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Research Article

Echocardiographic Assessment of Left Ventricular Diastolic Dysfunction in Type 2 Diabetes Mellitus: Correlation With Age, Disease Duration, and Glycemic Control

Vijayanand Metgudmath[1*], Suresh Patted[2], Sanjay Porwal[3], Abhishek Khobragade[4], Rashmita Padagi[5]

[1]Associate Professor, Department of Cardiology, Jawaharlal Nehru Medical College, KLES Dr. Prabhakar Kore Hospital and MRC, Belagavi India

[2]Professor, Department of Cardiology, Jawaharlal Nehru Medical College, KLES Dr. Prabhakar Kore Hospital and MRC, Belagavi India.

[3]Professor and Head, Department of Cardiology, Jawaharlal Nehru Medical College, KLES Dr. Prabhakar Kore Hospital and MRC, Belagavi India

[4]DM Resident, Department of Cardiology, Jawaharlal Nehru Medical College, KLES Dr. Prabhakar Kore Hospital and MRC, Belagavi India

[5]MSc in Echocardiography, Department of Cardiology, Jawaharlal Nehru Medical College, KLES Dr. Prabhakar Kore Hospital and MRC, Belagavi India

***Corresponding author:** Vijayanand Metgudmath, Department of Cardiology, Jawaharlal Nehru Medical College, KLES Dr. Prabhakar Kore Hospital and MRC Belagavi India

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Abstract

Background and objectives: This study aimed to evaluate left ventricular diastolic dysfunction (LVDD) in type 2 diabetes mellitus (T2DM) patients using echocardiography and assess its correlation with age, diabetes duration, and HbA1c levels. **Methodology:** This cross-sectional study included 90 T2DM patients aged 35-80 years without cardiovascular disease. Echocardiographic parameters including mitral inflow Doppler, tissue Doppler imaging, and pulmonary venous flow were used to assess diastolic function. **Results:** LVDD was present in 71 (78.89%) patients. The prevalence increased with age, with 100% of patients over 65 years having LVDD. LVDD was found in 91.65% of patients with diabetes duration >16 years compared to 58.9% in those with <5 years duration. Among patients with HbA1c >10%, 83.8% had LVDD versus 70.5% in those with HbA1c 6.4-7%. Grade I LVDD was most common (41.11%), followed by grade II (34.44%) and grade III (3.33%). Significant correlations were observed between LVDD and increasing age, diabetes duration, and HbA1c levels. **Conclusion:** LVDD is highly prevalent in asymptomatic T2DM patients with preserved systolic function. Its prevalence and severity increase with age, diabetes duration, and poor glycemic control. Echocardiography is a valuable non-invasive tool for early detection of LVDD in T2DM patients.

Keywords: Type 2 diabetes mellitus, left ventricular diastolic dysfunction, echocardiography, HbA1c, diabetes duration

Introduction

Diabetes mellitus is characterized by chronic hyperglycemia due to defects in insulin production or action [1]. It is a common chronic disease reaching epidemic proportions globally [2,3].

Type 2 diabetes, the most prevalent form, involves variable degrees of insulin resistance, impaired insulin secretion, and increased glucose production. The global burden is driven by increasing population age, obesity, and physical inactivity.

Cardiovascular disease is the primary cause of mortality in diabetes patients, mainly as coronary heart disease and heart failure. Diabetes can cause pathophysiological changes in the heart through direct effects on the myocardium and impacts on coronary circulation and cardiac autonomic function.

Diastolic dysfunction is an early indicator of diabetic cardiomyopathy, often preceding systolic dysfunction. It refers to abnormalities in mechanical function during diastole due to impaired myocardial relaxation or reduced passive diastolic compliance [4,5].

Echocardiography, particularly Doppler techniques, plays a crucial role in assessing left ventricular diastolic dysfunction. Key parameters include mitral inflow velocities, tissue Doppler imaging, and pulmonary venous flow.

Materials and Methods

Study Design and Setting

This cross-sectional study was conducted in the Department of Cardiology at KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, affiliated with KAHER Institute in Belagavi, Karnataka, India. The study period was from March 2020 to February 2021, focusing on patients with type 2 diabetes mellitus (T2DM) in both inpatient and outpatient departments.

