

Study of Left Ventricular Diastolic Dysfunction in Relation to HbA1c and Duration in Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Background: Diabetes mellitus affects multiple organ systems, including the heart, kidneys, and peripheral nerves. Diabetic cardiomyopathy — myocardial dysfunction occurring independently of ischemic, valvular, or hypertensive heart disease - often manifests first as left ventricular diastolic dysfunction (LVDD), preceding any decline in systolic function. Data correlating LVDD with glycemic control remain limited.

Objective: To determine the proportion of diastolic dysfunction among patients with type 2 diabetes mellitus (T2DM) and to correlate LVDD with HbA1c levels and duration of disease.

Methods: A cross-sectional study of 100 patients with T2DM of at least 5 years duration, recruited at Ramaiah Medical College and Hospital. All patients underwent Doppler echocardiography and HbA1c estimation.

Results: LVDD was present in 58 of 100 patients (58%). Prevalence was highest among patients with HbA1c 8.1–9.5% and was most frequent in patients with 6–12

years of diabetes duration. Mean fasting blood sugar was higher among patients with LVDD than those without.

Conclusion: LVDD is strongly associated with HbA1c level and duration of T2DM, and correlates significantly with age, fasting blood glucose, and lipid parameters. Routine echocardiographic screening for LVDD is recommended in patients with long-standing or poorly controlled T2DM.

Keywords: Left Ventricular Diastolic Dysfunction - HbA1c (Glycosylated Hemoglobin) - Type 2 Diabetes Mellitus

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder with wide-ranging effects on the cardiovascular, renal, and nervous systems, and its burden in India is substantial, with a national weighted prevalence of 11.4% among adults.⁽¹⁾

Among its cardiac manifestations, diabetic cardiomyopathy is defined as ventricular dysfunction occurring in diabetic patients in the absence of coronary artery disease, valvular disease, or hypertension, and is now understood to arise through

hyperglycemia- and insulin-resistance-driven myocardial injury.^(2,3)

Left ventricular diastolic dysfunction (LVDD) is one of the earliest detectable markers of diabetic myocardial involvement, frequently preceding measurable decline in systolic function and predicting subsequent progression to symptomatic heart failure.^(4,5)

Despite this, the relationship between LVDD and the degree of glycemic control — as reflected by glycosylated hemoglobin (HbA1c) — and duration of diabetes has not been extensively characterized, particularly in South Indian clinical populations, though similar cross-sectional studies elsewhere in India and the region have reported LVDD prevalence ranging from 54% to 65%.⁽⁶⁻⁸⁾

This study was undertaken to estimate the burden of LVDD among patients with type 2 diabetes mellitus (T2DM) at a tertiary care center and to examine its relationship with HbA1c level and duration of disease, with the broader aim of informing screening practice.

Objectives

- To determine the proportion of diastolic dysfunction in patients with type 2 diabetes mellitus.
- To correlate the relationship of LVDD with HbA1c levels.
- To correlate the relationship of LVDD with duration of diabetes mellitus.

MATERIALS AND METHODS

Study Design and Setting

This was a cross-sectional observational study conducted in the Department of Cardiology, Ramaiah Medical College and Hospital, Bangalore.

Study Population

A total of 100 patients with type 2 diabetes mellitus of at least 5 years duration were enrolled.

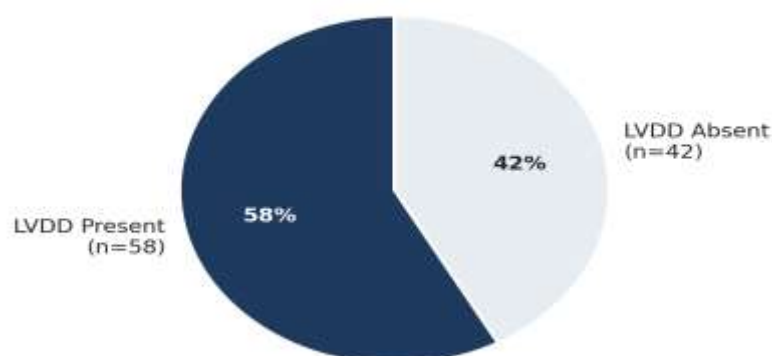
METHODOLOGY

All enrolled patients underwent transthoracic Doppler echocardiography for assessment of diastolic function, together with estimation of HbA1c, fasting blood sugar (FBS), and fasting lipid profile. Diastolic function was graded using standard mitral inflow Doppler parameters — peak early (E) and late (A) diastolic mitral inflow velocities, the E/A ratio, isovolumetric relaxation time (IVRT), deceleration time (DT), and left atrial (LA) size — in accordance with the American Society of Echocardiography/European Association of Cardiovascular Imaging recommendations.⁽⁹⁾

