Prevalence and Risk Factors of Serious Arrhythmia during 6-minute Walk Test in Phase II Cardiac Rehabilitation

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ABSTRACT

Objectives: To determine the prevalence and associated risk factors of serious arrhythmia indicating six-minute walk test (6MWT) termination in phase II cardiac rehabilitation patients.

Study design: Cross-sectional, analytic retrospective study.

Setting: Outpatient cardiac rehabilitation clinic, Phramongkutklao Hospital, Bangkok, Thailand.

Subjects: Cardiac patients conducted the 6MWT with electrocardiography (ECG) telemetry before commencing phase II cardiac rehabilitation program from June 2015 to March 2017.

Methods: Medical records were collected from cardiac patients conducted the first 6MWT within 12 weeks after the onset of cardiac event, cardiac surgery, or cardiac intervention. ECG telemetry was monitored at before, during and 3 minutes after the test to determine the prevalence of serious arrhythmia indicating 6MWT termination. Patients' data were analyzed to identify associated risk factors of serious arrhythmia occurrence.

Results: The data from 178 cardiac patients were collected and 143 males (80.3%) were included with mean age of 60.2 (SD 14) years old. There were 159 (89.3%), 17 (9.5%), and 2 (1.1%) patients receiving cardiac surgery, percutaneous coronary intervention (PCI) and other diagnosis, respectively. Prevalence of serious cardiac arrhythmia during 6MWT was 13.48% (24 patients) including paired premature ventricular contraction (PVC) (41.7%), frequent multifocal PVC (41.7%), ventricular tachycardia (VT) (8.3%) and a new onset atrial fibrillation (AF) (8.3%). The statistically significant associated risk factor for serious arrhythmia was only the presence of arrhythmia before 6MWT (adjusted odds ratio=5.88, p = 0.018, 95%CI 1.36-25.54).

Conclusion: Prevalence of serious arrhythmia indicating 6MWT termination was 13.48%. The presence of arrhythmia before test was statistically significant associated risk factor with 5.88 times increase in risk. Therefore, safety during 6MWT in phase II cardiac rehabilitation should be concerned.

Keywords: prevalence, arrhythmia, six-minute walk test, cardiac rehabilitation

ASEAN J Rehabil Med 2019; 29(3): 90-93.

Introduction

Cardiovascular disease is a major public health problem in the world leading to the number one cause of death from non-communicable diseases among Thai and people around the world.(1) Cardiac rehabilitation (CR) program has been reported to reduce cardiac symptoms, improve functional capacity and quality of life, and return to work, decrease recurrence, morbidity and mortality rate.(2,3) Therefore, CR is recommended for all eligible cardiac patients in most guidelines.(4)

Before attending outpatient CR, an exercise test should be performed for functional capacity assessment, identifying residual ischemia or cardiac arrhythmia, outcome measurement and appropriate exercise training prescription.(5,6) Symptom-limited maximal graded exercise stress test (EST) with 12 leads electrocardiography (ECG) is recommended for these purposes.(7) However, high cost and limited available equipment including cardiac specialist to interpret the result are the main practical problem for CR services in Thailand. Nowadays the 6-minute walk test (6MWT) is widely used clinical exercise test in patients with cardiovascular, pulmonary and other chronic diseases, due to its easy implementation, less time-consuming test, better acceptance and correlation with activities of daily living.(8-11)

Previous studies demonstrate not uncommon atrial and ventricular arrhythmia after cardiac surgery, myocardial infarction and percutaneous coronary intervention. Furthermore incidence of non-sustained ventricular tachycardia was found with 36% after cardiac surgery leading to safety concern for exercise testing and training in CR.(6,12) From a standard guideline for conducting 6MWT, there is no recommendation to monitor telemetry ECG during the test for cardiopulmonary response and safety.(9) Due to lack of data about safety in term of arrhythmia during 6MWT in phase II CR, this research aimed to study the prevalence and associated risk factors of serious arrhythmia which used the same indications to terminate EST during 6MWT in phase II CR.

