



Factors Related to Electrocardiogram Abnormality in Type 2 Diabetes Mellitus Patients

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Abstract. One of the most common causes of mortality in patients with Diabetes Mellitus (DM) is cardiovascular disease. Electrocardiography (ECG) is considered as a screening technique for cardiovascular disease, particularly in individuals who have hypertension or are suspected of having cardiovascular disease. This study aims to analyze the factors associated with ECG abnormalities in Type 2 Diabetes Mellitus patients. This study is an analytic observational with a cross-sectional study design. Patients with type 2 diabetes who were 40 to 70 years old were enrolled using a non-probability selection method. Approximately 60% of 104 patients have an abnormal ECG. Abnormal ECG found in this study are structural heart abnormalities such as left ventricular hypertrophy and left atrial hypertrophy, left and right axis deviation, impulse conduction abnormalities like right and left bundle branch block, an ischemic pattern such as old myocardial infarction, ST-segment depression, T wave inversion and electrical abnormality as atrial fibrillation. Chi-square analysis followed by logistic regression analysis found hypertension ($p = 0.001$), DM duration over 10 years ($p = 0.239$), age over 60 ($p = 0.001$), glucose levels over 200 mg/dl ($p = 0.500$), smoking ($p = 0.08$). Factors associated with ECG abnormalities in type 2 DM patients are hypertension and age over 60..

Keywords: Elderly · Electrocardiography · Hypertension · Type 2 Diabetes Mellitus · Prognosis

1 Introduction

Diabetes Mellitus (DM) continues to be a significant public health issue, with a growing number of patients. The projected rise in the number of individuals living with diabetes is 693 million by 2045 [1]. One of the most common causes of mortality in DM patients is cardiovascular disease (CVD) [2]. The death rate of type 2 DM patients due to cardiovascular disease is mainly due to coronary heart disease [3]. Cardiovascular risk in DM patients will increase with the increasing duration of diabetes mellitus and the evidence of DM complications in target organs. Individuals with cardiovascular disease have a much higher cardiovascular risk linked with diabetes [4].

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The high risk of cardiovascular and death caused by CVD in DM patients requires an early diagnosis of CVD. A resting electrocardiogram (ECG) is recommended as a screening tool for cardiovascular disease (CVD), especially in people with a history of hypertension or who are suspected of having CVD. The ECG is a diagnostic tool with high accuracy, is quick, and readily available for patients in Indonesia [5]. Based on a study conducted by Stern & Sclarowsky (2009), ECG can also be used to identify CVD in diabetes, such as silent myocardial ischemia, cardiac autonomic neuropathy, cardiomyopathy [6].

Macrovascular complications, especially coronary heart disease, are caused by a lack of O₂ supply in heart muscle cells due to a decrease in blood flow to the heart muscle, resulting in a decrease in energy formation, which disrupts ion exchange for depolarization and repolarization, all of which lead to impaired heart muscle contraction. Changes in electrical activity in this condition will have an impact on changes in the ECG picture [7].

This research examines the ECG pattern in type 2 diabetes mellitus patients and determines which variables are related to ECG abnormalities.

2 Method

This research is an analytic observational study. The research design used was a cross-sectional study to determine the factors associated with abnormal electrocardiogram images in type 2 diabetes mellitus patients. Non-probability sampling was employed on patients who were 40 to 70 years old. Exclusion criteria in this research include diseases that may hinder a patient from installing an EKG, such as a thoracic injury or mammary carcinoma. This research has received permission from the ethics committee of the medical faculty of the Universitas Muhammadiyah Palembang.

2.1 Electrocardiogram Examination

ECG examination was carried out at Muhammadiyah Palembang Hospital for inpatients and outpatients using electrocardiography.

2.2 Our Contribution

ECG examination is a recommended screening tool to detect complications in DM patients. In this study showed factors associated with ECG abnormalities so that DM patients who have these factors increase the benefits of having an ECG examination.

2.3 Paper Structure

The first section describes the selection of cases and the method of ECG examination for type 2 DM patients. The second section shows the results of the ECG examination which are then interpreted and analyzed using bivariate and multivariate analysis. The last section describes the conclusions from the results obtained.

3 Result and Discussion

There were 104 diabetes type 2 patients involved in this study; most patients were under 60 years old and female. Around 60% of individuals have abnormal ECG results. Abnormal ECG found in this study are structural heart abnormalities such as left ventricular hypertrophy (15,4%) and left atrial hypertrophy (2,9%), left and right axis deviation (27,9%), impulse conduction abnormalities (10,6%) like right and left bundle branch block, an ischemic pattern (18,3%) like old myocardial infarction (11,5%), ST-segment depression (2,9%) and T inversion (6,7%) and atrial fibrillation (1,9%).