RESULTS

Of the 100 patients with type 2 diabetes mellitus evaluated, 58 (58%) had echocardiographic evidence of left ventricular diastolic dysfunction.

Proportion of Left Ventricular Diastolic Dysfunction (LVDD) in Type 2 Diabetes Mellitus Patients (N=100)



LVDD Grading

Among the 58 patients with LVDD, the majority had Grade I (impaired relaxation)

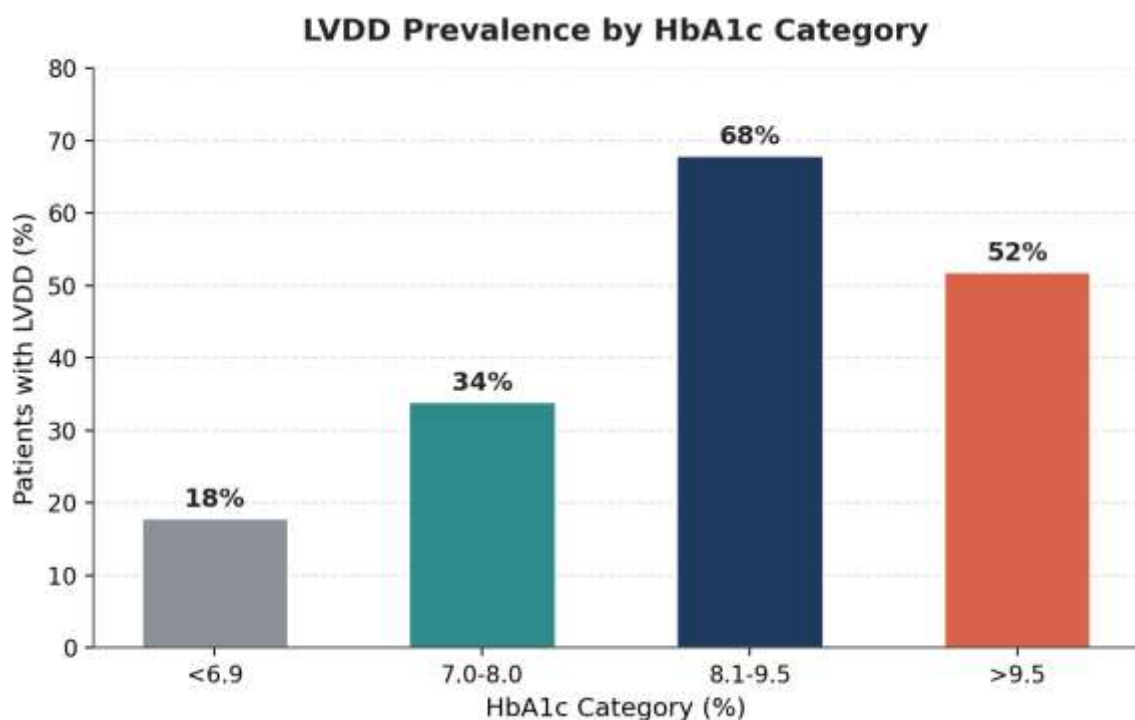
dysfunction, followed by Grade II (pseudonormal) and Grade III (restrictive) patterns, as summarized in Table 1.