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Received: 13th September 2019 Revised: 28th October 2019 Accepted: 27th November 2019

Methods

Participants

Inclusion criteria

• Cardiac patients who attended phase II CR program at CR clinic, Phramongkutklao Hospital, Bangkok, Thailand from June 2015 to March 2017

• Conducted the first 6MWT with an ECG telemetry monitoring during the test within 12 weeks after cardiac event or intervention or cardiac surgery

Exclusion criteria

• Having any cardiac arrhythmia in contraindication and indication to termination criteria for EST according to American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) and American College of Sport Medicine (ACSM) before 6MWT start [13,14]

• Having a chronic lung disease

• Having an implanted cardiac device

• Incomplete data in a 6MWT record form

Steps of the study

1. After permission from the Institutional Review Board and the Hospital's Medical Record Committee, the review and selection of eligible consecutive patients' CR record form including patients' demographic data, medical information and complete first 6MWT with ECG data were done by retrospective and prospective data collection.

2. Collected data from medical records including age, gender, body mass index, underlying disease, cardiovascular medication, smoking history, diagnosis of cardiovascular problem, time interval of 6MWT after cardiac event or intervention, left ventricular ejection fraction (LVEF), the ACSM's risk stratification for cardiac patients, type of coronary bypass grafting (CABG) and coronary bypass time (CPB), and ECG before 6MWT which was monitored from telemetry at rest within 3 minutes before testing.

3. Collected 6-minute walk distance (6MWD) and the ECG telemetry results before, during and 3 minutes after 6MWT. Identified patients with serious arrhythmia defined by using arrhythmia-related criteria indicating to terminate EST according AACVPR and ACSM including (1) ventricular tachycardia (VT), ≥ 3 consecutive premature ventricular contraction (PVC), (2) frequent multifocal PVCs (PVCs 7/minutes or more with at least 2 different PVC morphology, (3) paired PVCs or couplets, (4) supraventricular tachycardia (SVT), not including physiologic sinus tachycardia, (5) new onset 2nd or 3rd degree atrioventricular block, and (6) bradyarrhythmia (heart rate less than 50 beats per minute (bpm) including sinus bradycardia).[13,14] The PVC in this study was defined when the QRS complexes were premature, broad (≥ 0.12 sec), bizarre in shape and not preceded by premature P wave[15]

4. Analyzed data to determine the prevalence of serious arrhythmias during 6MWT in phase II and associated risk factors to the occurrence of serious arrhythmia.

Materials

• ECG Telemetry monitoring system (Hewlett Packard, Agilent Technologies, M2604A Telemetry Module)

Statistical analysis

Sample size calculation

$$N = [Z2\alpha/2PQ]/d^2$$

Defined α = 0.05 (two-sided test), $Z_{0.025}$ = 1.96, P = incidence of cardiac arrhythmias during 6MWT = 66.7% from Cipriano et al. study,[16] Q = 1-P, d = error value determined by not more than 11%, required sample size at least 71 patients

Statistical analyses were conducted using the STATA/MP 12 program. For descriptive statistics, data demonstrated in the percentage, average, standard deviation for quantitative data and using the percentage for qualitative data. Chi-square test and Fisher's exact test were used to compare within the categorical basic data and unpaired t-test for comparing continuous data. The multiple logistic regression statistic was used to determine the associated risk factors of serious arrhythmia. The statistical significance was considered at $p < 0.05$.

Note This research has been approved by the Institutional Review Board, the Royal Thai Army Medical Department with the code of R070h/59.

Results

The data from 178 cardiac patients were collected and 143 males (80.3%) were included. Average age was 60.2 (SD 14) years. There were 159 (89.3%), 17 (9.5%), and 2 (1.1%) patients receiving cardiac surgery, percutaneous coronary intervention (PCI) and other diagnosis, respectively. Time interval of 6MWT after cardiac event and intervention/surgery was 20.3 (SD 10.2) days. Most patients (44.4%) were classified into high risk cardiac patients. Demographic data are shown in table 1.

