilation followed the previously administrated ICU ventilation support routinely. Daily SBT was carried out in order, to evaluate the possibility of extubation. Daily chest radiographs were carried out in order to compare improvement in two groups and to exclude any atelactasis during ICU stay.

RESULTS

Of 60 patients who failed T-piece trials, 30 were placed on NIPPV and 30 were placed on IMV. The ages of patients in the NIPPV and IMV groups were 45.7±18.11 and 47.10±18.45 years respectively. Post-surgery respiratory failure and chronic pulmonary disease aggravation were the most frequent causes of IMV use. In both groups, ventilation time before T-piece trial was 2-3 days. Heart and respiratory parameters were similar for the two groups at 30 minutes of T-piece trial. The percentage of complications in the NIPPV group was lower with lower incidences of pneumonia and tracheotomy. Length of stay in the intensive care unit was statistically significant when comparing the two groups i.e., 2 days &09 hours in case of NIPPV while it was 07 days & 04 hours in IMV group.

The comparisons of gas measurements between the NIPPV and IMV groups showed no significant differences. Arterial blood gases at the end of ventilatory support were as follows PH; 7.40 ± 0.08 versus 7.4 ± 0.06, $PaCO_2$ 41.05±7.12 versus 41.50±8.0, Arterial Oxygen Pressure; 133.66 ± 29.01 verses 131.38 ± 32.74 and Oxygen saturation was 93.17 ± 18.26 versus 97.04 ± 2.45 for NIPPV and IMV groups respectively, similarly tidal volume, Systolic BP, Diastolic BP, Frequency of breaths, Heart rate,-FiO2 and PEEP were statistically not significant in two groups (Table 2). Patients of the NIPPV group had a shorter stay in the ICU and in the hospital (Table 1). No mortality was seen in the two groups. Of the 30 patients in the NIPPV group 26 had no

Table 1: Patients Demographics

	NIPPV group (n=30)	IMV group (n=30)	Significance
Age (in years)	72+1307	71.13+14.3	0.586 (NS)
Weight(Kg)	45.70+18.11	47.10+18.45	0.528 (NS)
Male / Female	20 / 10	25 / 5	
Length of ICU stay	2.9+0.785	7.4+1.118	P<0.05

Table 2: Parameters of patients in both groups at the end of ventilation support

Parameters	NIPPV group (n=30)	IMV group (n=30)	Significance
PH	7.40+.08	7.40+0.069	0.688 (NS)
PCO2	133.66+29.01	131.38+32.74	0.058 (NS)
PaO2	41.05+7.12	41.50+8.0	0.078 (NS)
SPO2	93.17+18.26	97.04+2.45	0.606 (NS)
Tidal volume	525.31+69.44	549.5+68.1	0.057 (NS)
PEEP	7.03+1.49	7.10+1.70	0.097 (NS)
Freq of breaths"f"	16.63+3.71	17.10+3.82	0.298 (NS)
PaO2/FiO2	51.40+7.57	51.83+6.84	0.867 (NS)
Systolic BP	132.55+22.6	127.77+24.4	0.178 (NS)
Diastolic BP	75.22+12.77	71.51+13079	0.084 (NS)
Heart rate	76.13+9.05	79.60+13.96	0.077 (NS)

NS= Not Significant

serious complications while only 4 patients had mild nausea and soreness on face which were treated with routine medication. No marked atelactasis were seen based on X-ray findings, clinical assessment and improvement of blood gases done daily in both of our studied groups.

DISCUSSION

The main findings of this study were that NIPPV compared to IMV resulted in better early postoperative blood gases, less atelectasis and a shorter duration of hospitalization and mechanical ventilation.

Atelectasis has been shown to be correlated with impaired gas exchange and increased shunt fraction, and therefore with reduced arterial oxygen pressure in the postoperative period[12]. We didn't see any marked atelectasis on X-ray findings in both of our studied groups, blood gases were within normal limits, except for a small decrease in SpO2 in NIPPV group compared to IMV group which was non-significant. Increased extravascular lung water and further collapse of the lung tissue may aggravate the shunt. Atelectatic lungs have been shown to be re-opened using high inspiratory pressures and kept open with high levels of PEEP. Peak end-inspiratory pressures of about 35 to 40 cm H_2O have been shown to provide lung recruitment[13, 14]. None of our patients suffered from lung oedema, we selected a PEEP pressure of 15mmHg in our studied group, which was better tolerated and showed very ideal results.

Studies show radiological improvement of atelectasis after open heart surgery with NIPPV compared to control groups. Besides that higher PEEP or sustained inflation may reduce cardiac output and left ventricular end-diastolic area in hemodynamically stable patients after cardiac surgery and in experimental models[15]. As we applied optimum level of PEEP i-e 15mmHg ,almost all of our patients were haemodynamically stable in both of our studied groups. CPAP can restore decreased FRC (Fractional residual capacity) as decrease in FRC and deterioration of pulmonary function develop rapidly after extubation. Early treatment with CPAP has been shown to reduce the need for intubation, ICU length of stay, and the incidence of pneumonia, and sepsis in patients who develop acute hypoxemia after elective major abdominal surgery[16,17]. None of our patients in NIPPV group need to be re-intubated, length of stay in ICU was significantly prolonged in IMV group i-e 07 days compared to 03 days in NIPPV group($P<0.05$). Some other studies showed that Patients who received oxygen plus continuous positive airway pressure had a lower intubation rate (1% vs. 10%; P=0.005;) and had a lower, infection (3% vs 10%, P=0.03), and sepsis (2% vs 9%; P=0.03) than did patients treated with oxygen alone. Patients who received oxygen plus continuous positive airway pressure also spent fewer mean (SD) days in the intensive care unit (1.4 [1.6] vs 2.6 [4.2], P=0.09) than patients treated with oxygen alone[18]. Girault and colleagues in one of his study showed that NIV allowed a reduction of the endotracheal mechanical ventilation period of 3 days on average[9]. Continuous nasal CPAP is recommended by some authors prophylactically, as a preventive measure against postoperative atelectasis because it is a well-tolerated and simple method for improving pulmonary functions, reducing pulmonary morbidity and length of hospitalization.

We applied NIPPV intermittently through a tight fitting CPAP mask i-e 4 hourly with 30 minutes gap to avoid nausea, vomiting, gastric distention and restricted oral intake in our studied group.

The disadvantages of NIPPV is that it can,t be used in patients with aspiratory risk or excessive secretion, loss of preventive airway reflex and upper airway obstruction and those who require entubation, it might not be effective in acute respiratory failure with severe hypoxemy, it may lead to distension of stomach, some lesions on the skin, facial ache, sense of drying in the nose, eye irritation (conjunctivity), clostrophobia, sleep disorders and mask leakage. It should not be used in patients who must not be resuscitated or unable to cooperate[19].

We don't have come across any major complications in any of our studied groups, minor complications such as nausea and retching were noticed in few patients in NIPPV group.

CONCLUSION

The results of this study suggest that the combination of early extubation and NIPPV is a good alternative for ventilation in a group of patients who initially failed weaning. NIPPV use resulted in decrease ICU and hospital stays by providing efficient gas exchange and more importantly it reduces the incidence of pneumonia as well as the need for tracheotomy when compared with conventional IMV weaning. Therefore, NIPPV is a useful and safe strategy that might be considered during mechanical ventilation weaning.

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CONTRIBUTORS

NL conceived the idea, planned and wrote the manuscript of the study. RAK and AM helped in the acquisition of data and gave input in the writing of the manuscript. All the authors contributed significantly to the research that resulted in the submitted manuscript.