

Detailed Electrocardiographic Interpretation in Type 2 Diabetes-Can be a Predictor of Cardiovascular and Other Complications

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Abstract: **Background:** Type 2 Diabetes Mellitus is a systemic disease with life-threatening complications and morbidity .The 12 lead ECG, an easily available investigation ,when studied in detail can give a lot of information ,and predict complications. **Aims & objectives:** To study the ECG ,and 2D echocardiography in type 2 Diabetes Mellitus patients ,and correlate abnormalities with macro and micro-vascular complications of Diabetes. **Methodology:** 100 patients, of age group 18-80 were included in study, subjected to ECG,2D echocardiography, and laboratory tests .Data collected and analysed. **Conclusions:** Arrhythmia was not detected in any patient .A resting tachycardia (HR>100) in 30 patients correlated with Prolonged QTc(>440miliseconds).QRS amplitude was reduced in 26 patients. Prolonged QTc also correlated with presence of Diabetic complications , Retinopathy of NPDR type and Nephropathy. Hence about 30% of our study group did show signs of early Diabetic Cardiac Autonomic Neuropathy and Cardiomyopathy

Keywords: Diabetes mellitus, Diabetic cardiac autonomic neuropathy ,QTc Prolongation , Resting tachycardia

1. Background

Our study, a cross-sectional observational study, was conducted over a 3 year period from august 2017 to September 2019 in a semi-urban medical college hospital in Western Maharashtra. Patients of type 2 Diabetes Mellitus were selected from Diabetes OPD, General OPD and Inpatients and subjected to ECG and 2D echocardiography. A detailed analysis of ECG was done, results tabulated and analysed.

1.1 Diabetes and the Heart

Diabetes can cause premature atherosclerosis, commonly presenting as coronary artery disease. Heart is supplied by Autonomic Nervous system , which controls both Rate and Rhythm. Diabetes affects nerves and hence brings about changes in Rate and Rhythm and also contractility ,by a direct toxic effect on the myocardium. The entire presentation of this condition can be summed up as Diabetic Cardiac Autonomic Neuropathy (DCAN) and Cardiomyopathy

1.2 Aims and Objectives

To study in detail the ECG of patients of type 2 Diabetes Mellitus ,for Heart Rate variability , Arrhythmias , and other abnormalities and correlate them with macro and microvascular complications of Diabetes.

2. Methodology

100 patients of type 2 Diabetes Mellitus between age group 18-80 yrs ,were selected for our study after excluding , those

who had Hypertension, and those who had evidence of Ischemic Heart Disease ,on ECG and echocardiography. Clinical examination , Blood sugar ,HbA1c levels were done.ECG of each patient was analysed for : Heart Rate ,Rhythm, P wave duration and height , PR interval, Q wave , Amplitude of QRS complex , QT interval and calculated QTc and , T wave. Data tabulated and analysed.



Bazett's formula for QTc

$$QTc = \frac{QT \text{ interval in seconds}}{\sqrt{\text{cardiac cycle in seconds}}} = \frac{QT}{\sqrt{RR}}$$

3. Results and Observation

In our study no arrhythmia was noted in study . 44% patients had prolonged QTc of more than 440msec. prolonged QTc did not correlate with age of the patients. Prolonged QTc correlated with mean HbA1c of 9.7%. (p =0.04). QTc prolongation in our study did not correlate with duration of diabetes mellitus. Prolonged QTc correlated significantly with high mean fasting blood sugar levels of 176.9mg/dl .(P<0.007).In our study QTc correlated with presence of

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nephropathy (p=0.015) as well as retinopathy (NPDR) (p=0.0004).

In our study 30% patients had resting tachycardia of more than 100 beats per minute.

Resting tachycardia did not correlate with either HbA1c (p=0.48) or duration of diabetes mellitus (p=0.19). Significant correlation was seen between resting tachycardia and prolonged QTc (p=0.003).

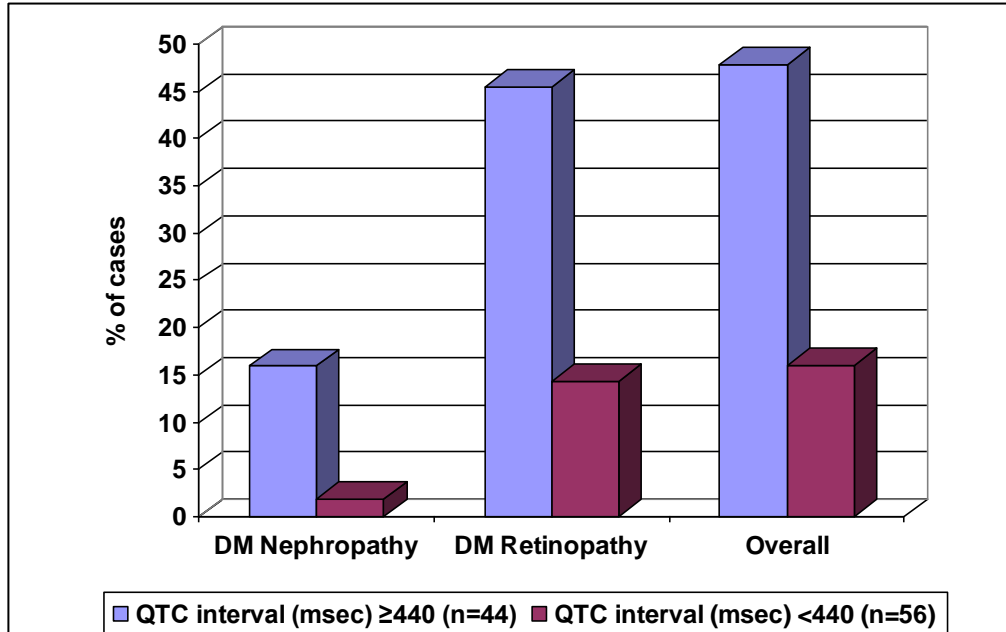
Correlation between P-wave duration ,PR-interval prolongation and duration of diabetes mellitus and HbA1c was not significant

