

Assessment of QTc Interval in Type 2 Diabetic Patients Asymptomatic for Cardiovascular Disease: A Cross-sectional Study in a Tertiary Care Hospital in North East India

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Abstract

Background: Diabetes mellitus is a disease of inadequate control of blood levels of glucose resulting in a group of metabolic disorders due to defects in insulin secretion, insulin action, or both. One of the common long-term complications of type 2 diabetes mellitus (T2DM) is cardiovascular disease in the form of coronary artery disease (CAD) and cardiac autonomic neuropathy (CAN). The QTc interval reflects the duration of the ventricular myocardial depolarization and repolarization and is a good indicator of cardiovascular status of the individual.

Aims and Objectives: The study aims to observe the QTc interval in patients with T2DM for early detection of cardiovascular changes, asymptomatic for cardiovascular diseases and to observe the effect of duration of disease, and glycemic control on QTc interval.

Materials and Methods: A cross-sectional study was carried out in a tertiary care hospital affiliated to a medical college situated in the North-East India among 100 T2DM patients. Detail history was taken as per the case study format. Blood samples were analyzed for glucose (fasting and postprandial) and HbA1C. Resting 12 leads that ECG was recorded and QTc interval was calculated.

Results: Statistical analysis was carried out using SPSS software 15.0 and results were statistically analyzed and correlated. $P < 0.05$ was considered significant. Mean QTc interval in T2DM patients was 495.58 ± 68.9 ms. There was a significant positive correlation between the duration of disease and QTc interval ($P = 0.032$).

Conclusion: Resting QTc abnormalities in patients with T2DM indicate the onset of cardiovascular changes which deteriorate as the disease duration increases. Regular monitoring of T2DM patients with ECG can help in the early detection of cardiovascular disease.

Key words: Cardiovascular complications, Diabetes mellitus, QTc interval

INTRODUCTION

Diabetes mellitus is a disease of inadequate control of blood levels of glucose due to insulin deficiency or

resistance to insulin action or both. Type 2 diabetes mellitus (T2DM) is the most common type of diabetes affecting the metabolic pathways and consequently causes end-organ damage in multiple organ-systems of the human body.^[1] Long-term complications of diabetes mellitus includes both macrovascular and microvascular complications. One of the most common complications of T2DM is cardiovascular disease.^[2] Cardiovascular complications can be in the form of coronary artery disease (CAD) or cardiac autonomic neuropathy (CAN) even arrhythmias. Silent ischemia of myocardial tissue where ischemic pain is blunted is one of the major causes of mortality due to

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cardiovascular complications of type 2 diabetes.^[3] CAN is associated with several variety of outcomes resulting in cardiovascular deaths^[4] and is often overlooked by the physicians due to its insidious onset and not routinely being tested in diabetic clinics. Several non-invasive tests are available like cardiac autonomic reflex tests, 24 h heart rate variability, spontaneous baroreflex sensitivity, and cardiac radionuclide imaging, but these are costly as well as time consuming.^[5] The QT interval in ECG reflects the duration of the ventricular myocardial depolarization and repolarization and is a good indicator of cardiovascular status of the individual. Various studies have shown the ECG abnormalities such as prolonged corrected QT interval (QTc) in patients with T2DM. Prolongation of QTc interval has been demonstrated to be a specific indicator of CAN. Although ECG abnormalities are found in diabetic patients in different studies, very few studies are done to assess the QTc interval in type 2 diabetics in Northeastern part of India. The aim of our study is to assess the corrected QT (QTc) interval in T2DM patients who are symptomatic for cardiac disease and to find out the correlation between ECG changes and duration of disease and HbA1C level.

Objectives

The objectives of this study were as follows:

1. To study the QTc interval in patients with T2DM for the early detection of cardiovascular changes, asymptomatic for cardiovascular diseases.
2. To study the effect of duration of disease and glycemic control on QTc interval.

MATERIALS AND METHODS

A hospital-based cross-sectional study was done in adults with T2DM attending diabetes and nutritional clinic OPD of AGMC and GBP Hospital, Agartala who had no complaints of cardiovascular diseases. Ethical clearance was obtained from the Ethical Committee of AGMC and GBPH. The study subjects were evaluated by general history, clinical examination, and blood HbA1c level. Study was conducted between the periods from May 2021 to April 2022.

