RESEARCH PAPER

ASSESSMENT OF SUBCLINICAL LEFT VENTRICULAR SYSTOLIC AND DIASTOLIC FUNCTION IN PATIENTS WITH TYPE 2 DIABETES MELLITUS USING ECHOCARDIOGRAPHIC PARAMETERS

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ABSTRACT

Introduction: Type 2 diabetes is an important risk factors for myocardial disease. it is associated with structural and functional changes that reduce left ventricular dysfunction and may remain silent in early stages of disease condition. Chronic hyperglycemia can cause structural and functional changes in myocardium, leading to diabetic cardiomyopathy. The increasing prevalence of T2DM has contributed to a growing burden of cardiovascular complications. Persistent metabolic abnormalities associated with diabetes may result in changes in myocardial dysfunction. These changes can occur before the development of clinically evident cardiovascular disease. Echocardiography can detect subtle abnormalities using parameters such as EDV, ESV, EF, E', E/A, E/E, and deceleration time. This study assessed subclinical left ventricular systolic and diastolic function in patients with T2DM using echocardiography.

Materials and methods: This cross-sectional study was conducted at Vels Medical College and Hospital, Thanakulam, India. Every participant was categorized into three groups which are diabetes, diabetes with hypertension, and healthy controls. Every participant was undergoing transthoracic echocardiography. Clinical and demographic data were collected. statistical analysis was using IBM SPSS Statistics version 25.0. A p-value <0.05 was statistically significant.

Results: Our cross sectional study included a total of 150 participants, with 50 participants in each group. One-way ANOVA showed significant differences among the groups for age, LVIDd, ESV, EDV, ejection fraction, e′ velocity, E/A ratio, E/e′ ratio, and deceleration time. LVIDs and RVSP did not differ significantly among the groups. Pearson's chi-square analysis demonstrated significant association between study group and grade of diastolic dysfunction (χ^2=56.558, df=6, p<0.001).

Conclusion: Type 2 diabetes mellitus is highly prevalent in patients particularly those with hypertension, showed subclinical left ventricular diastolic dysfunction. Echocardiographic parameters used to identify early myocardial structural and functional changes.

Keywords: Diabetes Mellitus, Type 2, Diabetic Cardiomyopathies, Echocardiography.

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INTRODUCTION

The cardiovascular structure and function is mainly caused in patients with T2DM lead to morbidity and mortality rate increases. The processes underlying the development and progression of CVD contribute to structural and functional remodeling of the myocardium, that lead to adverse effect left ventricular function and remain clinically silent in the early stages.

T2DM is currently a major global health concern, with its incidence and prevalence increasing worldwide. It is also becoming more common in children and adults due to similar lifestyle variables and

pathophysiological mechanisms. Hypertension and T2DM frequently coexist. Research indicates that hypertension is common in individuals with T2DM and is more prevalent among hospitalized patients.

Diabetic cardiomyopathy is a distinct myocardial disorder characterized by structural and functional abnormalities of the heart in patients with diabetes mellitus, independent of hypertension, coronary artery disease, valvular heart disease, or other known cardiac conditions. The condition was first recognized as a separate clinical entity because many patients with diabetes developed myocardial dysfunction despite the absence of significant coronary artery disease. The pathogenesis of diabetic cardiomyopathy is multifactorial and involves metabolic disturbances, oxidative stress, inflammation, microvascular dysfunction, autonomic neuropathy, myocardial fibrosis, and altered calcium homeostasis.

Persistent hyperglycemia plays a central role in the development of diabetic cardiomyopathy. Elevated blood glucose levels promote the formation of advanced glycation end-products (AGEs), which accumulate within the myocardium and increase collagen deposition. This results in myocardial fibrosis, reduced ventricular compliance, and impaired myocardial relaxation. In addition, oxidative stress and chronic inflammation further damage cardiomyocytes by causing cellular injury, mitochondrial dysfunction, and apoptosis. These pathological changes ultimately impair both systolic and diastolic function of the left ventricle.