Grade of LVDD	n (%)	Description
Grade I (Impaired relaxation)	33 (57%)	E/A < 0.8, prolonged DT and IVRT
Grade II (Pseudonormal)	19 (33%)	E/A 0.8–1.5, normal DT
Grade III (Restrictive)	6 (10%)	E/A > 2, shortened DT and IVRT

Relationship with HbA1c

LVDD prevalence rose with worsening glycemic control and was highest among patients with HbA1c between 8.1% and 9.5%, indicating a strong, dose-dependent

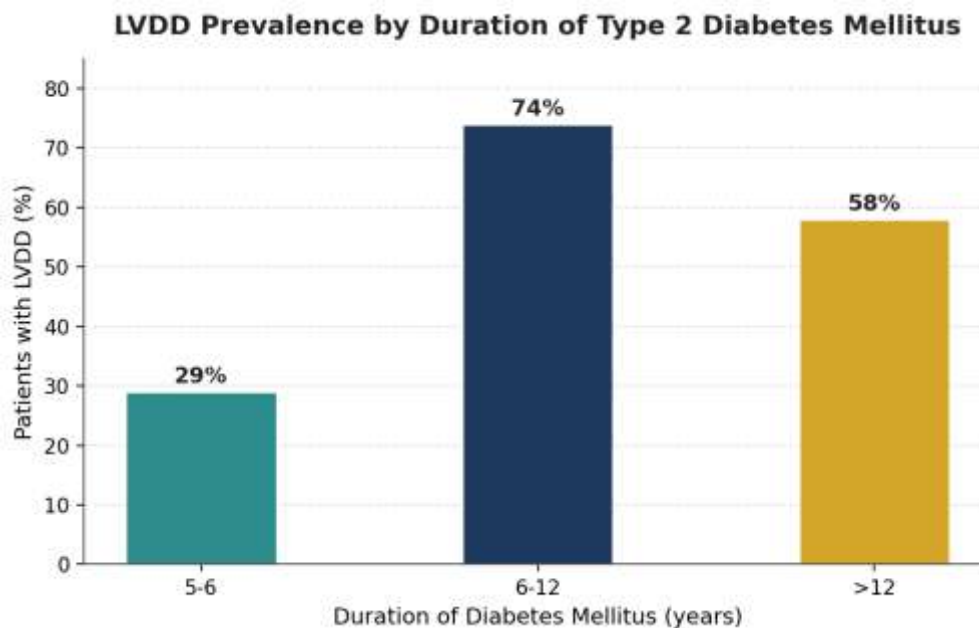
association between poor glycemic control and diastolic impairment, consistent with the stepwise relationship reported in comparable cohorts. ⁽¹⁰⁾



Relationship with Duration of Diabetes

Patients with a diabetes duration of 6–12 years from the time of diagnosis showed the

highest prevalence of LVDD, supporting a cumulative, duration-dependent pattern of diastolic impairment. ⁽¹¹⁾



Baseline and Metabolic Characteristics

Patients with LVDD had higher mean HbA1c, fasting blood sugar, total cholesterol, and triglyceride levels

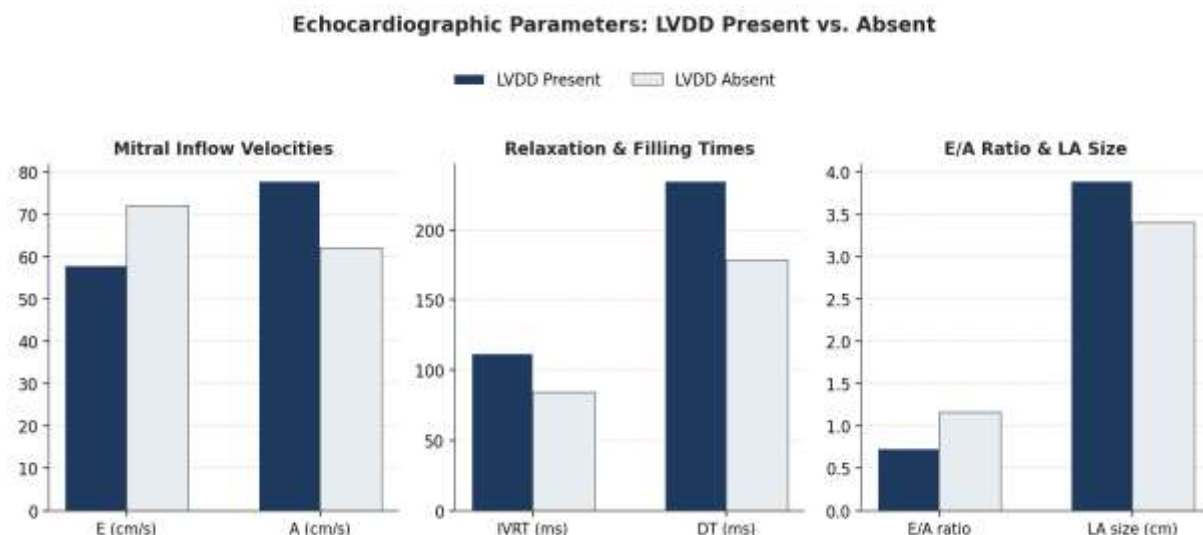
compared to those without LVDD, as shown in Table 2, mirroring the dyslipidemic and metabolic profile reported in similar asymptomatic diabetic cohorts.^(12,13)