Study Population and Sample Size

The study included a total of 90 patients diagnosed with T2DM. The sample size was calculated based on a previous study by Patil MB and Burji NP, using the following parameters:

- p = 66% (prevalence)

- q = 34%

- d = 10% (precision)

- Zα = 1.96 (at 5% α-error)

The minimum sample size was determined using the formula:

This calculation yielded a minimum required sample size of 86 patients.

Inclusion Criteria

- Patients with isolated T2DM

- Age group: 35-80 years

Exclusion Criteria

- Patients with a poor acoustic window

- Hypertensive patients

- Patients with valvular heart disease

- Patients with congenital heart disease

- Patients who have undergone CABG or PTCA

Echocardiographic Examination

All patients underwent a comprehensive echocardiographic examination using a Philips Affinity 3-Dimensional ultrasound system with S5-1 transducer for 2D echo and X5-1 transducer for 3D echo. Patients were examined in supine and left lateral decubitus positions. The following echocardiographic parameters were assessed:

1. 2D Echocardiography:

- Standard views were obtained for structural and functional assessment.

2. Mitral Doppler:

- Apical four-chamber view (AP4C) was used to obtain mitral inflow velocities.

- E wave and A wave velocities were measured, and E/A ratio was calculated.

- Deceleration time (DT) was measured from the slope of the early diastolic wave.

3. Isovolumic Relaxation Time (IVRT):

- Measured in the apical five-chamber view (AP5C) between aortic valve closure and mitral valve opening.

4. Tissue Doppler Imaging (TDI):

- Pulse wave Doppler sample volume was placed along the septal mitral valve annulus in AP4C view.

- Mitral septal E' velocity was measured, and E/E' ratio was calculated.

5. Pulmonary Venous Doppler:

- Recorded in the right upper pulmonary vein in AP4C view.

- Systolic (PVs), diastolic (PVd), and atrial reversal (PVa) flow velocities were measured.

Statistical Analysis

Data analysis was performed using SPSS version 20.0 software. The following statistical methods were employed:

- Categorical data were expressed as rates, ratios, and percentages.

- Continuous variables were presented as mean ± standard deviation (SD) and/or median and range (minimum and maximum).

- Normality of continuous variables was assessed using the Shapiro-Wilk test.

Results

Diastolic Dysfunction	Distribution (n=90)	
	Count	Percentage
Present	71	78.89%
Absent	19	21.11%
Total	90	100.00%

shows that in total study of 90 patients, diastolic dysfunction was present in 71 patients (78.89%) and absent in 19 patients (21.11%).

Table 1: Distribution of study population according to Diastolic Dysfunction

Gender	Distribution (n=90)	
	Count	Percentage
Male	62	68.89%
Female	28	31.11%
Total	90	100%

describes the gender distribution, indicates that out of 90 patients, 62 (68.89%) were male and 28 (31.11%) were female. The study observed that the incidence of males was predominant compared to females.

Table 2: Distribution of study population according to sex

Gender	Total	Diastolic Dysfunction		Percentage	
		Present	Absent	Present	Absent
Male	62	49	13	79.03%	20.97%
Female	28	22	6	78.57%	21.43%
Total	90	71	19	78.89%	21.43 %

Diastolic dysfunction was present in 71 patients, in which 49 (79.03%) were males and 22 (78.57%) were females.

Diastolic dysfunction was absent in 19 patients, which included 13 (20.97%) males and 6 (21.43%) females.

According to our study, Diastolic dysfunction was more prevalent in males

Table 3: Correlation between Gender & DDF

Gender with Normal DF	Count	Percentage
Male	13	68.42%
Female	6	31.58%
Total	19	100.00%

In our study 19 patients had normal diastolic function, out of which, 13 (68.42%) were males and 6 (31.58%) females

Table 4: Distribution of study population with Normal Diastolic Function

Patients with DDF	Count	Percentage
Male	49	69.01%
Female	22	30.99%
Total	71	100.00%

In our study, 71 patients with diastolic dysfunction were present, out of which 49 (69.01%) were males and 22 (30.99%) were females.

