

ELECTROCARDIOGRAPHIC ABNORMALITIES IN TYPE 2 DIABETES MELLITUS PATIENTS

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*1st Year PG Resident, **Associate Professor , Department of Physiology, B.J. Medical College, Ahmedabad-380016.**Abstract :-**

Background & Objectives:- Type 2 Diabetes Mellitus is a common metabolic disorder associated with the increased risk of Atherosclerotic Cardiovascular Disease (CVD), Ischaemic Heart Disease (IHD) and Diabetic Cardiomyopathy leading to increased morbidity and mortality. This study is aimed for the comparative evaluation of electrocardiographic abnormalities in Type 2 Diabetes Mellitus patients with that of healthy control group. **Methods:-** 30 Type 2 Diabetes Mellitus patients in the age group of 30 to 60 years with duration of diabetes ranging from 5 to 25 years and control group of 30 normal individuals who matched with diabetics in age and sex were taken for this study. Relevant history and consent were taken, physical examination was done & then resting ECG was recorded. **Results:-** BMI was significantly higher in Diabetics (26.63 ± 3.71) compared to controls (24.26 ± 2.74). Heart Rate (85.37 ± 11.96) & Blood Pressure (134 ± 9.35 / 82.67 ± 4.56) of Diabetics were significantly higher than Heart Rate (75.53 ± 7.7) and Blood Pressure (117.8 ± 12.15 / 78.87 ± 4.69) of controls, but not in the range of Tachycardia or Hypertension. The mean PR Interval of Diabetics (0.103 ± 0.029) is shorter than that of normal individuals (0.144 ± 0.031) & mean QT Interval of Diabetics (0.446 ± 0.042) is prolonged than that of normal individuals (0.408 ± 0.016). Both the ECG changes were Statistically Significant (P value < 0.05). Dyslipidaemia and poor Glycaemic control were found in 70% of diabetics. Among Diabetics 7% showed ST/T changes and 13% showed Left Axis Deviation(LAD).

Interpretation and Conclusion:- ECG changes in type 2 Diabetic patients were significant and are the commonest cause for sudden cardiac deaths in Diabetics. Therefore, in Type 2 Diabetic Patients regular ECG screening should be encouraged for early detection of ECG changes & preventing further morbidity & mortality due to cardiovascular complications.

Key Words: Diabetes Mellitus, Electrocardiogram, Heart rate, Blood pressure, PR interval, QT interval.

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Introduction:

Diabetes Mellitus refers to a group of common metabolic disorders that share the phenotype of hyperglycaemia and are caused by a complex interaction of genetic and environmental factors.

The prevalence of Type 2 Diabetes Mellitus is rising much more rapidly, presumably because of increasing obesity, reduced activity levels as countries become more industrialized and the aging of the population.

India continues to be home to the second largest number of adults with diabetes worldwide.(Around 77 million out of 463 million)

Type 2 Diabetes Mellitus is characterized by impaired insulin secretion, variable degree of

insulin resistance, excessive hepatic glucose production and abnormal fat metabolism.

Type 2 Diabetes Mellitus is associated with Microvascular complications(retinopathy, neuropathy, nephropathy) and Macrovascular complications(coronary heart disease, peripheral arterial disease, cerebrovascular disease, diabetic cardiomyopathy) leading to increased morbidity and mortality.

Normally glucose is metabolized via glycolysis, TCA cycle and oxidative phosphorylation but in persistently hyperglycaemic state glucose is metabolized via other pathways like Nonenzymatic glycation pathway, Polyol pathway (sorbitol), Diacylglycerol pathway (protein kinase c), Hexosamine pathway, Poly ADP ribose polymerase (PARP) pathway etc. All

these pathways lead to increase in oxidative stress, decreased NO action, vascular endothelial damage, decreased nerve blood flow leading to neuropathy and accelerated atherosclerotic changes. These pathways are responsible for various micro and macro vascular complications of Diabetes mellitus.

