Early mobilization reduces the atelectasis and pleural effusion in patients undergoing coronary artery bypass graft surgery: A randomized clinical trial

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Early mobilization reduces the atelectasis and pleural effusion in patients undergoing coronary artery bypass graft surgery: A randomized clinical trial

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*Atelectasis and pleural effusion are common after coronary artery bypass graft surgery (CABG). Longer stay in the bed is one of the most important contributing factors in pulmonary complications. Some studies confirm the benefits of early mobilization (EM) in critically ill patients, but the efficacy of EM on pulmonary complications after CABG is not clear. This study was designed to examine the effect of EM on the incidence of atelectasis and pleural effusion in patients undergoing CABG. In a single-blinded randomized clinical trial, 100 patients who were undergoing coronary artery bypass graft surgery were randomly assigned into two groups each consisted of 50 patients. Patients in the experimental group were enrolled in a mobilization protocol consisting of the mobilization from the bed in the first 3 days after surgery in the morning and evening. Patients in the control group were mobilized from bed in third postoperation day, according to the hospital routine. Arterial blood gases, pleural effusion, and atelectasis were compared between groups. Atelectasis and pleural effusion was reduced in experimental group. The partial pressure of oxygen in arterial blood in third postoperative day and the percentage of arterial oxygen saturation in the fourth postoperative day were higher in the intervention group (*P *value < .05). EM from bed could be an effective intervention in reducing atelectasis and pleural effusion in patients undergoing CABG.* (J Vasc Nurs 2017;35:141-145)

INTRODUCTION

Atelectasis and pleural effusion are common after coronary artery bypass graft surgery (CABG). Some experts believe that these complications may be observed in all patients following CABG.[1,2] These conditions may increase costs and length of the hospital stay.[3] Various interventions have been used for the treatment of the pulmonary dysfunction after cardiac surgery, including the physical and breathing exercises, incentive spirometry, and use of mechanical devices.[1,4] Inactivity is a leading cause of respiratory complications after CABG, so the early mobilization (EM) of patients from the bed is one of the interventions that currently is used in different situations. The long-term survival of patients in the bed has little or no benefit[5] and can cause many complications, including cardiovascular, pulmonary, and muscular complications.[6–9] The effectiveness of an EM program in the intensive Care Unit patients could be found in the Perme 2009, Morris 2008, Haines 2012 studies. The results of these studies indicate that the EM of the patient from the bed could improve the recovery of the heart, lung, and muscles function.[7,10,11]

Studies regarding the EM after cardiac surgery are limited,[12–14] and in most studies, EM is usually a part of a package of physiotherapy services including coughing, deep breathing, and other therapeutic measures, so the pure effect of EM in reducing the pulmonary complications such as atelectasis and pleural effusion in patients undergoing CABG is not well studied.[15] This study was designed to evaluate the effect of EM on pulmonary complications after CABG.

MATERIALS AND METHODS

This was a single-blinded randomly allocated parallel-group study conducted in during 2013 to 2014 in a university hospital. Totally, 100 patients who were undergoing CABG were randomly allocated into groups of intervention and control, each consisted of 50 patients. The study was performed. The eligible participants for this study were those with a negative history of movement disorder or defects in the lower extremities, chronic obstructive pulmonary disease, stroke, or other severe neurologic disorders. Exclusion criteria were drainage more than 400 mL at first 4 hours after

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TABLE 1

METHOD FOR THE EXPERIMENTAL GROUP

Intervention (49 People)	*2 Hours After Endotracheal Tube Extubation*	*The Second Day After Surgery*		*Third Day After Surgery*	
		Morning	*Evening*	*Morning*	*Evening*
Sitting on the edge of the bed and dangling legs	I	I	I	I	I
Standing next to the bed		I	I	I	I
Walk 30 meters		I	I	I	I

surgery, hemodynamic instability, and loss of consciousness, requiring mechanical ventilation more than 24 hours after the surgery.

The study protocol was approved by the ethics committee of a medical sciences university. One day before operation, the study objectives were explained to the participants and the informed consent was obtained.

Using the Altman nomogram with a power of 90% and $\alpha = 0.05$, the sample size was calculated 44 people for each group. Considering 10% attrition rate, the required sample size for this study was 100 patients. Patients were allocated to the control and intervention using the four part blocks.