This study showed arrhythmia at rest or before 6MWT including 7 patients (77.8%) with PVC and 2 patients (22.2%) with AF. The prevalence of serious arrhythmia during 6MWT in phase II CR patients was 13.48% (24 patients). Among all serious arrhythmia, paired PVC, frequent multifocal PVC, VT, a new onset AF were recorded as serious arrhythmia in 10 patients (41.7%), 10 patients (41.7%), 2 patients (8.3%) and 2 patients (8.3%), respectively. The clinical characteristics of serious arrhythmia and ECG before 6MWT are demonstrated in table 2.

The risk factor with statistically significant association to serious arrhythmia was the presence of arrhythmia before 6MWT with higher chance (5.88 times) than the absence of arrhythmia ($p = 0.018$, 95% CI 1.36-25.54). There were 9.6% of patients without any arrhythmia before 6MWT found serious arrhythmia as shown in table 3. Among patients with CABG surgery, off pump CABG developed serious arrhythmia in 3 from 20 patients (15%) compared with 12 from 73 patients (16.4%) in on pump CABG. There was no statistically significant difference between these two operation techniques. Age, sex, BMI, diabetes, history of smoking, time interval of 6MWT, 6MWD, LVEF, risk stratification for cardiac patients, cardiovascular diagnosis, medication and CBP time were not associated with serious arrhythmia.

Discussion

Based on data from this study, the prevalence of serious arrhythmia during 6MWT in phase II CR patients was 13.48%, which was less than in other studies. Cipriano et al. studied in 12 pre-heart transplantation patients who had low LVEF and found 25% in prevalence.[16] In phase I CR, Diniz et al. performed 6MWT in patients with myocardial infarction and serious

Table 1. Demographic data of all 178 cardiac patients

Age[1]		60.2 (14.0)
Sex[2]	Male	143 (80.3)
	Female	35 (19.7)
Body mass index (BMI)[1] (kg/m^2)		23.9 (3.4)
Time interval of 6MWT after cardiac event/surgery (day)[1]		20.3 (10.2)
6-minute walk distance (6MWD)[1] (m)		304.5 (99.8)
Diabetes[2]		60 (33.7)
Hypertension[2]		128 (71.9)
History of smoking[2]		45 (27.6)
Left ventricular ejection fraction (LVEF) (%)[1]		56.6 (15.9)
Risk stratification for cardiac patient[2]		
	Low	78 (43.8)
	Moderate	21 (11.8)
	High	79 (44.4)
Myocardial infarction (MI)[2]		10 (5.6)
Valvular heart disease (VHD)[2]		57 (32.0)
All type cardiac surgery[2]		159 (89.3)
Coronary Bypass Graph (CABG)[2]		
	Off pump	20 (21.5)
	On pump	73 (78.5)
Medication[2]	Beta-blocker	89 (50.0)
	Digoxin	9 (5.1)
	Amiodarone	37 (20.8)

[1]Mean (SD), [2]number (%)

arrhythmia was founded about 48%.[17] The reasons of higher prevalence from both studies might be higher risk patients group to develop arrhythmia including low LVEF in pre-heart transplantation and short time interval of 6MWT after cardiac event, intervention or surgery in phase I CR. Therefore, based on authors' knowledge, this is the first study to demonstrate the prevalence of serious arrhythmia from 6MWT in practical phase II CR patients by using the same criteria with EST.