This study is aimed for the comparative evaluation of electrocardiographic abnormalities in Type 2 Diabetes Mellitus patients with that of healthy control group.

Material and Methods:

➤ Selection of subjects:- 30 Type 2 Diabetes Mellitus patients in the age group of 30 to 60 years with duration of diabetes ranging from 5 to 25 years and 30 normal subjects whose age and sex matched with the diabetic patients were taken for the control group in this cross sectional study. Ethical committee permission was taken for conducting this study.

▪ Inclusion Criteria :- Type 2 Diabetic patients in the age group of 30 to 60 years who are devoid of any symptoms of Cardiovascular disease.

▪ Exclusion Criteria :-

1. Patients with any cardiovascular disorders.
2. Type 2 diabetes mellitus patients with concomitant diseases or conditions affecting lipid levels like chronic liver disease and hypothyroidism.
3. Patients on drugs like oral contraceptive pills, steroids, diuretics, anti arrhythmic, anti ischaemic drugs.
4. Patients with microvascular, macrovascular and other complications of type 2 diabetes mellitus. Informed written consent and detailed history were taken. General examination and systemic examination was done and then resting ECG was recorded.

➤ Methods :-

1. Measurement of height in cm and weight in kg
2. Measurement of BMI = $\frac{wt.(kg)}{(ht.)^2(m^2)}$ (BMI-Body Mass Index)
3. Measurement of BSA by Mosteller formula (BSA- Body Surface Area)

4. Measurement of Blood Pressure :- By Mercury Sphygmomanometer via auscultatory method

5. Recording of ECG :- A 12 lead resting ECG was recorded via the ECG machine (Allengers Pisces A-103i) of all patients and control group.

Significant ECG findings like increased heart rate, shortened PR interval, prolonged QT interval, ST/T changes, left axis deviation and right axis deviation were observed in both the groups.

➤ Statistical analysis :- Data of both the groups was entered and statistically analysed by using Microsoft Excel office 2019 version. Student t test was used to compare the parameters of two groups. Standard Deviation and Mean values were obtained. P value<0.05 is considered as statistically significant.

Result:

A total sample size of 60 with 30 Diabetic patients and 30 normal individuals were included in this study.

Mean age of Diabetic patients was 45.33±9.1 years and of control group was 41.27±8.3 years.

Among the diabetics, duration of diabetes was between 5 to 25 years.

BMI was significantly higher in Diabetics 26.63±3.71 (overweight) compared to controls 24.26±2.74.

Dyslipidaemia and poor Glycaemic control(HbA1c value \geq 6.5%) were found in 70% of Diabetics.

Cardiovascular changes :-

- Heart Rate – In the present study, the mean value of heart rate in diabetic patients was found to be 85.37 beats per minute with standard deviation of 11.96 which is significantly higher (but not in range of tachycardia) when compared with mean value of heart rate in control group which is 75.53 beats per minute with standard deviation of 7.7. (p<0.05)
- Blood Pressure – Mean systolic blood pressure of diabetics was found to be 134mmhg with standard deviation of 9.35 which is significantly higher (prehypertension) than mean systolic blood

pressure of control group which was 117.8mmhg with standard deviation of 12.2. Mean diastolic blood pressure of diabetics was found to be 82.67mmhg with standard deviation of 4.56 which is significantly higher (prehypertension) than mean diastolic blood pressure of control group which was 78.87mmhg with standard deviation of 4.69. (p<0.05)

ECG changes :-

- P-R interval :- In diabetics the mean PR interval is 0.103s with standard deviation of 0.029 which is shorter than mean PR interval of normal individuals which is 0.144s with standard deviation of 0.031. The difference between two groups was statistically significant (p<0.05).
- Q-T interval :- In diabetics the mean QT interval is 0.446s with standard deviation of 0.042 which is prolonged than mean QT interval of normal individuals which is 0.408s with standard deviation of 0.016. The difference between two groups was statistically significant (p<0.05). Corrected QT interval(Qtc) was calculated by Bazett formula and it was also higher(0.53s) in diabetics compared to normal value(0.36s to 0.44s).
- Among Diabetics 7% showed ST depression and 13% showed Left Axis Deviation(LAD).

