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Original Article

Comparison and Evaluation of the Effects of Administration of Postoperative Non-Invasive Mechanical Ventilation Methods (CPAP and BIPAP) on Respiratory Mechanics and Gas Exchange in Patients Undergoing Abdominal Surgery

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Abstract

Objective: The aim of our study is to investigate the effect of two different methods of continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BIPAP) and oxygen support under spontaneous ventilation on respiration mechanics, gas exchange, dry mouth and face mask lesion during an early postoperative period in patients undergoing upper abdominal surgery.

Methods: Eighty patients undergoing elective abdominal surgery with laparotomy, between the age of 25 and 75 years and American Society of Anesthesiologists Physical Status score (ASA) II–III with chronic obstructive pulmonary disease (COPD) diagnosis were included to the study. Subjects were randomly allocated in to four groups. During the first postoperative hour, the first group received BIPAP, second group received high-flow CPAP, third group received low-flow CPAP and fourth group received deep breathing exercises, respiratory physiotherapy and O_2 therapy. Preoperative, postoperative before and after treatment PaO_2, $PaCO_2$, SpO_2, tidal volume (TV), respiratory rate (RR) levels were recorded. Subjects with dry mouth or face mask lesion were recorded.

Results: In all groups, PaO_2 and TV measurements were higher at the postoperative first hour than the postoperative zero hour. We found that low-flow CPAP increased PaO_2 and SpO_2 values more, and TV levels were higher in the postoperative period than the preoperative period. $PaCO_2$ levels were elevated at the zero hour postoperatively and at the end of the first hour; they decreased approximately to preoperative values, except in the fourth group.

Conclusion: Administration of prophylactic respiratory support can prevent the deterioration of pulmonary functions and hypoxia in patients with COPD undergoing upper abdominal surgery. In addition, we found that low-flow CPAP had better effects on PaO_2, SpO_2, TV compared to other techniques.

Keywords: NIMV, COPD, postoperative respiratory failure

Introduction

Postoperative hypoxaemia and acute respiratory distress syndrome may often develop after abdominal and thoracic surgery. The risk increases as the surgical region gets closer to the diaphragm. A requirement for endotracheal intubation and mechanical ventilation may develop in 8–10% of these patients (1). Respiratory changes are at a maximum in the first few hours after surgery. For this reason, oxygenation and ventilation have to be effectively provided in the early postoperative period, and the development of acute respiratory distress syndrome must be prevented. It has been reported that in patients at high risk, notably in patients with chronic obstructive pulmonary disease (COPD), the applications of non-invasive mechanical ventilation (NIMV) in the early postoperative period improve gas exchange, increase alveolar ventilation, decrease inhalation, improve atelectasis and decrease respiratory distress syndrome development in the postoperative period when compared to spontaneous ventilation with or without oxygen support (2-4).

Continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BIPAP) are the most common methods of NIMV.

The aim of our study was to compare the effects of CPAP, BIPAP and spontaneous ventilation applications with oxygen support that we applied in two different ways on respiratory mechanics, gas exchange, facial pressure and mouth dryness in patients with a COPD diagnosis who underwent upper abdominal surgery in the early postoperative period (the first hour).

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Methods

The study was conducted as a prospective, randomised controlled clinical trial in Istanbul University Cerrahpaşa Medical Faculty Anaesthesiology Department, General Surgery Operating theatre, after receiving the approval of Istanbul University Cerrahpaşa Medical Faculty Ethics Committee and the written informed consent of the patients.

Eighty patients in the age group of 25–75 years, who had previously received a COPD diagnosis from a pulmonologist, who had a score of II-III according to the American Society of Anaesthesiologists (ASA) physical status classification and who would undergo upper abdominal surgery (hepatectomy, Whipple procedure, incisional hernia repair, splenectomy, cholecystectomy, omentectomy and nephrectomy) with elective laparotomy were included in the study.

