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Comparing the Planned Respiratory Cares and CPAP on Atelectasis and Arterial Blood Oxygen Levels of patients undergoing Coronary Artery Bypass Graft

Pouya Farokhnezhad Afshar[1], Sedighe Ghorbani[2*], Mostafa Alavi[3], Fatemeh Bahramnezhad[4], Hooman Bakhshandeh[5] and Hamidreza Pouraliakbar[6]

[1]PhD candidate in Gerontology, University of Social Welfare and Rehabilitation Science, Tehran, Iran
[2]Master of Science in Critical Care Nursing, Rajaie Cardiovascular Medical and Research Center, Iran University of Medical Sciences, Tehran, Iran
[3]Associate Professor of Cardiac Anesthesia, Rajaie Cardiovascular Medical and Research Center, Iran University of Medical Sciences, Tehran, Iran
[4]PhD Candidate in Nursing, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, Iran
[5]Assistant Professor of Epidemiology, Rajaie Cardiovascular Research Center, Tehran, Iran
Corresponding Email:ghorbani.s@gmail.com

ABSTRACT

This study aimed to investigate the effects of planned respiratory cares and Continuous Positive Airway Pressure (CPAP) on atelectasis and arterial blood oxygen levels in Coronary Artery Bypass Graft (CABG) patients. pulmonary complications and oxygenation impairment after Coronary Artery Bypass Surgery (CABS) are prevalent and lead to increased hospitalization and treatment costs. Planned respiratory cares and the application of ventilation with CPAP mode are among the proceedings that are conducted in most of the health centers, but there are not sufficient scientific evidences to confirm the effectiveness of one of these proceedings after CABS. The preset study was a three-group clinical trial with the sample size of 120 patients (40 patients in each group) candidate for CABG based on permuted-block randomization. This study was conducted at ShahidRajaei Hospital, Iran in 2015. Patients in experimental group (1) received planned respiratory cares; patient in experimental group (2) received noninvasive ventilation with CPAP mode and; patients in control group received conventional respiratory cares. Other treatments were similar for all three groups. The groups of interest were compared regarding the percentages of measured arterial oxygen saturation before surgery and days one, two, and three after surgery. Also, chest X-rays of patients both before and after surgery (day 3) were compared in terms of atelectasis. Data were analyzed by SPSS 16 using Chi-square tests, Kruskal-Wallis, and Friedman. the results showed that there is not any significant difference between three groups in terms of demographic variables, disease background, and arterial oxygen saturation values before surgery. In day (1), before intervention in patients of group 3, the arterial oxygen saturation values were higher compared to other two groups ($p=0.03$) and ($p=0.001$). In the case of atelectasis incidence, patients in group 2 had lowest incidence rate compared to other groups. However, there was no significant difference between three groups of the study. the results of this study showed that those patients who received noninvasive ventilation with CPAP mode after surgery, have better oxygenation status compared to patients receiving planned respiratory cares and patients receiving conventional cares. Also, oxygenation and recovery procedures are faster in these patients. The incidence of atelectasis in this group is lower compared to other groups. Therefore, it is recommended to use this noninvasive method to have better ventilation for patients under open heart surgery.

Keywords: Noninvasive ventilation, Planned respiratory cares, Arterial blood oxygen levels, Atelectasis

INTRODUCTION

Patients under heart surgery, due to background diseases and surgical trauma, are at the risk of multiple complications. The most important possible complications following Coronary Artery Bypass Graft (CABG) surgery include decreased cardiac output, impaired kidney function, impaired neurological function, and respiratory complications[1].where respiratory complications in patients under heart surgery are notable, so that it is estimated about 95%[2].There are not accurate information about the incidence of these complications following heart surgery in Iran[3].The most common respiratory complications following open heart surgery are pulmonary atelectasis and accumulation of secretions. The incidence of atelectasis within the first days after CABG surgery is reported about 27 to 95% [4, 5] that is accompanied by fever, chest pain, dyspnea, tachypnea, tachycardia, cough, dizziness, decreased lung sounds, sever weakness, and pallor of the skin [6] and brings complications such as hypoxemia, pneumonia, abscess formation within the lungs, permanent shrinkage of lung tissue, and formation of scar tissue[7]. The most important early complication following the incidence of atelectasis is arterial hypoxemia and the most important potential late complication following atelectasis is tendency toward infection. Therefore, if a part of the lung is experiencing atelectasis for 72 hours, the risk of pneumonia is almost certain[8].