Table:1: Comparison of study variables between Diabetic patients and Control group.

	Diabetic patients		Control group		P Value
	Sample-30		Sample-30		
	Mean	±SD	Mean	±SD	
AGE	45.33	9.1	41.27	8.3	
HEART RATE	85.37	11.96	75.53	7.7	0.00036
BMI	26.63	3.71	24.26	2.74	0.00668
SBP	134	9.35	117.8	12.2	3.06E-07
DBP	82.67	4.56	78.87	4.69	0.00234

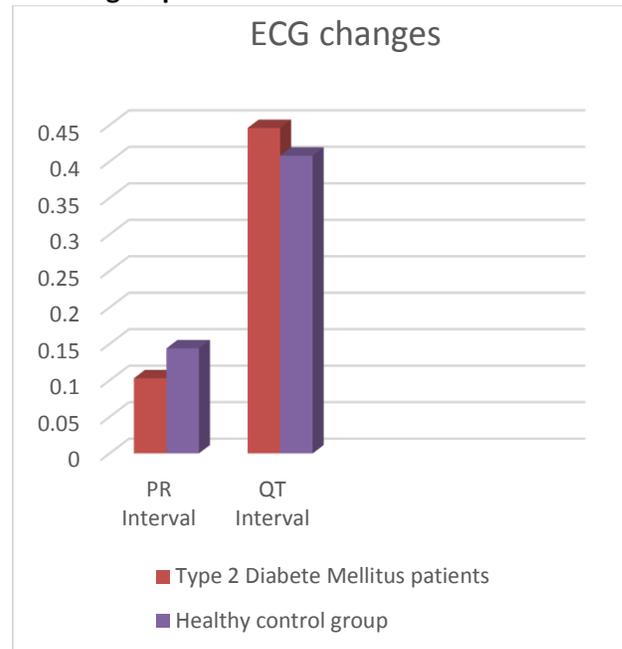
(p value<0.05 is considered statistically significant.)

Table:2 : Comparison of ECG changes- PR interval and QT interval in diabetic patients and control group.

	Diabetic patients		Control group		P value
	Mean	±SD	Mean	±SD	
PR interval	0.103	0.029	0.144	0.031	2.33E-06
QT interval	0.446	0.042	0.408	0.016	2.48E-05

(p value<0.05 is considered statistically significant.)

Graph- 1: Comparative evaluation of PR interval and QT interval of Type 2 Diabetic patients with control group.



Discussion:

- According to present study,
- Mean BMI of diabetic patients is 26.63(overweight) higher than that of normal healthy individuals which is 24.26. Dyslipidaemia and poor Glycaemic control were found in 70% of Diabetics. Obesity(central) and Dyslipidaemia are commonly associated with type 2 Diabetes Mellitus due to abnormal fat metabolism and poor glycaemic control (persistently elevated blood glucose level above 200mg/dl). Diabetic Dyslipidaemia is one of the major risk factor for cardiovascular disease characterized by high plasma triglyceride concentration, increased LDL levels and decreased HDL levels.

Similar results were also found in Sani FB, Anumah FEO(2009)⁽⁸⁾.

- Mean Heart rate of 30 diabetic patients is 85.37 that is higher compared to the control group which is 75.53. Diabetic patients are at a higher risk of developing cardiac arrhythmias which may be due to disturbance in electrical rhythm of the heart, cardiac autonomic neuropathy, vagal damage or decreased vagal tone. Resting tachycardia is seen in Diabetics.

