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Original Research Article

Study of Left Ventricular Diastolic Dysfunction in Non Hypertensive Asymptomatic Patient with Type 2 Diabetes Mellitus

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Abstract:

Background: Chronic hyperglycemia and abnormalities in the metabolism of carbohydrates, fats, and proteins are features of the syndrome known as diabetes mellitus, which is also characterised by an absolute or relative lack of insulin secretion and/or action. Congestive heart failure has been observed in diabetic people even in the absence of coronary heart disease, hypertension, or any other known structural heart disease. The objectives of this study were to examine the echocardiographic results in non-hypertensive T2DM patients and to evaluate the diastolic functions and their relationship to various parameters.

Methods: From January 2022 to December 2022, this cross-sectional study was carried out at the JLNMCH in Bhagalpur, Bihar, outpatient department of medicine. There were 50 patients enrolled in all. The study included all patients of type 2 diabetes mellitus (DM) reported at the OPD of Medicine with blood pressure less than 130/80. A predesigned semi-structured questionnaire was used to collect the data.

Results: Out of the 50 instances, diastolic dysfunction was present in 34 (68%) of them, with poor relaxation accounting for 27 (54%) of these cases, pseudonormality for 5 (10%), and restricted filling for 2 (4%) of them. Age, the length of diabetes, HbA1c levels, and the presence of retinopathy were revealed to be statistically significant (p 0.05) correlates of diastolic dysfunction. According to echocardiographic findings, there was a significant (p0.05) correlation between E/A, IVRT m-s, Deceleration time, and E/e' and diastolic dysfunction.

Conclusion: Patients with type II diabetes mellitus who have no clinically apparent heart disease have a higher frequency of left ventricular diastolic dysfunction.

Keywords: Diabetes mellitus, cross sectional study, predesigned semi-structured questionnaire, diastolic dysfunction.

Introduction

Chronic hyperglycemia and abnormalities in the metabolism of carbohydrates, fats, and proteins are features of the syndrome known as diabetes mellitus, which is also characterised by an absolute or relative lack of insulin secretion and/or action. The aetiology and prognosis of diabetes are influenced by a variety of hereditary and environmental variables. Diabetes mellitus used to be viewed as an expensive disease. It is now clear that factors such as population ageing, urbanisation, increased intake of refined foods, westernisation, sedentary lifestyles, and overnutrition are contributing to the rise in diabetes mellitus.[1,2]

By 2025, the World Health Organisation predicts that India would have the greatest proportion of diabetes people worldwide, with one in five of these people being Indian. The "Diabetic capital of the world" will be India.[1,2] By 2025, the number is anticipated to reach 5.72 crore, according to the WHO. A diabetes epidemic will most certainly be brought on by the rapid population growth, longer life expectancies, high ethnic sensitivity to the disease, rapid urbanisation, and departures from traditional lifestyles.[1,2]

A key contributor to early mortality, disability, and high healthcare expenses is diabetes mellitus. It is a silently fatal condition. Congestive heart failure has been observed in diabetic people even in the absence of coronary heart disease, hypertension, or any other known structural heart disease.[3] For this ailment, the term "diabetic cardiomyopathy" has been coined. The pathophysiology of diabetic cardiomyopathy has been hypothesised to entail microangiopathic lesions of the myocardium, altered composition and fibrosis of the cardiac interstitium, and accumulation of lipids in myocardial cells.[4,5] Asymptomatic patients with Type 1 or Type 2 diabetes mellitus exhibit impaired diastolic function as an early sign of cardiac involvement, according to studies utilising Doppler echocardiography.[6]

A worsened myocardial dysfunction that accelerates heart failure (diabetic cardiomyopathy) seems to be one cause of the poor prognosis in patients with both diabetes and ischemic heart disease. By using the variables (E/A, IVRT, DT, and E/e') used to measure the diastolic functions of the heart, diastolic dysfunction can be extremely simply and early recognised by echocardiography.

Diabetic cardiomyopathy may be prevented or lessened by better glucose control, better hypertension management, and atherosclerosis prevention with cholesterol-lowering therapy. Sulfonylureas, which are used to manage hyperglycemia, may worsen diabetic cardiomyopathy, according to a preliminary clinical research. A recent big clinical investigation, however, could not corroborate this side effect.[7] However, as evidence for myocardial dysfunction in diabetes patients without ischemic, valvular, or hypertensive heart disease has developed, the notion of a primary myocardial illness known as "diabetic cardiomyopathy" has been hypothesised.[8] Therefore, the study objectives were to examine the echocardiographic results in T2DM patients without hypertension and to evaluate the diastolic functions and their relationships to various variables.

