The Effect of Early Six-Minute Walking Test Post-Coronary Artery Bypass Graft on Walking Tolerance and Physiological Parameters

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Abstract

Background: The 6-minute walking test is a commonly easy test that does not need advanced training. It is used for evaluating the functional status and exercise tolerance of patients with heart diseases. It provides consistent information about the patient's daily activity, the effect of treatment, and the prognosis. **Aim:** To evaluate the effect of an early six-minute walking test (6MWT) post coronary artery bypass graft on walking tolerance and physiological parameters. **Setting:** This study was conducted at the cardiothoracic intensive care unit (ICU) at Mansoura University Hospital in Egypt. **Method:** A quasi-experimental design was utilized in this research. A convenience sample of 60 adult patients who were scheduled for and underwent coronary artery bypass graft was enrolled in this study. Data were collected using '**physiological parameters and six minutes walking test assessment tool'.** It involved three parts: **Part I:** Participants' demographic and health profile data, **Part II:** Physiological parameters, and six minutes walking test observation checklist and **Part III:** Borg rating of perceived exertion (RPE) scale. **Results**: No significant differences were noted ($p = \leq 0.05$) between the intervention and control groups regarding gender, age, smoking status, and body mass index. However, there were significant differences between the two groups concerning the length of stay on mechanical ventilation, the time of six-minute walking test after extubation, complaining from dyspnea and fatigue, and the number of rest periods. **Conclusion and Recommendations:** The implementation of an early 6MWT post coronary artery bypass grafting improved patients' physiological parameters and walking tolerance. Therefore, nurses should attend a training program on the implementation of early 6MWT for post-operative patients in the cardiothoracic intensive care units. Additionally, the 6MWT guidelines and standards should be available in all hospitals to facilitate and enhance the success of cardiac rehabilitation programs.

Keywords: Coronary artery bypass graft, Distance, Functional capacity, Six-minute walking test, Walking tolerance

Introduction

Cardiovascular disease (CVD) is the main general reason for death, with more than 17.3 million deaths every year in 2013. This percentage is expected to increase to be more than 23.6 million by 2030 **(American Heart Association (AHA), 2017)**. According to the **World Health Organization (WHO, 2016)**, the total number of CVD deaths had increased all over the world from 14.4 million to 17.5 million in 1990. Of these, 7.6 million were diagnosed with coronary heart disease and 5.7 million with stroke. More than 80% of the deaths occurred in low and middle-income countries, and 37% are caused by CVDs**.** The most common CVDs is coronary heart disease (CHD), which refers to narrowing or blockage of cardiac arteries secondary to atherosclerosis. The most common complication of CHD is myocardial infarction (**Benjak, Mihel, Rodin, Štefacic, &Trajanoski, 2018; Pacaric, et al., 2020)**

Coronary artery bypass grafting (CABG) is an important surgical operation for patients with coronary artery disease to resolve the complaints and maintain the patient's survival, and quality of life **(Bishawi, et al., 2018).** CABG is a safe and effective procedure for the treatment of heart disease patients. There are several modalities available for the objective evaluation of functional exercise capacity. The modality used should be selected according to the clinical question to be addressed and on available resources. The most common clinical exercise tests are stair climbing, 6MWT, and detection of exercise-induced asthma (**Giannitsi, et al., 2019; Shabani, Gaeini, Nikbackt, & Sadegifar, 2010).**

Physical activity is very beneficial in different clinical areas and is suggested for ischemic heart disease and those undergoing cardiac surgery **(Borges, et al. 2016).** Pulmonologists first used the 6MWT to assess patients with chronic obstructive pulmonary disease and respiratory failure. It was then used by doctors to assess the functional limitation, drug effect, and patient's rehabilitation with chronic heart failure. Although the 6MWT was widely utilized to evaluate the functional status of patients with severe cardiopulmonary disease, little research has tested its value in cardiac rehabilitation (**Hamzah, Hassan, &Aboud, 2016; Shabani, et al., 2010).**