Total sample size – 100.

Inclusion Criteria for the Cases

The following criteria were included in the study:

1. Patients aged between 30 and 60 years.
2. Diagnosed cases of T2DM as given by the American Diabetes Association (ADA)

Patients who fulfill the following criteria for the diagnosis of diabetes mellitus:

- a. Symptoms of diabetes plus random blood glucose (RBS) concentration ≥ 11.1 mmol/l (200 mg/dL) or
 - b. FBS ≥ 7.0 mmol/L (126 mg/dL) or
 - c. HbA1c $\geq 6.5\%$ or
 - d. PPBS ≥ 11.1 mmol/L (200 mg/dL) during an OGTT.
3. Patients having no cardiovascular complaints.
 4. Co-operative and willing to participate in the study.

Exclusion Criteria for the Cases

The following criteria were excluded from the study:

1. Already existing microvascular complications of diabetes such as retinopathy, neuropathy, and nephropathy.
2. Known cases of cardiovascular disorders such as hypertension, coronary artery disease, and congestive cardiac failure.
3. Presence of any other concomitant diseases disrupting cardiovascular homeostasis like thyroid disorders, pheochromocytoma, chronic renal failure due to any cause, respiratory disorders, and dyselectrolytemia.
4. History of smoking, alcoholism or intake of any drugs such as vasodilators, diuretics, anti-arrhythmic, beta-blockers, alpha-agonist, or alpha-blockers.
5. Those who are not willing to participate in the study.

Study Tools

- Electrocardiograph:- Model No. CARDIART 6108T
- Sphygmomanometer
- Stethoscope
- HbA1C kit
- Case study format.

Recording of ECG

Patients were made to relax comfortably in the ECG recording room. Resting ECG parameters of the patients were recorded (selected as elaborated in the sub-heading sampling procedure) only after obtaining their informed consent as per the inclusion criteria. All the variables such as name, age, and sex were noted as per the case study format. The following ECG parameter was assessed using Standardization (Calibration): 10 mm = 1 mV

QT interval – 0.39 ± 0.04 s/390 \pm 40 ms

RR interval – 60-100/min

QTc interval was calculated using the formula

$$QTc \text{ interval} = \frac{QT \text{ interval}}{\sqrt{RR \text{ interval}}}$$

Data Analysis

Data were analyzed using SPSS 15.0. *P* value was calculated to assess the significance of difference of ECG parameters. *P* < 0.05 was considered significant. Correlation between

QTc interval and HbA1c level and duration of disease had been analyzed.

RESULTS

A total of 100 T2DM patients had participated in this study. Mean HbA1C level was $9.51 \pm 2.65\%$. Mean QTc interval in T2DM patients was 495.58 ± 68.9 ms as mentioned in Table. 1. Correlation between HbA1c level and QTc interval was not statistically significant as shown in Figure 1. There was a significant positive correlation between the duration of disease and QTc interval ($P = 0.032$), as shown in Figure 2. Percentage of Prolong QTc interval in T2DM Patients is shown in Figure 3.

DISCUSSION

The present study included 100 known diabetic subjects who are asymptomatic for cardiovascular disease. Their blood glucose parameters were estimated and resting ECG was recorded and QTc interval was calculated in these patients to observe whether any changes were present. QTc interval was prolonged in type 2 diabetic patients. There was a positive correlation between the HbA1C level and QTc interval, but the correlation was not statistically significant. Disease duration had significant positive correlation with QTc interval ($P = 0.032$). The presence of prolonged QTc indicated onset of cardiovascular complications which deteriorated with increasing HbA1C as well as with duration of disease. Prolonged QTc interval increases the risk of ventricular arrhythmias and ventricular fibrillations.

