

Original Article

Does early use of bilevel positive airway pressure (bipap) in cardiothoracic intensive care unit prevent reintubation?

G Sağıroğlu¹, A Baysal², E Çopuroğlu¹, YG Gül⁴, YA Karamustafaoğlu³, M Dogukan⁵

¹Department of Anesthesiology and Reanimation, Trakya University, Edirne, Turkey; ²Anesthesiology and Reanimation Clinic, Kartal Kosuyolu High Speciality Research and Training Hospital, Istanbul, Turkey; ³Anesthesiology and Reanimation Clinic, Arnavutkoy State Hospital, Istanbul, Turkey; ⁴Department of Thoracic Surgery, Trakya University, Edirne, Turkey; ⁵Department of Anesthesiology and Reanimation, Adiyaman University, Adiyaman, Turkey

Received July 4, 2014; Accepted August 16, 2014; Epub October 15, 2014; Published October 30, 2014

Abstract: Introduction: Non-invasive ventilation (NIV) is a preferred treatment in acute respiratory failure after operations. Our aim is to investigate the success of early use of bilevel positive airway pressure (BIPAP) after cardiac or thoracic surgeries to prevent reintubation. Methods: In a prospective randomized study, 254 patients were divided into two groups depending on the time period between extubation and the application of BIPAP. In Group 1 BIPAP was applied after extubation within 48 hours after surgery following fulfilling of acute respiratory failure criterias whereas, in Group 2, BIPAP was applied one hour after extubation for two episodes of 20 minute duration and 3 hours apart. Arterial blood gas values (pH, PaO₂, PaCO₂) at first and fourth hour after BIPAP were collected. Results: In comparison between groups, no significant differences were observed for arterial blood gas values of pH and PaCO₂ at baseline, one and four hours after BIPAP ($p > 0.05$) however, the PaO₂ values at one and four hours after BIPAP were significantly better in Group 1 in comparison to Group 2 ($p < 0.001$, $p < 0.001$; respectively). Reintubation rate was 14 patients (11%) in Group 1 and 7 patients (5.5%) in Group 2 ($p = 0.103$). Conclusions: The early and prophylactic use of BIPAP after cardiac or thoracic operations did not provide diminished rates in the postoperative complications such as reintubation.

Keywords: Non-invasive ventilaton, bilevel positive airway pressure, hypoxia, postoperative complications, reintubation

Introduction

Postoperative pulmonary dysfunction after cardiac or thoracic surgeries occur due to; impairment in gas exchange and lung mechanics secondary to general anesthesia and mechanical ventilation, use of cardiopulmonary bypass (CPB), hypothermia, activation of the inflammatory cascade, decreased extravascular lung water, atelectasis, pleural opening, possible phrenic nerve injury, pain, prolonged recumbent position and reduction of diaphragmatic movement. Previous studies have shown that a longer duration of mechanical ventilation, difficulty in weaning of the patient, and prolonged duration of hospitalization does occur after almost all abdominal, thoracic or cardiovascular surgeries however, a relation with a higher incidence of mortality was not shown [1-4].

Non-invasive ventilation (NIV) was investigated during respiratory failure treatment in cardiothoracic surgery units to provide beneficial effects in lung and heart functions and these include; (1) to partially compensate for the affected respiratory function by reducing the work of breathing, (2) to improve alveolar recruitment with better gas exchange (oxygenation and ventilation) and (3) to reduce left ventricular afterload by increasing cardiac output and improving haemodynamics. One of the methods of NIV is the use of a bilevel positive airway pressure (BIPAP) and in this method the pressure is higher during inspiration and decreases during expiration. Several randomized, controlled studies were published using different methods of NIV after cardiac surgeries [2, 5-7, 9-13]. The main concerns during use of NIV are; 1- a reduction in the left ventricular pre-