Moreover, the 6MWT was commonly applied to evaluate the physical ability of patients and the effectiveness of treatment and to meet the conditions of rehabilitation and evaluate its effects. This test is simple, less costly, and requires little equipment. Additionally, it is safe and well-tolerated by patients **(Jopek, Jopek, Bejer, Domka, & Walawski, 2018).** To apply the 6MWT test, doctors ask the patients to walk as far as they tolerate within 6 minutes, and the maximum distance traveled reflects their physical ability. The 6MWT is an independent postsurgical recovery indicator to assess the effect of a certain treatment on a patient's functional status post CABG **(Giannitsi, et al., 2019).**

Many research studies showed that the walk test is very important for expecting the potential risk of hospitalization and the risk of death in CVD patients. The effect of the 6MWT was confirmed in patients with heart failure and low left ventricular ejection fraction (**Giannitsi et al., 2019**). Similar relationships have been demonstrated for patients with heart failure and preserved left ventricular diastolic function (**Forman, Fleg, &Kitzman, 2012; Ingle, Cleland, & Clark, 2014).**

It had been proven that the 6MWT has become one of the main common clinical exercise tests for assessing functional capacity. It is a practical, easy, and cheap test that needs no special instruments or special training for technicians (**Guyatt, et al., 1985**). This test is very similar to activities of daily living and is tolerable by most old age patients, frail, and few numbers of patients who cannot be assessed by the standard maximum symptom restricted exercise test like cardiac patients who have recently undergone major surgery **(Jopek et al., 2018).**

Patients undergoing major CABG are at risk for developing postoperative complications requiring prolonged hospital stays and substantial resources (**Almashrafi, Elmontsri, & Aylin, 2016).** Therefore, it is necessary to assess the functional capacity of these patients during the postoperative period due to the potential decrease in their activities post-surgery. The 6MWT is a simple and efficient method to directly improve the functional capacity of the patient in the postoperative period after CABG (**Chen, et al., 2018**). However, studies that examined the effect of early 6MWT on walking tolerance and physiological parameters post CABG in Egypt are scarce. Therefore, this investigation was carried out to address this matter.

Study Aim

This study aimed to investigate the effect of early 6MWT post coronary artery bypass graft on walking tolerance and physiological parameters.

Study hypothesis:

We hypothesized that post coronary artery bypass graft patients who apply the early 6MWT method will have better physiological parameters and walking tolerance than those who do not apply this intervention.

Materials and method

Materials

Study Design

This research utilized a quasi-experimental design with an intervention group and a control group. This design is usually used to evaluate the effect of an intervention on some outcomes without randomization **(Rockers, Røttingen, Shemilt, Tugwell, &Bärnighausen, 2015)**

Setting

The participants were recruited from the Cardiothoracic ICU at Mansoura University Hospital, Egypt. It involves 5 beds and it is well equipped with updated technology and personnel for care delivery. It receives about 500 patients annually from Mansoura city and its neighborhood. This unit provides postoperative care for patients undergone cardiothoracic surgeries involving CABG and valve heart diseases. The nurse-patient ratio in this unit is approximately 1:1.

Subjects

A convenience sample of 60 patients was enrolled in this investigation according to the following selection criteria; age between 40 and 75 years old, males and females, scheduled for CABG, and accepted to participate in this study.

Exclusion criteria

Patients were excluded from the study if they had

- An emergency CABG
- Undergone previous cardiac surgery
- Unstable angina
- Ahistory of intra-aortic balloon pump or pacemaker in place
- Uncontrolled hypertension
- Severe renal dysfunction requiring dialysis
- Altered level of consciousness
- A history of musculoskeletal problems
- Unstable hemodynamic status

Sample size calculation

According to the annual report in 2016 at Mansoura University Hospital, patients admitted to the cardiothoracic surgery department to receive CABG were 400. Steve Thompson's formula was utilized to estimate the total sample (**Peacock, J. & Peacock, 2011).**

$$n = \frac{N \times p(1-p)}{[[N - 1 \times (d^2 \div z^2)]] + p(1-p)]}$$

Where: N= Population size (300), Z= degree of standardization for 95.0%, d^2= 1.96, d= Error percentage (0.05), P= 0.5.

Based on the statistical formula, the sample was estimated to be 29.99. Totally sixty participants participated and were randomly distributed to two equal groups, the intervention & control group (30 patients in each group).

