ORIGINAL RESEARCH

Assessment of ECG Abnormalities in Patients with Type 2 Diabetes Mellitus compared to non-diabetic individuals

[1]Dr. Aviral Shah, [2]Dr. Priya Bhardwaj

[1]Assistant Professor, Department of General Medicine, Major S.D. Singh Medical College & Hospital,Farrukhabad, Uttar Pradesh, India.
[2]Assistant Professor, Department of Pathology, Major S.D. Singh Medical College & Hospital,Farrukhabad, Uttar Pradesh, India.

Corresponding Author: Dr.Priya Bhardwaj
Assistant Professor, Department of Pathology, Major S.D. Singh Medical College & Hospital,Farrukhabad, Uttar Pradesh, India.

Received: 20 April, 2021 Accepted: 10 May, 2021 Published: 27 May, 2021

ABSTRACT

Background: The most prevalent endocrine condition impacting people worldwide is diabetes. Worldwide, the prevalence of this illness is still increasing. The present study was conducted to assess ECG abnormalities in patients with type 2 diabetes mellitus compared to non-diabetic individuals.**Materials & Methods:**60 diabetes and 60 non-diabetes subjects of both genders were selected. Every participant had five milliliters of venous blood drawn. Electrocardiography (ECG), lipid profiles (fasting and postprandial), fasting and postprandial blood sugar, and glycosylated hemoglobin (HbA1c) were performed on each participant.**Results:** Group I had 32 males and 28 females and group II had 40 males and 30 females. The mean FBS was 203.6 and 86.4, HbA1c was 8.5 and 5.2, total cholesterol was 170.4 and 169.8, triglycerides was 185.2 and 124.6, LDL was 92.4 and 100.2 and HDL was 40.2 and 52.8 in group I and II respectively. The difference was significant (P< 0.05). Out of 60 diabetes patients, ST depression & T wave inversion was found in 24, 10 had LAE, 6 had LVH, 4 had RBBB and 2 had LBBB.**Conclusion:** Patients with T2DM had higher prevalence of ECG abnormality.

Keywords: Diabetes, ECG, T wave inversion

INTRODUCTION

The most prevalent endocrine condition impacting people worldwide is diabetes. Worldwide, the prevalence of this illness is still increasing. According to estimates from 2014, 9% of people over the age of 18 worldwide had diabetes. One According to World Health Organization (WHO) projections, diabetes will rank as the seventh most common cause of death by 2030.[1] By 2035, it is predicted that 109 million people in India will have diabetes, making it the diabetes capital of the world. Diabetes mellitus has been acknowledged as a known risk factor for cardiovascular morbidity and mortality for a number of decades. Diabetes is a significant modifiable risk factor for coronary artery disease (CAD), which has a complex etiology and multiple contributing risk factors.[2]

ECG abnormalities are widespread in people with type 2 diabetes, according to studies. Even those with a history of CVD exhibit this. ECG abnormalities are very common and are caused by traditional cardiovascular risk factors.[3] When evaluating CVD in patients with type 2 diabetes, ECG anomalies can be a valuable tool. However, there is little data to support ECG abnormalities in type 2 diabetes.[4] Catastrophic cardiac events may be avoided if type 2 diabetes patients with asymptomatic coronary artery disease are identified early. However, a resting electrocardiogram (ECG) and a regular, comprehensive clinical examination might not be able to identify coronary artery disease.[5] Therefore, advanced non-invasive cardiovascular

testing have to be suggested for the early identification of asymptomatic CAD in these individuals. The most essential screening test for substantial CAD is still the exercise electrocardiograph, which can detect most patients who are likely to have considerable ischaemia during their regular activities.[6]

AIM AND OBJECTIVES

Aim

To assess and compare the prevalence and types of electrocardiographic (ECG) abnormalities in patients with Type 2 Diabetes Mellitus (T2DM) versus non-diabetic individuals, and to evaluate associated biochemical parameters.