Bilevel positive airway pressure applications after cardiothoracic surgeries

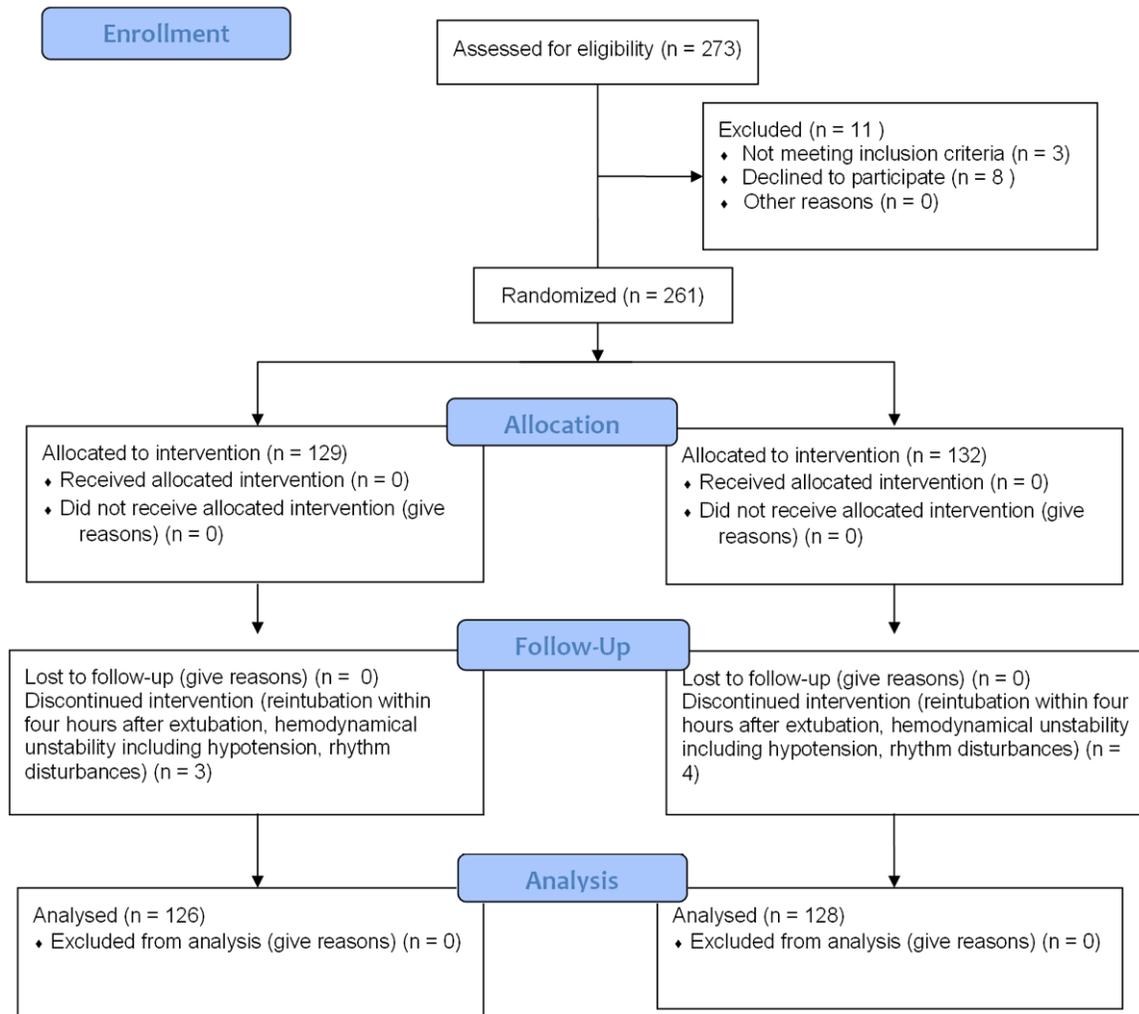


Figure 1. CONSORT 2010 flow diagram.

load and afterload that may cause hypotension, 2- an increase in pulmonary compliance due to recruiting of previously collapsed alveolar units [3, 8]. There are not enough well established randomized clinical studies that will enlighten these concerns and the current literature providing evidence for the use of NIV to avoid postextubation respiratory failure and reintubation is limited [9-14]. Our aim is to investigate the success of early use of BIPAP after cardiac or thoracic surgeries to prevent reintubation.

Material and methods

In a prospective randomized study, 273 patients with normal preoperative spirometric study (forced expiratory volume in one second (FEV1) values between 80 and 120% of the average value) were evaluated and after exclu-

sion of 19 patients, a total of 254 patients were divided into two groups depending on the time period between extubation and the application of BIPAP. The study was approved by The Hospital Ethical Committee and an informed written consent was obtained for study protocol prior to surgery from all patients. From a total of 261 patients that were randomized after fulfilling the inclusion criterias, seven of them did not complete the study secondary to problems related to 1- reintubation within four hours after extubation (before completion of the second BIPAP treatment as per study protocol), 2- hemodynamical instability including hypotension, rhythm disturbances. A consort diagram and consort checklist is presented in **Figures 1** and **2**.