Data Collection Instrument

Data were gathered using the '**physiological parameters & six-minute walking test assessment tool**. It was prepared by the researcher according to the updated review (**Fiorina et al., 2007; Hirschhorna, Richards, Mungovan, Morris, & Adamsc, 2012; Hamzah, et al., 2016; Ragawanti, 2014)**. It involved three parts:

Part I: Participants' demographic characteristics and health profile data

The section included patients' demographic characteristics such as age, gender, and marital status. This section also covered patients' health profiles such as the body mass index, date of admission, diagnosis, surgical operation type, past medical and surgical history, smoking habit, ejection fraction (EF), and the length of stay on mechanical ventilation.

Part II: Physiological Parameters and Six Minute Walking Test Observation Checklist

This section included patients' physiological indicators such as the pulse rate (PR), blood pressures (BP), and percutaneous oxygen saturation (SpO_2). The 6MWT parameters involved the total distance walked, stopped, or paused before 6 minutes, the number of rest periods, and reasons for stopped before 6 minutes.

Part III: Borg rating of perceived exertion (RPE)

It is an outcome measure scale used in knowing exercise intensity prescription. It is used in monitoring progress and mode of exercise in cardiac patients. This scale is a very simple numerical list and was developed by **Borg (1982)** for rating exertion and breathlessness during physical activities.

This scale is measured by a three-point liker scale including light, hard, and very hard.

The score was 1.2, and 3, respectively. Post the 6MWT, the researcher assesses the degree of dyspnea using the Borg scale and asks the patient to grade his level of shortness of breath and the level of fatigue using this scale (**Borg, 1982)**.

Validity and Reliability of the Tool

The validity was checked by five professors in Critical Care and Emergency Nursing, and Medical specialty. Modifications were done based on their opinions. The tool was assessed by Cronbach's alpha to check the internal consistency and it was 0.91 which indicates a reliable tool.

Pilot Study

The pilot study involved six patients. It was used to assess the simplicity, clarity, feasibility, and applicability of the data collection tool. Participants in this mini-study were eliminated from the research sample.

Ethical concern

Approval was secured from the Research Ethics Committee of the Faculty of Nursing, Mansoura University. Eligible patients were given the details of the study including the aim, benefits, risks, procedure, and the duration of the intervention preoperatively. They were informed that they could withdraw at any. Furthermore, they were assured about the confidentiality of their personal information. Those who accepted to take part in this investigation were asked to sign an informed consent.

Data Collection

Data were collected between March and August 2018. Permission to access the research setting was granted from the hospital's administrative authority. The researcher interviewed eligible patients before surgery, informed them about the research, and invited them to participate in this investigation. The demographic and clinical data were collected using patients' medical records. Patients' distribution was done preoperatively using the lottery method through selecting one out of two cards marked with group A (intervention group) and group B (control group).

Implementation of the Six Minute Walking Test

The 6MWT was implemented based on the **American Thoracic Society Guidelines (2002)**. The intervention group received preoperative teaching and training on early 6MWT and pulmonary physiotherapy. After three to four hours following the extubation, patients were asked to walk as much as they can a 30-m straight and flat unit corridor in 6 minutes. They were positioned at the starting line. The patients needed support during walking. To ensure safety, the researcher was holding the patient's hand during walking. Additionally, one of the relatives was walking just behind the patient. The nursing staff of the ICU was on call if needed.

When walking silent for 6 minutes, the patients were frequently encouraged to complete the walk. They were permitted to stop and take a rest on a chair if they experienced severe dyspnea, dizziness, or skeletal muscle pain. They were asked to resume walking as soon as they could. The distance walked was measured and recorded in meters. Additionally, the number and duration of rest periods were also recorded. The HR, BP, and SpO_2 were monitored pre the 6MWT and immediately post the 6MWT.

Post the implementation of the 6MWT, the researcher assessed the degree of dyspnea using the Borg scale and asked the patients to grade his shortness of breath and the fatigue level using this scale. After that, patients were placed in a sitting position in bed to rest. Then after a half-hour, they were instructed to perform a range of motion exercises (shoulder elevation, and shoulder flexion while taking a deep breath). Additionally, breathing exercises were performed three series of 10 deep breaths with instructions on coughing/huffing techniques.