Parameter	LVDD Present (n=58)	LVDD Absent (n=42)
Mean age (years)	58.4 ± 7.1	49.2 ± 8.3
Mean HbA1c (%)	9.1 ± 1.2	7.4 ± 1.0
Mean FBS (mg/dL)	168 ± 24	134 ± 19
Mean duration of DM (years)	10.6 ± 3.4	6.9 ± 2.1
Mean total cholesterol (mg/dL)	214 ± 28	186 ± 22
Mean triglycerides (mg/dL)	196 ± 34	152 ± 27

Echocardiographic Parameters

Mitral inflow velocities (E, A), E/A ratio, IVRT, DT, and LA size were all significantly altered in patients with LVDD compared with those without, consistent

with impaired ventricular relaxation and compliance; subclinical systolic strain abnormalities have also been reported by speckle-tracking studies in similarly staged T2DM cohorts.⁽¹⁴⁻¹⁶⁾



DISCUSSION

This study found that more than half of patients with T2DM of at least 5 years duration had echocardiographic evidence of LVDD, reinforcing the concept that diastolic impairment is an early and common cardiac complication of diabetes, often preceding overt symptomatic heart disease.

The strong association observed between LVDD and higher HbA1c levels supports the hypothesis that chronic hyperglycemia contributes directly to myocardial stiffness and impaired relaxation, likely through mechanisms including advanced glycation end-product accumulation, myocardial fibrosis, and microvascular dysfunction. ^(2,11)

Similarly, the duration-dependent pattern observed — with peak prevalence in the 6–12 year band — suggests a cumulative injury process rather than an acute or early-onset phenomenon, in keeping with longitudinal community data showing progressive worsening of diastolic grade over time. ⁽⁵⁾

The higher fasting blood sugar, cholesterol, and triglyceride levels observed in the LVDD group point to a broader metabolic syndrome-like profile that may compound diastolic dysfunction beyond glycemic control alone. These findings are consistent with existing literature on diabetic cardiomyopathy and support incorporating routine diastolic function assessment into

the cardiovascular risk evaluation of diabetic patients. ^(3,9)

Limitations

- Single-center, cross-sectional design limits causal inference and generalizability.
- Relatively modest sample size (n=100) may limit precision of subgroup estimates.
- Confounders such as blood pressure control and duration of associated comorbidities were not fully adjusted for.

CONCLUSION

LVDD is common among patients with long-standing type 2 diabetes mellitus and is strongly correlated with HbA1c levels and duration of disease. Age, fasting blood glucose, cholesterol, and triglyceride levels also correlate significantly with LVDD, and standard echocardiographic parameters (E, A, E/A, IVRT, DT, LA size) are significantly altered across LVDD grades. Routine screening for LVDD is recommended in all patients with long-standing or poorly controlled type 2 diabetes mellitus, to enable earlier intervention before progression to overt cardiac dysfunction.

Abbreviations

A – Peak velocity of late (atrial) mitral inflow

E – Peak velocity of early mitral inflow

E/A – Ratio of early to late mitral inflow velocity
 IVRT – Isovolumetric Relaxation Time
 DT – Deceleration Time
 LA – Left Atrium
 LVDD – Left Ventricular Diastolic Dysfunction
 T2DM – Type 2 Diabetes Mellitus
 FBS – Fasting Blood Sugar

Declaration by Authors

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