Table 1: Electrocardiograph parameters in type 2 diabetes mellitus patients

Sample size (n=100)	
ECG parameter	QTc interval (ms)
Values	495.58±68.9

ECG: Electrocardiograph

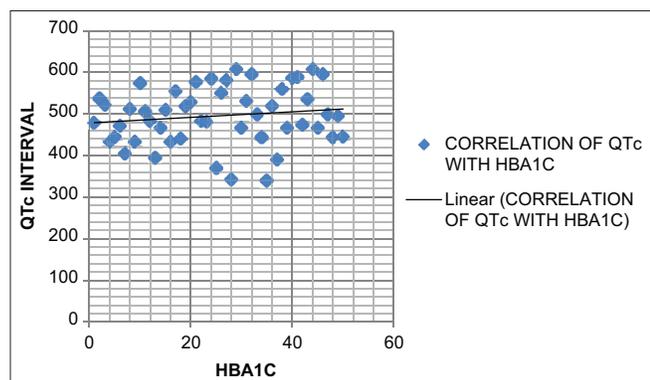


Figure 1: Correlation Graph of HbA1C with QTc interval

In a study comprising 200 patients in two referral centers in Nigeria, prolonged QTc interval was found in 25.5% cases of diabetes mellitus. The mean duration of disease in this study was 20 years.^[6] Ewing *et al.*, in 1991, showed in their studies that typical impairment of ECG parameters in diabetic people was in QT region of the ECG.^[7] Rossing *et al.* observed in their study that QTc interval was significantly prolonged in cases of diabetes.^[8] Maser *et al.* also concluded in their study that diabetic people were at increased risk of ventricular arrhythmias as indicated by prolonged QTc interval.^[9] Khoharo and Halepoto, in their study, concluded that in patients with diabetes mellitus, QT_c prolongation and autonomic dysfunction are closely correlated, and QT_c prolongation is considered to be a specific sign of autonomic cardiac dysfunction and high mortality risk.^[10] Prolongation of QT_c was studied by Chugh *et al.*, Nelson *et al.* individually concluded that prolonged QT_c is indeed a sign of CAN and a predictor of cardiovascular mortality in type 2 diabetes.^[11,12]

Finding of all these studies supports the finding of our study. Increased blood glucose level in diabetics leads to the activation of protein kinase C, which can cause atherosclerotic changes in the blood vessels, retarding the blood flow to the myocardium. Altered blood flow can lead to ischemic damage to the myocardial cells.

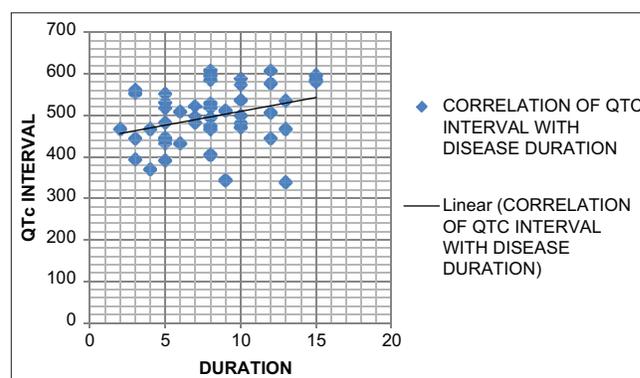


Figure 2: Correlation graph of duration of disease with QTc interval ($P = 0.03$)

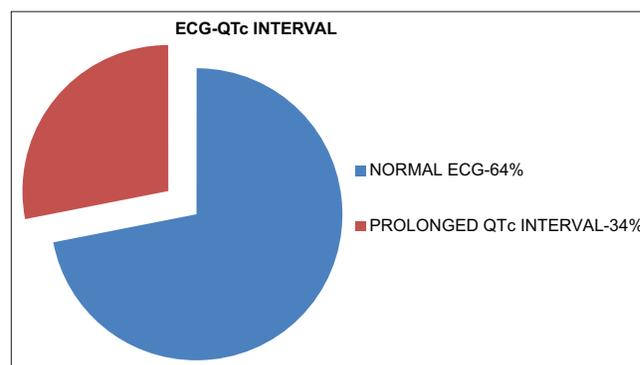


Figure 3: Pie chart representation of percentage of prolong QTc interval in type 2 diabetes mellitus patients

Microvascular and macrovascular complications are well known in diabetes mellitus. Hyperglycemia is proposed to cause end-organ damage and damage to the nerve fibers by increasing the generation of reactive oxygen species. In T2DM, hyperglycemia also leads to the formation of the advanced glycation end product (AGEs), which can cause degeneration of autonomic neurons leading to CAN. The combined effect of all these factors can lead to increased risk of cardiovascular morbidity and mortality.