Objectives

1. **Gender-wise Distribution**: To analyze the gender distribution among T2DM patients (Group I) and non-diabetic controls (Group II).
2. **Biochemical Parameters Assessment**: To measure and compare fasting blood sugar (FBS), HbA1c, total cholesterol, triglycerides, LDL, and HDL levels between the two groups.
3. **ECG Abnormalities Evaluation**: To identify and quantify specific ECG changes in T2DM patients, including:
   - ST depression & T wave inversion
   - Left Atrial Enlargement (LAE)
   - Left Ventricular Hypertrophy (LVH)
   - Right Bundle Branch Block (RBBB)
   - Left Bundle Branch Block (LBBB)
4. **Statistical Significance**: To determine the statistical significance of differences observed in biochemical and ECG parameters between the two groups.

MATERIALS AND METHODS

Study Design

This study was an observational case-control study aimed at evaluating ECG abnormalities in patients with Type 2 Diabetes Mellitus (T2DM) compared to non-diabetic individuals.

Study Population

The study comprised 120 participants, divided into two groups:

- **Group I**: 60 individuals diagnosed with Type 2 Diabetes Mellitus and
- **Group II:**60 non-diabetic individuals as the control group. Both male and female participants were included in the study.

Study Place

The study was conducted in the Department of General Medicine,Major S.D. Singh Medical College & Hospital,Farrukhabad, Uttar Pradesh, Indiain collaboration with Department of Pathology, Major S.D. Singh Medical College & Hospital,Farrukhabad, Uttar Pradesh, India, where participants were recruited from outpatient and inpatient departments.

Study Duration

The study was conducted over a period of one years and six months, from June 2019 to December 2020, including patient recruitment, follow-up, and data analysis.

Inclusion Criteria

1. Patients diagnosed with Type 2 Diabetes Mellitus as per the American Diabetes Association (ADA) criteria.
2. Age group: 35-70 years.
3. Both male and female participants.
4. Non-diabetic individuals with no history of diabetes were included as controls.
5. Participants willing to provide written informed consent.

Exclusion Criteria

1. Patients with a history of Type 1 Diabetes Mellitus.
2. Individuals with pre-existing cardiovascular diseases such as myocardial infarction, ischemic heart disease, or arrhythmias.
3. Patients on medications that significantly affect ECG readings.
4. Pregnant women and lactating mothers.
5. Individuals with chronic kidney disease or any other major systemic illness.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee before the commencement of the study. All participants provided written informed consent after being explained the purpose, procedure, risks, and benefits of the study. Confidentiality of participants' data was strictly maintained.

Study Procedure

- Demographic data including name, age, and gender were recorded.
- Venous blood samples (5 mL) were drawn from each participant after overnight fasting for biochemical analysis.
- Fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycosylated hemoglobin (HbA1c), and lipid profile (total cholesterol, LDL, HDL, triglycerides) were measured using standard laboratory techniques.
- ECG was performed using a 12-lead electrocardiograph, and abnormalities were assessed based on standard criteria.

- Data obtained from diabetic and non-diabetic individuals were compared and analyzed statistically.
- Pathologists play a crucial role in several key areas in present study:

1. **Biochemical Analysis and Interpretation**

- Pathologists are responsible for overseeing the analysis of biochemical parameters such as fasting blood sugar (FBS), HbA1c, total cholesterol, triglycerides, LDL, and HDL levels. They ensure the accuracy and reliability of these laboratory results, which are essential for correlating metabolic control with ECG findings. Their expertise aids in interpreting how these biochemical markers relate to cardiovascular risks in T2DM patients.

2. **Quality Assurance and Laboratory Oversight:** Ensuring the integrity of laboratory processes is a fundamental responsibility of pathologists. They implement and monitor quality control measures to maintain the precision and accuracy of laboratory tests. This oversight is vital for the validity of the study's findings, as it guarantees that the data collected is both reliable and reproducible.
3. **Data Interpretation and Clinical Correlation:** Beyond generating laboratory results, pathologists contribute to interpreting these findings in a clinical context. They collaborate with clinicians to correlate laboratory data with ECG abnormalities, providing insights into the pathophysiological mechanisms linking T2DM with cardiovascular complications. This interdisciplinary approach enhances the understanding of disease processes and informs patient management strategies.