Association between QTC interval and HR in study group

HR (beats per minute)	QTC interval (msec)		Total
	≥440	<440	
≥100	20	10	30
<100	24	46	70
Total	44	56	100

Chi-square = 8.94, P=0.003

Bar diagram showing association between QTC interval and complication in study group



On 2D echocardiography 19 patients showed Grade 1 Diastolic dysfunction and borderline LVH

4. Discussion

Shlomo Stern and Samuel Sclarowsky^(1,2,3,5,12,13,14) in their review on “the ECG in Diabetes Mellitus” stated that sinus tachycardia, prolonged QTc, HRV, ST-T changes and LV hypertrophy all signs of Early CAN(cardiac autonomic neuropathy),and that these are due to slow progressive fibrosis of myocardium.

Ana de Santiago⁽⁴⁾ in her PhD concluded that ECG findings can be predictors of more serious events which could be aggressively prevented.

Prolongation of QTc was studied by Sumeet.Chugh et al, Nelson MR et al, and Peter M Okin individually^(5,6,7,17) , and concluded that prolonged QTc is indeed a sign of CAN and a predictor of Cardiovascular Mortality in Type 2 Diabetes Amanda Seyerle⁽⁸⁾in her dissertation using GWAS(genome-wide association studies) felt that QT is heritable , and may be responsible for cardiac events like SCD(sudden cardiac death), TdP(Torsade de Pontis), but there are Non-cardiac acquired causes of QT prolongation like Diabetes, Liver Cirrhosis and Hypothyroidism.All QT prolongations though

are prone to Arrhythmia ,both the highly prevalent Atrial Fibrillation or the highly fatal TdP

Christina Voulgari^(9,16) et al in Athens Greece felt that subtle ECG changes may be the only way to diagnose Early Diabetic cardiomyopathy

Flavia Franconi⁽¹⁰⁾ et al studied sex-gender differences in Cardiovascular events in Diabetics ,while Sahil Gupta⁽¹⁹⁾ et.al felt ECG abnormalities were more in older Diabetics.

Yi-Cheng Chang⁽¹⁵⁾et.al from university of Taiwan studied Early Myocardial Repolarization Heterogenity using Magnetocardiography, and found changes in diabetics who did not have overt cardiac disease

Vinod Kumar Balkrishnan⁽¹⁸⁾et.al studied and correlated BNP and NT-BNP >600 as an indication to investigate further with 2Decho and TMT. Dr.T.Benichou⁽²⁰⁾et.al studied HRV..heart rate variability as an index of CAN. Srilata Moningi⁽²¹⁾et.al felt that ECG changes in Diabetics could have Anesthetic implications and thus overall effects on outcomes of Surgery ,and hence should be looked into carefully in pre-anesthetic assessments. Kazuaki Negishi from Hobart Australia⁽²²⁾ studied 2D echo findings of LVH and Diastolic dysfunction in Diabetics and concluded that these predict a limited cardiac Reserve .

5. Conclusions

Our study showed Resting Tachycardia and prolongation of QTc. Prolonged QTc did not correlate with age, gender, duration of Diabetes. However it did correlate with mean high fasting blood glucose. The correlation between prolonged QTc and Retinopathy (NPDR) was significant, and so also Nephropathy and 19 patients showed grade 1 Diastolic dysfunction and LVH on 2D echocardiography. Thus we conclude that about 30% of our patients did show signs of early (DCAN) Diabetic Cardiac Autonomic Neuropathy and Cardiomyopathy

Limitations of study: small sample size

6. Clinical Implications

- 1) A detailed study of the ECG, a cheap and easily available investigation must be performed in all Type 2 Diabetic patients regularly
- 2) ECG in Asymptomatic Diabetes Mellitus type 2, can predict more severe cardiovascular events, which could then be age-sively prevented
- 3) ECG in type 2 Diabetics could also be a good pre-anesthetic guide for further extensive investigations

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