The earliest manifestation of diabetic cardiomyopathy is usually left ventricular diastolic dysfunction, which often occurs before abnormalities in systolic function become evident. Diastolic dysfunction refers to impaired relaxation and reduced compliance of the left ventricle during diastole, leading to abnormal ventricular filling and increased filling pressures. Patients with early diastolic dysfunction are frequently asymptomatic, making diagnosis difficult without appropriate imaging techniques. If left undetected, progressive diastolic dysfunction may eventually lead to heart failure with preserved ejection fraction (HFpEF).

Although left ventricular systolic function generally remains preserved during the initial stages of diabetes, subtle impairment in myocardial contractility may already be present. Conventional assessment using left ventricular ejection fraction (LVEF) may fail to detect these early abnormalities because compensatory mechanisms maintain a normal ejection fraction despite underlying myocardial damage. Therefore, patients with apparently normal systolic function may still have subclinical left ventricular systolic dysfunction that can only be identified using more sensitive echocardiographic parameters.

Subclinical left ventricular dysfunction refers to myocardial impairment that is detectable by imaging techniques before the appearance of clinical symptoms or overt heart failure. Early detection of subclinical systolic and diastolic dysfunction is clinically important because it provides an opportunity for timely intervention before irreversible myocardial damage occurs. Appropriate glycemic control, risk factor modification, and evidence-based medical therapy may delay or prevent the progression of diabetic cardiomyopathy and reduce the incidence of heart failure.

Since these structural and functional changes remain clinically silent for many years, regular cardiovascular assessment has become an essential component of diabetes management. Echocardiography serves as an invaluable diagnostic tool for identifying these early abnormalities, allowing clinicians to evaluate both systolic and diastolic function non-invasively. Early recognition of myocardial dysfunction in patients with Type 2 Diabetes Mellitus contributes significantly to improved prognosis, better treatment strategies, and enhanced quality of life.

Heart failure with an intact ejection fraction (EF) has emerged as an enormous worldwide epidemic in recent decades, and developing type 2 diabetes is a risk factors for the development LV dysfunction.

Approximately 529 million people worldwide developed diabetes in 2021, while that number is anticipated to rise by almost 1.3 billion by 2050, according to the global burden of disease research.

Lifestyle are driving this increase, which is significantly straining the already fragile health care system.

Type 2 diabetes is an important risk factors for myocardial disease. It is associated with structural and functional changes in myocardium may adversely affect the left ventricular function and remain clinically silent during the early stages. Echocardiography parameters can be used to detect these subtle changes.

The increasing prevalence of T2DM has contributed to a growing burden of cardiovascular complications. Persistent metabolic abnormalities associated with diabetes may result in changes in myocardial structure and function. These changes can occur before the development of clinically evident cardiovascular

disease. In addition, hypertension commonly coexists with T2DM and may further contribute to left ventricular structural and functional abnormalities.

Echocardiography is a noninvasive diagnostic tool .it is used to assess the subclinical left ventricular systolic and diastolic function.

Conventional two-dimensional and Doppler echocardiography were used to assess **LVIDd, LVIDs, EDV, ESV and LVEF** for systolic function. Transmitral **E wave, A wave, E/A ratio and deceleration time (DT)** used to assessed the diastolic dysfunction**.** Tissue Doppler Imaging was used to measure the **early diastolic mitral annular velocity (e′)**, and the **E/e′ ratio** was calculated to assess left ventricular filling pressure.

AIM

To assess subclinical left systolic and diastolic dysfunction in patients, with Type 2 diabetes mellitus using echocardiographic parameters.

OBJECTIVE

To evaluate subclinical left systolic and left diastolic function in patients with Type 2 diabetes mellitus using echocardiographic parameters.

MATERIALS AND METHODS

A cross-sectional study was performed at Vels Medical College and Hospital from September 2025 to February 2026.In every participant were divided into three groups which are Group 1 (diabetes), Group 2 (diabetes with hypertension), and Group 3 (healthy controls), with 50 participants in each group. Echocardiography parameters were used to assess the left ventricular systolic and diastolic dysfunction. Statistical analysis was using IBM SPSS Statistics version 25.0.