Outcome Measures:

- Prevalence of ECG abnormalities among T2DM patients versus non-diabetic controls.
- Association between glycemic control (HbA1c) and ECG changes.
- Correlation between lipid profile and ECG abnormalities.

StatisticalAnalysis: Data were analyzed using statistical software. Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as percentages. Comparisons between groups were made using the independent t-test for continuous variables and the chi-square test for categorical variables. A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1:Gender wise distribution of patients

Groups	Group I	Group II
Status	Type 2 DM	Control
M:F	32:28	30:30

Table 1 shows that group I had 32 males and 28 females and group II had 40 males and 30 females.

Table 2:Assessment of biochemical parameters

Parameter	Group I (Diabetic) Mean ± SD	Group II (Non-Diabetic) Mean ± SD	P-value
Fasting Blood Sugar (mg/dL)	203.6 ± 40.7	86.4 ± 10.0	0.01
HbA1c (%)	8.5 ± 1.3	5.2 ± 0.5	0.03
Total Cholesterol (mg/dL)	170.4 ± 23.4	169.8 ± 20.0	0.15
Triglycerides (mg/dL)	185.2 ± 76.7	124.6 ± 30.0	0.01
LDL Cholesterol (mg/dL)	92.4 ± 20.7	100.2 ± 15.0	0.72
HDL Cholesterol (mg/dL)	40.2 ± 11.0	52.8 ± 12.0	0.02

Table 2, figure I shows thatFasting Blood Sugar (FBS) in Group I exhibited significantly higher FBS levels, averaging 203.6 mg/dL, compared to 86.4 mg/dL in Group II (P = 0.01). This indicates poor glycemic control among the diabetic participants.The mean glycosylated Hemoglobin (HbA1c)level in Group I was 8.5%, reflecting chronic hyperglycemia, whereas Group II had a mean of 5.2% (P = 0.03), within the normal range.Total Cholesterol in both groups had similar levels, with Group I at 170.4 mg/dL and Group II at 169.8 mg/dL (P = 0.15), indicating no significant difference.Triglycerides in Group I had elevated triglyceride

levels averaging 185.2 mg/dL, significantly higher than the 124.6 mg/dL observed in Group II (P = 0.01).Low-Density Lipoprotein (LDL) levels were comparable between the groups, with Group I at 92.4 mg/dL and Group II at 100.2 mg/dL (P = 0.72).High-Density Lipoprotein in Group I had lower HDL levels, averaging 40.2 mg/dL, compared to 52.8 mg/dL in Group II (P = 0.02), suggesting a higher cardiovascular risk for the diabetic group.

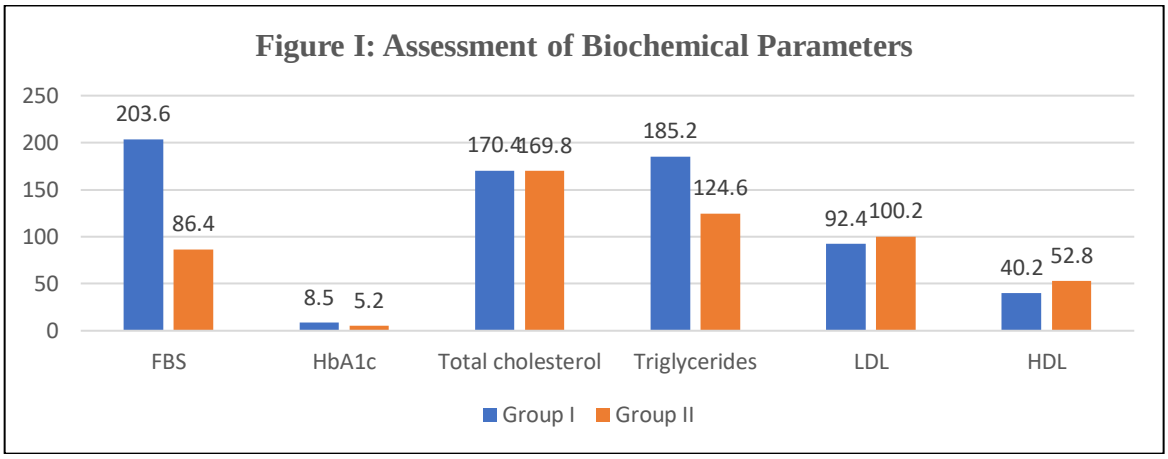

Table 3: Assessment of ECG changes in diabetes patient

ECG changes	Number	P value
ST depression & T wave inversion	24	0.02
LAE	10	
LVH	6	
RBBB	4	
LBBB	2	