In Group 1 of 126 patients, BIPAP was applied after extubation within 48 hours after surgery

Bilevel positive airway pressure applications after cardiothoracic surgeries

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	0
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	2-4
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	2-4
	2b	Specific objectives or hypotheses	2-4
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	2-4
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	2-4
Participants	4a	Eligibility criteria for participants	2-4
	4b	Settings and locations where the data were collected	2-4
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	2-4
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	2, 6, 7
	6b	Any changes to trial outcomes after the trial commenced, with reasons	2-4
Sample size	7a	How sample size was determined	7
	7b	When applicable, explanation of any interim analyses and stopping guidelines	
Randomisation:			
□Sequence generation	8a	Method used to generate the random allocation sequence	4
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	4
□Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	
□Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	4
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	4
	11b	If relevant, description of the similarity of interventions	7
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	7
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	8
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	8
	13b	For each group, losses and exclusions after randomisation, together with reasons	none
Recruitment	14a	Dates defining the periods of recruitment and follow-up	4
	14b	Why the trial ended or was stopped	none
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Table 2
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	4
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	7-10
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	7, 8
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	none
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	none
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	13
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	10-13
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	10-13
Other information			
Registration	23	Registration number and name of trial registry	4
Protocol	24	Where the full trial protocol can be accessed, if available	4
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	none

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming; for those and for up to date references relevant to this checklist, see www.consort-statement.org.

Figure 2. CONSORT 2010 checklist of information to include when reporting a randomised trial*.

Bilevel positive airway pressure applications after cardiothoracic surgeries

Table 1. The comparison of perioperative parameters

	Group 1	Group 2	p*
Patients (n)	126	128	
Age, (years) *	60.0 (39.0-76.0)	63.0 (29.0-78.0)	0.770
Height (cm) *	161.0 (148.0-183.0)	162.0 (141.0-184.0)	0.645
Weight (kg) *	70.0 (57.0-110.0)	74.50 (53.5-103)	0.421
Men (n, %) **	52 (74.3)	54 (77.1)	0.693
Women (n, %)	18 (25.7)	16 (22.9)	
Ejection fraction* (%)	60.0 (40.0-65.0)	60.0 (45.0-65.0)	0.07
EuroSCORE*	2.0 (0-10.0)	2.0 (0-8.0)	0.469
Hematocrit* (preoperative, %)	36.5 (27.5-43.5)	38.0 (28.5-44.5)	0.213
Thoracic surgery (n, %)	35 (27.8)	30 (23.4)	0.347
Cardiac surgery with CPB* (n, %)	91 (72.2)	98 (76.6)	0.763

*p < 0.05 statistically significant; * Mann Whitney U test; **Pearson chi-square test; n: number; %: percentage; data is presented as median (minimum-maximum); CPB, cardiopulmonary bypass.

Table 2. Serial clinical and arterial blood gas parameters of two groups

Parameters	Group 1 (n = 126)				Group 2 (n = 128)			
	Before operation	Before BI-PAP (Postop. Day 1)	1 hour after BIPAP	4 hour after BIPAP	Before operation	Before BIPAP	1 hour after BIPAP	4 hour after BIPAP
RR* (rate/minute)*	23.0 ± 1.3	24.5 ± 3.2	24.5 ± 3.2 ^b	21.7 ± 6.9 ^c	24.9 ± 2.3	26.8 ± 2.6	22.8 ± 2.6 ^b	20.4 ± 6.9 ^c
HR* (rate/minute)*	106.8 ± 14.6	108.3 ± 11.6	108.3 ± 11.6	101 ± 10.2 ^c	104.4 ± 13.3	105.6 ± 10.6	105.6 ± 10.6	102.1 ± 11.2 ^c
pH	7.36 ± 0.02	7.36 ± 0.02	7.36 ± 0.03	7.35 ± 0.05	7.36 ± 0.02	7.36 ± 0.02	7.37 ± 0.05	7.35 ± 0.06
PaO ₂ (mmHg)	86.29 ± 7.5	82.6 ± 10.2 ^a	93.7 ± 7.3 ^b	99.9 ± 8.1 ^c	85.6 ± 7.04	80.2 ± 11 ^a	85.4 ± 10.2 ^b	86.4 ± 12.8 ^c
PaCO ₂ (mmHg)	38.6 ± 3.5	39.0 ± 4.2	37.7 ± 3.2 ^b	36.9 ± 3.1	37.8 ± 2.3	38.1 ± 2.1	37.9 ± 7.2	36.7 ± 4.5
SpO ₂ (%)	95.9 ± 1.82	93.9 ± 2.4 ^a	97.1 ± 2.59 ^b	98.5 ± 3.24 ^c	96.0 ± 1.4	93.9 ± 2.5 ^a	94.1 ± 2.13 ^b	95.6 ± 1.33 ^{cd}