One of the most effective prevention methods of respiratory complications, especially atelectasis, is ventilation with Continuous Positive Airway Pressure (CPAP). This method is one of the noninvasive ventilation methods with positive pressure that after surgery, increases vital capacity and oxygen saturation and decreases respiration rates and function[9]. Also, it can be used as an efficient method to prevent respiratory complications in heart surgery patients. Numerous studies are conducted on CPAP and it has been identified that the application of CPAP is related to decreased respiratory complications after surgery and it decreases the risk of re-intubation and compared to conventional methods, it has more beneficial effects to improve lung function after surgery [10]. On the other hand, the application of CPAP has complicated and less predictable hemodynamic effects [3, 11]. In the case of using this mode alternatively, it is possible to prevent the potential complications.

Respiratory care set under a comprehensive planning and instruction is another effective method that is used to decrease respiratory complications [12].Respiratory care set is a set of standard cares that their implementation has been emphasized in the related guidelines [13].Although these cares are implementing in health centers through various modes, the important issue that is less considered by the care group is the synergistic effect that is the implementation of cares and at the same time, commitment to the full and correct implementation under specific plan and instructions as well as continuous training before and after surgery for all patients. This set includes: 1) the use of motivational spirometry 2) coughing and deep breathing 3) mouth washing 4) patient training 5) getting out of the bed immediately and repeatedly 6) putting above the head of bed and controlling the pain.

According to numerous effects that high incidence of atelectasis has on the patient after CABG as well as costs and health system, selecting the best control and prevention technique for health is vital [14]. Previous studies have shown that respiratory complications after surgery, with noninvasive CPAP or planned respiratory cares can be prevented more [12, 14]. So far, no study has been conducted on the application of CPAP compared to planned respiratory cares set. Therefore, the present study focuses on the effect of planned respiratory cares set compared to noninvasive ventilation with CPAP mode on the incidence of atelectasis and blood oxygen levels in patients under CABG surgery and by presenting the results to the authorities, offer practical solutions for using desired method to improve blood oxygen level and decreasing atelectasis in patients under CABG surgery.

MATERIALS AND METHODS

The present study is a randomized clinical trial in ShahidRajaei Hospital, Iran in 2015. The purpose of the present study was to compare the effect of planned respiratory cares set and noninvasive ventilation (CPAP) on the incidence of atelectasis and arterial blood oxygen levels in patients under CABG surgery. Therefore, 120 patients candidate for CABG surgery who were hospitalized in ShahidRajaei training, research, and treatment center were divided into three groups based on the criteria of interest (age range of 30-70, non-emergency heart surgery, and no history of respiratory diseases).

Patients were divided into three groups of 40 subjects according to permuted-block randomization. Patients in experimental group (1) received planned respiratory cares; patient in experimental group (2) received noninvasive ventilation with CPAP mode and; patients in control group received conventional respiratory cares. Also, the two

experimental groups received conventional respiratory cares based on hospital procedures. Written and informed consents were obtained from all patients and the study was confirmed by the committee on ethics and research center of the hospital. The patients who needed mechanical ventilation more than 12 hours or suffered from severe hemodynamic disorders or alteration of consciousness after surgery or prevented to participate or died, were extracted from the study.