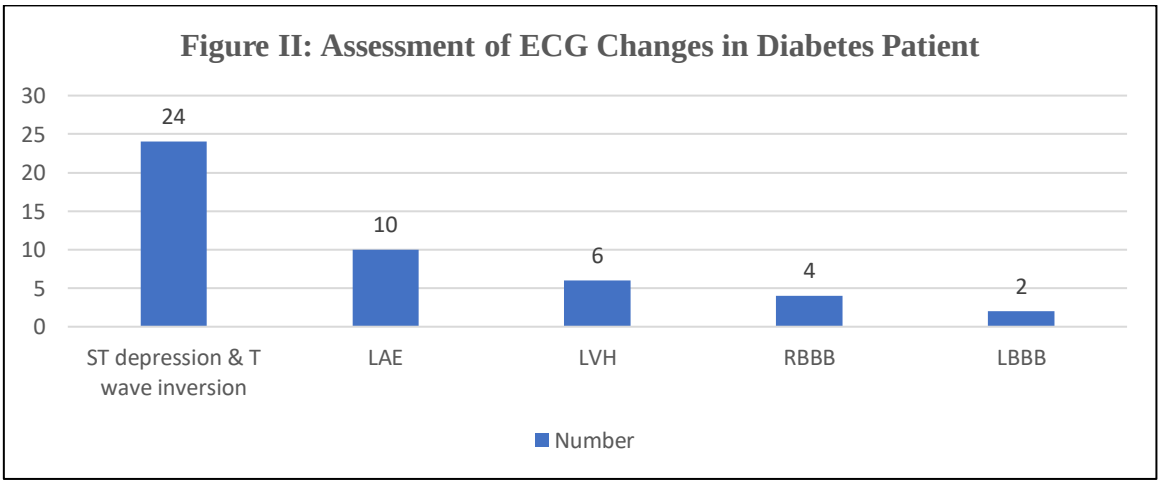

Table 3, figure IIshows that out of 60 diabetes patients, ST depression & T wave inversion was found in 24, 10 had LAE, 6 had LVH, 4 had RBBB and 2 had LBBB. The difference was significant (P< 0.05).

DISCUSSION

Patients with diabetes have a higher risk of coronary heart disease and are frequently hyperlipidemic. A prolonged, exacerbated postprandial state is the cause of the elevated cardiovascular mortality linked to Type 2 DM.[7] When it comes to creating atherosclerosis problems in Type 2 diabetics, the aberrant lipid profile in the postprandial state is more important than the bad lipid profile in the fasting state.[8] Over the past forty years, the prevalence of diabetes mellitus in India has skyrocketed due to rapid socioeconomic development, demographic changes, and increasing susceptibility for Indian

