

Original Research Article

An Echocardiographic evaluation of left ventricular diastolic dysfunction in asymptomatic, normotensive patients with type 2 diabetes mellitus at tertiary centre

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Abstract: Diabetes Mellitus is a disease with multi-system complications. Left ventricular diastolic dysfunction (LVDD) represents the first stage of diabetic cardiomyopathy preceding changes in systolic function, reinforcing the importance of early examination of ventricular function in individuals with diabetes mellitus (DM). Doppler echocardiography is reliable noninvasive means to assess early diastolic dysfunction. The aim is to study the prevalence of LV diastolic dysfunction in asymptomatic, normotensive patients with diabetes mellitus. A study was carried out on 50 normotensive diabetic patients and compared with 50 age and sex matched controls. In all the patients, detailed history, physical examination and specific investigations (conventional Doppler echocardiography at rest) were done to find out the prevalence of diastolic dysfunction. The study group of 100 patients were of age 30-55years, 50 type 2 diabetic patients and 50 non-diabetic controls had 32 males and 18 females in both the groups respectively. Among 50 Type 2 DM cases 29 (58%) had LV diastolic dysfunction. Out of 32 males, 20 males (62.5%) and out of 18 females, 9 females (50%) had diastolic dysfunction. LVDD is common in patients with type 2 DM even in normotensive patients independent of confounding effect of hypertension, ischemia and BMI. We conclude that early diagnosis and institution of treatment will reduce morbidity and improve the outcomes, and prevent future heart failure.

Keywords: LVDD (left ventricular diastolic dysfunction), DM (diabetes mellitus), Doppler echocardiography, E/A ratio

INTRODUCTION

Diabetes mellitus (DM) is a common endocrine disorder affecting around 387 million people worldwide [1]. The Indian Council of Medical Research-Indian Diabetes Study (ICMR-INDIA), a national DM study, estimates that currently India has 62.4 million people with DM [2]. The incidence of diabetes mellitus (DM) is increasing worldwide and rapidly assuming epidemic proportions.

A number of studies have reported a high prevalence of pre-clinical diastolic dysfunction among subjects with DM [3]. Diabetes mellitus is one of the major risk factors for diastolic heart failure (DHF). The mortality rates among the patients with DHF ranges from 5-8% annually as compared with 10-15% among patients with systolic heart failure [4]. Diastolic heart failure (HF) is also referred to as HF, with preserved left ventricular systolic function. The evidence indicates

that myocardial damage in diabetic subjects affects diastolic function before the systolic function.

The pathogenesis of this left ventricular (LV) dysfunction in diabetic subjects is not clearly understood. It has been proposed that diabetic cardiomyopathy is an independent cardiovascular disease and many underlying mechanisms, such as microvascular disease, autonomic dysfunction, metabolic disorders, and interstitial fibrosis, have been suggested as etiological factors [5]. Diastolic dysfunction in diabetic patients is believed to represent an earlier stage in the natural history of diabetic cardiomyopathy, its timely recognition may help to avoid or significantly delay the onset of CHF [6]. The early and commonest hemodynamic derangement of diabetic cardiomyopathy is left ventricular diastolic dysfunction [7]. The objective of our study was to determine whether there is any association between

diastolic dysfunction and type 2DM, even in the asymptomatic subjects.

METHODS

A total of 50 normotensive subjects (cases), with type 2 DM with no clinical evidence of cardiac disease were studied. A total 50 apparently healthy subjects with age and sex matched were included as the control group. This case control study was designed to determine the prevalence of asymptomatic left ventricular diastolic dysfunction in type2 DM subjects. This was a case-control prospective, observational study conducted out at SDM college of Medical Sciences and Hospital. This study was approved by the institutional ethical committee.

Inclusion criteria

All Type 2 DM patients with normal left ventricular systolic function (LVEF: $\geq 50\%$).

Exclusion criteria

- Subjects with evidence of coronary artery disease
- Coronary artery disease [excluded by history of angina, chest pain, Electrocardiogram Changes and abnormal, Treadmill test results];
- Subjects with evidence of valvular disease;
- Hypertensive patients,;
- Subjects with poor transthoracic echo window.
- Patients above 55 years of age.

The diagnosis of type 2 diabetes was made by WHO criteria-

- 1) Symptoms of diabetes plus random blood glucose concentration ≥ 1.1 mmol/L (200mg/dL). OR
- 2) Fasting plasma glucose ≥ 7.0 mmol/L (126mg/dL). OR
- 3) Two hour plasma glucose ≥ 11.1 mmol/L (200mg/dL) during an oral glucose tolerance test.

Detailed history and clinical examination were done in all patients. Investigations like FBS, PPBS, blood urea, serum creatine, serum cholesterol, x-ray Chest, ECG, Doppler echocardiography, urine and blood routine examination and Fundus examination was done. Patients with low ejection fraction were excluded from study. Doppler echocardiography was done in each patient and 3-4 cardiac cycles were analyzed to get best phase for better outcome of results. 2-Dimensional Mmode images were obtained and ejection fraction was calculated in all patients.