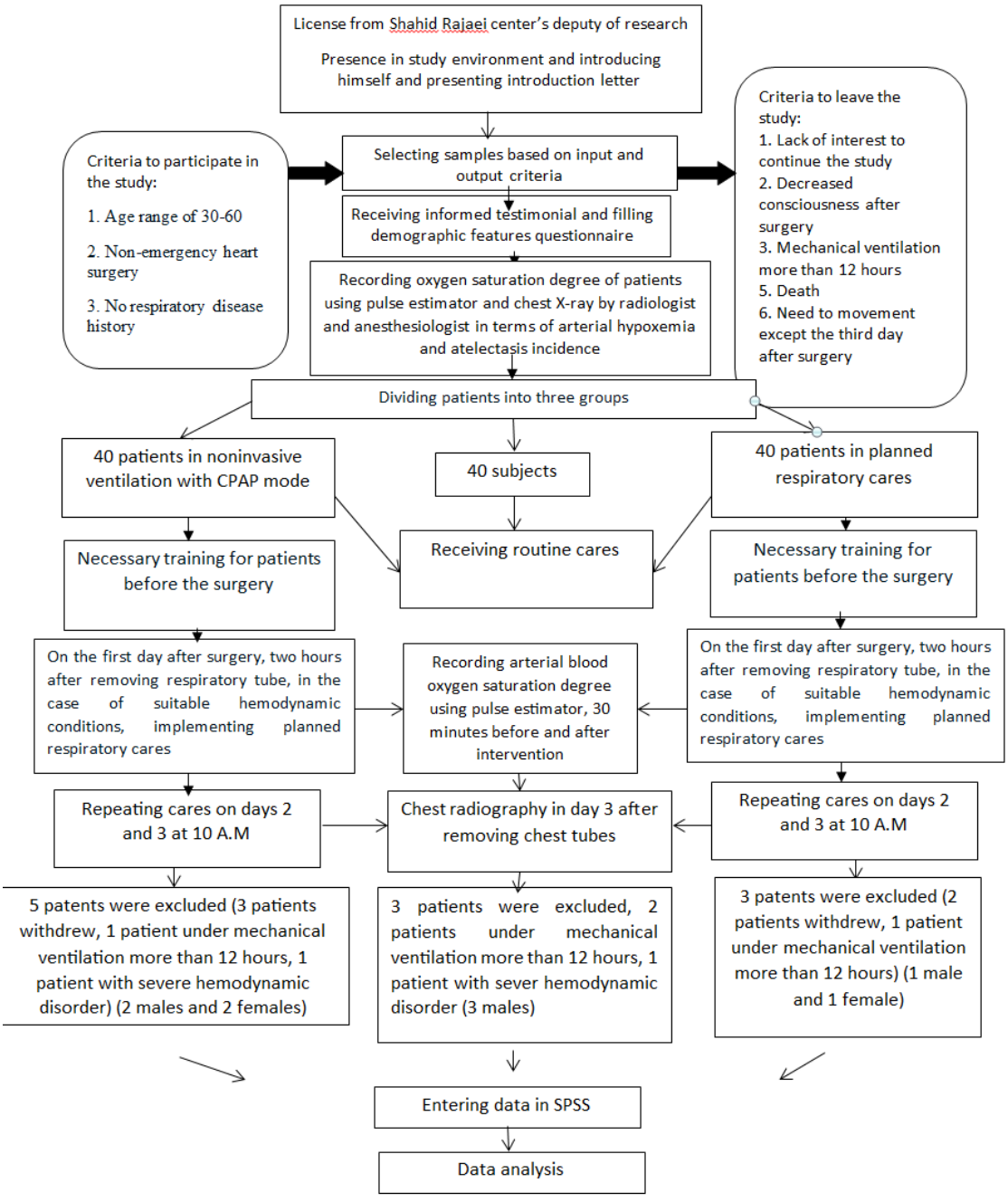

Figure 1: Flow chart: Design plan

In experimental groups, first, some explanations were given to the patients about coronary bypass surgery and then, planned respiratory cares instruction and patients' collaboration and how to apply noninvasive CPAP were trained carefully. Cares were implemented two hours after removing the tracheal tube and in the case of appropriate

hemodynamic conditions and agreement of the anesthetist within the first three days after surgery. In experimental group (1), the planned respiratory cares set consisted of six parts. First, patients used motivational spirometry for five minutes. Second, three deep breathings including a deep breath (for 3 seconds) and exhale followed were done followed by two effective coughs. Third, mouth washing was done using mouthwash solution or brush. Fourth, gestures appropriate to the circumstances including changing the position and moving the legs in the shape of bicycle on the bed and in the case of permission of the surgeon, leaving the bed (sitting on the bed, walking or moving with wheelchair). Fifth, the angle of the bed head was appointed at 30-40 degrees. Sixth, necessary instructions were given for proper implementation of each case and repeating instructions 1, 2, and 4. In the experimental group (2), noninvasive ventilation with CPAP mode was used using mask and pressure of 8 to 12 cm of water for 20 minutes based on patient's tolerance. In control group, conventional procedures of the hospital were followed. All patients received physiotherapy in the first three days after the surgery.