Formulae:

• Ejection fraction = [(End diastolic velocity – End systolic velocity) / EDV] × 100%

• E/e′ ratio = ratio of E wave to e′ velocity

• E/A ratio = ratio of E wave to A wave

RESULTS

Every participant of 150 were included in the study, comprising 50 participants in each of the three groups. Group 1 participants with diabetes, Group 2 of participants with diabetes and hypertension, and Group 3 participants of healthy controls

Table 1. One-way ANOVA comparing echocardiographic parameters among the three study groups

Parameter	Group 1 (Diabetes) Mean ± SD	Group 2 (Diabetes + HTN) Mean ± SD	Group 3 (Controls) Mean ± SD	F-value	p-value	Significance
Age (years)	40.74 ± 16.10	54.02 ± 13.64	56.22 ± 12.56	17.492	<0.001	Significant
LVIDd (mm)	44.64 ± 2.86	42.00 ± 0.00	44.46 ± 1.99	27.464	<0.001	Significant
LVIDs (mm)	26.72 ± 1.90	27.75 ± 6.37	26.94 ± 1.87	0.919	0.401	Not significant
ESV (mL)	53.66 ± 25.13	60.10 ± 14.29	72.14 ± 9.79	14.209	<0.001	Significant
EDV (mL)	93.82 ± 34.67	138.67 ± 38.47	169.26 ± 27.56	62.638	<0.001	Significant
EF (%)	62.90 ± 1.64	61.41 ± 4.37	59.98 ± 3.82	8.755	<0.001	Significant
e′ velocity (cm/s)	6.780 ± 1.148	5.039 ± 1.058	9.630 ± 2.247	427.950	<0.001	Highly significant
E/A ratio	1.248 ± 0.408	0.914 ± 0.265	1.504 ± 0.744	428.098	<0.001	Highly significant

E/e′ ratio	8.52 ± 2.30	7.71 ± 1.59	7.72 ± 1.59	3.167	0.045	Significant
Deceleration time (DT) (ms)	181.72 ± 46.12	214.84 ± 40.94	202.70 ± 40.38	8.066	0.001	Significant
RVSP (mmHg)	33.84 ± 1.87	32.80 ± 1.21	33.12 ± 4.39	1.654	0.195	Not significant

One-way ANOVA showed statistically significant differences among the three groups for age, LVIDd, ESV, EDV, EF, e′ velocity, E/A ratio, E/e′ ratio and DT. LVIDs and RVSP did not show statistically significant differences among the groups.

PEARSON CHI-SQUARE ANALYSIS

Table 2. Pearson's chi-square analysis of diastolic dysfunction grade

Variable	χ^2 value	df	p-value	Significance
Diastolic dysfunction grade	56.558	6	<0.001	Significant

Pearson's chi-square analysis showed statistically significant association between study group and grade of diastolic dysfunction (χ^2=56.558, df=6, p<0.001).

INDEPENDENT SAMPLES T-TEST

Table 3. Independent-samples t-test

Parameter	Groups compared	p-value	Interpretation
Ejection Fraction (EF)	Diabetes vs Diabetes + HTN	0.026	Significant
E/A ratio	Diabetes vs Diabetes + HTN	<0.001	Significant

Independent-samples t-test showed a statistically significant difference in EF between the diabetes and diabetes with hypertension groups (p=0.026). A statistically significant difference was also observed in the E/A ratio between these groups (p<0.001).

TUKEY POST HOC ANALYSIS

Table 4. Tukey post hoc analysis

Parameter	Post hoc test	Result
Age	Tukey HSD	Significant pairwise differences observed
LVIDd	Tukey HSD	Significant pairwise differences observed
ESV	Tukey HSD	Significant pairwise differences observed
EDV	Tukey HSD	Significant pairwise differences observed
EF	Tukey HSD	Significant pairwise differences observed
e′ velocity	Tukey HSD	Significant pairwise differences observed
E/A ratio	Tukey HSD	Significant pairwise differences observed

E/e′ ratio	Tukey HSD	Significant pairwise differences observed
DT	Tukey HSD	Significant pairwise differences observed
LVIDs	Tukey HSD	Not performed (ANOVA not significant)
RVSP	Tukey HSD	Not performed (ANOVA not significant)

DISCUSSION

The earliest manifestation of diabetic cardiomyopathy is usually left ventricular diastolic dysfunction, which often occurs before abnormalities in systolic function become evident. Diastolic dysfunction refers to impaired relaxation and reduced compliance of the left ventricle during diastole, leading to abnormal ventricular filling and increased filling pressures. Patients with early diastolic dysfunction are frequently asymptomatic, making diagnosis difficult without appropriate imaging techniques. If left undetected, progressive diastolic dysfunction may eventually lead to heart failure with preserved ejection fraction (HFpEF).