Table 5: Distribution of study population with Diastolic Dysfunction

Diastolic Dysfunction Grade (DDF)	Male	Female	Total	Percentage
Normal	13	6	19	21.11%
I	25	12	37	41.11%
II	22	9	31	34.44%
III	2	1	3	3.33%
Total	62	28	90	100.00%

In total study of 90 patients, 19(21.11%) patients had normal diastolic function, 37(41.11%) patients had grade I DDF, 31(34.44%) patients had grade II DDF and 3(3.33%) patients had grade III DDF.

Table 6: Distribution of study population according to grading of Diastolic Dysfunction

Age-wise distribution	Number of cases			Percentage	Diastolic Dysfunction	
	Male	Female	Total		Present	Absent
35-44	7	5	12	13.33%	1	11
45-54	21	8	29	32.22%	23	6
55-64	19	8	27	30.00%	25	2
65-74	11	6	17	18.89%	17	0
>75	4	1	5	5.56%	5	0
Total	62	28	90	100.00%	71	19

In our present study, 12 (13.33%) patients were in age group of 35-44 years, out of which 1 patient had DDF. 29 (32.22%) patients were in age group 45-54 years, in which 23 patients had DDF. In age group 55-64 years, total 27(30.00%) patients, DDF was present in 25 patients. In age group of 65-74 years and above 75 years, DDF was present in all 22(24.45%) patients.

Table 7: Age-wise Distribution and correlation with Diastolic Dysfunction

Age-wise distribution	Grade I	Grade II	Grade III
35-44	1	0	0
45-54	9	11	3
55-64	17	8	0
65-74	7	10	0
>75	3	2	0
Total	37	31	3

In our present study, in population of age group of 34-44 years, had 1 patient with grade I DDF. In age group of 45-54 years, 9 patients had grade I DDF, 11 patients had grade II DDF & 3 patients had grade III DDF. In age group of 55-64 years, 17 patients had grade I DDF & 8 patients had grade II DDF. In 65-75 years of age group, grade I DDF was present in 7 patients and grade II DDF in 10 patients and in age group of above 75 years, grade I DDF was present in 3 patients and grade II DDF in 2 patients.

Table 8: Age-wise Distribution of study population with Grading of Diastolic Dysfunction

Duration in year	Number of cases			Percentage	Diastolic Dysfunction	
	Male	Female	Total		Present	Absent
0-5	23	16	39	43.33%	23	15
6-10	18	4	22	24.44%	21	1
11-15	13	4	17	18.89%	16	1
16-20	4	4	8	8.89%	7	1
>20	4	0	4	4.44%	4	0
Total	62	28	90	100.00%	71	19

According to duration of diabetes mellitus, we had 39(43.33%) patients with less than 5 years duration of DM, DDF was present in 23 patients & absent in 15 patients. 22 (24.44%) patients with 6-10 years duration of DM, 21 patients had DDF & absent in 1 patient. 17(18.89%) patients with 11-15 years duration of DM, DDF was present in 16 patients & absent in 1 patient. 8(8.89%) patients with 16-20years duration of DM, DDF was present in 7 patients & absent in 1 patient. And in patients with above 20 years duration of DM, all 4 patients had DDF.

Table 9: Correlation between duration of Diabetes Mellitus & Diastolic Dysfunction

Diabetes Mellitus Duration in years	Grade I	Grade II	Grade III
0-5	17	5	1
6-10	10	10	1
11-15	7	8	1
16-20	2	5	0
>20	1	3	0
Total	37	31	3

Table 10: Distribution of study population according to duration of Diabetes Mellitus with Grading of Diastolic Dysfunction.