Material and Methods

From January 2022 to December 2022, the current observational cross-sectional study was carried out on adult patients with type 2 diabetes mellitus (DM) who visited the outpatient department of Jawaharlal Nehru Medical College and Hospital in Bhagalpur, Bihar. 50 patients in all were enrolled in the trial. After explaining the study's nature and goals to each participant, their informed consent was obtained. On the basis of inclusion and exclusion criteria,

participants were enrolled. A thorough clinical examination was done in addition to data collection using a predesigned semi-structured questionnaire that included information on participant baseline characteristics. ECG testing and biochemical research were also carried out.

In this study, type 2 diabetes mellitus cases that met the following criteria: age range of 25 to 60; blood pressure of less than 130/80; and at least three measurements, with the highest measurement being taken into account. This study excluded participants having a history of acute coronary syndrome, Rheumatic heart disease, documented overt renal disease, such as CRF, diabetes with a duration of more than 10 years, cardiac signs and symptoms, exertional dyspnea, chest discomfort, and a history of hypertension. MS Excel was used to compile and analyse the data. Frequency and percentages were used to express categorical variables. The Chi-Square test was employed to examine proportional differences. A P value of <0.05 was regarded as statistically significant.

Results

Table 1: Distribution of study participants on the basis of echocardiographic evaluation

Echocardiographic evaluation	Number of Patients	Percentage
Normal	16	32.0%
Impaired relaxation	27	54.0%
Pseudonormal	5	10.0%
Restricted filling	2	4.0%

The distribution of study participants is shown in Table 1 based on the results of the echocardiographic evaluation. Of the 50 cases, diastolic dysfunction was present in 34 (68%) of them, while poor relaxation was seen in 27 (54%) of them. 2 cases (4%) had restricted filling, while 5 cases (10%) had pseudonormal filling.

Table 2: Association of diastolic dysfunction with baseline characteristics of study participants

Variable	Category	No. of cases (%)	Diastolic dysfunction		Chi square, p value
			Present (%)	Absent (%)	
Sex	Male	28(56.0%)	19(67.86%)	9(32.14%)	0.249, 0.672
	Female	22(44.0%)	16(72.73%)	6(27.27%)	
Age (years)	25-39	11(22.0%)	5(45.45%)	6(55.55%)	13.27, 0.00229
	40-49	16(32.0%)	10(62.5%)	6(37.5%)	
	50-60	23(46.0%)	19(82.60%)	4(17.39%)	
Cholesterol (mg/dl)	<200	40 (80.0%)	28(70.0%)	12(30.0%)	0.304, 0.908
	200-239	8 (16.0%)	5 (62.5%)	3(37.5%)	
	≥240	2 (4.0%)	1 (50.0%)	1 (50.0%)	
BMI (Kg/m^2)	19-24.9	25 (50.0%)	19(76.0%)	6(24.0%)	1.819, 0.602
	25-25.9	19(38.0%)	11(57.89%)	8(42.11%)	
	30-39.9	6(12.0%)	4(66.67%)	2(33.30%)	

Table 2 shows that of the study participants, 28 (56%) were men and 22 (44%) were women. Although diastolic dysfunction was shown to be more prevalent in women (72.73%) than in men (67.86%), this finding was statistically insignificant. 11 (22%) of the cases are in the 25–39 age range, 16 (32%) are in the 40–49 age range, and 23 (46%) are in the 50–60 age range. The age range of 50 to 60 years has the

highest frequency of diastolic dysfunction. P<0.05 denotes a statistically significant relationship between age and diastolic dysfunction. The majority of the patients, 40 instances (80.0%), had blood cholesterol levels < 200, followed by 8 cases (16.0%) with levels between 200 and 239 and 2 cases (4.0%) with levels of 240 mg/dl or above.