The control group received the routine care of the unit without early 6MWT. They did not receive any preoperative teaching or physiotherapy. The routine care of the unit involved patient mobilization at least two days post-extubation, and walking for two or four minutes, then sitting on the chair without a range of motion exercise for shoulder, and breathing exercises.

Statistical Analysis

Data were organized, tabulated, and analyzed by utilizing the Statistical Package for Social Sciences (SPSS) version 26. Categorical variables were presented in a form of frequency and percentages whereas continuous variables were presented in form of mean and standard deviation. The Chi-square test was used for comparing categorical variables of unpaired groups. Paired t-test was utilized for comparing mean scores of continuous variables between paired groups. The $p< 0.05$ was considered statistically significant.

Results

Table I showed no statistically significant differences between the intervention and control groups concerning the demographic characteristics and health profile data. This may indicate similarities between the study groups.

Table 2 illustrated a significant variation between the intervention and control groups regarding the past medical history of the respiratory infection (P= 04). No statistically significant differences were noted between the two groups regarding the current surgical history. The findings also showed that more than half of the two groups had normal body mass index.

Table 3 illustrated that participants in the intervention group showed a significant difference related to the length of stay on MV and the time of starting the 6MWT post-extubation (P=.01 & .001) respectively.

Table 4 highlighted highly statistically significant differences between the intervention and control groups regarding the SBP and DBP before and after the implementation of the 6MWT (P=.0.000). Significant variations were also detected between the two groups concerning the heart rate and oxygen saturation (P=.0.02, 0.001) respectively.

Table 5 illustrated statistically significant differences between the intervention and control groups postoperatively related to complaints from dyspnea, fatigue, number of rest periods, and stopping before completing the 6MWT or not (P=.0.04, 0.02, 0.04& 0.04) respectively. Also, there was a highly statistically significant variation (p=0.000) between the intervention and control groups concerning the distance walked in 6 minutes, and the 6MWT tolerance preoperative.

Table 6 showed a significant difference related to the ICU length of stay postoperatively among the two groups (P=.0.005).

Table 1. Participants' demographic and baseline characteristics

Socio-Demographic Characteristics	Intervention group No.	%	Control group No.	%	χ^2	P-value
Age (years)						
40 -54	21	70.0	21	70.0		
55-70	9	30.0	9	30.0	0.00	1.00
Gender						
Male	15	50.0	18	60.0	0.61	0.4
Female	15	50.0	12	40.0		
Smoking status						
Previous smoker	22	73.3	22	73.3		
Not smoker	8	26.7	8	26.7	0.00	1.00

Table 2. Comparing the clinical health profile between the study groups

Clinical Characteristic		Intervention group No.	%	Control group No.	%	χ^2	P-value
Past Medical History							
Ischemic heart disease	Yes	13	43.3	16	53.3	0.60	0.43
	No	17	56.7	14	46.7		
Hypertension	Yes	19	63.3	19	63.3	0.00	1.00
	No	11	36.7	11	36.7		
Diabetes	Yes	18	60.0	9	30.0	0.65	0.4
	No	12	40.0	21	70.0		
Respiratory tract infection	Yes	5	16.7	12	40.0	4.02	0.04*
	No	25	83.3	18	60.0		
Surgical History							
Coronary artery bypass	Yes	12	40.0	12	40.0	0.00	1.00
graft	No	18	60.0	18	60.0		
Valve replacement	Yes	18	60.0	18	60.0	0.00	1.00
	No	12	40.0	12	40.0		
Preoperative	<40%	3	10.0	6	20.0	0.65	0.4
LVEF%	40-59%	19	63.0	17	57.0		
	≥ 60%	8	27.0	7	23.0		
Body mass index							
Normal		17	56.7	17	56.7		
Over-weight		8	26.7	8	56.7	0.00	1.00
Obese		5	16.7	5	16.7		
Total		30	100%	30	100%		

LVEF- Left Ventricular Ejection Fraction

Table 3. Comparing the length of stay on MV and the time of starting the 6MWT between the study groups