In our present study, patients with duration less than 5 years of DM, grade I DDF was present in 17 patients, grade II DDF in 5 patients & grade III DDF in 1 patient. In patients with duration 6-10 years of DM, grade I DDF was present in 10 patients, grade II DDF in 10 patients & grade III DDF in 1 patient. In patients with 11-15 years duration of DM, 7 patients had grade I DDF, grade II DDF in 8 patients & grade III DDF in 1 patient. In patients with 16-20 years duration of DM, grade I DDF was present in 2 patients & grade II DDF in 5 patients . And in patients with duration of DM more than 20 years, had 1 patient with grade I DDF & 3 patients with grade II DDF.

HbA1c level	Total	Diastolic Dysfunction	
		Present	Absent
6.4-7	17	12	5
7.1-8	18	15	3
8.1-10	24	18	6
>10	31	26	5
Total	90	71	19

Table 11: Correlation between HbA1c level and Diastolic Dysfunction

In our present study, according to HbA1c levels, 17 patients had HbA1c between 6.4-7, out of which DDF was present in 12 patients & absent in 5 patients. 18 patients had HbA1c 7.1-8, in which DDF present in 15 patients & absent in 3 patients. 24 patients had HbA1c 8.1-10, 18 patients had DDF & 6 of them had normal diastolic function. 31 patients had HbA1c more than 10, out of which 26 patients had DDF & 5 patients Had normal diastolic function.

HbA1c level	Grade I	Grade II	Grade III
6.4-7	7	5	0
7.1-8	6	8	1
8.1-10	11	6	1
>10	13	12	1
Total	37	31	3

Table 12: Distribution of study population according to HbA1c level with Grading of Diastolic Dysfunction.

In our present study, in patients with HbA1c 6.4-7, 7 patients had grade I DDF, & 5 patients had grade II DDF. In patients with HbA1c 7.1- 8, 6 patients had grade I DDF, 8 patients had grade II DDF & 1 patient had grade III DDF. In patients with HbA1c 8.1-10, grade I DDF was present in 11 patients, grade II DDF in 6 patients & grade III DDF in 1 patients and with HbA1c more than 10, had 13 grade I DDF patients, 12 grade II DDF patients & 1 grade III DDF patient.

Discussion

This study examined left ventricular diastolic dysfunction (LVDD) in patients with type 2 diabetes mellitus (T2DM) aged 35-80 years at KLE Hospital. The study cohort comprised 90 patients, with 68.89% male and 31.11% female participants (Table 2). The age distribution was as follows: 32.22% between 45-54 years, 30.00% between 55-64 years, 18.89% between 65-74 years, 13.33% between 35-44 years, and 5.56% above 75 years (Table 7).

The prevalence of LVDD in T2DM patients (78.89%) was significantly higher compared to normal subjects (21.11%) (Table 1). This study demonstrated a correlation between LVDD severity and patient age, diabetes duration, and HbA1c levels. As these parameters increased, so did the severity of diastolic dysfunction.

Two-dimensional echocardiography with pulsed Doppler assessment of transmitral inflow (E-wave, A-wave, E/A ratio), myocardial tissue blood flow estimation (E' and E/E' ratio), and pulmonary venous Doppler were utilized to evaluate LVDD severity. The results indicated a strong positive correlation between LVDD and diabetes duration, age, and HbA1c levels.

These findings align with previous research. Mamatha B Patil et al. (2012) [3] reported LVDD in 64% of T2DM patients, with higher prevalence in those over 60 years, HbA1c >10%, and diabetes duration >15 years. Our study found similar trends, with 100% LVDD prevalence in patients over 75 years, 83.87% in those with HbA1c >10%, and 100% in those with diabetes duration >20 years.

V Suresh Kumar et al. (2017) [6] found LVDD in 66% of T2DM patients with normal systolic function, emphasizing the importance of E/A ratio and color flow Doppler in LVDD evaluation. Our study corroborated these findings, noting significant changes in E/A ratio, deceleration time, isovolumetric relaxation time, and venous flow Doppler parameters.

Jasna Cerkez Habek et al. (2014) [7] reported LVDD in 79% of T2DM patients, with varying grades of dysfunction. Our study found similar results, with 78.89% LVDD prevalence and a distribution of 41.11% grade I, 34.44% grade II, and 3.33% grade III LVDD. Both studies noted a significant association between LVDD grade and diabetes duration.