*p < 0.05 statistically significant; RR, respiratory rate (breaths/minute); HR, heart rate (beat/minute); PaO₂, partial pressure of arterial oxygen; PaCO₂, partial pressure of arterial carbon dioxide; SpO₂, peripheral oxygen saturation; ICU, intensive care unit, BIPAP, Bi-level positive airway pressure; ^avalue at 1 hour significantly different from that at baseline within the groups; ^bvalue at 4 hour significantly different from that at 1 hour within groups; ^cvalue at 1 hour significantly different from that at baseline between the groups; ^dvalue at 4 hour significantly different from that at 1 hour between the two groups; postop., postoperative.

following fulfilling of acute respiratory failure criterias whereas, in Group 2 of 128 patients, BIPAP was applied one hour after extubation for two episodes of 20 minute duration and 3 hours apart without an acute respiratory failure episode. BIPAP ventilatory support device (BIPAP S/T-D30 Ventilatory Support System, Respirationics Inc., PA, USA) was used. BIPAP was applied with expiratory positive airway pressure (EPAP) of 4 cmH₂O and inspiratory positive airway pressure (IPAP) of 8 cmH₂O in a spontaneous mode. The pressures were gradually adjusted as tolerated based on continuous pulse oximetry to achieve an oxygen saturation of greater than 92%, a normal pH on arterial blood gases. Parameters collected at baseline, before and after BIPAP included; 1- Arterial blood gas values (pH, partial arterial oxygen pressure (PaO₂), partial arterial carbon dioxide pressure (PaCO₂) and arterial oxygen saturation (SpO₂)),

2- Tidal volume, respiratory and heart rate. All patients received a standard therapy protocol including diuretics and inhaled beta agonists. Patients receiving intravenous theophylline or other broncodilators were not included into the study. The primary end-point was to prevent reintubation. Other adverse events (pneumothorax, aspiration, pulmonary edema, transient ischemic attack, stroke, bronchospasm) were recorded.

The inclusion criterias to the study include; ages 50 and older, cardiac or thoracic surgery, ejection fraction equal to or greater than 50%, patients extubated in a twelve hour period postoperatively without any complications and these include; 1- Spontaneous respiratory rate (RR) < 25/min, 2- Spontaneous respiratory volume (Vt) > 0.005 L/kg of body weight, 3- Heart rate < 140/min, 4- Body temperature <

37.5°C, 5- Partial arterial oxygen pressure (PaO_2) > 60 mmHg with inspired oxygen fraction (FiO_2) \leq 0.4, 6- No need for vasoactive and/or inotropic support, 7- $\text{PaO}_2/\text{FiO}_2$ ratio > 200, 8- pH > 7.34, 8-No clinical signs and symptoms of acute respiratory distress (dyspnea, respiratory rate more than 24 breaths/minute, use of accessory muscles of respiration, presence of paradoxical breathing). In Group 2 of patients acute respiratory failure is diagnosed with the following criteria after extubation within fourty eight hours and these include: 1- Spontaneous respiratory rate > 25/min, 2- SpO_2 < 90%, 3- Heart rate > 140/min (or more than 20% change from the initial heart rate), 4- Systolic blood pressure > 200 mmHg or < 80 mmHg, 5- $\text{PaO}_2 \leq$ 60 mmHg, 6- pH \leq 7.30, and 7- Restlessness.