Although left ventricular systolic function generally remains preserved during the initial stages of diabetes, subtle impairment in myocardial contractility may already be present. Conventional assessment using left ventricular ejection fraction (LVEF) may fail to detect these early abnormalities because compensatory mechanisms maintain a normal ejection fraction despite underlying myocardial damage. Therefore, patients with apparently normal systolic function may still have subclinical left ventricular systolic dysfunction that can only be identified using more sensitive echocardiographic parameters.

Subclinical left ventricular dysfunction refers to myocardial impairment that is detectable by imaging techniques before the appearance of clinical symptoms or overt heart failure. Early detection of subclinical systolic and diastolic dysfunction is clinically important because it provides an opportunity for timely intervention before irreversible myocardial damage occurs. Appropriate glycemic control, risk factor modification, and evidence-based medical therapy may delay or prevent the progression of diabetic cardiomyopathy and reduce the incidence of heart failure. Since these structural and functional changes remain clinically silent for many years, regular cardiovascular assessment has become an essential component of diabetes management. Echocardiography serves as an invaluable diagnostic tool for identifying these early abnormalities, allowing clinicians to evaluate both systolic and diastolic function non-invasively.

Early recognition of myocardial dysfunction in patients with Type 2 Diabetes Mellitus contributes significantly to improved prognosis, better treatment strategies, and enhanced quality of life. A cross-sectional study was performed at Vels Medical College and Hospital from September 2025 to February 2026.In every participant were divided into three groups which are Group 1 (diabetes), Group 2 (diabetes with hypertension), and Group 3 (healthy controls), with 50 participants in each group. Echocardiography parameters were used to assess the left ventricular systolic and diastolic dysfunction. Statistical analysis was using IBM SPSS Statistics version 25.0.

Conventional two-dimensional and Doppler echocardiography were used to assess **LVIDd, LVIDs, EDV, ESV and LVEF** for systolic function. Transmitral **E wave, A wave, E/A ratio and deceleration time (DT)** used to assessed the diastolic dysfunction**.** Tissue Doppler Imaging was used to measure the **early diastolic mitral annular velocity (e′)**, and the **E/e′ ratio** was calculated to assess left ventricular filling pressure. These findings may be associated with echocardiography abnormalities contributed to the pathophysiological mechanism of diabetic cardiomyopathy alternations majorly caused by chronic hyperglycemia that indicates stress and persistent inflammation. ventricular remodeling, increased myocardial stiffness and impaired myocardial relaxation resulting in (RAAS) caused by insulin resistance activates the sympathetic nervous system. Left ventricular systolic function remain preserved even before the abnormalities occurs in myocardium. The complex interplay between hyperglycemia insulin may be contribute the developed of diabetic cardiovascular complication.

CONCLUSION:

Our cross sectional study demonstrates that patients with T2DM especially when complicated by hypertension showed evidence of developing subclinical left ventricular diastolic dysfunction at early stages. Therefore, tissue Doppler measurements of e’ an E/e’ ratio as well as Doppler parameters such

as DT and E/A ratio may help to identify the early detection of LV in patients with T2DM and hypertension.

LIMITATIONS OF THE STUDY

- The study was conducted at a single center.
- It does not allow assessment of the progression of cardiac dysfunction over time.
- The study primarily focused on conventional echocardiographic and tissue Doppler parameters for assessment of LV function.
- Global longitudinal strain (GLS) were not included, although these may detect subtle myocardial dysfunction at an earlier stage.
- Long-term was not follow-up, so the progression of subclinical LV dysfunction could not be assessed.
- Further larger, multicenter prospective studies are recommended to validate the findings.

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