Section: Medicine

Original Research Article

RELATION OF GLYCEMIC STATUS WITH LEFT VENTRICULAR FUNCTION IN PATIENTS WITH TYPE 2 DIABETES MELLITUS: A CROSS-SECTIONAL OBSERVATIONAL STUDY FROM NORTH-EAST INDIA

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) significantly contributes to global cardiovascular morbidity and death. Diabetic cardiomyopathy, defined by myocardial failure without evident coronary artery disease or hypertension, frequently presents first as left ventricular diastolic dysfunction (LVDD). The relationship between long-term glycemic management and left ventricular function is little investigated in populations from North-East India. **Objectives:** To assess left ventricular systolic and diastolic function in individuals with T2DM by Doppler echocardiography, and to examine the correlation between glycemic management, as shown by HbA1c levels, and left ventricular dysfunction.

Materials and Methods: This hospital-based cross-sectional observational study was carried out over two years in a tertiary care teaching hospital in Tripura. A total of 384 adult patients with T2DM, devoid of established coronary artery disease or structural heart disease, were included. We looked at clinical data, metabolic tests, and echocardiographic markers such ejection fraction (EF), E/A ratio, and mitral annular plane systolic excursion (MAPSE). We looked at the statistical links between HbA1c and heart parameters.

Results: The average age of the people who took part was 58.26 ± 16.48 years. Fifty-eight percent of patients had LVDD. Patients with LVDD had a mean HbA1c level that was much higher than those without LVDD (10.78% vs 8.95%). HbA1c had a moderate negative connection with EF ($r = -0.32$, $p = 0.001$) and a weak negative correlation with the E/A ratio ($r = -0.25$, $p = 0.005$). Older age, a longer history of diabetes, and poor glycemic control were all strongly linked to a higher rate of LVDD.

Conclusion: Poor glycemic management is significantly linked to left ventricular diastolic dysfunction in individuals with T2DM. Regular echocardiographic screening may help find subclinical heart problems early and allow for quick treatment to lower the risk of heart disease.

Keywords: Type 2 diabetes mellitus, HbA1c, left ventricular diastolic dysfunction, diabetic cardiomyopathy, echocardiography.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) has become one of the most important public health problems in the world in the 21st century. T2DM is marked by insulin resistance and worsening β-cell dysfunction, and it can lead to a wide range of problems with small and large blood vessels. Cardiovascular disease continues to be the primary cause of morbidity and mortality in diabetes people.[1]

Diabetes independently influences cardiac shape and function, resulting in a unique clinical condition termed diabetic cardiomyopathy, in addition to promoting accelerated atherosclerosis and coronary

artery disease. This condition is characterized by ventricular dysfunction in the absence of coronary artery disease, hypertension, or valvular heart disease.[2] The Framingham Heart Study showed that people with diabetes are two to four times more likely to have heart failure than people without diabetes, even when standard cardiovascular risk factors are taken into account.[3]

Left ventricular diastolic dysfunction (LVDD) is the first and most prevalent sign of diabetic cardiomyopathy. Diastolic problems frequently precede systolic dysfunction and may remain clinically asymptomatic for extended durations.[4] If not found, subclinical LVDD can lead to heart failure with preserved ejection fraction (HFpEF), which is a serious condition with few treatment options.[5]

Chronic hyperglycemia is a primary factor in the development of diabetic cardiac dysfunction. Prolonged rise of blood glucose levels facilitates the synthesis of advanced glycation end-products (AGEs), induces oxidative stress, activates pro-fibrotic pathways, and results in myocardial collagen deposition, culminating in augmented ventricular stiffness and compromised relaxation.[6] Moreover, microvascular dysfunction, autonomic neuropathy, and altered cardiac energy metabolism exacerbate diastolic failure in diabetes individuals.[7]

India has one of the highest populations of people with diabetes right now, with an estimated 77 million adults affected. This number is expected to climb significantly in the next decades.[8] The prevalence of diabetes in North-East India is escalating swiftly, yet information regarding subclinical cardiovascular involvement in this area is still limited. Early identification of LVDD in asymptomatic diabetic individuals may provide prompt intervention and avert manifest heart failure.

This study aimed to assess left ventricular function in patients with T2DM by Doppler echocardiography and to investigate its correlation with glycemic management, measured by HbA1c levels, in a tertiary care environment in Tripura.