persons.[9,10]The present study was conducted to assess ECG abnormalities and treadmill test findings in patients with type 2 diabetes mellitus.
We found that group I had 32 males and 28 females and group II had 40 males and 30 females. ECG alterations in asymptomatic Type 2 DM patients were assessed by Gupta et al.[11] The study included fifty participants who were matched for age and sex. A protocol was established to document pertinent results from the physical examination and history. Gender, age, smoking, physical activity, waist circumference, body mass index (BMI), and blood pressure were the factors that were examined. The ECG was recorded while at rest. Patients with asymptomatic diabetes ranged in age from 25 to 75 years, with a mean age of 50.3±11.90 years. In this study, 26% of asymptomatic diabetics had aberrant ECG readings, while none of the control group did. Seventy percent of patients with ECG changes had poor glycaemic control, elevated triglyceride, and decreased HDL levels; the majority of silent individuals with ECG changes had diabetes mellitus for five to ten years. Left Atrial Enlargement (LAE), Left Ventricular Hypertrophy (LVH), Left Bundle Branch Block (LBBB), and Right Bundle Branch Block (RBBB) were the most frequently seen abnormalities, followed by ST-T alterations.
The diabetic group exhibited significantly elevated FBS levels (203.6 ± 40.7 mg/dL) compared to the non-diabetic group (86.4 ± 10.0 mg/dL), with a P-value of 0.01. According to the World Health Organization, an FBS level of ≥126 mg/dL is diagnostic for diabetes mellitus, underscoring the hyperglycemic state observed in the diabetic cohort.[12]
The diabetic group's mean HbA1c was 8.5 ± 1.3%, significantly higher than the non-diabetic group's 5.2 ± 0.5% (P = 0.03). The American Diabetes Association recommends an HbA1c level of ≥6.5% for the diagnosis of diabetes, indicating poor glycemic control in the diabetic participants.[13]
No significant difference was observed between the diabetic (170.4 ± 23.4 mg/dL) and non-diabetic (169.8 ± 20.0 mg/dL) groups (P = 0.15), suggesting that total cholesterol alone may not distinguish between these populations.The diabetic group had significantly higher triglyceride levels (185.2 ± 76.7 mg/dL) compared to the non-diabetic group (124.6 ± 30.0 mg/dL) (P = 0.01). Elevated triglycerides are a component of diabetic dyslipidemia and are associated with an increased risk of cardiovascular disease. A longitudinal study by Han et al. (2016) found that each 10 mg/dL increase in triglyceride levels significantly increased the risk of developing diabetes by 4%.[14]
LDL levels were slightly lower in the diabetic group (92.4 ± 20.7 mg/dL) than in the non-diabetic group (100.2 ± 15.0 mg/dL), but this difference was not statistically significant (P = 0.72).HDL levels were significantly lower in the diabetic group (40.2 ± 11.0 mg/dL) compared to the non-diabetic group (52.8 ± 12.0 mg/dL) (P = 0.02). Low HDL is a known risk factor for atherosclerotic cardiovascular disease. The Beijing Longitudinal Study of Aging (2021) reported that lower HDL cholesterol levels are associated with an increased risk of developing T2DM.[15]
We found that out of 60 diabetes patients, ST depression & T wave inversion was found in 24, 10 had LAE, 6 had LVH, 4 had RBBB and 2 had LBBB. The frequency of ECG anomalies and their cross-sectional correlations with cardiovascular risk factors in individuals with type 2 diabetes were examined by Harms et al.[13] The Minnesota Classification was used to categorize and classify ECG abnormalities into several kinds. Both the whole population (n = 8068) and the subset of individuals without a history of CVD (n = 6494) had their prevalences determined. ECG abnormalities were minor (16.0%) or substantial (13.1%) in around one-third of the group. About 25% of people without a history of CVD showed minor (14.9%) or major (9.1%) ECG abnormalities, while the prevalence was 27.5% and 39.6%, respectively, among those with hypertension and extremely high CVD risk. Abnormalities in the ECG were regularly and strongly linked to known risk factors for CVD.

LIMITATIONS OF THE STUDY

- The sample size was relatively small, which may limit the generalizability of findings.
- The study was conducted in a single institution, which may introduce selection bias.

- The cross-sectional nature of the study does not establish causality between diabetes and ECG abnormalities.
- The influence of factors such as physical activity, diet, and medication adherence was not assessed.
- Long-term follow-up was not conducted to assess the progression of ECG abnormalities over time.

CONCLUSION

Authors found that patients with T2DM had higher prevalence of ECG abnormality.The study indicates that patients with Type 2 Diabetes Mellitus exhibit a higher prevalence of ECG abnormalities compared to non-diabetic individuals. Notably, ST depression and T wave inversion were observed in 24 out of 60 diabetic patients, with a statistically significant difference (P=0.02). Additionally, diabetic patients demonstrated significantly elevated levels of FBS, HbA1c, and triglycerides, along with reduced HDL levels, compared to controls. These findings underscore the importance of regular ECG monitoring and comprehensive cardiovascular risk assessment in T2DM patients to facilitate early detection and management of potential cardiac complications.