Madhumathi R (2014) [4] observed higher LVDD prevalence in older age groups, longer diabetes duration, and higher HbA1c levels. Our study confirmed these trends, finding higher LVDD rates in patients aged 45-54 years (79.3%) compared to 35-44 years (8.3%), in those with diabetes duration >11 years (93.1%) compared to 0-5 years (58.9%), and in those with HbA1c >10% (83.8%) compared to 6.4-7% (70.5%).

Virendra C. Patil (2011) [8] reported a 54.33% LVDD prevalence in T2DM patients, while our study found a higher prevalence of 78.89%. Both studies noted increased LVDD incidence with longer diabetes duration, higher HbA1c levels, and advancing age.

Mikael Kjaer (2010) [9] screened 305 T2DM patients without cardiovascular disease, finding 40% LVDD prevalence. Our study observed a higher prevalence of 78.89%, possibly due to differences in study population or methodology. Both studies noted higher grades of LVDD in older age groups.

Conclusion

This study demonstrates a high prevalence of left ventricular diastolic dysfunction (LVDD) in patients with type 2 diabetes mellitus, even in the absence of overt cardiovascular disease. The presence and severity of LVDD exhibited significant correlations with patient age, duration of diabetes, and glycated hemoglobin (HbA1c) levels.

Doppler echocardiography proved to be an excellent non-invasive modality for assessing and quantifying LVDD. The utilization of various echocardiographic parameters, including the E/A ratio, E/E' ratio, isovolumetric relaxation time (IVRT), and deceleration time (DT), provided comprehensive insights into left ventricular diastolic function.

The findings of this study underscore the importance of early detection of diastolic heart failure (DHF) in patients with type 2 diabetes mellitus. Early identification and management of LVDD may lead to improved clinical outcomes and potentially reduce the incidence of mortality and morbidity associated with DHF in this patient population. These results highlight the need for routine echocardiographic screening in diabetic patients, even in the absence of clinical symptoms of cardiovascular disease.

References

1. Ta S (2014) Diagnosis and classification of diabetes mellitus. Diabetes care. 37: 81–90.
2. Lilly LS, Braunwald E (2012) Braunwald's heart disease: a textbook of cardiovascular medicine. Elsevier Health Sciences.
3. Patil MB, Burji NPA (2012) Echocardiographic evaluation of diastolic dysfunction in asymptomatic type 2 diabetes mellitus. J Assoc Physicians India. 60:23–6.
4. Madhumathi R, Gowdaiah PK, Dudhwewala A, Chaithra AN, Dande T (2014) Echocardiographic evaluation of diastolic dysfunction in asymptomatic type 2 diabetes mellitus patients. J Evol Med Dent Sci. 3: 200–209.
5. Armstrong WF, Ryan T (2012) Feigenbaum's echocardiography. Lippincott Williams & Wilkins.
6. Porel R, Shyama S, Ahmad S, Kumar N, Ahmad S, et al. (2024) Can glycated haemoglobin (HbA1c) be used as a predictor of left ventricular diastolic dysfunction in non-hypertensive patients with newly diagnosed type 2 diabetes mellitus: a cross-sectional study at a tertiary care centre in Eastern India. BMJ Open. 14: e081269.
7. Habek JC, Lakusic N, Kruzliak P, Sikic J, Mahovic D, et al. (2014) Left ventricular diastolic function in diabetes mellitus type 2 patients: correlation with heart rate and its variability. Acta Diabetol. 51:999–1005.
8. Patil VC, Patil HV, Shah KB, Vasani JD, Shetty P (2011) Diastolic dysfunction in asymptomatic type 2 diabetes mellitus with normal systolic function. J Cardiovasc Dis Res. 2: 213–22.
9. Poulsen MK, Henriksen JE, Dahl J, Johansen A, Gerke O, et al. (2010) Left ventricular diastolic function in type 2 diabetes mellitus: prevalence and association with myocardial and vascular disease: Prevalence and association with myocardial and vascular disease. Circ Cardiovasc Imaging. 3: 24–31.