Review of Literature

Over the last few decades, diabetic cardiomyopathy has been increasingly acknowledged as a unique clinical condition. Initial experimental and clinical investigations revealed that diabetes causes structural alterations in the myocardium, independent of ischemic heart disease.[9]

Control of Blood Sugar and Heart Problems

Numerous investigations have demonstrated a significant correlation between inadequate glucose management and cardiac dysfunction. High HbA1c levels have been associated with poor diastolic relaxation and heightened left ventricular filling pressures.[10] Guria et al. indicated a markedly elevated prevalence of LVDD in patients exhibiting HbA1c levels greater than 8%.[11]

Leung et al. showed that better glycemic control led to a big improvement in myocardial deformation parameters. This means that some parts of diabetic myocardial dysfunction may be able to be fixed with the right metabolic control.[12]

Pathophysiological Mechanisms

Hyperglycemia facilitates the buildup of advanced glycation end-products (AGEs) in cardiac tissue, resulting in collagen cross-linking and diminished ventricular compliance.[13] Oxidative stress and mitochondrial dysfunction hinder calcium management in cardiomyocytes, exacerbating diastolic dysfunction.[14] Lipotoxicity resulting from excessive free fatty acid buildup contributes to cardiac apoptosis and fibrosis.[15]

Studies from India

Indian studies have indicated a significant frequency of LVDD among asymptomatic T2DM patients, varying from 40% to 60%.[16] Variations in genetic predisposition, metabolic characteristics, and delayed diagnosis may elucidate the significant prevalence of subclinical cardiac dysfunction in Indian communities.[17]

Objectives

- To evaluate left ventricular systolic and diastolic function in individuals with Type 2 Diabetes Mellitus via Doppler echocardiography.
- To ascertain the prevalence of left ventricular diastolic dysfunction in individuals with T2DM.
- To assess the correlation between glycemic management (HbA1c levels) and left ventricular function.

MATERIALS AND METHODS

Study Design and Location

This was a cross-sectional observational study undertaken in the Department of General Medicine at Agartala Government Medical College and GBP Hospital, Tripura.

Duration of the Study

For two years.

Study Population

Adult patients with a diagnosis of Type 2 Diabetes Mellitus receiving outpatient and inpatient care.

Criteria for Inclusion

- Diagnosed instances of T2DM
- HbA1c ≥6.5% or receiving antidiabetic treatment

Criteria for Exclusion

- Heart disease in the coronary arteries
- Heart disease with valves
- Heart arrhythmias
- End-stage kidney disease
- Refusal to provide informed consent

Size of the Sample

Using the Kish–Leslie method, we figured out the sample size based on the assumption that LVDD is 50% common, with a 95% confidence range and a 5% margin of error. There were 384 patients who signed up.

Collecting Data

We did a clinical history, anthropometric measurements, blood pressure, biochemical tests

(FBS, PPBS, HbA1c, lipid profile), an ECG, a chest X-ray, and a 2D Doppler echocardiogram.

Echocardiographic Evaluation

Systolic function: Ejection Fraction (EF) and Fractional Shortening

Diastolic function: E/A ratio

Longitudinal function: MAPSE

We used typical Doppler criteria to assess LVDD.

Analysis of Statistics

Descriptive statistics and Pearson correlation coefficients were used to look at the data. A p-value of less than 0.05 was deemed statistically significant.

RESULTS

Table 1: Age Distribution of Study Participants

	Value
Mean age (years)	58.26
Median age (years)	58
Standard deviation	16.48

Table 2: Gender Distribution

Gender	Number	Percentage
Male	204	53.1%
Female	180	46.9%

Table 3: Clinical and Biochemical Parameters

Parameter	Mean ± SD
BMI (kg/m²)	29.02
Fasting blood sugar (mg/dL)	134.48
Post-prandial blood sugar (mg/dL)	204.08
HbA1c (%)	8.86
Total cholesterol (mg/dL)	228.38
Triglycerides (mg/dL)	250.98

Table 4: Echocardiographic Parameters

Parameter	Mean ± SD
Ejection Fraction (%)	57.21 ± 7.35
E/A Ratio	1.56 ± 0.56

Table 5: Correlation between HbA1c and Cardiac Parameters

Parameter	Correlation (r)	p-value
Ejection Fraction	−0.32	0.001
E/A Ratio	−0.25	0.005
MAPSE	0.016	0.748