According to bivariate Chi-square analysis, the variables linked with ECG abnormalities were hypertension ($p = 0.001$) and age ($p = 0.001$), and these factors remained substantially correlated after multivariate logistic regression analysis.

3.1 Discussion

Type 2 DM patients often have abnormalities in the ECG picture [8]. In this study, 60.6% of patients with type 2 diabetes had abnormal features on the ECG. This is in line with Maradjabessy's (2015) research, in which abnormalities ECG pictures were found in 75% of Type 2 DM patients [9]. According to Gupta (2017), 26% of asymptomatic Type 2 diabetes patients without a history or symptoms of the cardiovascular disease reported abnormalities ECG pictures [10] (Table 1 and 2).

The role of the ECG in diagnosing cardiovascular disease is crucial, including in diagnosing complications of diabetes other than coronary artery disease [11]. The high rate of asymptomatic ischemic heart disease [12] and the incidence of Left Ventricular Hypertrophy (LVH) [13] based on ECG examination makes the ECG examination a recommended diagnostic tool in detecting the risk of cardiovascular events [4].

Age was significantly associated with the incidence of ECG abnormalities. The results of this study are in line with research conducted by Soejima (2019), which showed an increase in the incidence of asymptomatic and symptomatic myocardial infarction in line with increasing age and duration of diabetes [14]. Based on research conducted by Sayeed (1998), the incidence of coronary heart disease in DM patients is one of them associated with increasing age [15]. However, these results are not in line with research by Pineda (2018), which showed an increased prevalence of ischemic heart disease in asymptomatic DM patients associated with a poor prognosis worse but not related to age [12].

Hypertension is also a factor associated with ECG abnormalities in this study. According to Hampton (2013) research, hypertension in type 2 DM patients is one of the risk factors that cause ECG picture abnormality [7]. In the hypertension subgroup, the prevalence of atrial fibrillation in DM patients was also significantly higher than in patients without a history of DM. Hypertension and DM had share pathophysiology including inappropriate activation of the RAAS, increased oxidative stress, increased sympathetic nervous system (SNS) activation, dysfunctional innate and adaptive immune responses and abnormal renal handling of sodium [16].

DM duration of more than ten years increases cardiovascular risk, and it is advised to undertake early screening for events in individuals with a DM duration of more than five years. Asymptomatic heart disease corner especially in patients with other

Table 1. Baseline Characteristics of Respondent comprising Age, Hypertension, ECG Abnormality, Smoking habits, DM duration and Blood Glucose level (n = 104)

Characteristic	N	(%)
Age		
40–59 years old	69	66.3
60–70 years old	35	33.7
Sex		
man	33	31.7
woman	71	68.3
Hypertension		
Yes	29	27.8
No	75	72.2
ECG Abnormality		
Yes	63	60.6
No	41	39.4
Smoking		
Yes	21	20.1
No	83	79.9
DM Duration		
> 10 years	14	13.4
≤ 10 years	90	86.6
Blood Glucose		
> 200 mg/dl	52	50.0
≤ 200 mg/dl	52	50.0

risk factors [17]. The duration of DM, blood sugar levels and smoking history in this study were not associated with the incidence of ECG abnormalities. Information of DM duration taking from anamnesis and randomized blood sugar cannot describe properly natural history of the diaseses. When hyperglycemia is present, the pulse rate variability decreases and the pulse rate increases [18]. Smoking significantly increases the risk of cardiovascular problems in individuals with diabetes mellitus [19]. Smoking is linked with QT prolongation in diabetes mellitus [20]. There is no QT prolongation on the ECG results found in this study.

The state of hyperglycemia in prolonged DM will create an imbalance between the bioavailability of Nitric Oxide (NO) and the accumulation of Reactive Oxygen Species (ROS) or oxidative stress. High oxidative stress will cause structural dysfunction of the endothelium and smooth muscle of blood vessels, causing foam cells or foam cells. This condition is said to continue into atherosclerosis. Atherosclerosis will make the formation of plaque on the endothelium of blood vessels. At first, the plaque will be in a

Table 2. Statistical Analysis Factors Associated with ECG Abnormality

Independent variables	ECG Abnormality		p Value ¹	Adjusted p Value ²
	Yes	No		
Hypertension (Yes)	25	4	0.001*	0.007*
DM duration (> 10 years)	11	3	0.239	0.879
Blood glucose level (> 200 mg/dl)	32	20	0.500	0.429
age (> 60 years old)	29	6	0.001*	0.005*
Smoking (Yes)	16	5	0.08	0.308

stable state, and this condition is called coronary heart disease [21]. Atherothrombosis impairs the supply of oxygen to the heart muscle. This affects both depolarization and repolarization [22]. ECG abnormalities are also an ECG feature of DM [23].

4 Conclusion

Factors associated with ECG abnormalities are the hypertension and age.

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