Study the Frequency of Left Ventricular Dysfunction in Normotensive Type 2 Diabetic Patients

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ABSTRACT

Introduction: Type 2 diabetes mellitus (T2DM) is characterized by variable degrees of insulin resistance. Impaired insulin secretion and increased glucose production have a very high prevalence in India as well as across the world. Especially elderly diabetic patients are at risk of cardiovascular diseases due to micro and macro-vascular complications. Left ventricular dysfunction, increased left ventricular wall thickness, increased left ventricular mass, and specific diabetic cardiomyopathies are some of the cardiovascular complications associated with diabetes.

Material and methods: It is an observational, cross sectional design to study the frequency of left ventricular dysfunction in 100 normotensive type II diabetic patients of both genders conducted in the department of medicine, CSS Hospital, Subharti Medical College, Meerut. Patients recruited in the study were evaluated for left ventricular dysfunction.

Results: Out of 100 type 2 diabetic non-symptomatic subjects, 62% were males and 38% were males. The mean age was 52.91±12.58 and 56.83±10.69 years among males and females respectively. 53 (53%) patients were detected with Left Ventricular Diastolic Dysfunction (LVDD) among the 100 patients under study. Mild, moderate and severe dysfunction was found among 41%, 10% and 2% of the subjects respectively. 38 (38%) patients were detected with Left Ventricular Systolic Dysfunction (LVSD). It was also observed that with the duration of the diabetes, the incidence of LVDD was increased.

Conclusion: Type II DM has a significant impact on the functioning of the left ventricular. This effect increases with the advancing age. This study reinforce the vital role of echocardiogram to evaluate the diastolic functional parameters. Early diagnosis and therapeutic interventions in diabetes mellitus before the deleterious cardiac sequelae become established.

Key words: Type II Diabetes Mellitus, Left Ventricular Systolic Dysfunction, Left Ventricular Diastolic Dysfunction, Echocardiography

INTRODUCTION

Type 2 DM is a heterogeneous disorder characterized by variable degrees of insulin resistance, impaired insulin secretion, and increased glucose production. Prevalence of diabetes in adult worldwide was estimated to be 4.0% in 1995 and is expected to rise to 5.4% by the year 2025. It is higher in developing countries. The number of adults with diabetes in the world will rise from 135 million in 1995 to 300 million in the year 2025.[1] In India, 69.1 million people with DM survive and is further moving to be the second highest number of cases of DM in the world. In India, diabetes mellitus is found to be maximum in the southern part of the country and in urban areas and the prevalence of DM ranges from 5-17%. There are more women with diabetes then men, especially in developed countries.[2]

Type 2 Diabetes, especially in the elderly is one of the risk factors for the development of symptomatic heart failure.[3,4] The morbidity and mortality due to type 2 DM is due to its micro and macro-vascular complications which affect nearly every organ system in the body – particularly heart. The relative risk of developing heart failure is 3.8 in diabetic men and 5.5 in diabetic women, when compared with non-diabetic individuals. Left ventricular dysfunction, increased left ventricular wall thickness, increased left ventricular mass and specific diabetic cardiomyopathies are some of the cardiovascular complications associated with diabetes.[5] Left ventricular diastolic dysfunction has been demonstrated in diabetic patients who are normotensive and have no symptoms of cardiac disease.[6,7] Increased mortality among type II diabetic patients with heart failure with normal ejection fraction also suggests a role for diastolic heart failure.[8]

An early diagnosis on that account can be of great help to prevent or delay the development of these complications. This underlines the necessity of early diagnosis. Presently very few studies have been carried out to study the relation between ventricular dysfunction in DM (type2). Therefore, the present study was undertaken to evaluate the frequency of left ventricular dysfunction in normotensive type 2 diabetes mellitus patients using echocardiography.

MATERIAL AND METHODS

The present study was an observational, cross sectional

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design to study the frequency of left ventricular dysfunction in 100 normotensive type II diabetic patients of both genders. Study subjects were recruited from both in and out patient departments, and were age and sex matched. The study was conducted in the department of medicine, CSS Hospital, Subharti Medical College, Meerut from December 2018 to August 2020. Informed consent of all participants was obtained after explaining the purpose of the study. Permission to carry out the study was obtained by Institutional Ethical Committee of CSS Hospital, Subharti Medical College, Meerut.

All the patients of type 2 diabetes mellitus clinically having no symptoms of cardiovascular disease and normal blood pressure of < 130/80 mmHg, with normal ECG were included in the study. Patients with history of myocardial infarction by history and resting electrocardiogram (ECG), angina pectoris, hypertension, Type I DM, alcoholism, thyroid diseases, renal failure, other underlying heart diseases such as congenital or valvular heart disease, pericardial diseases were excluded from the study. Patients with regional wall motion abnormalities or not consenting to participate were also excluded.