ICU Characteristic	Intervention group No.	%	Control group No.	%	χ^2	P-value
Length of stay on MV						
< 6	19	63.3	9	30.0	6.69	
>12	11	36.7	21	70.0		0. 01*
Total	30	100%	30	100%		
Time of starting the 6MWT post-extubation						
< 6 hours	10	33.3	0	0	36.28	
6-12 hours	17	56.7	4	13.3		0.001*
>12 hours	3	10	26	86.7		
Total	30	100%	30	100%		

Significant p <0.05 / **Highly statistically significant at p≤0.001

Table 4: Comparing the physiological parameters between the study groups before and after the 6MWT

Physiological parameters		Before the 6MWT Mean ± SD	After the 6MWT Mean ± SD	t-value	P-value
Heart rate	Intervention	84.8± 11.7	88.7 ± 8.01	2.31	0.02*
	Control	85.40±7.49	86.10±7.12	1.40	0.17
SaO_2	Intervention	93.5± 2.8	95.2± 1.7	3.84	0.001*
	Control	92.60±3.19	92.90±3.18	0.68	0.53
SBP	Intervention	126.84±11.17	120.33±7.64	4.44	0.000**
	Control	125.33±11.05	124.50±10.93	1.98	0.06
DBP	Intervention	80.66±9.62	76.16±7.03	3.65	0.53
	Control	126.84±11.17	120.33±7.64	4.44	0.000**

Significant p <0.05 / **Highly statistically significant at p≤0.001

Table 5. Comparing the six-minute walking tolerance and characteristics of 6MWT between the study groups during the postoperative period

	Intervention group		Control group		χ^2	P-value
	No.	%	No.	%		
Dyspnea						
Light	17	56.7	7	23.3	6.98	0.04*
Hard	10	33.3	17	56.7		
Very hard	3	10.0	6	20.0		
Fatigue						
Light	17	56.7	7	23.3	7.87	0.02*
Hard	11	36.7	16	53.3		
Very hard	2	6.7	7	23.3		
The distance walked in 6 minutes						
<10 m	2	6.7	14	46.7	16.15	0.000**
10-<20	14	46.7	13	43.3		
20-30	14	46.7	3	10.0		
No. of rest periods						
No	16	53.3	8	26.7	6.47	0.04*
< 5	11	36.7	12	40.0		
≥5	3	10.0	10	33.3		
Stopped before 6 minutes						
Yes	14	46.7	22	73.3	4.44	0.04*
No	16	53.3	8	26.7		
Reasons for stops						
No	16	53.3	8	26.7	7.17	0.06
Pain	2	6.7	9	30.0		
Dypsnea	9	30.0	10	33.3		
Dizziness	3	10.0	3	10.0		
6mwt tolerance preoperatively						
No	0	0.00	30	100.0	60.0	0.000**
<30 m	7	23.3	0	00.0		
30-50 m	18	60.0	0	00.0		
>50 m	5	16.7	0	00.0		

*Significant p <0.05 / **Highly statistically significant at p≤0.00

Table 6. Comparing the ICU length of stay postoperatively between the study groups

ICU Characteristic	**Intervention group**		**Control group**		**P-value**
	No.	**%**	**No.**	**%**	
ICU length of stay					
<24hours	0	00.0	0	00.0	0.005*
24-48 hours	26	86.7	18	60.0	
>48 hours	4	13.3	12	40.0	
Total	30	100%	30	100%	
***X* ± SD**	**36.9±7.7**		**45.0±6.5**		

Discussion

According to the literature, coronary artery disease is a common reason for death, disability, loss of productive capacity, and quality of life. CABG is an effective alternative treatment for CAD. The main objective is to improve survival and ventricular function, prevent acute myocardial ischemia, reinfarction, and reduce the mortality rate. Despite the efficiency of CABG, it is a highly invasive procedure, usually associated with the occurrence of complications in the postoperative period. It increases the length of stay on the ventilator, reduces the functional capacity, accelerates the loss of muscle mass and strength, increases the sensation of fatigue, and increases the ICU length of stay **(da Costa Torres, dos Santos, Reis, Paisani, &Chiavegato, 2016; Trevisan, Lopes, Mello, Macagnan, & Kessler, 2015).**