Patients were excluded from the study if they met any of the following criteria: Patients who required immediate reintubation within four hours after extubation, history of asthma, a restrictive pattern on spirometry (FEV1 less than 80% and FEV1/FVC greater than 0.7), spirometric data providing a diagnosis of severe obstructive pattern as a FEV1 less than 50% and FEV1/FVC ratio of 0.7 or less, lack of spirometric data, history of pneumonia or acute lung injury prior to operation, medically unstable condition (hypotension, uncontrolled cardiac ischemia/arrhythmia), inability to protect airway (excess secretions, stuporous or comatose patient), neurologic or psychiatry realted disorders (agitated or uncooperative patient).

The primary outcome was failure of NIV and it is defined as; 1- the need for endotracheal intubation during the ICU stay due to inability to improve gas exchange during BIPAP, 2- failure to improve mental status after two episodes of BIPAP in patients who are lethargic from CO_2 retention or agitated from hypoxemia, bradycardia (heart beat < 60 beats/minute with altered mental status), hypotension (systolic blood pressure < 90 mmHg), respiratory arrest, failure to maintain pulse oximetry (SpO_2) > 90%, significant metabolic and/or respiratory acidosis (pH < 7.20) [14]. Ultimately, clinical evaluation was conducted by the anesthesiologist in the intensive care unit before a decision for intubation was made. The other parameters that were collected include; duration of mechanical ventilation before initial

extubation, duration of NIV, the initial settings and final settings for IPAP and EPAP, whether the patient tolerated NIV, need for re-intubation, time to re-intubation, ICU length of stay, hospital length of stay, complications that may be related to NIV such as development of aspiration or pneumonia, mortality.

Statistical analysis

All statistical analysis was performed using SPSS Statistical Package 15.0 (SPSS Inc. California, USA). Based on the power analysis (PASS 11 (NCSS Inc. Utah, USA)), the study aimed to recruit 136 patients in order to have a clinically significant difference in the proportion of patients experiencing BIPAP trial failure for a clinically significant 3% difference in reintubation rate with a confidence interval of 95% and 80% power ($\alpha = 0.05$) and this was based on a previous study sample size calculation [15]. Data are presented as mean and standard deviation (SD) or as frequencies and percentages. Differences were assessed using chi square or Fisher exact test for categorical variables. Mann Whitney U-test is used for continuous or non-parametric data. After testing for normal distribution, data were compared using a two-way analysis of variance (ANOVA) for repeated measurements. *P* values < 0.05 were considered statistically significant.

Results

There were no differences regarding age, sex, or weight and perioperative clinical characteristics between Groups 1 and 2 ($p > 0.05$) (Table 1).

The comparison of types of cardiac surgical procedures between groups included; coronary artery bypass graft [59/126 (46.8%) versus 62/128 (48.4%); $p = 0.626$], mitral valve with or without tricuspid valve repair [16/126 (12.7%) versus 19/128 (14.8%); $p = 0.589$], aortic valve repair with or without mitral valve repair or reconstruction [9/126 (7.1%) versus 12/128 (9.4%); $p = 0.789$], coronary artery grafting without cardiopulmonary bypass (off-pump) [7/126 (5.6%) versus 5/128 (3.9%); $p = 0.314$]. The comparison of types of thoracic surgical procedures between groups included; lobectomy [20/126 (16%) versus 17/128 (13.3%); $p = 0.513$], bilobectomy [8/126 (6.3%) versus 3/12 (2.3%); $p=0.098$], pneumonecto-

Table 3. The comparison of risk factors for postoperative morbidity and mortality between groups

Parameters	Group 1	Group 2	p*
Complications, n (%)			
Cerebrovascular events	2 (1.6)	3 (2.3)	0.853
Atrial fibrillation	11 (8.7)	9 (7)	0.682
Other arrhythmias	13 (10.3)	16 (12.5)	0.421
Pneumonia	3 (2.4)	1 (0.8)	0.462
Pleural effusion	5 (4)	6 (5)	0.743
Reintubation	14 (11)	7 (5.5)	0.103
Intensive care unit stay (days) (M ± SD)	2.7 ± 1.2	2.9 ± 1.9	0.371
Hospital stay (days)	11.8 ± 6.9	10.8 ± 6.8	0.415
Mortality	6 (5)	6 (5)	0.857

*p < 0.05 statistically significant; M ± SD: mean and standard deviation; n (%): number, percentage; BIPAP, bilevel positive airway pressure.

my [7/126 (5.6%) versus 10/128 (7.8%); p = 0.192], and these were not found to be statistically different between groups (p > 0.05).