REFERENCES

1. Gandiah P, Nandyala V, Srinivas B, Reddy BRK, Farheen N, Reddy GY. A study to show postprandial hyper triglyceridemia as a risk factor for macrovascular complications in type 2 DM. International Journal of Contemporary Medical Research 2016;3(6):15871590.
2. Kundu D, Roy A, Mandal T, Bandyopadhyay U, Ghosh E, Ray D. Relation of microalbuminuria to glycosylated hemoglobin and duration of type 2 diabetes. Nige J Clinic Pract. 2013;16(2):216-20.
3. Varghese A, Deepa R, Rema M, Mohan V. The prevalance of microalbuminuria in Type 2 diabetes mellitus at a diabetes center in southern India. Postgrad Med J. 2001; 77:399-402.
4. Kumar JG, Abhilash K, Saya RP, Tadipaneni N, Bose J M. A retrospective study on epidemiology of hypoglycemia in Emergency Department. Indian J EndocrMetab2017; 21:119- 24.
5. Sarwar CN, P. Gao, et al. Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies Lancet. 2010; 375: 2215-2222,
6. Peter P. Harms, Amber A. van der Heijden, Femke Rutters, Hanno L. Tan, Joline W.J. Beulens, Giel Nijpels et al. Prevalence of ECG abnormalities in people with type 2 diabetes: The Hoorn Diabetes Care System cohort. Journal of Diabetes and its Complications. 2021; 35 (2):107810.
7. Naz S, Sadaruddin A, Khannum A, Osmani R. Frequency of microalbuminuria in diabetic patients of Islamabad and Rawalpindi. Pak J Med Res. 2007;46(3):70-4.
8. Parving HH, Oxenball B, Svendsen PA, Christiansen J S and Andersen AR. Early detection of patients at risk of developing diabetic nephropathy: a longitudinal study of urinary albumin excretion". Acta endocrinal (Copenh). 1982; 100:550-5.
9. Raghavendra S, Dutta TK, Tumbanatham A, Sethuraman KR, Jayasingh K, Pyadala N. Fasting and postprandial lipid profile in type 2 diabetes mellitus: a comparative study. International Journal of Contemporary Medicine Surgery and Radiology. 2018;3(1):161-5.
10. Viberti GC, Hill Rd, Jarrett RJ, Argyropoulos A, Mahmud U, Keen H. Microalbuminuria as a predictor of clinical nephropathy in insulin dependent diabetes mellitus. Lancet. 1982; 1:1430-2.
11. Gupta S, Gupta RK, KulShReStha M, Chaudhary RR. Evaluation of ECG abnormalities in patients with asymptomatic type 2 diabetes mellitus. Journal of clinical and diagnostic research: JCDR. 2017 Apr;11(4): 39.
12. World Health Organization. (1999). Definition, diagnosis and classification of diabetes mellitus and its complications: Report of a WHO Consultation. Part 1: Diagnosis and classification of diabetes mellitus.
13. American Diabetes Association. (2019). 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes—2019. Diabetes Care, 42(Supplement 1), S13–S28.
14. Han, C., et al. (2016). Triglyceride levels and risk of type 2 diabetes mellitus: a longitudinal large study. Journal of Investigative Medicine, 64(6), 1087–1092.
15. Zhang, Y., et al. (2021). Association between high-density lipoprotein cholesterol and type 2 diabetes mellitus among Chinese: the Beijing longitudinal study of aging. Lipids in Health and Disease, 20(1), 1–9.
16. Harms PP, van der Heijden AA, Rutters F, Tan HL, Beulens JW, Nijpels G, Elders P. Prevalence of ECG abnormalities in people with type 2 diabetes: The Hoorn Diabetes Care System cohort. Journal of Diabetes and its Complications. 2021 Feb 1;35(2):107810.