Patients having a known history of heart and respiratory arrest, perioperative haemodynamic instability and unplanned extubation, having developed postoperative severe agitation and encephalopathy, having hypercarbia, increased secretions and uncontrolled vomiting, not being able to maintain airway safety, having postoperative reintubation, a body mass index of 40 and above and haemoptysis, having undergone upper gastrointestinal bleeding and who would undergo oesophageal surgery were excluded from the study. The patients were randomly divided in to four groups.

Respiratory rate per minute (RPM), preoperative arterial blood gas parameters (PaO_2, $PaCO_2$ and SpO_2) and expiratory tidal volume (mL) measurements with a Wright spirometer of the patients taken in the holding area were recorded. Premedication was provided in all patients with 0.03 mg kg^{-1} intravenous (IV) midazolam by establishing vascular access with a 20 G cannula.

Electrocardiography (ECG), non-invasive blood pressure, peripheral oxygen saturation (SpO_2) (Datex-Engström, ADU, Finland) and neuromuscular functions using a train-of-four (TOF) guard (Organon Teknika, Odense, Denmark) were monitored.

Anaesthesia induction was conducted with 2 mg kg^{-1} propofol, 0.6 mg kg^{-1} rocuronium and 1 µg kg^{-1} IV fentanyl. When TOF values were 0%, female patients were intubated with ID 7.5 mm, and male patients were intubated with ID 8.0-mm endotracheal tubes. The maintenance of anaesthesia was provided with 2% sevoflurane and 40% oxygen–air mixture. When a 20% increase in non-invasive blood pressure and heart rate was observed, 50 µg of IV fentanyl was additionally given to the patients. Neuromuscular blocking drug maintenance was conducted with IV rocuronium at 45-min intervals. Right radial artery cannulation and invasive arterial monitoring were conducted on all patients following anaesthesia induction.

For all patients in the preoperative period in pressure-controlled mode, the inspiration pressure was adjusted so that the respiratory frequency would be 12 min^{-1}, FiO_2 would be 40% and the tidal volume would be 6–8 mL kg^{-1}, and mechanical ventilation was conducted so that I:E would be 1/2, PEEP would be 6–8 cmH_2O and $EtCO_2$ values would be 35–38 mmHg.

For postoperative analgesia, each patient was intravenously given 100 mg of tramadol and 5 g of metamizole sodium in 100 mL 0.9% of NaCl 30 min before extubation. After surgery, when the TOF values became 90%, patients were extubated by reversal of neuromuscular blocker action with IV 0.01 mg kg^{-1} atropine and 0.02 mg kg^{-1} neostigmine.

All patients were transferred to the recovery room following extubation. Patients were placed in a sitting position at an angle of 60^0. An additional dose of 1 mg kg^{-1} IV tramadol was given to patients who had a visual analogue pain score of 4 and above. An arterial blood gas sample was taken from the radial artery cannula at the 5th minute from patients who were given 6 L dk^{-1} O_2 with a mask, and RPM, arterial blood gas parameters (PaO_2, $PaCO_2$ and SpO_2) and expiratory tidal volume with a Wright spirometer were recorded.

An appropriate-sized face mask was provided to patients for conducting NIMV, and air leaks were prevented by air leak control during NIMV application.

Group 1: Prophylactic BIPAP was applied for 60 min with the parameters (with Respironics BiPap Vision device), FiO_2: 40%, IPAP: 12 cmH_2O and EPAP: 5 cmH_2O.

Group 2: Prophylactic CPAP was applied for 60 min with the parameters CPAP (flow generator HAROL) (Harol, Via Marcora, Italy), CPAP level: 5 cmH_2O and FiO_2: 40%.

Group 3: Prophylactic CPAP was applied for 60 min with the parameters (with Respironics BiPap Vision device), CPAP level: 5 cmH_2O and FiO_2: 40%.

Group 4: 6 L min^{-1} oxygen treatment with face mask for 60 min, deep breathing exercises (instructed by the physician for 15-min intervals) and respiratory physiotherapy were conducted on the patients.

