A study of electrocardiographic and 2D echocardiographic changes in type 2 diabetes mellitus patients without cardiovascular symptoms

Vasudha V. Sardesai, Hemant T. Kokane, Souradip Mukherjee, Shashikala A. Sangle

Department of Medicine, B. J. Government Medical College and Sassoon General Hospital, Pune, Maharashtra, India

Abstract

Context: Cardiovascular diseases in diabetic patients are mostly asymptomatic due to autonomic neuropathy. Many patients with left ventricular dysfunction remain undiagnosed and untreated until advance disease causes disability. This delay could be avoided if screening techniques are used to identify left ventricular dysfunction in its preclinical phase. Aims: This study was undertaken to find out the incidence of electrocardiographic (ECG) and 2D echocardiographic (2 D Echo) abnormalities in diabetic patients without cardiovascular symptoms. The correlation of control of diabetes with these abnormalities was also studied. Settings and Design: A hospital-based, cross-sectional observational study. Methods and Material: Type 2 diabetic patients (outpatient and indoor) without cardiovascular symptoms like palpitations, chest pain, syncope, and breathlessness were included in the study. Their ECG and 2D Echo findings were noted and correlated with their blood sugar levels. Statistical Analysis Used: Chi-square test. Results: Type 2 diabetic patients without cardiovascular symptoms had significant abnormal findings on ECG and 2D Echo. Control of postprandial blood sugar level was of primary importance to prevent cardiovascular abnormalities. Conclusions: Type 2 diabetics without cardiovascular symptoms must be screened for cardiovascular abnormalities so that early interventions can be done to prevent further progression to symptomatic cardiovascular abnormalities. There is a significant number of people having normal ECG but abnormal 2D Echo and vice versa, so not only ECG but also 2D Echo should be done to predict cardiovascular risk in type 2 diabetic patients without cardiovascular symptoms.

Keywords: Asymptomatic diabetics, echocardiogram, electrocardiogram

Introduction

Diabetes Mellitus (DM) is a chronic disease caused by inherited or acquired deficiency in the production of insulin or by insulin resistance. DM has attained epidemic proportions in India and high proportion of patients seen by primary care physicians are diabetic. India has an estimated 77 million people with diabetes and after China, it is the second most affected country in the world. The leading cause of morbidity and mortality in patients with type 2 DM is cardiovascular disease, and these patients have a high risk of coronary artery disease that is many times silent. Premature atherosclerosis due to endothelial dysfunction, vascular effects of advanced glycation products, untoward effects of circulating free fatty acids and increased systemic inflammation is seen with diabetes. This results into coronary artery disease, heart failure or arrhythmias due to diabetic cardiomyopathy. Most diabetic cardiovascular diseases are
asymptomatic (silent or painless ischemia) due to autonomic neuropathy. Many patients with left ventricular dysfunction remain undiagnosed and untreated until advanced disease causes disability or death. This is the biggest challenge for primary physicians. This delay can be avoided if screening techniques are used to identify left ventricular dysfunction in its preclinical phase.\(^6\) Hence, a study was undertaken to find out the incidence of electrocardiographic (ECG) and 2 dimensional echocardiographic (2D echo) abnormalities in diabetic patients without cardiovascular symptoms. The correlation of control of diabetes with these abnormalities was also studied.

**Subjects and Methods**

It was a hospital-based, cross-sectional observational study in a tertiary care center and teaching institute. Institutional ethics committee clearance was taken (ref: 1218233-233). One hundred and thirty adult patients of type 2 DM coming to tertiary care hospital, either for out-patient advice or indoor treatment and who were willing to participate in the study, were included. These patients were without cardiovascular symptoms like palpitations, chest pain, blackout, or breathlessness. Their ECG and 2D echo findings were noted and correlated with their blood sugar levels.

Patients with any cardiovascular symptom or with previous diagnosis of cardiovascular disease were excluded from the study.

**Results**

In the present study, a total of 130 diabetic patients without cardiovascular symptoms were studied. The mean age of patients was 56.3 ± 8.60 and maximum number of cases (52.3%) were in the age group between 51 and 60 years of age. Males were 58.5%, whereas females were 41.5%. Patients with duration of diabetes more than 5 years were 39.2%. Epidemiological characteristics such as sex, age, and duration of diabetes showed no correlation with ECG findings. (p = 0.215 with age), (p = 0.215 with sex), (p = 0.430 with duration of diabetes). Characteristics such as sex and duration of diabetes showed no correlation with 2D Echo findings. (p = 0.724 and P = 0.067, respectively), but there was significant correlation between abnormal 2D Echo findings and age (p = 0.01). 2D Echo abnormalities increase with increasing age.

ECG abnormalities showed significant correlation with random and postprandial blood sugar, but not with fasting blood sugar [Table 1]. 2D Echo abnormalities showed significant correlation with random, fasting, and postprandial blood sugar levels [Table 2].