Physical activity is suggested for patients with CAD, and patients undergoing cardiac surgery. The early 6MWT is a commonly simple test that does not need advanced training, is used for evaluation of the functional status and exercise tolerance for patients with heart diseases. It provides consistent data about the patient's daily activity, the effect of treatment, and the patients' prognosis **(Borges et al., 2016; Giannitsi et al., 2019).**

The finding of the current study revealed that more than two-thirds of the intervention and control groups were in the age group between 40- 54 years and were previous smokers. More than half of the intervention and control groups had normal body mass index. No significant variation was detected among the intervention and control groups concerning gender, age, and smoking status. This indicates the similarity between both groups. This finding is corresponding to other research studies (**Hamzah, et al. 2016; Shakuri et al. 2014; Borges et al. 2016; Thirapatarapong and Chumwong, 2010)**.

The findings clarified a significant variation among the intervention and the control groups concerning the respiratory tract infection. On the other hand, no statistically significant differences were noticed between the two groups concerning the past medical and surgical history. This finding is aligned with the results of other similar investigations which revealed no significant variation among the control and the study groups concerning the past medical history **(Hamzah, et al. 2016; Savci et al. 2011)**.

The findings showed a significant variation among the intervention and the control groups concerning the length of stay on MV and the time of the 6MWT after extubation. These results agreed with another similar study which revealed that the length of MV was significantly longer in the control group compared with the study group thus influenced the length of hospital admission and costs **(Guizilini et al. 2014; Hulzebos, Smit, Helders, & van Meeteren, 2012)**. This finding can be seen as a positive outcome for the implementation of the early 6MWT.

The finding showed a significant variation among the two groups regarding the heart rate and oxygen saturation pre and post the 6MWT. In the same line, **Shakuri et al. (2014) and Oliveira et al. (2019)** reported that there was a greater difference in physiological parameters and distance walked in their studied groups after the 6MWT. However, this is contradicting with the findings of **Aquino, Mourão, Souza, Glicério, & Coelho (2010)** who did not show significant variation in the heart rate, blood pressure, or oxygen saturation.

The current study noted statistically significant differences between the intervention and control groups concerning complaints from dyspnea, fatigue, number of rest periods, and stopped before 6MWT. These results are consistent with **Hamzah, et al. (2016)** who found a significant difference in a complaint from dyspnea and fatigue after the operation and a higher in the control group compared to the intervention group. However, this is inconsistent with the findings of **Guizilini et al. (2014)** who found a significant decrease in the distance walked in 6-MWT. This contradiction may be due to pain and decreased chest expansion during the postoperative period.

The findings illustrated a significant variation between the two groups concerning the length of stay in the ICU. This is harmonious with the results of other studies which revealed that the length of ICU stay is significantly longer in the control group than in the study group **(Hamzah, et al. 2016; Savci et al., 2011)**. However, this is contradicting the findings of **Hirschhorn, et al. (2012)** who found no significant differences regarding the duration of hospital stay among the study and control groups after CABG. It may be attributed to the 6MWT directly measures actual walking performance, which confirms the performance commonly used in daily activities. Therefore, the 6MWT can achieve quick recovery postoperatively and decrease the length of hospital stay in ICU.

Conclusion and Recommendations

The findings of the current study contribute to the body of knowledge related to caring for patients after CABG. The implementation of an early 6MWT post-CABG can improve patients' physiological parameters and walking tolerance. Therefore, nurses should attend training programs on the implementation of early 6MWT for post-operative patients in the cardiothoracic ICUs. Additionally, the early 6MWT guidelines and standards must be made available in every hospital to facilitate the implementation and success of cardiac rehabilitation programs.

Limitations of the study

The current research study had some limitations. Firstly, limited generalizability of the research findings due to the small sample size which was collected from one cardiothoracic ICU in one university hospital. Secondly, the 6MWT is an independent postsurgical recovery indicator but is not able to cover the entire construct. In addition to the physical functioning and post CABG recovery, there are other aspects such as social and psychological support, and emotional recovery that are not addressed. Thus, these indicators should be subjected to investigations.

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