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Literature Review

Electrocardiogram abnormality and distance covered during six-minute walk test on type 2 Diabetes Mellitus

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ARTICLE INFO

Submitted : November 2019
Accepted : February 2020
Published : July 2020

Keywords:

Diabetes Mellitus type 2, Electrocardiogram, Six Minute Walk Test

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Abstract

Diabetes Mellitus (DM) is a metabolic disease that has the characteristics of hyperglycemia that occurs due to abnormalities of insulin secretion, insulin action, or both. Macrovascular complications are often also referred to as secondary atherosclerosis due to DM, which can cause cerebral vascular disease, coronary arterial disease, and peripheral atrial disease. Diagnostic tools are needed for early detection in cardiovascular diseases which is accurate, inexpensive, comfortable, and available in almost health center. One of the diagnostic tools for early detection of cardiovascular diseases is an electrocardiogram (ECG). Six Minute Walk Test (SMWT) is a simple, objective, inexpensive, and efficient test to assess functional capacity and prognosis. This study aims to see whether there is a correlation between abnormalities of ECG and distance covered during SMWT in DM patients. This study was a cross-sectional study design from DM patients in the Polyclinic of the Muhammadiyah Hospital in Palembang. Forty patients with type 2 DM who fulfilled inclusion and exclusion criteria were selected using a consecutive sampling method. Twenty-seven patients have abnormal ECG, and only thirteen patients had distance covered during SMWT >300m. There is a correlation between abnormalities of ECG and distance covered during SMWT in DM patients with a significance value p = 0.011.

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INTRODUCTION

Diabetes mellitus (DM) is a metabolic disease that has the characteristics of hyperglycemia that occurs due to abnormalities in insulin secretion, insulin action, or both (Purnama, 2014). This is a chronic disease where long-term treatment is needed in addition to ensuring an adequate supply of glucose to the tissues, control, and protection from damage caused by hyperglycemia are also needed. The state of hyperglycemia can cause direct and indirect effects. Generally, this damage is divided into microvascular (microangiopathy) and macrovascular (macroangiopathy) complications (Fowler, 2011). Macrovascular complications are often also referred to as secondary atherosclerosis due to DM which can cause Cerebral Vascular Disease (CVD), Coronary Atrial Disease (CAD), Peripheral Atrial Disease (PAD) and other vascular diseases (Katakami, 2018).

One of the most common causes of mortality in people with DM is cardiovascular disease (CVD) (da Rocha Fernandes et al., 2016). According to WHO, in 2008, deaths due to CVD in Indonesia reached 400 per 100,000 people in men, and 300 per 100,000 people in women, and that number continues to increase. Early diagnosis tool on CVD is needed, which is accurate, fast, and comfortable for patients, available in various health service centers in Indonesia and easily accessed. One of the diagnostic tools in CVD is the Electrocardiogram (ECG) (Qureshi, Tabinda, & Vehra, 2017). In macrovascular complications of DM, there is a lack of oxygen supply in heart muscle cells due to decreased blood flow. It can decrease the energy formation, then disruption of ion exchange for depolarization and repolarization. All of this process leads to disruption of heart muscle contraction. The process of depolarization and repolarization will be recorded on ECG records; therefore, ECG plays a role in evaluating and providing information about the status of the heart (Hampton, 2013).

Six Minute Walk Test (SMWT) is a simple, objective, inexpensive, and efficient test for assessing functional capacity and the prognosis of patients (Adiniyi, Uluko, & Sani-Sulaiman, 2009). This test can reflect daily activities and can evaluate all systems involved. Low performance at SMWT can reflect poorer clinical outcomes, such as impaired vascular reactivity, higher risk of systemic heart disease, and describes a low level of physical activity among patients.

The importance of ECG images in detecting CVD in DM patients is associated with a decrease in functional capacity due to CVD that has an impact on the distance covered during SMWT. Therefore, an analysis of the relationship between ECG abnormalities and the distance covered during SMWT in type 2 DM patients is needed.

METHODS

This observational analytic study with a cross-sectional study design conducted at the Palembang Muhammadiyah Hospital Polyclinic in October 2018 involved 40 patients who met the inclusion criteria. Range of age between 40 to 70 years old and had been diagnosed with type 2 DM. The exclusion criteria were not willing to take part in the study, neuromusculoskeletal disorders in the inferior limb (trauma, ulcer, arthritis, hemiparesis, paralysis, and others), unstable angina or myocardial infarction within in a month, systolic blood pressure> 180 mmHg and diastolic> 100 mmHg, cognitive impairment, pregnant patients, CHF NYHA>III and moderate to severe asthma. Samples were selected using the consecutive sampling method.

Research data were collected from type 2 DM patients who met the inclusion criteria by giving informed consent and interviews to find out additional information needed for the

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study. Then, the patient performed ECG and SMWT. After the data have been collected, a correlation test is performed between ECG abnormalities and distance covered during the SMWT using the Chi-Square test.

RESULTS

Forty patients aged 40-70 years old fulfilled the inclusion and exclusion criteria. Twenty-seven respondents had an abnormal ECG, and only 13 had distance covered during the SMWT above 300 meters. Abnormal ECGs found in this study are left ventricular hypertrophy, left atrial hypertrophy, left and right axis deviation, right and left bundle branch block, old myocardial infarction, ST-segment depression, T inversion, and atrial fibrillation.