About 46.2% of total cases had normal findings and 53.8% of total cases had abnormal findings on 2D Echo. Among patients with abnormal 2D echo, 48.5% of cases had diastolic dysfunction, 46.9% had left ventricular hypertrophy or LVH, 11.5% systolic dysfunction, 13.8% valvular dysfunction, and 1.5% regional wall motion abnormality.

About 25 cases out of 65 having abnormal 2D Echo had normal ECGs (38.5%) and 24 out of 69 (34.8%) having abnormal ECGs had normal 2D Echo [Table 3].

**Discussion**

In our study, 2 D Echo abnormalities showed significant correlation with age similar to the study by Khaire et al.\(^9\) where there is a linear progression of 2 D echocardiographic abnormality like diastolic dysfunction with the increasing age. About 53.1% of patients had abnormal electrocardiographic findings in our study. In the above study, 40% patients had ECG abnormalities.

ECG abnormalities showed significant correlation with random and postprandial blood sugar, though correlation with fasting

**Table 1: Correlation of ECG findings with blood sugar levels**

| Blood sugar | Value | ECG | Total | \(P\) |
|-------------|-------|-----|-------|------|
| Random      | Normal| 32  | 22    | 54   | 0.021* |
|             | Abnormal| 29  | 47    | 76   |
| Fasting     | Normal| 33  | 28    | 61   | 0.159  |
|             | Abnormal| 28  | 41    | 69   |
| Post prandial| Normal| 22  | 12    | 34   | 0.018* |
|             | Abnormal| 39  | 57    | 96   |

*Significant (\(P<0.05\)); Chi-square test used

**Table 2: Correlation of 2D echocardiographic findings with blood sugar levels**

| Blood sugar | Value | 2D Echo | Total | \(P\) |
|-------------|-------|---------|-------|------|
| Random      | Normal| 33     | 21    | 54   | 0.005* |
|             | Abnormal| 27  | 49    | 76   |
| Fasting     | Normal| 38     | 23    | 61   | 0.001* |
|             | Abnormal| 22  | 47    | 69   |
| Post prandial| Normal| 21   | 13    | 34   | 0.045* |
|             | Abnormal| 39  | 57    | 96   |

*Significant (\(P<0.05\)); Chi-square test used

**Table 3: Correlation of electrocardiographic findings with 2D echocardiographic findings**

| ECG findings | 2D Echo | Total | \(P\) |
|--------------|---------|-------|------|
| Normal       | 36      | 25    | 61   | 0.008* |
| Abnormal     | 24      | 45    | 69   |
| Total        | 60      | 70    | 130  |

*Significant (\(P<0.05\)); Chi-square test used
blood sugar was not significant. It was also reflected in the Diabetes Intervention Study\(^9\) involving 1139 newly diagnosed Type 2 diabetic patients of 30–55 years of age. In this study, 2 hours' postprandial blood glucose was associated with higher rates of myocardial infarction and mortality. This correlation was not seen with fasting blood sugar.

In another multivariate regression analysis, post prandial but not fasting blood glucose was an independent predictor of total mortality.\(^7\)

However, 2D Echocardiographic abnormalities showed significant correlation with random, fasting, and postprandial blood sugar similar to a study by Hasan et al.\(^8\) where patients with 2D echocardiographic abnormalities like left ventricular diastolic dysfunction had higher levels of fasting blood glucose and postprandial glucose in comparison to those with preserved left ventricular diastolic function.

Older the age group, more was the diastolic dysfunction in that study. Similar results were found by Patil et al.\(^9\) who concluded that diastolic dysfunction was significantly higher in more than 45 years age group as compared to less than 45 years (p value < 0.05).

In a study by Roy et al.\(^10\) poor glycemic status, that is, high fasting blood sugar (FBS) (p = 0.007) and postprandial blood sugar (PPBS) (p = 0.001), was associated with left ventricular systolic dysfunction on 2D echocardiography. In this study among 226 patients (151 males, 75 females), it was seen in 29.2% patients, but in our study only 11.5% had systolic dysfunction.

In our study, 46.9% had Left Ventricular Hypertrophy or LVH. Valensi, in an African diabetic population, found LVH in 33.6% and hypokinesia in 6.1% of study population.\(^11\) The patients he included had one or more CVD risk factors and he used rest echocardiography and myocardial scintigraphy for assessment. In a study by Muddha et al.\(^12\) prevalence of LVH was up to 19.3% and regional wall motion abnormalities were present among 4.0% of the patients as compared to 1.5% in our study. The lower prevalence of LVH in the above study was probably because of maximum number of patients having duration of diabetes less than 2 months, while our study had higher number of patients with duration more than 5 years.