Arterial blood gases were taken from patients at 0 and 60 min postoperatively and SpO_2, RPM,, PaO_2, $PaCO_2$, Wright spirometry and ETV measurement values were recorded.

Patients were asked if they had dryness of the mouth and it was recorded whether there were mask-related pressure marks in the patients to whom NIMV was applied. After the applications, O_2 therapy was conducted on the patients with 4 L min^{-1} by mask until they were transferred to their clinics.

At the end of the preoperative study period, post-extubation and post-prophylactic NIMV values of the 4 groups were compared statistically. The effect of post-extubation prophylactic NIMV types on clinical and oxygenation pa-

rameters was investigated in patients who underwent upper abdominal surgery.

Statistical analysis

For evaluating the data of the study, in addition to descriptive statistical methods (mean, standard deviation, minimum, maximum, median, frequency, rate), in the comparison of quantitative data a one-way ANOVA test was used for comparison of 3 groups or more that displayed normal distribution, a Tukey HSD test was used to detect the group that caused difference and a Kruskal–Wallis test was used for comparison of 3 groups or more that did not display normal distribution. Repeated-measures analysis of variance was used in the evaluation of variables within groups according to the follow-ups. The Pearson chi-squared test and Fisher–Freeman–Halton test were used in comparison of qualitative data. Significance was evaluated at the level of $p<0.05$.

Results

Demographic features of the cases that were included in the study are displayed in Table 1. There was no significant difference between the groups.

Although there was no significant difference between the groups with regard to RPM values, within group 4 postoperative 0th hour RPM values were significantly higher than preoperative RPM values (p=0.045) (Table 2).

There was no significant difference with regard to $PaCO_2$ values between the groups. Within the groups, postoperative 0th hour $PaCO_2$ values of groups 1 and 2 were significantly higher than preoperative values (p=0.001, p=0.002). Groups 2 and 4 postoperative 1st hour $PaCO_2$ values were found to be significantly higher than preoperative values (p=0.032, p=0.021). Group 2 postoperative 1st hour values were significantly lower compared to postoperative 0th hour values (p=0.043) (Table 3).

There was no significant difference between the groups with regard to PaO_2 values. Within the groups, groups 2 and 4 postoperative 0th hour PaO_2 values were significantly higher than preoperative values (p=0.005, p=0.006). In all the groups, postoperative 1st hour PaO_2 values were significantly higher compared to preoperative values (p=0.001). Groups 1 and 3 postoperative 1st hour PaO_2 values were found to be significantly higher compared to postoperative 0th hour values (p=0.001, p=0.002) (Table 4).

No statistically significant difference was found between preoperative and postoperative 1st hour SpO_2 values of cases among the groups. Group 1 postoperative 0th hour values were lower compared to other groups (p=0.046). Within the groups, groups 1, 2, 3 and 4 postoperative 1st hour SpO_2 values were significantly higher compared to preoperative SpO_2 values (p=0.017, p=0.001, p=0.001 and p=0.038). In groups 1 and 3, postoperative 1st hour values were significantly higher than postoperative 0th hour values (p=0.001, p=0.019) (Table 5).

There was no significant difference in ETV values between the groups. Within the groups, groups 2 and 4 postoperative 0th hour ETV values were significantly lower compared to preoperative ETV values (p=0.001, p=0.042). Group 2 postoperative 1st hour ETV values were significantly lower compared to preoperative ETV values (p=0.001). Groups 1, 2 and 3 postoperative 1st hour ETV values were found to be significantly higher compared to postoperative 0th hour values (p=0.029, p=0.002 and p=0.015) (Table 6).

The incidence rates of dryness of the mouth in the cases of groups 1, 2 and 3 were found to be significantly higher compared to cases in group 4 (p=0.011) (Table 7). The rates of incidence of mask pressure traces in groups 1 and 3 were significantly higher compared to cases in group 4 (p=0.003; p=0.020) (Table 7).