Table 2 shows that 22 respondents who have abnormal ECG have distance on the SMWT ≤300 meters, and 8 out of 13 respondents with normal ECG have distance covered >300 meters on the SMWT. There is a relationship between ECG abnormalities and the distance covered during SMWT with p = 0.011 (p <0.05).

Table 1. Baseline Characteristics

Characteristic	N	(%)
Age		
40-49 years old	7	17,5
50-59 years old	17	42,5
60-70 years old	16	40,0
Sex		
Man	16	40,0
Woman	24	60,0
Nutritional Status		
Underweight	2	5,0
Normal	19	47,5
Overweight	7	17,5
Obesity	12	30.0
Smoking Status		
No	29	72,5
Yes	11	27,5
6MWT Distance		
≤300m	27	67,5
>300-400m	13	32,5
ECG		
Normal	13	32,5
Abnormal	27	67,5

Table 2. Comparison of ECG and Distance Covered during SMWT

			SMWT		Total	
			≤300 meter	>300 meter		
ECG	Abnormal	Count	22	5	27	p=0,011
		Expected Count	18,2	8,8	27,0	
	Normal	Count	5	8	13	
		Expected Count	8,8	4,2	13,0	
Total		Count	27	13	40	
		Expected Count	27,0	13,0	40,0	

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DISCUSSION

In this study, the results show that 27 of the 40 respondents had abnormal ECGs. The result was consistent with the opinion of Papa et al. (2013), where cardiovascular complications are a major cause of disability and death in patients with type 2 DM, and the risk of cardiovascular disease (CVD) is two to eight times higher in diabetic patients compared with non-diabetic patients of the same age, sex, and race (Papa et al., 2013).

Diabetes is associated with the development of a premature cardiovascular disease, which relates to the clustering of risk factors such as dyslipidemia, hypertension, obesity, and hyperglycemia in the presence of insulin resistance. In addition, diabetes is associated with an inflammatory and pro-thrombotic environment, exacerbating the development of atherothrombosis. Insulin resistance and hyperglycemia both contribute to the development of endothelial cell dysfunction and increased oxidative stress, culminating in accelerated atherosclerosis. Clot formation and function are also directly affected by insulin resistance and hyperglycemia, with increased levels of coagulation factors and anti-fibrinolytic proteins and a fibrin network that is more resistant to lysis, coupled with increased platelet activation (King & Grant, 2016).

There are many theories and hypotheses about the relationship between type 2 DM and cardiovascular disease. Three-quarters of the five million deaths due to DM are related to CVD as a complication. The ECG as an early diagnosis for CVD in type 2 DM becomes very important. In research at the Endocrine Outpatient Clinic of BLU Prof. Dr. dr. R. D. Kandou Manado, found LAH picture, coronary artery disorders (myocardial ischemia and old myocardial infarction), blockade of the bundle branches, and left ventricular hypertrophy in DM patients (Maradjabessy, Rampengan, & Langi, 2015).

Cardiovascular complications in people with DM are related to changes in ECG. Several studies have shown a relationship between DM and left ventricle hypertrophy (LVH). The Strong Heart Study (SHS) reports an increase in left ventricular mass and ventricular wall thickness in both women and men with DM. Similar findings were reported in The Cardiovascular Heart Study (CHS) and The Multi-Ethnic Study of Atherosclerosis (MESA). A recent study in type 2 DM patients in Japan reported an association between insulin resistance, arterial stiffness, and left ventricular mass index (using cardiac MRI). This finding is also supported by studies with a more significant number of samples in Sweden that show an association between metabolic syndrome, insulin resistance, and increased mass and thickness of the ventricular wall (Shahab, 2014).

Other ECG features found in DM patients are prolongation of the QT interval and QT dispersion, even at the onset of DM (Stern & Sclarowsky, 2009). In a review of an article by Movahed MR mentioned that there are several non-randomized studies that report an increase in the prevalence of heart conduction blockade in DM patients, such as right bundle branch block (RBBB), bifascicular block and high degree atrioventricular (AV) block (Movahed, 2008).

The result of this study shows there is an association between abnormal ECG and distance covered during SMWT. Cardiovascular complications in DM patients that can be detected on the ECG are associated with decreased functional capacity linear with research by Ramos et al. (2015) found that reduced distanced covered in SMWT occurs due to manifestations of diabetes mellitus. It can occur because of a lack of activity that leads to decreased function, or conversely, a decrease in

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glucose tolerance will lead to cardiopulmonary complications (Ramos et al., 2015).

A similar study conducted by Adiniyi, Uluko, and Sani-Sulaiman (2009) found that DM patients had lower SMWT values than non-DM patients, significantly lower in women, old age, and obese patients. It is likely because DM patients are closely related to cardiovascular and pulmonary disorders, which have been shown to significantly reduce functional capacity (Adiniyi et al., 2009).

CONCLUSION

There is a relationship between ECG abnormalities and distance covered during SMWT in patients with type 2 DM with a significance value of p = 0.011 (p <0.05).

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