The arterial blood oxygen saturation was measured using Pulse Estimator in the day prior to surgery as the bases and in the first day and thirty minutes before the intervention and in days 1, 2, and 3 after surgery, and six hours after each intervention. Also, before surgery and three days after surgery, according to the routines of ShahidRajaei Hospital, chest X-ray was performed. The required oxygen for each patient was considered equal and about 4-6 liters per minute before measuring arterial blood oxygen saturation by pulse estimator.

The data related top personal characteristics and history of disease including age, sex, body mass index, smoking and drugs were extracted from patients' files or by asking questions by the researcher. The data of interest were analyzed using SPSS 16, Chi-square, Kruskal-Wallis, and Friedman. The descriptive statistics are shown as median and interquartile range. The basis of statistical significance is P<50.

RESULTS

The mean age of group 1 was 53.76±8.24, the mean age of group 2 was 53.50±7.39, and the means age of group 3 was 53.70±8.21. The demographic features are mentioned in Table 1. Eleven subjects were excluded during the study that the reasons are mentioned in Chart (1) (Chart 1). The samples in all three groups were married and according to the results of Chi-square, there was not any significant difference in marital status of all three groups (Table 1). Regarding the arterial oxygen saturation on the first day, before intervention in patients in group 3, the arterial oxygen saturation was higher than group 2 (p=0.006). On the second and third days after intervention, the arterial oxygen saturation levels in group 2 patients were higher than other two groups (Table 2).

Table 1. Demographic variables and disease history and some of clinical characteristics of control and experimental groups

Variable		Group			Test Result
		1	2	3	
Sex	Female	18(48.6)	18(51.4)	14(37.8)	X^2=1.51 df = 2 p= 0.05
	Male	19(51.4)	17(48.6)	23(62.2)	
Diabetic history	Yes	20(54.1)	18(51.4)	19(51.4)	X^2=0.07 df= 2 p = 0.97
	No	17(45.9)	17(48.6)	18(48.6)	
Blood pressure history	Yes	30(81.1)	27(77.1)	27(73)	X^2=0.69 df = 2 p =0.71
	No	7(18.9)	8(22.9)	10(27)	
Smoking history	Yes	13(35.1)	12(34.3)	12(32.4)	X^2=1.97 df = 4 p =0.74
	No	23(65.7)	24(64.9)	25(67.5)	
Drug Use	Yes	8(21.6)	5(14.2)	6(16.2)	X^2=3.22 df = 4 p =0.52
	No	29(78.3)	30(85.7)	31(83.7)	
BMI/(interquartile range)-median		27(25-30)	26(25-28)	27(25-28)	H= 1.82 df = 2 p = 0.004

Table 2. Comparing arterial blood oxygen saturation values measured by pulse oximetry in three groups of the study

Variable	Day	Group			Results of Kruskal-Wallis
		1	2	3	
Arterial oxygen saturation percentage (SPO2) (interquartile range)-median	Day 1 before intervention	94(92-96)	95(94-97)	96(95-97)	H=10.17 Df=2 P=0.006
	Day 1 after intervention	94(94-96)	95(93-96)	94(93-96)	H=2.33 Df=2 P=0.31
	Day 2 after intervention	94(93-95)	95(94-96)	94(92-95)	H=6.63 Df=2 P=0.03
	Day 3 after intervention	94(93-96)	96(94-97)	93(91-95)	H=17.27 Df=2 P=0.001
Friedman test results		H=4.28 Df=3 P=0.23	H=9.68 Df=3 P=0.02	H=4.28 Df=3 P=0.23	

In the case of atelectasis incidence, patients in group 2 showed lowest incidence level compared to other groups. However, there was no significant difference between three groups of study (Table 3).