Discussion

Incision site pain and residual anaesthetic effect after abdominal surgery, lying positions, decreasing lung volumes

Table 1. Demographic data

		Group 1 Mean±SD	Group 2 Mean±SD	Group 3 Mean±SD	Group 4 Mean±SD	p
Age (years)		60.80±9.02	61.45±7.21	61.75±8.28	58.30±7.89	0.529[a]
Weight (kg)		68.95±12.57	78.20±17.38	71.25±12.40	75.05±9.84	0.140[a]
Height (cm)		163.85±6.67	166.50±8.88	163.70±7.97	164.90±8.78	0.680[a]
BMI (kg m^{-2})		25.74±4.95	28.35±6.80	26.73±5.42	27.76±4.11	0.444[a]
ASA (Median)		2.10±0.31 (2.0)	2.10±0.31 (2.0)	2.05±0.22 (2.0)	2.15±0.37 (2.0)	0.778[b]
		n (%)	n (%)	n (%)	n (%)	
Gender	Male	11 (55.0)	12 (60.0)	14 (70.0)	12 (60.0)	0.801[c]
	Female	9 (45.0)	8 (40.0)	6 (30.0)	8 (40.0)	

[a]One-way ANOVA test, [b]Kruskal–Wallis test, [c]Pearson chi-squared test. SD: standard deviation; BMI: body mass index; ASA: American Society of Anaesthesiologists

Table 2. Comparison of RPM data of the groups

RPM (breath min^{-1})	Group 1 Mean±SD	Group 2 Mean±SD	Group 3 Mean±SD	Group 4 Mean±SD	p
Preop	16.70±3.06	16.95±2.86	15.60±3.02	15.25±2.45	0.179[a]
Postop 0. hour	17.40±4.98	18.45±3.50	16.70±2.77	16.90±4.04	0.496[a]
Postop 1. hour	16.85±4.07	17.75±2.90	15.80±3.04	16.50±3.10	0.315[a]
p[b]	0.623	0.237	0.199	0.036*	
Preop-postop 0. hour	1.000	0.351	0.536	0.045*	
Preop-postop 1. hour	1.000	1.000	1.000	0.119	
Postop 0. hour-postop 1. hour	1.000	0.926	0.211	1.000	

[a]One-way ANOVA test; [b]Repeated-measures analysis of variance; *p<0.05. Preop: preoperative; Postop 0. hour: postoperative 0th hour; Postop 1. hour: postoperative 1st hour; SD: Standard deviation; RPM: Respiratory rate per minute.

Table 3. Comparison of $PaCO_2$ (mmHg) data of the groups

$PaCO_2$ (mmHg)	Group 1 Mean±SD	Group 2 Mean±SD	Group 3 Mean±SD	Group 4 Mean±SD	p
Preop	36.38±4.73	36.51±3.81	37.22±4.46	36.21±3.54	0.875[a]
Postop 0. hour	41.97±4.79	42.43±6.23	39.78±3.48	39.74±5.64	0.214[a]
Postop 1. hour	38.67±9.26	39.76±4.48	39.95±4.18	40.04±4.51	0.880[a]
p[b]	0.001**	0.001**	0.053	0.027*	
Preop-postop 0. hour	0.001**	0.002**	0.234	0.111	
Preop-postop 1. hour	1.000	0.032*	0.079	0.021*	
Postop 0. hour-postop 1. hour	0.467	0.043*	1.000	1.000	

[a]One-way ANOVA test, [b]Repeated-measures analysis of variance, *p<0.05, **p<0.01. SD: standard deviation; Preop: preoperative; Postop 0. hour: postoperative 0th hour; Postop 1. hour: postoperative 1st hour