In Doppler study, following values were studied.

- a) E-Peak velocity of early mitral flow.
- b) A-Peak velocity of late mitral flow.
- c) E/A ratio.
- d) VTIM- Velocity time integral of entire mitral curve.
- e) VTIA- Velocity time integral of atrial curve.
- f) VTIA/VTIM ratio.
- g) PHT- Pressure half time.
- h) IRT- Isovolumic relaxation time

Reduction in E velocity, increase in A velocity, E/A ratio less than 1.0 and prolonged IRT were considered as the evidence of left ventricular diastolic dysfunction.

DATA ANALYSIS:

The results were analyzed by calculating percentages, and the mean values. Statistical software: The statistical software namely SPSS 15.0 and SYSTAT 11.0 were used for the analysis of the data and Microsoft word and excel have been used to generate the tables. Interval data are expressed as Mean \pm SD and between groups is compared by student's t-test. Categorical data are analyzed by Chi-square test. A 'P' value of less than 0.05 was considered significant.

RESULTS

In the present study of hundred patients i.e. fifty cases and fifty controls with age ranging from 30-55 years were included. Among 50 cases, 32 were males (64%) and 18 cases were females (36%). Among 50 controls, 32 were males (64%) and 18 cases were female (36%) (Table 1). Among 50 diabetic patients 29 had diastolic dysfunction (58%), in that 20 patients were males and 9 patients were females (Table 2). Prevalence of LVDD in study subjects according to sex is depicted in (Table 3).

Peak velocity of early mitral flow (E) in controls was 81.6 ± 5.1 cm and 70.6 ± 8.22 cm in type 2 diabetics. There is significant reduction of E value compared to controls ($P < 0.001$). Peak velocity of late mitral flow (A) in controls was 50.24 ± 4.17 cm and 66.22 ± 9.37 cm in diabetics. There is significant increase in 'A' value compared to controls ($P < 0.001$). E/A ratio was significantly reduced in diabetics as compared to controls (1.09 ± 0.24 Vs 1.63 ± 0.17) $P < 0.001$. Isovolumic relaxation time was also significantly prolonged in diabetics as compared to controls (80.2 ± 11 Vs 72.0 ± 3.9) $P < 0.001$. Velocity time integral of entire mitral curve (VTIM) was 14.172 ± 2.4 cm in control subjects and 11.5 ± 3.9 in diabetics which is significant ($P < 0.001$). Velocity time integral of atrial curve (VTIA) was 1.63 ± 0.17 cm in controls and $3.57 \pm$

1.11 cm was significant (P=0.05).VTIA / VTIM ratio was significant with P = 0.0074. Pressure half time was significantly prolonged in diabetics compared to controls (56.86 + 8.504 Vs 48.96 + 2.8) (P < 0.001) (Table 4).

Table 1: Distribution of according to age and sex in the study

Age	Male	Percentage	Female	Percentage
35-40	17	17	6	6
41-45	13	13	7	7
46-50	26	26	17	17
51-55	8	8	6	6
Total	64		36	

Table 2: Distribution of diastolic dysfunction according to age in study group

Age (yrs)	Without LVDD	Percentage	With LVDD	Percentage
35-40	8	16	4	8
41-45	4	8	6	12
46-50	9	18	12	24
51-60	0	0	7	14
Total	21	42	29	58

$\chi^2=8.08$; d.f=3; p-value=0 .0442 (S)

Table 3: Incidence and comparison of LVDD among males and female diabetics

LVDD	Male	Percentage	Female	Percentage
Present	20	40	9	18
Absent	12	24	9	18
Total	32		18	

$\chi^2=0.74$; p=0.39 (NS)

Table 4: Comparison of Doppler echocardiographic values among control group and diabetic group

Echo Cardiaographic parameters	Cases	Controls	P -Value	Significance
E	70.6 + 8.221	81.6 + 5.142	<0.001	HS
A	66.22 + 9.37	50.24 + 4.17	<0.001	HS
E/A	1.09 + 0.24	1.6358 + 0.175	<0.001	HS
VTIM	11.478 + 3.885	14.172 + 2.404	<0.001	HS
VTIA	3.57 + 1.111	3.28 + 0.616	=0.055	S
VTIA/VTIM	0.2859 + 0.099	0.241 + 0.077	=0.0074	HS
PHT ms	56.86 + 8.504	48.96 + 2.863	<0.001	HS
IRT ms	80.2 + 11.067	72.024 + 3.97	<0.001	HS
EF %	67.68 + 8.981	76.0 + 5.114	<0.001	HS

