The most common electrocardiographic abnormalities in patients with diabetes mellitus

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Abstract
Diabetes mellitus (DM) is a term used to describe a group of metabolic illnesses caused by an increase in blood sugar (hyperglycemia), which causes defects in insulin secretion, insulin function, or both. Cardiovascular diseases (CVDs) are the underlying cause of death in people with DM. Electrocardiography is a non-invasive clinical screening method for the early diagnosis of CVDs. This review study was performed with the aim of electrocardiogram (ECG) changes in diabetic patients.
Keywords: Cardiovascular diseases, Electrocardiography, Diabetes Mellitus

Introduction

Diabetes mellitus (DM) is a term used to describe a group of metabolic illnesses caused by an increase in blood sugar (hyperglycemia), which causes defects in insulin secretion, insulin function, or both (1).

The American Diabetes Association (ADA) divides DM into three general types: type 1 diabetes (insulin-dependent DM), type 2 diabetes (non-insulin-dependent DM), and gestational diabetes (2). DM is a major rapidly expanding public health problem in low- and middle-income nations (3). Diabetic patients have surged in number globally in recent decades, from 108 million in 1980 to 463 million in 2019. According to current projections, this number will approach 700 million by 2045 (4). This disease has become a major issue in most Asian nations, particularly Iran, where it is anticipated that 9.2 million people would have diabetes by 2030 (5). DM damages several organs of the body over time, including the heart, blood vessels, eyes, kidneys, and nerves; the incidence of cardiovascular is higher in diabetic patients than in the general population (6). Cardiovascular diseases (CVDs) are the leading cause of death in those who have type 2 DM (T2DM) (7). DM leads to damage to the cardiovascular system through oxidative stress, endothelial dysfunction, and atherogenesis (8). There is a link between diabetes and the risk of heart failure, which increases more than twice in males and more than five times in women, according to studies (9). Einarson et al according to a meta-analysis of medical data on 454,9481 people with T2DM showed

that nearly one-third of patients had CVDs and half of all deaths were due to CVDs (10). Electrocardiogram (ECG) is a common and non-invasive screening tool for assessing CVDs (7). Electrocardiogram is a record of electrical currents caused by stimulation of the heart muscle, there are three main components to the Electrocardiography, namely P, QRS complex, and T waves (11). In patients with DM, the ECG changes (12). The QT interval on the ECG represents the entire time of ventricular depolarization and repolarization and varies with heart rate, thus more accurately expressed as corrected QT interval (QTc), QT interval prolongation (greater than 440 milliseconds) is more common in patients with DM (13). This article aims to investigate ECG changes in patients with DM.

Materials and Methods

In this article, we review recently published works focusing on ECG changes due to DM. Articles were searched in PubMed, Google Scholar, and ScienceDirect databases with related keywords including diabetes mellitus, electrocardiography, and cardiovascular diseases.

Electrocardiographic changes

Sardesai et al, to determine ECG abnormalities examined 130 patients (58.5% male, 41.5% female) with T2DM without a history of heart disease with a mean age of 56.3 years in India. Findings of this study show that 53.1% of patients had abnormal ECG, In 17.7% of patients, changes in ST-segment and T wave occurred (14). In a

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■ **Implication for health policy/practice/research/ medical education**

Electrocardiographic abnormalities are common in diabetic patients. The most common ECG abnormality was QT interval prolongation.

study of 258 patients (133 males and 125 females) with T2DM in Ethiopia, Sinamaw et al found that 45% of patients underwent ECG changes. The most common ECG abnormalities included T-wave inversion (14.73%), ST-Segment depression (6.6%), prolongation of the QT interval (3.1%), and prolongation of the QRS complex duration (4.7%) (15). Charamba et al, at a clinical center in Ireland conducted a study on seventeen men with type 1 diabetes mellitus (T1DM) with a mean age of 52.5 years. They showed that mean QTc was significantly longer in these patients (16).

In a study of 100 patients with T2DM who had no history of heart disease (mean age of 50.3 years) and 50 healthy people as a control group, Gupta et al examined ECG alterations. ECG abnormalities were detected in 26% of diabetic patients, with ST-segment depression and T-wave inversion being the most prevalent, followed by left atrial enlargement (17).

In a study of 100 patients (43 males and 57 females) with T2DM with a mean age of 58.3 years in Senegal, Ndour et al Found that QT interval increased in 21% of patients, Arrhythmia was also observed in 20% of patients (18). In a case-control study in Denmark, Isaksen et al examined 855 people with T1DM (442 males, 413 females) with a mean age of 48 years without heart disease, and 1710 people as a control group were studied. They discovered that patients with T1DM had a longer QTc interval and a longer QRS complex than the control group (97 ± 11 versus 95 ± 11 ms) (12). Ninkovic et al in a study of 501 patients (227 males, 274 females) with T2DM with a mean age of 60.4 years discovered that QTc interval prolongation was significant in these patients (more than 440 ms) (13).

In a study conducted by Fagher et al in Sweden, 54% of 70 T2DM patients with an average age of 72 years died after three years of follow-up. They found that QT interval prolongation (more than 440 milliseconds) was found in 51.4% of patients and was highly linked to three-year death (19). Cox et al studied 1020 people with T2DM (569 females, 451 males) with a mean age of 61.4 years. Their study reported a prolongation of the QTc interval (more than 450 ms) (20). 35 women with gestational DM, with an average age of 32 years, and 31 healthy pregnant women were studied in the Czech Republic by Žákovičová et al (21). They found that the QT interval was significantly longer in Pregnant women with diabetes (21). In a study by Medová et al in the Czech Republic, an ECG test was taken from 3 groups of women, including group 1, 26 pregnant women with diabetes, group 2, 54 healthy pregnant women, and group 3, 18 healthy non-pregnant women. The results of this study showed that in pregnant patients with DM the duration of the QRS complex was shorter than in the other two groups (82 ± 6.8 ms) in pregnant women with diabetes, (89.5 ± 8.2 ms) in healthy pregnant women, and (90.8 ± 7.9 ms) in the control group (22). In a large study, Pfister et al analyzed 5238 people with T2DM and found that the QTc interval was increased in these patients, which was associated with heart failure (23). The results of these studies are summarized in Table 1.

Conclusion

ECG abnormalities are common in diabetic patients. The most common ECG abnormality was QT interval prolongation. Routine ECG screening should be performed for all patients with diabetes to lessen the risk of ECG abnormalities and other problems.

Table1. Summary of ECG findings in patients with diabetes mellitus

First author	Year	ECG findings
Sardesai et al	2022	ST-T changes
Sinamaw et al	2022	T-wave inversion, QT interval prolongation, ST-Segment Depression, prolonging QRS complex duration
Charamba et al	2021	QTc interval prolongation
Isaksen et al	2018	QTc interval prolongation, prolonging QRS complex duration
Gupta et al	2017	ST-Segment Depression, T-wave inversion
Ndour et al	2017	QT interval prolongation
Ninkovic et al	2016	QTc interval prolongation
Fagher et al	2015	QT interval prolongation
Cox et al	2014	QTc interval prolongation
Žákovičová et al	2014	QT interval prolongation
Medová et al	2012	Shortened QRS complex duration
Pfister et al	2011	QTc interval prolongation

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