Table 4. Comparison of PaO_2 (mmHg) data of the groups

PaO_2 (mmHg)	Group 1 Mean±SD	Group 2 Mean±SD	Group 3 Mean±SD	Group 4 Mean±SD	p
Preop	82.86±10.54	85.39±13.24	89.13±14.80	86.98±9.67	0.429[a]
Postop 0. hour	92.14±37.91	119.91±36.37	105.74±39.85	123.89±50.35	0.072[a]
Postop 1. hour	125.27±45.83	132.65±47.73	160.70±57.06	138.72±55.08	0.150[a]
p[b]	0.001*	0.001*	0.001*	0.001*	
Preop-postop 0. hour	0.579	0.005*	0.130	0.006*	
Preop-postop 1. hour	0.001*	0.001*	0.001*	0.001*	
Postop 0. hour-postop 1. hour	0.001*	0.681	0.002*	0.649	

[a]One-way ANOVA test; [b]Repeated-measures analysis of variance; *p<0.01. Preop: preoperative; Postop 0. hour: postoperative 0th hour; Postop 1. hour: postoperative 1st hour; SD: standard deviation

and rapid and shallow respiration may lea may lead to hypoxaemia by causing diaphragm dysfunction and atelectasis (5). Prophylactic CPAP or BIPAP are used in addition to methods such as mobilisation in the early period, breathing exercises and spirometers in order to decrease the complications related to the respiratory system that are encountered in the postoperative period (6-8).

In our study we aimed to observe the effects of prophylactic CPAP with a flow generator and mechanical ventilator, prophylactic BIPAP and mask oxygen-supported sponta-

Table 5. Comparison of SpO_2 (%) data of the groups

SpO_2 (%)	Group 1 Mean±SD	Group 2 Mean±SD	Group 3 Mean±SD	Group 4 Mean±SD	p
Preop	96.63±0.83	96.80±0.99	96.61±1.68	96.83±0.99	0.903[a]
Postop 0. hour	95.62±2.41	97.82±1.38	96.24±3.51	97.15±2.68	0.046[a],*
Postop 1. hour	97.66±1.44	98.27±1.00	98.39±0.74	98.00±1.39	0.224[a]
pb	0.001**	0.001**	0.001**	0.035*	
Preop-postop 0. hour	0.170	0.061	1.000	1.000	
Preop-postop 1. hour	0.017*	0.001**	0.001**	0.038*	
Postop 0. hour-postop 1. hour	0.001**	0.559	0.019*	0.486	

[a]One-way ANOVA test, [b]Repeated-measures analysis of variance, *p<0.05, **p<0.01. SD: standard deviation; Preop: preoperative; Postop 0. hour: postoperative 0th hour; Postop 1. hour: postoperative 1st hour

Table 6. Comparison of expiratory tidal volume (ETV, mL) data of the groups

ETV (mL)	Group 1 Mean±SD	Group 2 Mean±SD	Group 3 Mean±SD	Group 4 Mean±SD	p
Preop	572.00±217.39	702.50±182.95	547.50±146.82	628.25±195.82	0.057[a]
Postop 0. hour	493.50±176.85	541.00±157.54	544.00±189.39	516.40±154.54	0.763[a]
Postop 1. hour	558.0	616.50±145.36	624.50±198.00	559.00±191.09	0.544[a]
p[b]	0.023*	0.001**	0.019*	0.014*	
Preop-postop 0. hour	0.195	0.001**	1.000	0.042*	
Preop-postop 1. hour	1.000	0.001**	0.279	0.156	
Postop 0. hour- Postop 1. hour	0.029*	0.002**	0.015*	0.517	

[a]One-way ANOVA test, [b]Repeated-measures analysis of variance, *p<0.05, **p<0.01. SD: standard deviation; ETV: expiratory tidal volume; Preop: preoperative; Postop 0. hour: postoperative 0th hour; Postop 1. hour: postoperative 1st hour

Table 7. Evaluation of the frequencies of dryness of the mouth and mask pressure traces according to the groups