Similar results were also found in Ewing DJ, Martyn CN(1985)⁽³⁾, Zeigler D, Zentel C (2006)⁽⁴⁾, Syeda Samina, Saima Aziz (2016)⁽¹⁰⁾.

- Blood pressure of Diabetic patients 134/82.67 (prehypertension) is also higher compared to the control group which is 117.8/78.87. Autonomic function is also affected in Type 2 Diabetes Mellitus patients which has a crucial role in maintaining Blood Pressure and Cardiac function. High free fatty acid and cholesterol level is also partly responsible for high blood pressure in diabetic patients. Combined effect of Hypertension and Diabetes Mellitus have higher incidence of cardiovascular morbidity and mortality than hypertension or diabetes mellitus alone.

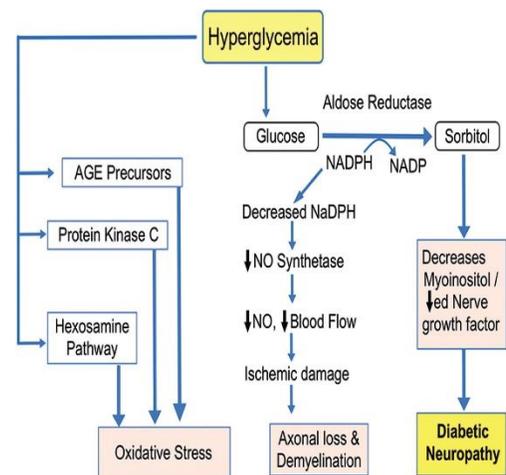
Similar results were also found in Framingham heart study(2003)⁽¹²⁾, Isfahan Diabetes prevention study(2011)⁽¹³⁾.

ECG changes :-

- PR Interval - Normally PR Interval is 0.12 to 0.20 s which represents atrial depolarization and conduction through AV node. In Diabetic patients mean PR Interval is 0.103 s which is shorter than that of control group which is 0.144 s. Shorter PR interval is due to increased Heart Rate as PR interval and Heart rate are inversely related to each other.
- QT Interval - Normally QT Interval is 0.40 to 0.43 s which represents ventricular depolarization and repolarization. QT prolongation predisposes to cardiac arrhythmias and sudden death. In diabetic patients mean QT Interval is 0.446 s which is longer than that of control group which is 0.408s. Prolonged QT interval is due to cardiac autonomic neuropathy and nonquantifiable

sympathetic imbalance.⁽¹⁵⁾ Animal studies suggest that insulin is responsible for Tyrosine kinase /Phosphoinositide 3 kinase signalling which in turn regulates the action potential duration of individual myocytes and thus the QT interval by altering multiple ion current channels in heart. In diabetic mice low insulin/PI3K signalling is the cause of the cardiac repolarization defect and QT prolongation.

Similar results were also found in Ewing DJ, Boland O, Neilson JMM(1991)⁽⁵⁾, Pappachan et al(2009)⁽⁶⁾, Ong JJ, Sarma JS(1993)⁽⁷⁾, Syeda Samina(2016)⁽¹⁰⁾.



(Pathways responsible for micro and macro vascular complications in Diabetes Mellitus)

Conclusion: A large number of the individuals who meet the current criteria for diabetes mellitus are asymptomatic and unaware that they have the disorder. Epidemiological studies suggest that Type 2 Diabetes Mellitus may be present for up to a decade before diagnosis. In asymptomatic Type 2 Diabetes Mellitus patients due to dyslipidaemia and hyperglycaemia there is increased risk of cardiovascular complications which can be diagnosed by resting 12 lead ECG. Many of the diabetes related complications can be prevented or delayed with early detection, aggressive glycaemic control with dietary modifications and exercise and medical treatment. Therefore, in Type 2 Diabetic patients regular ECG screening should be encouraged for early detection of ECG changes and preventing further morbidity and mortality due to cardiovascular complications.

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