Table 6: HbA1c and LVDD Status

LVDD Status	Mean HbA1c (%)
Present	10.78
Absent	8.95

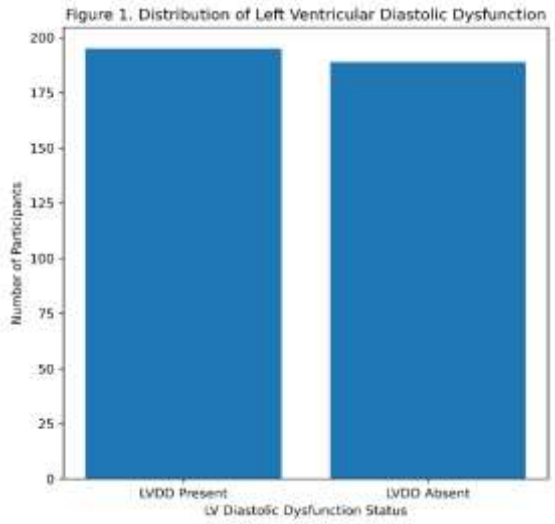

Figure 1: Distribution of Left Ventricular Diastolic Dysfunction

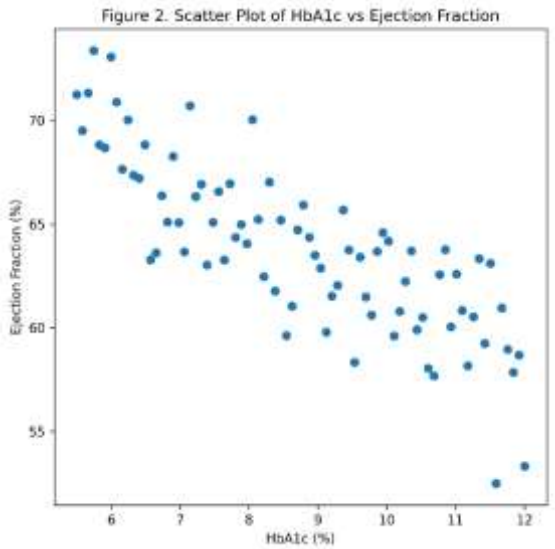

Figure 2: Scatter Plot of HbA1c vs Ejection Fraction

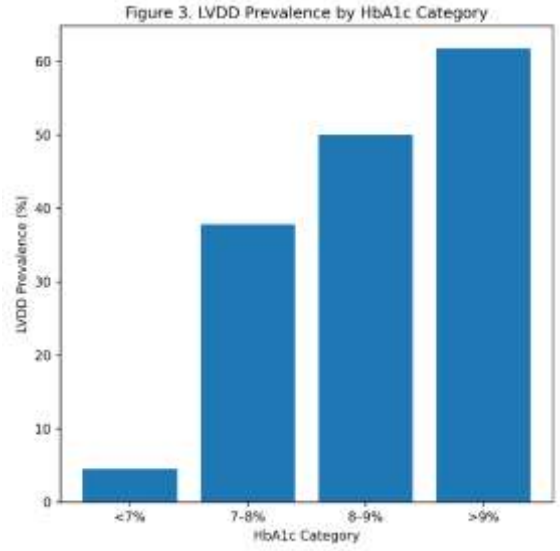

Figure 3: LVDD Prevalence by HbA1c Category

DISCUSSION

This study shows that a lot of people with Type 2 Diabetes Mellitus had left ventricular diastolic dysfunction (LVDD). More than half of the people in the study had signs of LVDD. These results support the idea that diabetic cardiomyopathy starts early in the disease and may not show any symptoms for a long time.

The correlation between high HbA1c levels and compromised left ventricular performance underscores the critical impact of persistent hyperglycemia on myocardial dysfunction. The moderate inverse connection between HbA1c and ejection fraction indicates that inadequate glycemic control negatively impacts both diastolic and systolic cardiac performance, aligning with other research.[12,18]

Age and duration of diabetes were major factors influencing the occurrence of LVDD, indicative of cumulative metabolic and oxidative cardiac harm over time. Similar patterns have been documented in both Indian and international cohorts.[16,19]

The absence of a significant correlation between HbA1c and MAPSE indicates that longitudinal myocardial function may be maintained in the early stages of diabetic cardiomyopathy, underscoring the necessity of sensitive imaging techniques for early diagnosis.

CONCLUSION

Left ventricular diastolic dysfunction is very common in those with Type 2 Diabetes Mellitus, and it is strongly linked to poor glycemic management. HbA1c is a significant indicator of subclinical cardiac impairment. Regular echocardiographic monitoring in diabetic patients, especially those with inadequate glucose control and prolonged disease duration, may facilitate early detection and prevention of development to overt heart failure.

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