		Group 1 Mean±SD	Group 2 Mean±SD	Group 3 Mean±SD	Group 4 Mean±SD	p
Dryness of the mouth	Yes	7 (35.0)	15 (75.0)	11 (55.0)	18 (90.0)	0.002[a],*
	None	13 (65.0)	5 (25.0)	9 (45.0)	2 (10.0)	
Mask pressure mark	Yes	12 (60.0)	18 (90.0)	14 (70.0)	20 (100.0)	0.004[b],*
	None	8 (40.0)	2 (10.0)	6 (30.0)	0 (0.0)	

[a]Pearson chi-squared test, [b]Fisher–Freeman–Halton test, *p<0.01. SD: Standard deviation.

neous respiration applications on respiratory mechanics, gas exchange, facial pressure and dryness of the mouth in patients with a COPD diagnosis who underwent upper abdominal surgery with laparotomy in the early postoperative period.

Bohrer et al. (9) in their study applied nasal CPAP with a flow generator for 12 hours following extubation to one group of patients who had undergone elective laparotomy and they reported that they encountered less trouble related to oxygenation compared to another group.

Antonelli et al. (10) compared BIPAP and mask oxygen therapy in the study that they conducted in patients who underwent solid organ transplantation such as liver, lung and kidney and who developed acute respiratory distress syndrome and they showed that the P/F ratio improved in 70% of patients in the oxygen therapy group and 25% of patients in the NIMV group in the first hour of treatment.

Squadrone et al. (1) included 209 patients who had hypoxaemia after elective abdominal surgery in their study. They gave oxygen to 104 patients with a venturi mask and

applied CPAP at a pressure of 7.5 cmH_2O through a flow generator to 105 patients. The mean PaO_2/FiO_2 ratio after treatment was higher in the patients treated with CPAP compared to the other group.

On the other hand, Denehy et al. (11) compared prophylactic CPAP application and respiratory physiotherapy in their study and they detected no difference between groups with CPAP applied and not applied with regard to FRC, vital capacity and SpO_2 parameters.

In the study by Joris et al. (7), in which they investigated the efficiency of postoperative nasal BIPAP in morbidly obese patients who had undergone gastroplasty, they showed that the effect of BIPAP that was applied with pressures of EPAP: 4 cmH_2O and IPAP: 12 cmH_2O was maintained despite ventilator support being interrupted and that BIPAP's prophylactic use can be beneficial in patients at high risk with regard to the development of pulmonary complications.

In our study, which was different from other studies, the prophylactic effects of CPAP with two different devices (flow generator and mechanical ventilator) and BIPAP in the postoperative period were compared in patients who had a COPD diagnosis. In addition the NIMV application period and pressures also differed from the other studies. We observed the short-term effects of applying NIMV in our cases prophylactically with oxygenation in the first 60 min.

We found that postoperative 1st hour PaO_2 values were higher compared to those with the postoperative 0th hour values in all groups. Although there was no statistical difference between the groups, the highest increase was in group 3, in which CPAP was applied with a mechanical ventilator. This indicates that CPAP application, especially with a mechanical ventilator, in the postoperative period is effective for improving oxygenation. The postoperative 0th hour and 1st hour PaO_2 values in all groups were found to be higher than the preoperative values. This may be explained by the fact that the cases that were included in the study, even if they had a COPD diagnosis, responded with high PaO_2 values to oxygen application and did not have signs of preoperative acute infection and hypoxia, which is an expected finding.

In comparison among the groups, the preoperative, postoperative 0th hour and postoperative 1st hour RPM measurements in our cases demonstrated no statistically significant difference. The changes among preoperative, postoperative 0th hour and postoperative 1st hour RPM measurements within groups were found to be not statistically significant in all groups.

