



Research Article

PREVALENCE AND CLINICAL SIGNIFICANCE OF LEFT VENTRICULAR DIASTOLIC DYSFUNCTION IN PATIENTS WITH TYPE 2 DIABETES MELLITUS: AN ECHOCARDIOGRAPHIC STUDY

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ABSTRACT

Objective: To investigate the prevalence of left ventricular diastolic dysfunction (LVDD) in patients with diabetes mellitus (DM) and examine its correlation with diabetes-related factors such as glycemic control, duration of diabetes, and associated complications.

Methods: This cross-sectional study included 120 patients with type 2 diabetes mellitus, assessed from January 2023 to December 2023 at a tertiary care hospital. Patients underwent comprehensive echocardiographic evaluation to measure diastolic function parameters including early diastolic filling velocity (E), late diastolic filling velocity (A), E/A ratio, and E/E' ratio. Data on demographics, duration of diabetes, HbA1c levels, and presence of hypertension and diabetic nephropathy were collected. Diastolic dysfunction was categorized based on echocardiographic findings.

Results: Of the 120 patients, 55% exhibited LVDD. Echocardiographic analysis revealed that 40% of patients had abnormal E velocities, 45% had a reduced E/A ratio, and 35% had an elevated E/E' ratio. Severe LVDD was present in 8% of the cohort. There were significant correlations between LVDD severity and longer duration of diabetes ($r = 0.45$, $p < 0.01$) and higher HbA1c levels ($r = 0.38$, $p < 0.05$). Additionally, hypertension and diabetic nephropathy were associated with more severe forms of diastolic dysfunction.

Conclusion: LVDD is prevalent among patients with type 2 diabetes mellitus and is significantly associated with poor glycemic control, longer duration of diabetes, and diabetes-related complications. Early detection and management of LVDD are crucial for improving patient outcomes and preventing progression to symptomatic heart failure. Future studies should focus on optimizing treatment strategies for managing diastolic dysfunction in diabetic patients.

Keywords: Left ventricular diastolic dysfunction, diabetes mellitus, echocardiography, glycemic control, cardiovascular complications

INTRODUCTION:

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Over time, diabetes can lead to significant cardiovascular complications, including left ventricular diastolic dysfunction (LVDD), which is increasingly recognized as a major contributor to heart failure in diabetic patients

(1,2). LVDD occurs when the left ventricle (LV) is impaired in its ability to relax and fill with blood during diastole, which can lead to increased filling pressures and symptoms of heart failure (3).

Diabetes-induced LVDD is thought to arise from a combination of metabolic and structural changes. Hyperglycemia and insulin resistance can cause myocardial

fibrosis, endothelial dysfunction, and alterations in the extracellular matrix, contributing to impaired diastolic function (4,5). Additionally, diabetic cardiomyopathy, characterized by structural and functional abnormalities in the absence of other cardiovascular diseases, can exacerbate LVDD (6,7). The condition is often asymptomatic until it progresses to heart failure with preserved ejection fraction (HFpEF), which complicates its diagnosis and management (8,9).

Several studies have highlighted the prevalence of LVDD among diabetic patients, noting that it occurs even in those with early-stage diabetes or without overt heart failure symptoms (10,11). Diastolic dysfunction can be assessed using echocardiography, with parameters such as early diastolic filling velocity (E) and late diastolic filling velocity (A), E/A ratio, and tissue Doppler imaging providing valuable diagnostic information (12,13). Abnormalities in these parameters are indicative of impaired ventricular relaxation and compliance (14,15).

The impact of LVDD on clinical outcomes in diabetes is significant. Patients with LVDD and diabetes are at higher risk of developing symptomatic heart failure, increased hospitalizations, and reduced quality of life (16,17). Managing LVDD in diabetic patients requires a multifaceted approach, including glycemic control, management of comorbidities, and potentially specific therapies targeting diastolic dysfunction (18,19).

This study aims to explore the prevalence and clinical significance of LVDD in patients with diabetes mellitus, using echocardiographic assessments to characterize diastolic function and examine its associations with diabetes-related variables. Understanding these relationships is crucial for developing targeted

interventions to mitigate the impact of LVDD and improve cardiovascular outcomes in diabetic patients.

Aim

To evaluate the prevalence and clinical significance of left ventricular diastolic dysfunction (LVDD) in patients with diabetes mellitus and to assess the correlation between LVDD and diabetes-related factors.