Diastolic dysfunction was most frequently observed in 28 (70.0%) instances in individuals with serum cholesterol levels < 200 mg/dl, 1 (50.0%) cases in individuals with serum cholesterol levels of 240 mg/dl and above, and 5 (62.5%) cases in individuals with serum cholesterol levels between 200 and 239 mg/dl. The relationship between diastolic dysfunction and rising blood cholesterol levels was determined to be nonexistent, and the data were statistically insignificant (p = 0.908). 25 instances (50.0%) had BMIs between 19 and 24.9 kg/m2, 19 patients (38.0%) had BMIs between 25 and 25, and 6 cases (12.0%) had BMIs between 30 and 39. The prevalence of diastolic dysfunction was highest in BMI 19-24.9 (19(76%), followed by 4(66.67%) in BMI 30-39.9, and lowest in BMI 25-25.9 (1(57.89%). Statistics show that this result is not significant (p=0.602).

Table 3: Association of diastolic dysfunction with clinical profile of study participants

Variable	Category	No. of cases(%)	Diastolic dysfunction	Chi square,p value	
			Present (%)	Absent (%)	
Duration of diabetes	<2 years	18(36.0%)	9(50.0%)	9(50.0%)	11.99, 0.0035
	2-5 years	20(40.0%)	14(70.0%)	6(30.0%)	
	> 5 years	12(24.0%)	11(91.66%)	1(8.33%)	
HbA1c (in %)	<7.5	14(28.0%)	6(42.86%)	8(57.14%)	7.02, 0.008
	>7.5	36(72.0%)	28 (77.78%)	8 (22.22%)	
Nephropathy	Present	16 (32.0%)	11(68.75%)	5(31.25%)	0.023, 0.966
	Absent	34 (68.0%)	23 (67.64%)	11 (32.36%)	
Retinopathy	Present	15 (30.0%)	14(93.33%)	1(6.6.67%)	12.01, 0.0006
	Absent	35 (70.0%)	21 (60.0%)	14(40.0%)	

Table 3 shows how the clinical characteristics of the study participants and diastolic dysfunction are related. Of the study population, 18 (36.0%) had diabetes for less than two years. Twenty people (40%) had diabetes for two to five years, whereas 12 people (24%) had it for more than five years. Statistically significant (p value =0.0024), the highest prevalence of diastolic dysfunction was observed in diabetic patients with a diabetes duration of more than 5 years.HbA1C values were higher than 7.5 in 72% of patients, and diastolic dysfunction occurred in 77.78% of those cases. 72.86% of subjects with HbA1c levels below 7.5% had diastolic dysfunction. The results had a substantial statistical impact (p=0.008). 11 patients (68.75%) of the patients with nephropathy (32%) had diastolic dysfunction, while 46 patients (67.64%) of the patients without nephropathy (68%) had diastolic dysfunction. (p = 0.966) The statistics are not statistically significant. In the 30% of patients with retinal, 14 patients (93.33%) demonstrated diastolic dysfunction, and in the 70% of patients without retinopathy, 21 patients (60.0%) shown diastolic dysfunction. (p=0.0006) The statistics are statistically significant.

Table 4: Association of diastolic dysfunction with Echocardiographic observations of study participants

Variable	Category	No. of cases (%)	Diastolic dysfunction		Chi square,p value
			Present (%)	Absent (%)	
E/A	<1	27 (54.0%)	27(100.0%)	0(0%)	67.719, <0.001
	01-02	21 (41.0%)	5 (23.80%)	16(76.19%)	
	>2	2 (5.0%)	2 (100.0%)	0 (0%)	
IVRT m-s	<60	3 (3.0%)	3(100.0%)	0(0%)	27.552, 0.0001
	60-100	29 (57.0%)	13(44.82%)	16(55.17%)	
	>100	18 (36.0%)	15 (83.34%)	2(11.11%)	
Deceleration Time m-s	<160	04 (8.0%)	03(75.0%%)	1(25.0%)	12.48, 0.001
	160-220	38(76.0%)	22(57.89%)	16(42.11%)	
	>220	8 (16.0%)	8(100.0%)	0 (0%)	
E/e’	<8	5(10.0%)	1(20.0%)	4(80.0 %)	15.26, 0.0004
	8 to 12	38(76.0%)	26(68.42%)	12(31.58%)	
	>12	7(14.0%)	7(100.0%)	0(0%)	

In Table 4, the majority of cases (54%) have E/A values <1 and 100% of these cases have diastolic dysfunction, followed by (41) cases with E/A values between 1-2, of which 5 cases (23.80%) have diastolic dysfunction, and (5) cases with E/A values >2, and all 2 cases (100%) have diastolic dysfunction. The data are statistically significant (p<0.001) in all cases.