Patients recruited in the study were evaluated for left ventricular dysfunction defined as (1) an inability to fill the left ventricle, during rest or exercise, to a normal end-diastolic volume without an abnormal increase in LV end diastole or mean left atrial pressure; or (2) failure to increase LV end diastolic volume and therefore cardiac output during exercise. Early and late diastolic myocardial velocities were attained and the ratio (E/A) was calculated. A reduced E/A ratio of <1 and increase in the size of LA was considered to be evidence of left ventricular diastolic dysfunction.

Data so collected was tabulated in an excel sheet, under the guidance of statistician. The means and standard deviations of the measurements per group were used for statistical analysis (SPSS 22.00 for windows; SPSS inc, Chicago, USA). Difference between two groups was determined using student t-test as well as chi square test and the level of significance was set at $p < 0.05$.

Gender	N	Mean Age (years)
Male	62 (62%)	52.91
Female	38 (38%)	56.83
BMI (kg/m^2)		
Normal	67 (67%)	
Overweight	22 (22%)	
Obese	11 911%)	
Mean±SD	24.78±2.98	

Table-1: Demography of the patients

Parameters	Mean	SD
FBS	164.02	15.83
PPBS	222.98	28.72
HbA1c	7.94	1.28
Creatinine (mg/dl)	0.74	0.16
Urea (mg/dl)	21.93	3.67
Cholesterol	189.43	13.07
Triglyceride	183.31	39.97
VLDL	33.27	4.74
LDL	125.97	30.04
HDL	44.29	5.99
Total bilirubin (mg/dl)	1.18	1.07
SGOT (IU/l)	45.95	27.66
SGPT (IU/l)	48.07	20.97
Alkaline phosphatase (u/l)	109.85	51.61
Total protein (g/dl)	6.88	0.7
Serum albumin (mg/dl)	3.72	0.81

Table-2: Laboratory parameters at baseline

RESULTS

The present cross sectional study was conducted among 100 asymptomatic diabetic subjects to evaluate the frequency of left ventricular dysfunction. Out of 100 subjects, 62% were males and 38% were males. The mean age was 52.91±12.58 and 56.83±10.69 years among males and females respectively. The overall mean age was 54.79±11.71 years. 67% of the patients were in the normal range while 22% and 11% patients were overweight and obese respectively. The mean BMI of patients was 24.78 kg/m2. (Table 1)

The duration of diabetes <5, 5-10 and >10 year was reported 36%, 42% and 22% of the subjects respectively. The mean duration of diabetes was 7.43±6.17 years. The mean FBS, PPBS and HbA1c values were 164.02±15.83, 222.98±28.72and 7.94±1.28 mg/dl respectively. The mean creatinine and urea values were 0.74±0.16and 21.93±3.67 mg/dl respectively.

Out of 100, 53 (53%) patients were detected with Left Ventricular Diastolic Dysfunction (LVDD) among the 100 patients under study. Mild, moderate and severe dysfunction was found among 41%, 10% and 2% of the subjects respectively. (Table 3) Statistically significant difference was found among subjects with and without LVDD in relation to E/A ratio. (Table 4)

The patients were also evaluated for the systolic left ventricular dysfunction. 38 (38%) patients were detected with Left Ventricular Systolic Dysfunction (LVSD). Mean LVEF% was comparatively more among subjects with LVSD (65.04) as compared to subjects without LVSD (42.69) with statistically significant difference as p<0.01. (Table 5)

LVDD	Mitral E/A Ratio	Deceleration Time (m sec)	N	%
Normal Function	0.75<E/A<1.5	<220	47	47
Mild Dysfunction	EA ≤0.75	>220	41	41
Moderate Dysfunction	0.75<E/A<1.5	150-200	10	10
Severe Dysfunction	E/A≥1.5	<150	2	2

Table-3: Distribution of patients according to left ventricular diastolic dysfunction (LVDD)

Parameters	Patients with LVDD (N=53)		Patients without LVDD (N=47)		P value
	Mean	SD	Mean	SD	
E/A ratio	1.03	0.35	0.7	0.13	0.009
DT (msec)	195.01	11.47	224.6	15.89	0.07
IVRT (msec)	71.52	7.3	76.74	13.16	0.19

Table-4: Echocardiography (LVDD) parameters of patients

LVEF	N	%	LV Ejection Fraction (%)		P value
			Mean	SD	
Normal Range (52%-72%)	62	62	65.04	3.11	<0.01
Mild Abnormal (41%-51%)	17	17	42.69	5.92	
Moderate Abnormal (30%-40%)	14	14			
Severe Abnormal (<30%)	7	7			

Table-5: Distribution of patients according to left ventricular systolic dysfunction (LVSD) based on LVEF and mean LVEF (%) comparison

Duration of Diabetes (in years)	Patients with LVDD (N=53)		Patients without LVDD (N=47)		P value
	N	%	N	%	
<5	9	16.98	27	57.45	0.009
5-10	25	47.17	17	36.17	
>10	19	35.85	3	6.38	

Table-6: Correlation of diastolic dysfunction of diabetes mellitus with duration of diabetes