The findings of our study, that is, the presence prolonged QTc interval even when the patients are asymptomatic for cardiovascular disease, emphasize on regular ECG monitoring of diabetic patients. Prompt management of diabetes and controlling HbA1c level can prevent further cardiac complications. All type 2 diabetic patients should be screened for cardiovascular changes at the time of diagnosis and regularly there after using simple 12 lead ECG recording to reduce the burden of cardiovascular morbidity and mortality.

CONCLUSION

Prolonged QTc interval in T2DM patients even in absence of any symptoms indicates development of cardiovascular disease and increased risk for cardiac arrhythmias. Regular ECG monitoring can help in screening for cardiovascular complications among those T2DM patients who are asymptomatic for cardiovascular diseases. Regular assessment of ECG parameters and maintaining strict glycemic control can delay the cardiovascular complications in asymptomatic diabetic patients.

Limitations of the Present Study

The sample size in the present study is relatively small. Furthermore, unknown and subclinical complications,

which are unaccounted for, may contribute to ECG changes.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas. 5th ed. Brussels: International Diabetes Federation; 2011.
2. Juutilainen A, Lehto S, Ronnemaa T, Pyorola K, Laakso M. Type 2 diabetes as a coronary heart disease equivalent: An 18-year prospective population-based study in Finnish subjects. *Diabetes Care* 2005;28:2901-7.
3. Draman MS, Thabit H, Kiernan TJ, O'Neill J, Sreenan S, McDermott JH. A silent myocardial infarction in the diabetes outpatient clinic: Case report and review of the literature. *Endocrinol Diabetes Metab Case Rep* 2013;2013:130058.
4. Dimitropoulos G, Tahrani AA, Stevens MJ. Cardiac autonomic neuropathy in patients with diabetes mellitus. *World J Diabetes* 2014;5:17-39.
5. Li X, Ren H, Xu ZR, Liu YJ, Yang XP, Liu JQ. Prevalence and risk factors of prolonged QTc interval among Chinese patients with Type 2 diabetes. *Exp Diabetes Res* 2012;2012:234084.
6. Olamoyegun AM, Ogunmola OO, Oladosu YT, Kolawole BA. Prevalence, variants and determinants of electrocardiographic abnormalities amongst elderly Nigerians with Type 2 diabetes. *J Med Med Sci* 2013;4:324-8.
7. Ewing DJ, Boland O, Neilson JM, Cho CG, Clarke BF. Autonomic neuropathy, QT interval lengthening, and unexpected deaths in male diabetic patients. *Diabetologia* 1991;34:182-5.
8. Rossing P, Breum L, Major-Pedersen A, Sato A, Winding H, Pietersen A, *et al.* Prolonged QTc interval predicts mortality in patients with Type 1 diabetes mellitus. *Diabet Med* 2001;18:199-205.
9. Maser RE, Mitchell BD, Vinik AI, Freeman R. The association between cardiovascular autonomic neuropathy and mortality in individuals with diabetes a meta-analysis. *Diabetes Care* 2003;26:1895-901.
10. Koharo HK, Halepoto AW. QTc-interval, heart rate variability and postural hypotension as an indicator of cardiac autonomic neuropathy in Type 2 diabetic patients. *J Pak Med Assoc* 2012;6:328-31.
11. Chugh SS, Reinier K, Singh T, Uy-Evanado A, Socoteanu C, Peters D, *et al.* Determinants of prolonged QT interval and their contribution to sudden death risk in coronary artery disease: The Oregon sudden unexpected death study. *Circulation* 2009;119:663-70.
12. Nelson MR, Daniel KR, Carr JJ, Freedman BI, Prineas RJ, Bowden DW, *et al.* Associations between electrocardiographic interval durations and coronary artery calcium scores: The diabetes heart study. *Pacing Clin Electrophysiol* 2008;31:314-21.

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