In a total of 29 cases (57%) with IVRT between 60 and 100, 13 cases (44.82%) have diastolic dysfunction, followed by 36% of cases with IVRT >100, 15 cases (83.34%), and 3% of cases with IVRT 60, all of which have diastolic dysfunction (100%) in all three cases. The data is highly significant (p <0.0001). The majority of the patients 38 cases (76%) with DT between 160 and 220, of which 22 cases (57.89%) have diastolic dysfunction are followed by 16% of the cases with DT greater than 220, all of which developed diastolic dysfunction, and then 4 cases with DT less than 160, of which 3 cases did as well. Statistics show that the data are significant (p <0.001). Out of 50 instances, 38 (76%) had E/e' 8 to 12, and only 26 (68.42%) had diastolic dysfunction. The remaining 7 cases had E/e' >12, and all 7 (100%) had diastolic dysfunction. (p=0.0004) The statistics are statistically significant

Discussion

In order to determine the prevalence of left ventricular diastolic dysfunction, 50 type 2 diabetes mellitus patients with normal resting ECG underwent echocardiography in this study. In the current investigation, 27 instances (54%) of the 34 cases with diastolic dysfunction also exhibited poor relaxation. Two (4%) cases showed restricted filling, while 5 cases had pseudonormal filling.

According to studies by Mamatha B. Patil et al.[9], Paul Poinier et al.[10], S. Cosson et al.[11], Patil et al.[12], Gani et al.[13], and Rajput et al.[14], diastolic dysfunction was seen in 64%, 60%, 69%, 54.33%, 65.8%, and in more than 60% of patients, respectively. In the current study, patients with diastolic dysfunction included 28 men (56%) and 22 women (44%); the diastolic dysfunction was observed to be higher in women (16/72.73%) than in men (67.86%), but this finding was statistically insignificant (p=0.672). The findings were consistent with a research by Sohail Ashraf et al.15 that found diastolic dysfunction to be more prevalent in men (17.5%) than in women

(12.2%). Although there are few exceptions, such as the studies by Rajput et al.[14] with an equal prevalence of male and female cases and Mamatha B Patil et al.[9] with a higher incidence of female cases.

50 type 2 diabetes individuals, ranging in age from 25 to 60, were involved in the current study. 11 (22.0%) of the cases fell into the 25–39 age range, followed by 16 (32%) of the cases in the 40–49 age range, and 23 (46%) of the cases in the 50–60 age range. The age group of 50 to 60 years old had the highest incidence of diastolic dysfunction. ($p = 0.00229$) This finding was statistically significant. Similar findings were made in a study by Patilet al.[12], which showed that age >45 years was significantly associated with greater diastolic dysfunction than age 45 years ($p < 0.05$). According to Mamatha B. Patilet al[9], the prevalence of diastolic dysfunction increases linearly with age group. Additionally, according to Ganiet et al.[13], there was a significant ($p<0.01$) association between patient age and the E/A ratio of trans mitral doppler flow. In the current study, 25 cases (50.0%) had a BMI between 19 and 24.9 kg/m^2, 19 cases (38.0%) had a BMI between 25 and 25.9 kg/m^2, and 6 cases (12.0%) had a BMI between 30 and 39.9 kg/m^2. The prevalence of diastolic dysfunction was highest in those with BMIs of 19–24.9 (76.0%), followed by those with BMIs of 30-39.9 (66.67%), and lowest in those with BMIs of 25–24.9 (57.89%).

The statistical significance of this discovery is zero ($p=0.602$). According to Virendra et al.[12], the link between high BMI and diastolic dysfunction was found to be statistically significant in 33.33% of male and 24.41% of female patients. In a related study by C. Halley et al.[16], a higher prevalence of diastolic dysfunction was found in 460 (26.5%) and 407 (23.5%) subjects who were overweight or obese, respectively ($P <0.001$). BMI remained significant in both ordinal (all levels of diastolic function) and binary (normal versus pathological) analyses using multivariable logistic regression. Contrarily, a study by Gani et al.[13] found no significant association between EF and E/A ratio and BMI or waist/hip ratio.

In the current study, 12 (24%) of the population had diabetes for more than 5 years, 20 (40%) had diabetes for less than 2 years, and 18 (36%) had diabetes for less than 2 years. Diastolic dysfunction was most frequently observed in diabetic patients with a diabetes duration of more than 5 years (91.66%), which was statistically significant ($p=0.0035$). According to research by Gani et al13, diastolic dysfunction was found to be independently correlated with the length of diabetes.