Table 3. Determining atelectasis incidence in day 3 after surgery in three groups of the study

Group	**CPAP**	**Planned care**	**Control**
	N(%)	N(%)	N(%)
Yes	5(14.3)	7(18.9)	12(32.4)
No	30(85.7)	30(81.1)	25(67.6)
Total	35(100)	37(100)	37(100)
Chi-square result	X2= 3.76 df = 2 *p* =0.15		

DISCUSSION

The results of this study showed that the application on noninvasive ventilation (CPAP) and planned respiratory cares including the use of motivational spirometry, effective cough, the high end of the bed, faster movement on the bed and early leaving as well as continuous training compared to conventional cares in the hospital, all can improve oxygenation and decrease the risk of atelectasis. This is consistent with Moradian et al., (2012) who state that patients who have followed respiratory cares based on a specific plan with sufficient frequency (with training before surgery), have better oxygenation status compared to patients with conventional treatment. Also, oxygenation improvement period and recovery in these patients are faster[15]. Also, El-Kader el al., (2010) state that motivational spirometry, noninvasive ventilation (CPAP), and noninvasive ventilation (IPPB) in all groups showed that arterial blood gases in the groups under intervention are enhanced [16].

In the case of decreased atelectasis, these findings are consistent with Al-Mutairi et al., (2002) who state early application of noninvasive CPAP in patients after heart surgery, significantly promotes atelectasis treatment and decreases hospitalization period (2). Also, the result of the present study is consistent with Possa et al., (2010). They investigated the effect of applying guidelines in physiotherapy after upper abdominal surgeries in decreasing atelectasis and hospitalization period and found that atelectasis incidence and hospitalization period in the experimental group that received respiratory physiotherapy according to a specific guideline has significantly decreased compared to pre-intervention [17]. Generally, it is logical to say that respiratory cares based on regular planning accompanied by daily exercises have priority. In this regard, Cassidy (2013) who investigated the effect of planned respiratory cares on the incidence of respiratory complications, found that simultaneous implementation of planned respiratory cares decreases respiratory complications after surgery.

Also, the findings indicate improved oxygenation trend in experimental group (2) that is consistent with Dehghani et al., [18]. In experimental group (1) that included planned cares, comparing arterial blood oxygen levels before and after intervention shows that patients' oxygenation status has been stable and the planned cares prevented its reduction. This is significant in comparison with pre- and post-intervention in control group, because in control

group and comparing before and after surgery, a significant reduction is observed. This point is more important when patients' clinical conditions in all groups are considered. Although all three groups entered the study with homogenous conditions, it should be noted that the planned cares group has highest obese subjects and smokers and highest frequency in diabetics and blood pressure existed in this group. Maybe, the effect of these factors prevent effects of planned cares. Generally, what was observed in patients' clinical condition shows the positive effect of this technique. Also, comparing noninvasive ventilation (CPAP) and planned cares shows that noninvasive ventilation (CPAP) is more efficient. However, in planned cares group, due to more obese subjects and smokers, this technique has preserved patients' oxygenation during three days and prevented atelectasis incidence with a little difference compared to CPAP group.

The main limitation of this study was the lack of real control group. In this study, despite conventional respiratory exercises as an intervening variable, due to moral reason, it was not possible to present conventional respiratory exercises to patients in control groups. Therefore, routine cares were considered for all groups to minimize its effect.

CONCLUSION

The results of the present study show that those patients who received noninvasive ventilation (CPAP) and planned respiratory cares after surgery have better oxygenation status compared to those who received conventional cares. Moreover, those who received noninvasive ventilation (CPAP) showed better oxygenation status compared to those who received planned respiratory cares. The atelectasis incidence in all three groups included highest incidence in control group and lowest incidence in noninvasive ventilation (CPAP) group. However, there was not any significant difference regarding the incidence of atelectasis among three groups of the study. Therefore, respiratory cares in patients after CABS should be based on a specific plan and continuous training. Also, if the patient is faced by more dangerous factors or does not collaborate well, noninvasive ventilation (CPAP) should be used.

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