Based on the literature review, the best practice for doing the mobilization in the CABG patients is not clear. In our study, the available protocols were presented in an expert panel (consisting of two anesthesiologists, two physiotherapists, two experienced nurses, and two respiratory therapists). They validated and recommended the following protocol. Patients who were allocated to the intervention group were in the first postoperative day; 2 hours after extubation, patients were placed in sitting position, and then, their feet were hanging about 15 minutes. In the second postoperative day morning, they were sitting on the bed edge for 5 minutes, and then, they walked in the ward about 10 meters with pulse oximetry monitoring. In the evening, they repeated these steps and walked 30 meters. In the third postoperative day, before removing the chest tubes, they walked 30 meters and repeated this step after chest tube removal (Table 1). During this process, they were monitored by an experienced nurse. If the heart rate and respiratory rate were

TABLE 2

DEMOGRAPHIC VARIABLES, DISEASE HISTORY, AND SOME CLINICAL FEATURES OF THE EXPERIMENTAL AND CONTROL GROUPS

Variable	*Group*	
	Experimental (49)	*Control (49)*
Age/mean (SD)	59 (10)	60 (11.3)
Sex (percent)		
Women	16 (33)	19 (39)
Men	33 (67)	30 (61)
History of diabetes mellitus (percent)	20 (41)	17 (35)
History of hypertension (percent)	27 (55)	27 (55)
History of smoking (y)	12 (24.5)	11 (22)
A history of drug abuse/y (percent)	5 (10)	6 (12)
Left ventricular ejection fraction/mean (SD)	49.2 (7)	49.4 (5.8)
Duration of mechanical ventilation (min)/mean (SD)	330 (118)	377 (250)
Cardiopulmonary bypass time (min)/mean (SD)	57 (16.6)	61 (16.4)
BMI/mean ± SD	28.4 (4.1)	26.6 (3.9)
Number of grafts/mean (SD)	3.1 (0.84)	3 (0.85)

BMI = body mass index; SD = standard deviation.

TABLE 3

COMPARISON OF THE PAO_2 AND SPO_2 BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS

Variable	*Group*		P *Value*
	Experimental	*Control*	
Partial pressure of oxygen in arterial blood (SD) (PaO_2)			
First day after CABG	95.4 (2.8)	95.5 (3.1)	.92
Second day after CABG	93 (3.1)	94 (3.7)	.68
Third day after CABG	95 (2.5)	93.5 (3)	.01
The percentage of arterial oxygen saturation (SpO_2)			
Before CABG	92.4 (1.9)	92.6 (1.6)	.65
The fourth postoperative day	92.3 (2.9)	91 (2.9)	.03

CABG = coronary artery bypass graft surgery; SD = standard deviation.

increased more than 20% from baseline, the intervention was discontinued. Patients in the control group received the hospital routine treatment. They were mobilized in the third postoperative day after chest tube removal.

The amount of arterial oxygen saturation (SaO_2) and partial pressure of oxygen in arterial blood (PaO_2) that was measured in arterial blood gas, compared between groups. These parameters were measured in the morning and evening. The atelectasis and pleural effusion were investigated through the daily review of chest radiographs by an anesthesiologist that was blinded to the grouping of units. The presence of atelectasis in the chest x-ray was considered as atelectasis. The data were analyzed using SPSS version 11 software. The independent *t* tests, chi-square, and analysis of variance statistical tests were used to interpret the data. *P* value less than .05 was considered as statistically significant.

RESULTS

Totally, 100 patients were eligible to participate in the study. One patient from the intervention group due to hemodynamic instability and one patient from the control group due to prolonged mechanical ventilation were excluded. Finally, 98 patients completed the study.

Mean age in the experimental group was 59 ± 10 and 60 ± 11.3 years in the control group. In general, 33 patients (67%) in the intervention groups and 30 patients (61%) in the control group were men. There was no statistically significant difference in the terms of demographic characteristics and underlying conditions between groups ($P > .05$). These data are presented in Table 2.