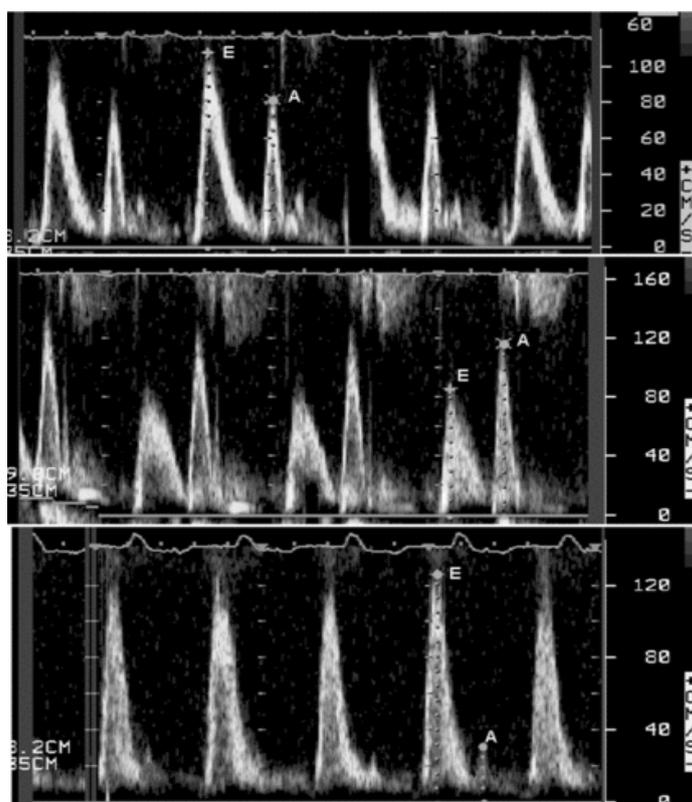


Fig 1: Doppler echocardiography to assess LVDD

DISCUSSION

Diastolic dysfunction may be the earliest marker of a diabetes induced heart muscle disease which leads to the progressive development of cardiac failure [8]. Myocardial damage in patients with diabetes affects diastolic function before systolic function [9]. In 1996, Di Bonito *et al.*; demonstrated that an impairment of left ventricular diastolic function occurs early in the natural history of NIDDM and this abnormality is unlikely to be related to clinical evidence of micro angiopathic complication [10]. Fiorini G *et al.*; in 1995 evaluated LV diastolic function in 30 type 2 diabetic patients without coronary artery disease and concluded that, E/A ratio and Isovolumic relaxation time are significantly altered in non insulin dependent diabetic patient without coronary artery disease [11]. Paul Poirier *et al.*; 2001 evaluated 40 diabetic patients without clinical evidence of cardiac disease by Doppler echocardiography and came to the conclusion that diastolic function in diabetic patients were impaired even though they had normal systolic function [12]. Schannwell CM *et al.*; in 1999 evaluated 92 type I patients without known cardiac disease and 50 controls with Doppler echocardiography and concluded that even young type 1 diabetic patients with normal systolic ventricular function suffer diastolic dysfunction which

serves as a marker of a diabetic cardiomyopathy [13]. Our present study revealed that, echo Doppler can detect diastolic dysfunction in diabetic subjects much before clinical symptoms appear. Peak velocity of early mitral flow 'E' was significantly lower in diabetic patients compared to non diabetics. Our study results regarding this were similar to earlier studies. Doppler echocardiography is a reliable non invasive means to assess early diastolic dysfunction of left ventricle [14].

Limitations of the Study:

Measurement of mitral inflow velocities is dependent on sample volume location which moves during cardiac cycles and respiration. The different mitral flow velocity indices are dependent on many factors such as left ventricular relaxation, left atrial pressure and left ventricular passive distensibility, that cannot be ascertained without sophisticated catheterization.

CONCLUSION:

In our study diastolic dysfunction was observed in 58% of type 2 DM cases studied. Peak velocity of early mitral flow (E) were low in diabetes (70.6 ± 8.2) as compared to control (81.6 ± 5.1) $P < 0.001$. Peak velocity of late mitral flow value (A) were

significantly high in diabetes (66.2 + 9.3) as compared to control (50.2 + 4.1) $P < 0.001$). E/A ratio was significantly low in diabetes (1.09 + 0.24) compared to controls (1.63 + 0.17) $P < 0.001$.

Doppler echocardiography is a valuable non invasive method to detect left ventricular diastolic impairment and the intentional assessment of diastolic function is advisable for early detection of LV dysfunction before clinical symptoms appear with follow up to detect further deterioration of cardiac status irrespective of type of diabetes. We conclude that early diagnosis and institution of treatment for diastolic dysfunction in the form of ACE inhibitors, angiotensin II receptor blockers, aldosterone antagonists, diuretics etc. depending on clinical scenario, will reduce the morbidity and improve the outcome of diastolic HF.

DECLARATIONS

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Conflict of interest: none declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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