When we looked at the postoperative 0th and 1st hour tidal volumes in our p, we found that at the 0th Hour, the tidal volumes of the cases in all groups decreased and at the 1st hour, the tidal volumes of the cases in all groups except group 3 decreased compared with the preoperative period but increased compared with the 0th hour values. Although there was no statistical difference between these values, 100–150 mL of increase or decrease in tidal volumes may be clinically significant. These changes can be explained by the fact that patients were more cooperative at the postoperative 1st hour and that their pain treatments were more effective; therefore, they took deeper breaths. However, in our group 3, in which we applied CPAP with a mechanical ventilator, the tidal volumes at the postoperative 1st hour were found to be even higher than the preoperative values. This makes us think that CPAP application with a mechanical ventilator provides more effective support in the postoperative period. The reason why CPAP application with a mechanical ventilator was more effective was that it was more comfortable and that gases were humidified. The PaO_2 and SpO_2 values of group 3 also support this view. The fact that the decrease in the expiratory tidal volumes of our patients in the group to which we applied BIPAP at the postoperative 1st hour was more than in the other groups was a surprising outcome for us. The reason for this may be the inclusion of patients who had a COPD diagnosis and who will undergo upper abdominal surgery and the application of the same pressure to every patient by keeping the IPAP and EPAP values constant.

We did not increase the pressures to protect the anastomosis line as the patients underwent upper abdominal surgery. We are of the opinion that this approach could decrease the effectiveness of BIPAP application to patients. In the study by Battisti et al., in which they applied CPAP to non-hypercapnic patients and BIPAP to hypercapnic patients, it was found that BIPAP application decreased $PaCO_2$ in hypercapnic patients.

On the other hand, in the study by Pasquina et al. (13), in which they compared CPAP and BIPAP with a flow generator, they did not find any difference between $PaCO_2$ values when the patients were discharged from the hospital.

In our study, the $PaCO_2$ measurements preoperatively and at postoperative 0th and 1st hours displayed no statistically significant difference among the groups. With regard to changes within groups, $PaCO_2$ values increased at the postoperative 0th hour compared with the those of the preoperative period in all groups. This statistically insignificant increase may be due to the residual effect of anaesthesia during this period. $PaCO_2$ values fell close to the initial values at the postoperative 1st hour in all groups except group 4. Even though $PaCO_2$ values at the postoperative 1st hour in group 4 were found to be higher than those in the other groups, as mechanical ventilation support to decrease respiration was not given to the patients in this group, these values were at acceptable levels.

Stock et al. (14) detected dryness of the mouth in all patients in whom they applied CPAP; however, they did not encounter distension complaints.

Joris et al. (7) did not detect nasal abrasion in patients in whom they applied NIMV with a mask.

Pasquina et al. (13) pointed out that mask pressure related face lesions did not occur and that gastric distension and nausea were seen at a rate of 25% in the CPAP group and 16% in the BIPAP group.

There were nasogastric tubes in all our cases during NIMV application. Therefore, there were no patients in whom gastric distension developed. However, the presence of a nasogastric tube increased air leaks and decreased patient comfort. The frequency of dryness of the mouth and incidence of mask pressure were greater in the group 1 patients in whom BIPAP was applied. This is a surprising outcome because dryness of the mouth in CPAP applications with a flow generator is a more common problem due to the fact that humidification cannot be sufficiently conducted and this discomforts the patient. When we evaluated the other parameters, PaO_2 and SpO_2 values, although not significant, they were found to be lower in group 1 than in the other groups due to the discomfort of patients or because we were unable to provide sufficient pressure support.

Mask pressure marks were observed in all the groups other than group 4. However, ulceration in the face did not develop in any of our cases. The reason for this may be that the NIMV application period was as short as 60 min. Contrary to expectations, dryness of the mouth was less in patients in group 4.

Conclusion

Prophylactic postoperative early respiratory support in patients with a COPD diagnosis who underwent upper abdominal surgery prevents the impairment of respiratory functions and hypoxia that may develop. Although CPAP application with a mechanical ventilator was not statistically significant, its positive impact on increasing PaO_2, SpO_2 and expiratory tidal volume was determined to be remarkable.

We are of the opinion that large-series, clinical, randomised, prospective studies are required for more precise results.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul University Cerrahpaşa Faculty of Medicine.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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