This study also showed that the presence of arrhythmia in which most of the cases presented with PVC before 6MWT was the only statistically significant factor related with serious arrhythmia. This finding was corresponded with Dewey et al. 's study which concluded that PVC while resting was an important predictor for the occurrence of PVC during and after exercise.[18] This may be explained from sympathetic excitation evoked by PVC contributing to increased life-threatening tachyarrhythmias susceptibility.[19] However, there was no statistical relationship between LVEF and severity of arrhythmia, as opposed to the study in pre-heart transplantation patients.[16] There was no association between age, sex, BMI, 6MWD, taking anti-arrhythmic drugs, diabetes, hypertension, smoking, CPB time and serious arrhythmia which was consistent with previous studies.[17,20-22] The right coronary artery stenosis and inferior wall myocardial infarction (MI) were not related to serious arrhythmia, however, Hreybe et al. 's study demonstrated the relationship of these factors because of conduction system disturbance.[23] Most cardiac patients in this study underwent CABG surgery, and there was no difference in serious arrhythmia between off-pump and on-pump CABG patients which was also corresponded with a previous research due to no difference in proinflammatory mediators production.[24] Although Hashemzadeh et al. found that off-pump CABG could reduce post-operative AF, the different results compared with this study might be caused by small number of a new onset AF during 6MWT from presented study (1.1%).[25]

Up to the present time, there is no recommendation to monitor ECG during 6MWT in CR patients from many cardiopulmonary rehabilitation guidelines.[9,13,14] Due to the prevalence and associated factor from this study, the authors suggest safety concern during 6MWT without ECG monitoring in phase II CR service among patients with associated factor. Before 6MWT, patients with any arrhythmia had an increase in risk of 5.88 times for serious arrhythmia occurrence and should be monitored with ECG telemetry.

There are many limitations in this study. Firstly, the cross-sectional descriptive retrospective study might not be able to control all factors and may encounter with incomplete or incorrect data collection problems. Secondly, the proportion of

Table 2. Serious arrhythmia indicating to terminate 6MWT and ECG before 6MWT

Serious arrhythmia	Number (%)	ECG before 6MWT (Number)			
		NSR No arrhythmia	Unifocal PVC	Multifocal VC	Atrial fibrillation (AF)
Ventricular tachycardia (VT)	2 (1.1)	2	0	0	0
Paired PVC	10 (5.6)	7	2	1	0
Frequent multifocal PVC	10 (5.6)	4	4	0	2
New onset Atrial fibrillation (AF)	2 (1.1)	2	0	0	0
Total	24 (13.48)	15	6	1	2

ECG, electrocardiograph; 6MWT, 6-minute walk test; PVC, premature ventricular contraction; NSR, normal sinus rhythm

Table 3. Relationship between arrhythmia before 6MWT and serious arrhythmia

Arrhythmia before 6MWT	Number (%)	Serious arrhythmia		*p*-value	Adjusted Odds Ratio[§] (95% CI)
		Absent	Present		
Absent	156 (87.6)	141 (90.4)	15 (9.6)	0.001[†*]	1
Present	22 (12.4)	13 (59.1)	9 (40.9)		5.88 (1.36-25.54)

6MWT, 6-minute walk test

[*]Significant ($p < 0.05$), [†]calculated by using Fisher's exact test, [§]multiple logistic regression

patients with MI or undergoing PCI or some type of cardiac surgery was too small to draw the prevalence of serious arrhythmia in these patient groups. Thirdly, the study did not consider ischemic or ST segment change which may be serious abnormality affecting the cardiac patient safety during 6MWT. Fourthly, gender of patients in this study was mostly male (80.3%) leading to a difficulty to conclude the real prevalence of serious arrhythmia in female cardiac patients. Lastly, it was found that some patients without arrhythmia before 6MWT developed serious arrhythmia, therefore, other associated factors should be studied in the future for clear conclusion.

In conclusion, the prevalence of serious arrhythmia during 6MWT in phase II CR was 13.48%. The presence of arrhythmia before test was statistically significant associated risk factor with increased risk 5.88 times. Therefore, the safety during 6MWT in phase II CR should be concerned.

Disclosure

The authors declare no conflicts of interest.

Acknowledgment

The authors wish to thank Col. Assoc. Prof. Pattrawut Intarakamheang, Head of Physical Medicine and Rehabilitation Department of Phramongkutklao Hospital, for research advice and cardiac rehabilitation service support.

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