Significant correlations were found between the duration of diabetes and the EF ($r = -0.26$, $p<0.01$) and E/A ratio ($r = -0.295$, $p<0.01$). 32 (41.02%) of the 78 participants in Virendra c Patil et al.12's study who had had diabetes for between 6 and 10 years exhibited diastolic dysfunction. 37 (75.51%) of the 49 (38.58%) patients with diabetes for between 11 and 15 years showed diastolic dysfunction. Patients with diabetes who had had the disease for 11 to 15 years showed a higher prevalence of diastolic dysfunction than those who had had it for 6 to 10 years ($P < 0.02$). In diabetic patients, IVRT and atrial peak filling velocity were higher, while the early to late atrial filling velocity was significantly lower, according to Di Bonito et al. This proves that the natural course of NIDDM includes an early impairment of ventricular diastolic function. In a different study by Madhumathi R et al.[18], it was found that 20 patients (40%) had diabetes for a length of 5 to 10 years, whereas 21 patients (42%) had diabetes for a term of less than 5 years. As the duration of diabetes grew, we saw a higher number of patients with diastolic dysfunction, which was significant statistically. The outcomes matched our study observations.

According to a recent study, 6 (42.86%) of the patients whose HbA1C levels were below 7.5 percent and 28 (77.78%) of the cases with HbA1C levels over 7.5 percent, respectively, had diastolic dysfunction. The remaining 14 (28.0%) cases did not. Statistics indicated that the findings were significant (p 0.008). The findings matched those of a study by Virendra C. Patil et al.14, which found that out of 89 participants with HbA1c 7.5%, 39 (42.82%) had diastolic dysfunction, and out of 38 subjects with HbA1c > 7.5%, 31 (81.57%) did as well.

The prevalence of diastolic dysfunction was higher in patients with HBA1c > 7.5% than in subjects with HBA1c <7.5% (P < 0.02). According to Mamatha B Patil et al study[9], the prevalence of diastolic dysfunction gradually increased as HbA1C levels rose. In a study by Madhumathi R et al.[18], 25 individuals (or 50%) had HbA1c levels above 8%, a sign of poor glycemic management. It was statistically significant that the prevalence of diastolic dysfunction increased progressively as HbA1c levels rose. According to the current study, 23 patients (67.64%) who do not have nephropathy also exhibit diastolic dysfunction, making a total of 16 patients (32.0%) who had nephropathy. Of these, 11 patients (68.75%) had nephropathy. (p=0.966) The statistics are not statistically significant. Sampson et al.[19] discovered that the presence of microalbuminuria and proteinuria caused the E/A ratio in type 1 diabetes individuals to gradually decline. In the group of diabetics with proteinuria, a considerably higher proportion of abnormal diastolic function (E/A 1) was seen. However, since a considerably higher blood pressure was seen in the subgroup of diabetics with proteinuria, it was hypothesised that arterial blood pressure may have an impact on the emergence of diastolic dysfunction in the early stages of diabetic nephropathy.

In the study population, 15 patients (30.0%) had retinal, and 14 of those patients (93.33%) demonstrated diastolic dysfunction. Of the 35 patients (70.0%) who did not have retinopathy, 21 patients (60.0%) demonstrated diastolic dysfunction. (p=0.0005) The statistics are statistically significant. Patients with mild to severe retinopathy displayed LV diastolic dysfunction, according to research by S. Cosson et al. According to the most current study, patients with an aberrant mitral filling pattern (E/A ratio <1) had a higher prevalence of retinopathy (49%) than patients with a normal diastolic function (20%).

Conclusion

It can be said that type II diabetes mellitus individuals who have no clinically apparent cardiac disease have a higher incidence of left ventricular diastolic dysfunction. Patients with diabetic problems, especially retinopathy, and those with HbA1c levels greater than 7.5 had a higher incidence in the current series. Additionally, it was discovered that the prevalence of diastolic dysfunction strongly correlated with the patient's age and the duration of their diabetes.

In the current investigation, there was no relationship between the prevalence of diastolic dysfunction and the patient's gender, BMI, or S. cholesterol. Diastolic dysfunction is the first sign of diabetic cardiomyopathy, therefore catching it early and treating it would stop the condition from progressing to clinical heart failure. To detect diastolic dysfunction, all diabetes patients should have 2D echocardiographic assessment. Diabetes should be strictly controlled in order to lower the chance of developing diastolic dysfunction, and patients should be told of this.

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