The comparison of the clinical and arterial blood gas parameters preoperatively and postoperatively in the intensive care unit are presented in **Table 2**. This table includes respiratory rate, heart rate, pH, PaO₂, PaCO₂ values before BIPAP, one and four hour after BIPAP. In comparison between groups, no significant differences were observed for arterial blood gas values of pH and PaCO₂ at baseline and one and four hours after BIPAP (p > 0.05) however, the PaO₂ and SpO₂ (peripheral oxygen saturation) values at one and four hours after BIPAP were significantly better in Group 1 in comparison to Group 2 (p < 0.001, p < 0.001; respectively) and there was no significant difference in comparison of baseline values of PaO₂ and SpO₂ (p > 0.05) (**Table 2**). Within group comparisons revealed that, in both groups in comparison to baseline values, there were no significant differences of pH and PaCO₂ values at one and four hours after BIPAP (p > 0.05). In both groups, in comparison to baseline values, the PaO₂ and SpO₂ values showed increase one and four hours after BIPAP in comparisons to baseline values (p < 0.001, p < 0.001; respectively). In comparison between groups, reintubation rate was 14 patients (11%) in Group 1 and 7 patients (5.5%) in Group 2 (p = 0.103).

Among the 254 patients that were included in the study, 6 patients (5%) from each group died within 30 days after operation (p = 0.713). In each group, four (Group 1, 4%, Group 2, 3%) of

these patients had underwent cardiac surgery and 1 patient in each group had thoracic surgery (p > 0.891). The duration of intensive care unit stay and hospital stay were similar between groups. Postoperative complications related to respiratory and cardiovascular systems showed no significant differences (p > 0.05) (**Table 3**).

Discussion

In postextubation respiratory failure after open heart or thoracic surgeries early treatment is mandatory as patients with normal lung functions developed respiratory related complications in the early postoperative period within eight to twelve hours after extubation [4, 9-14]. We investigated the effects of BIPAP, a non-invasive method of positive pressure ventilation on early acute respiratory failure in patients who underwent open heart surgery with CPB and our main finding is that whether the BIPAP treatment is applied during acute respiratory event or as a preventive treatment after extubation in the early postoperative period, there is no significant difference in reintubation rate or other postoperative complications and this finding is in correspondance with the recent publications [16-18]. The only important finding is that the arterial partial pressure of oxygen values were significantly better in patients with acute respiratory failure after first and fourth hour BIPAP treatments (p < 0.001, p < 0.001; respectively). The reason for this is that; after one and four hour of BIPAP application, a rapid improvement in arterial blood gas PaO₂ values, respiratory and heart rate are more significant in patients with hypoxemia showing prompt physiologic responses within four hours in comparison to patients without hypoxemia and this correlated with previous reports [19]. In cardiac and thoracic surgeries, main concerns are the impairment of the pulmonary ventilation-perfusion ratio due to atelectasis, pleural effusions, diminished caused by recumbent position, temporary diaphragmatic dysfunction, impairment of pulmonary secretion clearance, and pain [20]. Several studies have shown that, in patients with postoperative hypoxemic respiratory failure, NIV improves gas exchange, mini-

mizes atelectasis formation, and increases functional residual capacity in the early postoperative period [21].

The published literature providing evidence for the use of NIV to avoid postextubation intubation is limited. There are two randomized controlled studies that have provided information regarding use of NIV as an adjunct to weaning from mechanical ventilation and suggested that NIV permits earlier removal of the endotracheal tube [22, 23]. Our study design did not provide us information regarding the use of BIPAP for early removal of the endotracheal tube. Another issue is that the published literature providing evidence for the use of NIV to avoid postextubation intubation is limited. In a recent meta-analysis, Agarwal et al. Reviewed and summarized four studies on postextubation respiratory failure and they showed that NIV can be used in the early postoperative period in patients "at risk" for developing postextubation respiratory failure to prevent re-intubation and this study design was conducted in two of these studies on patients that were randomized immediately after extubation [24]. In our study design, in one group of patients BIPAP treatment was started in acute respiratory failure within forty eight hours after extubation however, the other group of patients received BIPAP treatment without signs of immediate postextubation respiratory failure and these patients were considered "at risk" without signs of respiratory failure and in our study design it is not possible to show a difference in reintubation rates. There is also an improvement in heart rate by the use of NIV and this was explained as to increase the intrathoracic pressure by rising the lung volume during inspiration. This physiological event leads to the consequent events reported as; 1- a reduction in right and left ventricular preload, 2- a reduction in left ventricular afterload, 3- a rise in cardiac output. During these changes a reduction in heart rate as well as mean systemic arterial pressure were reported [25]. This mechanism is related to the success of BIPAP applications in early postoperative period acute respiratory failure in open heart surgery patients. Another limitation of our study is that we were not able to include blood pressure measurements in our study design.