As compared to previous reports, left ventricular diastolic dysfunction (LVDD) is much more common in subjects with well-controlled type 2 diabetes who have no clinically detectable heart disease.\(^13\) The high prevalence of this phenomenon suggests that screening for LVDD in type 2 diabetes should be done regularly.\(^13,14\) More the age more will be the 2D echocardiographic abnormalities. So, it is very important to screen for cardiovascular abnormalities through 2D echocardiography as the person grows older. 2D echocardiography is cost-effective and non-invasive diagnostic technique. It provides useful information regarding cardiac hemodynamic and function.\(^15\)

**Conclusions**

Type 2 diabetic patients seen by primary physicians may have silent cardiovascular disease of long duration. Hence, these patients in spite of having no cardiovascular symptoms should be screened for cardiovascular abnormalities, so that early interventions can be done to prevent further progression to symptomatic cardiovascular abnormalities.

Blood sugar control, post prandial more than fasting, is of primary importance to prevent cardiovascular abnormalities and prevent cardiovascular morbidity and mortality.

There is a significant number of people having normal ECG but abnormal 2D Echo and vice versa, so not only ECG but also 2D Echo should be added to it to predict cardiovascular risk in type 2 diabetic patients without cardiovascular symptoms.

**Take home message**

ECG and 2D Echo are two modalities of investigations which are non-invasive and easily available for family physicians and primary care providers and they should make full use of these cost-effective modalities for diagnosis of cardiovascular disease in asymptomatic diabetic patients.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Powers AC, Stafford JM, Rickels MR. Harrison’s Principles of Internal Medicine. 20th ed. New York: McGraw Hill Education; 2018.

2. Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes research and clinical practice. 2011;94:311-21.

3. Ramachandran A. Know the signs and symptoms of diabetes. Indian J Med Res 2014;140:579-81.

4. Jia G, Hill MA, Sowers JR. Diabetic cardiomyopathy: An update of mechanisms contributing to this clinical entity. Circ Res 2018;122:624-38.

5. Khair U, Shinde S, Bhattacharya M. A study of ECG and 2D echo findings in type-II diabetes mellitus patients. Int J Sci Technol Res 2018;7:327-34.

6. Hanefeld M, Fischer S, Julius U, Schulze J, Schwanebeck U, Schmechel H, et al. Risk factors for myocardial infarction and death in newly detected NIDDM: The diabetes intervention study, 11-year follow-up. Diabetologia 1996;39:1577-83.

7. Bonora E, Muggeo M. Postprandial blood glucose as a risk factor for cardiovascular disease in type II diabetes: The epidemiological evidence. Diabetologia 2001;44:2107-14.

8. Ayman KH, Mahmoud AA, Eman AA, Marwa S, Mona MS, Yehia TK. Correlation between left ventricular diastolic dysfunction and dyslipidaemia in asymptomatic patients.
with new-onset type 2 diabetes mellitus. Egypt J Intern Med 2021;33:1-1.

9. Patil VC, Shah KB, Vasani JD, Shetty P, Patil HV. Diastolic dysfunction in asymptomatic type 2 diabetes mellitus with normal systolic function. J Cardiovasc Dis Res 2011;2:213-22.

10. Roy S, Kamal R, Kumar B, Khapre M, Bairwa M. Systolic dysfunction in asymptomatic type 2 diabetic patients, a harbinger of microvascular complications: A cross-sectional study from North India. Diab Vasc Dis Res 2020;17:1479164120944134. doi: 10.1177/1479164120944134.

11. Nguyen MT, Cosson E, Valensi P, Poignard P, Nitenberg A, Pham I. Transthoracic echocardiographic abnormalities in asymptomatic diabetic patients: Association with microalbuminuria and silent coronary artery disease. Ann Cardiol Angeiol (Paris) 2013;62:3-7.

12. Muddu M, Muteti E, Mondo C. Prevalence, types and factors associated with echocardiographic abnormalities among newly diagnosed diabetic patients at Mulago Hospital. Afr Health Sci 2016;16:183-93.

13. Garneau C. Diastolic dysfunction in normotensive men with well controlled type 2 diabetes mellitus: Importance of maneuvers in echocardiographic screening for preclinical diabetic cardiomyopathy. Diabetes Care 2001;24:5-10.

14. Faden G, Faganello G, De Feo S, Berlingieri N, Tarantini L, Di Lenarda A, et al. The increasing detection of asymptomatic left ventricular dysfunction in patients with type 2 diabetes mellitus without overt cardiac disease: Data from the SHORTWAVE study. Diabetes Res Clin Pract 2013;101:309-16.

15. Fagiry MA, Hassan IA, Mahmoud MZ. Two-dimensional echocardiography in the diagnosis of ischemic heart disease. J Radiat Res Appl Sci 2019;12:177-85.