PaO_2 was compared between groups in the three consecutive postoperative days. The difference in the first and second days after surgery was nonsignificant, but the values were higher in the intervention group on the third day. The mean PaO_2 was 95 ± 2.5 in the intervention group and 93.5 ± 3 in the control group (P value = .01). In the fourth postoperative day and after removing the arterial sheath, the oxygen saturation measured by pulse oximetry was compared between groups. The data showed that the percentage of arterial oxygen saturation

TABLE 4

COMPARISON OF ATELECTASIS AND PLURAL EFFUSION AND LENGTH OF STAY IN HOSPITAL BETWEEN EXPERIMENTAL AND CONTROL GROUPS

Group	*Variable*		P *Value*
	Experimental	*Control*	
Atelectasis (percent)			
Second day after surgery	10 (20)	23 (47)	.005
Third day after surgery	10 (20)	24 (49)	.003
Pleural effusion (percent)			
Second day after surgery	10 (20)	26 (56)	.001
Third day after surgery	11 (22)	26 (56)	.002

(SpO_2) was 92/3 versus 91% in the intervention and control groups, respectively (P value = .03) (Table 3). This amount was statistically significant and higher in the intervention group.

Daily chest x-ray was the basis for detecting the atelectasis and pleural effusion. There was not any significantly different between groups in the terms of the incidence of atelectasis and pleural effusion on the first postoperative day. The overall incidence of atelectasis and pleural effusion was higher in the control group. The incidence of the atelectasis was 18 patients (37%) in the intervention group and 27 cases (55%) in the control group. Also, the pleural effusion was detected in 12 patients (24/5%) in the intervention group versus 27 cases (55%) in the control group (Table 4). The data also showed that the length of stay was 9.7 (5.9) and 8.5 (4.8) in the intervention and control groups, respectively (P value = .27). This difference was not statistically significant.

DISCUSSION

The results of this study showed that early mobility from the bed reduces the incidence of atelectasis and pleural effusion and improves the oxygenation in patients undergoing CABG. Overall, the incidence of atelectasis and pleural effusion was decreased in the intervention group. Inactivity is reported as a major cause of pulmonary complications in different populations of critical care patients.[10,12] Also, it is stated that the EM reduces pulmonary complications such as atelectasis and improves lung function.[1,16–18]

In our study, it was observed that the PaO_2 and SaO_2 on the third and fourth postoperative days were significantly higher in the intervention group. By the time, the overall oxygenation was improved; therefore, this intervention could be used as a safe measure for preventing the pulmonary complications. Some studies report the reduction in mixed venous oxygen saturation during EM after cardiac surgery.[19] In our study, the reduction in SpO_2 and PaO_2 was not observed. The reduction of mixed venous oxygen saturation during the mobilization could be the results of exercise and more oxygen consumption.

The hospital stay was lower in the intervention group, but this difference was not statistically significant (P = .27). This difference is clinically important and could reduce the treatment costs. In the study with Morris et al[11] in 2008, the health care costs and length of stay were reduced through the implementation of the mobility protocols. Also, an important fact should be notified that there is not a clear criterion for discharging the patients from hospital, and they are discharged routinely several days after surgery. Also, the respiratory complications that did not change the patient situation critically are not considered in discharge plan.

The signs of discontinuation of the intervention were observed several days after the last sampling days. EM has various barriers consisting the patient, provider, and institutional barriers.[20] Despite the evidences regarding the benefits of such interventions, the routine use of them is not welcomed by medical staffs. The nurses and physiotherapist reported self-injury and excess work stress during EM.[21] Some of them are afraid from the hemodynamic and respiratory instability during the EM. The results of the current study and other studies showed that this intervention is safe.[22,23] In our study, nearly all the participants completed the protocol without any complication. Some studies reported the orthostatic intolerance in some cases. It could be prevented by putting the patient in sitting position before mobilization.[24]

LIMITATIONS

The EM in this study was designed based on similar studies and an expert panel, but the best way to implement the EM is not identified by the available evidences. So studies with appropriate methodology should be done to identify the appropriate time to start, the duration, intensity, and the frequency of the EM. Also, the appropriate method and exercises should be mentioned.

The feasibility of EM is not assessed in the critical patients. Most of studies about the EM are done in stable patients. Such as other studies, this study was implemented for stable patients.

In the data gathering period, we did not matched the ventilator setting. As mentioned, the ventilator could be a source of atelectasis. It is suggested that in the future studies, the role of mechanical ventilation setting be excluded. In some patients, the amount of inspired oxygen was changed due to the hypoxemia. this could be a source of confounding, so we matched the group for this variable.

CONCLUSIONS

The results of this study showed that the intervention group had a lower incidence of pleural effusion and atelectasis and a better oxygenation compared to the control group. This intervention could be a safe part of routine care in CABG.

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