Our study includes several limitations and these include; 1- The sample size of our study may not be enough to detect the difference of

incidence for reintubation, 2- The two groups of patients that we have enrolled into the study are equal in terms of preoperative data however, in the group of patients with acute onset of respiratory failure the hemodynamic data including heart rate may change and this may change the pathophysiological status of each group that were compared. 3- There is need for a group of patients that did not receive BIPAP treatment and it would be a better study design to observe the intubation rate in that group of patients as well, 4- This data shows that the group of patients with acute respiratory failure may have done better in terms of reintubation however, we are unable to compare with a group of patients that did not receive BIPAP treatment.

Conclusion

The early and prophylactic use of BIPAP without acute respiratory failure in the early postoperative period after extubation did not show an improvement in the rates of postoperative adverse events including reintubation.

Address correspondence to: Dr. Gonul Sagiroglu, Department of Anesthesiology, Faculty of Medicine, Trakya University, Edirne, Turkey. Tel: +90 505 4689459; Fax: +90 2842369827; E-mail: gonulsagiroglu45@gmail.com

References

- [1] Nicholson DJ, Kowalski SE, Hamilton GA, Meyers MP, Serrette C, Duke PC. Postoperative pulmonary function in coronary artery bypass graft surgery patients undergoing early tracheal extubation: a comparison between short-term mechanical ventilation and early extubation. *J Cardiothorac Vasc Anesth* 2002; 16: 27-31.
- [2] Lopes CR, Brandão CM, Nozawa E, Auler JO Jr. Benefits of non-invasive ventilation after extubation in the postoperative period of heart surgery. *Rev Bras Cir Cardiovasc* 2008; 23: 344-50.
- [3] Jaber S, Michelet P, Chanques G. Role of non-invasive ventilation (NIV) in the perioperative period. *Best Pract Res Clin Anaesthesiol* 2010; 24: 253-65.
- [4] Auriant I, Jallot A, Hervé P, Cerrina J, Le Roy Ladurie F, Fournier JL, Lescot B, Parquin F. Noninvasive ventilation reduces mortality in acute respiratory failure following lung resection. *Am J Respir Crit Care Med* 2001; 164: 1231-5.