Objectives

1. To determine the prevalence of left ventricular diastolic dysfunction in a cohort of patients with diabetes mellitus using echocardiographic assessments.
2. To investigate the relationship between LVDD and various diabetes-related factors such as glycemic control, duration of diabetes, and presence of diabetic complications.

Materials and Methods

This cross-sectional study was conducted to evaluate left ventricular diastolic dysfunction (LVDD) in patients with diabetes mellitus (DM) and its association with diabetes-related factors. The study was carried out at a tertiary care hospital between January 2017 and December 2018. A total of 120 patients with a confirmed diagnosis of type 2 diabetes mellitus were enrolled.

Inclusion Criteria:

1. **Confirmed Diagnosis of Type 2 Diabetes Mellitus:** Patients aged 18 years or older with a clinical diagnosis of type 2 diabetes mellitus, either newly diagnosed or with a history of the condition.
2. **Informed Consent:** Patients who provided written informed consent to participate in the study.
3. **Echocardiographic Assessment:** Patients who underwent a comprehensive echocardiographic evaluation, including

Doppler studies, to assess left ventricular diastolic function.

Exclusion Criteria:

- Type 1 Diabetes Mellitus:** Patients with type 1 diabetes mellitus were excluded.
- Presence of Other Cardiac Conditions:** Patients with significant valvular heart disease, coronary artery disease, or heart failure with reduced ejection fraction were excluded, as these conditions could confound the assessment of LVDD.
- Uncontrolled Hypertension:** Patients with uncontrolled hypertension defined as systolic blood pressure >180 mmHg or diastolic blood pressure >110 mmHg at the time of assessment were excluded, to avoid confounding effects of severe hypertension on diastolic function.
- Inadequate Echocardiographic Data:** Patients with incomplete or technically inadequate echocardiographic studies were excluded to ensure accurate assessment of diastolic function.

Data Collection: Clinical data including demographic information, duration of diabetes, glycemic control parameters (HbA1c levels), and presence of diabetic complications were collected. Echocardiographic measurements included the evaluation of diastolic function parameters such as early diastolic filling velocity (E), late diastolic filling velocity (A), and the E/A ratio. The data were analyzed to determine the prevalence of LVDD and its association with diabetes-related factors.

Statistical Analysis: Descriptive statistics were used to summarize patient demographics and echocardiographic findings. Correlation analysis was performed to assess the relationship between LVDD severity and diabetes-related factors. Chi-square tests and t-tests were used to compare categorical and continuous variables, respectively. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Baseline Characteristics of Patients with Diabetes Mellitus

Characteristic	Value (n = 120)
Mean Age (years)	58.4 ± 10.2
Gender (Male/Female)	50/70
Duration of Diabetes (years)	10.2 ± 6.5
Mean HbA1c (%)	8.3 ± 1.4
Prevalence of Hypertension (%)	65%
Prevalence of Diabetic Nephropathy (%)	30%
Prevalence of Retinopathy (%)	25%

The cohort of 120 patients had a mean age of 58.4 years, with a majority being female. The average duration of diabetes was 10.2 years, and the mean HbA1c level was 8.3%, indicating suboptimal glycemic control. Hypertension was present in 65% of patients, and diabetic nephropathy and retinopathy were observed in 30% and 25% of patients, respectively.

Table 2: Echocardiographic Findings Related to Diastolic Function

Parameter	Mean Value	Normal Range	Percentage Abnormal
Early Diastolic Filling Velocity (E) (cm/s)	75.4 ± 15.3	60-100	40%

Late Diastolic Filling Velocity (A) (cm/s)	70.2 ± 14.6	50-80	50%
E/A Ratio	1.05 ± 0.3	1.0-2.0	45%
Average E/E' Ratio	10.8 ± 2.7	< 15	35%

The average early diastolic filling velocity (E) and late diastolic filling velocity (A) were within normal ranges but showed variations indicative of diastolic dysfunction. The E/A ratio was slightly below the normal range, and the average E/E' ratio, used as a measure of filling pressures, was higher than normal in 35% of patients, indicating impaired diastolic function.

Table 3: Prevalence of Left Ventricular Diastolic Dysfunction (LVDD) Based on Echocardiographic Criteria

LVDD Classification	Number of Patients (n)	Percentage (%)
Normal Diastolic Function	54	45%
Mild LVDD	32	27%
Moderate LVDD	24	20%
Severe LVDD	10	8%

LVDD was classified into normal, mild, moderate, and severe based on echocardiographic findings. Mild LVDD was the most common form, affecting 27% of patients, while severe LVDD was observed in 8% of the cohort.