Bilevel positive airway pressure applications after cardiothoracic surgeries

- [5] Gust R, Gottschalk A, Schmidt H, Böttiger BW, Böhrer H, Martin E. Effects of continuous (CPAP) and bi-level positive airway pressure (BiPAP) on extravascular lung water after extubation of the trachea in patients following coronary artery bypass grafting. *Intensive Care Med* 1996; 22: 1345-50.
- [6] Matte P, Jacquet L, Van Dyck M, Goenen M. Effects of conventional physiotherapy, continuous positive airway pressure and non-invasive ventilatory support with bilevel positive airway pressure after coronary artery bypass grafting. *Acta Anaesthesiol Scand* 2000; 44: 75-81.
- [7] Peters JV, Moran JL, Phillips-Hughes J, Warn D. Noninvasive ventilation in acute respiratory failure—a meta-analysis up-date. *Crit Care Med* 2002; 30: 555-62.
- [8] Lenique F, Habis M, Lofaso F, Dubois-Randé JL, Harf A, Brochard L. Ventilatory and hemodynamic effects of continuous positive airway pressure in left heart failure. *Am J Resp Crit Care Med* 1997; 155: 500-5.
- [9] Keenan SP, Powers C, McCormack DG, Block G. Noninvasive positive-pressure ventilation for postextubation respiratory distress: a randomized controlled trial. *JAMA* 2002; 287: 3238-44.
- [10] Esteban A, Frutos-Vivar F, Ferguson ND, Arabi Y, Apezteguía C, González M, Epstein SK, Hill NS, Nava S, Soares MA, D'Empaire G, Alía I, Anzueto A. Noninvasive positive-pressure ventilation for respiratory failure after extubation. *N Engl J Med* 2004; 350: 2452-60.
- [11] Nava S, Gregoretti C, Fanfulla F, Squadrone E, Grassi M, Carlucci A, Beltrame F, Navalesi P. Noninvasive ventilation to prevent respiratory failure after extubation in high-risk patients. *Crit Care Med* 2005; 33: 2465-70.
- [12] Ferrer M, Valencia, Nicolas JM, Bernadich O, Badia JR, Torres A. Early noninvasive ventilation averts extubation failure in patients at risk: a randomized trial. *Am J Respir Crit Care Med* 2006; 173: 164-70.
- [13] Agarwal R, Aggarwal AN, Gupta D, Jindal SK. Role of noninvasive positive-pressure ventilation in postextubation respiratory failure: A meta-analysis. *Respir Care* 2007; 52: 1472-79.
- [14] Michalopoulos A, Geroulanos S, Papadimitriou L, Papadakis E, Triantafyllou K, Papadopoulos K, Palatianos G. Mild or moderate chronic obstructive pulmonary disease risk in elective coronary artery bypass grafting surgery. *World J Surg* 2011; 25: 1507-11.
- [15] Matić I, Danić D, Majerić-Kogler V, Jurjević M, Mirković I, Mrzljak Vucinić N. Chronic obstructive pulmonary disease and weaning of difficult-to-wean patients from mechanical ventilation: randomized prospective study. *Croat Med J* 2007; 48: 51-8.
- [16] Spivack SD, Shinozaki T, Albertini JJ, Deane R. Preoperative prediction of postoperative respiratory outcome. Coronary artery bypass grafting. *Chest* 1996; 109: 1222-30.
- [17] Michalopoulos A, Geroulanos S, Papadimitriou L, Papadakis E, Triantafyllou K, Papadopoulos K, Palatianos G. Mild or moderate chronic obstructive pulmonary disease risk in elective coronary artery bypass grafting surgery. *World J Surg* 2011; 25: 1507-11.
- [18] Manganas H, Lacasse Y, Bourgeois S, Peron J, Dagenais F, Maltais F. Postoperative outcome after coronary artery bypass grafting in chronic obstructive pulmonary disease. *Can Respir J* 2007; 14: 19-24.
- [19] Mehta S, Hill NS. Noninvasive ventilation. *Am J Respir Crit Care Med* 2001; 163: 540-577.
- [20] Antonelli M, Conti G, Rocco M, Bui M, De Blasi RA, Vivino G, Gasparetto A, Meduri GU. A comparison of noninvasive positive pressure ventilation and standard mechanical ventilation in patients with acute respiratory failure. *N Engl J Med* 1998; 339: 429-434.
- [21] Brochard L, Mancebo J, Wysocki M, Lofaso F, Conti G, Rauss A, Simoneau G, Benito S, Gasparetto A, Lemaire F. Noninvasive ventilation for acute exacerbation of COPD. *N Engl J Med* 1995; 151: 1799-1806.
- [22] Nava S, Ambrosino N, Clini E, Prato M, Orlando G, Vitacca M, Brigada P, Fracchia C, Rubini F. Noninvasive mechanical ventilation in the weaning of patients with respiratory failure due to chronic pulmonary disease. A randomized, controlled trial. *Ann Intern Med* 1998; 128: 721-8.
- [23] Girault C, Daudenthun I, Chevron V, Tamion F, Leroy J, Bonmarchand G. Noninvasive ventilation as a systematic extubation and weaning technique in acute-on-chronic respiratory failure. A prospective randomized controlled study. *Am J Respir Crit Care Med* 1999; 160: 86-92.
- [24] Agarwal R, Aggarwal AN, Gupta D, Jindal SK. Role of noninvasive positive-pressure ventilation in postextubation respiratory failure: a meta-analysis. *Respir Care* 2007; 52: 1472-9.
- [25] Lenique F, Habis M, Lofaso F, Dubois-Randé JL, Harf A, Brochard L. Ventilatory and hemodynamic effects of continuous positive airway pressure in left heart failure. *Am J Resp Crit Care Med* 1997; 155: 500-5.