Table 4: Correlation of LVDD Severity with Diabetes-Related Factors

Diabetes-Related Factor	Correlation with LVDD Severity	p-value
Duration of Diabetes (years)	Positive correlation (r = 0.45)	<0.01
HbA1c Level (%)	Positive correlation (r = 0.38)	<0.05
Presence of Hypertension (%)	Higher prevalence in severe LVDD	0.02
Presence of Diabetic Nephropathy (%)	Higher prevalence in moderate/severe LVDD	0.03

Longer duration of diabetes and higher HbA1c levels were positively correlated with increased severity of LVDD. The presence of hypertension and diabetic nephropathy was also associated with more severe forms of diastolic dysfunction, highlighting the compounded impact of these diabetes-related complications.

Discussion

This study explores the prevalence and clinical significance of left ventricular diastolic dysfunction (LVDD) in patients with diabetes mellitus (DM). Our findings demonstrate a high prevalence of LVDD among diabetic patients, with 55% showing

varying degrees of diastolic dysfunction. This prevalence aligns with previous studies, which indicate that LVDD is a common complication in diabetes, often preceding the onset of symptomatic heart failure (1,3).

The echocardiographic parameters in our study reveal that early diastolic filling velocity (E) and the E/A ratio were notably abnormal in a significant portion of patients. Specifically, 40% of patients had abnormal E velocities and 45% had a reduced E/A ratio, consistent with impaired relaxation and increased filling pressures (12). The average E/E' ratio was elevated in 35% of patients, suggesting a significant number of patients

had elevated left atrial pressures indicative of more severe diastolic dysfunction (13). These findings corroborate previous research indicating that alterations in these parameters are key markers of diastolic dysfunction in diabetes (8,9).

Our study also highlights the impact of diabetes-related factors on LVDD severity. We observed positive correlations between LVDD severity and both duration of diabetes and HbA1c levels, reinforcing findings from earlier studies which suggest that prolonged hyperglycemia and poor glycemic control exacerbate diastolic dysfunction (4,5). Specifically, a higher HbA1c level was associated with more severe diastolic dysfunction, reflecting the adverse effects of chronic hyperglycemia on myocardial structure and function (14).

Additionally, the presence of hypertension and diabetic nephropathy was associated with increased severity of LVDD. Hypertension is a well-established risk factor for diastolic dysfunction, as it can cause increased ventricular stiffness and impaired relaxation (10). Similarly, diabetic nephropathy, a common complication of diabetes, contributes to cardiovascular disease through mechanisms such as fluid overload and increased left atrial pressure, further exacerbating diastolic dysfunction (11).

These findings underscore the importance of early detection and management of LVDD in diabetic patients. Monitoring diastolic function through echocardiography can aid in identifying patients at risk of progressing to symptomatic heart failure. Effective management strategies, including strict glycemic control and treatment of hypertension, are crucial for mitigating the adverse cardiovascular effects of diabetes (12,13).

In conclusion, LVDD is prevalent among diabetic patients and is significantly influenced by glycemic control, diabetes

duration, and associated complications. Early intervention and comprehensive management of these factors can improve outcomes and reduce the risk of heart failure in this high-risk population.

Conclusion

This study underscores the high prevalence of left ventricular diastolic dysfunction (LVDD) among patients with diabetes mellitus (DM) and highlights its significant association with diabetes-related factors. Our findings indicate that LVDD is prevalent in a substantial proportion of diabetic patients, with varying degrees of severity. Key echocardiographic parameters, including early diastolic filling velocity (E), the E/A ratio, and the E/E' ratio, were notably abnormal, reflecting impaired diastolic function.

The study reveals that prolonged duration of diabetes and poor glycemic control, as evidenced by higher HbA1c levels, are strongly correlated with more severe LVDD. Additionally, the presence of hypertension and diabetic nephropathy further exacerbates diastolic dysfunction, highlighting the complex interplay between diabetes-related complications and cardiovascular health.

These results emphasize the importance of early detection and proactive management of LVDD in diabetic patients. Routine echocardiographic screening could be beneficial for identifying diastolic dysfunction early, allowing for timely intervention. Effective management strategies, including strict glycemic control and treatment of comorbid conditions such as hypertension, are crucial for mitigating the progression of diastolic dysfunction and reducing the risk of heart failure.

Overall, integrating routine assessment of diastolic function into the care of diabetic patients could improve outcomes and quality of life by addressing this often-subclinical but

significant complication. Future research should focus on developing targeted interventions and refining treatment

protocols to better manage LVDD in the context of diabetes