It was also observed that with the duration of the diabetes, the incidence of LVDD was increased. 16.98% of the patients having T2DM for less than 5 year were found to have LVDD as compared to 57.45% who didn't show LVDD. The diastolic dysfunction was evident in 47.17% of the patients with T2DM since 5-10 years whereas out of total 22 patients having long standing T2DM (>10 years), 19 were found to have associated LVDD. (Table 6)

DISCUSSION

The prevalence of diabetes mellitus is increasing, with projections suggesting that, worldwide, the number of adults with diagnosed type 2 diabetes will more than double to 300 million in 2025.[1] The epidemiology and characteristics of coronary artery disease in type 2 diabetes are well described in the literature.[9-11] The focus in reducing cardiovascular deaths in diabetes tends almost exclusively to be on reducing fresh coronary events. However, abnormalities in the left ventricular structure and function could be equally important contributors to cardiac death in diabetes.

The role of elevated blood sugar in the causation of various cardiovascular diseases has been investigated by several researchers.[12, 13] These studies have shown that DM causes structural and functional abnormalities that are independent of the effect of atherosclerosis and these abnormalities contribute significantly to adverse cardiovascular events. Left ventricular diastolic dysfunction has been proposed to be the first stage of the putative "diabetic cardiomyopathy".[14] A reduced E/A ratio has been shown to be independently associated with increased all-cause mortality as well as cardiovascular mortality.[15]

53 (53%) patients were detected with Left Ventricular Diastolic Dysfunction (LVDD) among the 100 patients in the present study. Mild, moderate and severe dysfunction was found among 41%, 10% and 2% of the subjects respectively in our study. D. Sai Vittal et al[16] in their study observed diastolic dysfunction among 66% of the patients, while in a study by Sharavanan et al[17], 55% prevalence was reported. A study by Patil VC et al[18], reported a prevalence of 54.33% of diastolic dysfunction in patients with asymptomatic type 2 diabetes mellitus. A study by Ashraf et al[19], reported a lesser prevalence of 30.76% while another study by Patil MB et al[20], reported the same to be as high as 64.3%.

In our study, statistically significant difference was found among subjects with and without LVDD in relation to E/A ratio while no significance was found in relation to DT (msec) and IVRT (msec). V Suresh Kumar et al[21] in their study reported that a total of 33 out of 50 patients have diastolic dysfunction as defined by E/A <1, with mean E/A of 0.73 with standard deviation (SD) ± 0.01.

Mean LVEF% was comparatively more among subjects with LVSD (65.04) as compared to subjects without LVSD (42.69) with statistically significant difference as p<0.01. 38 (38%) patients were detected with Left Ventricular Systolic Dysfunction (LVSD) among the 100 patients in our study. Dodiyi-Manuel et al[14] in their study demonstrated a significant reduction in mean left ventricular ejection fraction in diabetics compared to healthy controls (62.2% versus 68.5%; P<0.001), which is similar to our study. This significant reduction in mean ejection fraction signifies early left ventricular systolic dysfunction in these diabetic patients despite absence of symptoms of cardiovascular disease. V Suresh Kumar et al[21] in their study assessed systolic function by fractional shortening (FS) and EF. EF though it is reduced in diabetes patients, it is within normal limits with mean of 57.98 ± 2.1.

In our study, it was found that chances of diastolic function increase with the duration of LVDD as $p<0.05$. V Suresh Kumar et al[21] in their study revealed that duration of diabetes of 6-10 years had more incidence of diastolic dysfunction. Senthil N et al[22] reported that among 60 patients with <6months duration of diabetes, LVDD was found in 18 patients. Out of 30 patients who had DM of 6 months-3years duration LVDD was found in 9. Out of 10 patients who had DM more than 3years duration, LVDD was found in 3 patients. Masugata et al[23] in their study of 77 normotensive patients found that the cardiac diastolic dysfunction without LV systolic dysfunction in patients with well-controlled Type 2 DM is related neither to hypertension nor LV hypertrophy but rather to aging and duration of Type 2 DM. Mishra et al[24] in their case control study of 71 patients with Type 2 DM found that asymptomatic patients with diabetes have reduced diastolic function as compared with the patient without Type 2 DM. LV diastolic abnormalities correlated with the duration of diabetes. Hameedullah et al[25] in their study population of 60 patients with type 2 DM found that there was a strong correlation between HbA1c level and diastolic indices. Diastolic dysfunction was more frequent in poorly controlled patients with diabetes, and its severity was correlated with glycemic control. Similarly, in our study, HbA1c >7.5% had a higher prevalence of diastolic dysfunction compared to HbA1c <7.5%.

The present study had some limitations. Stress electrocardiography, stress echocardiography, myocardial perfusion imaging, and coronary angiography were not used to exclude sub clinical coronary disease. A larger number of subjects may be required to draw definitive conclusions.

As a preliminary study, this emphasizes the need for early detection of diastolic dysfunction as part of the preventive management in the treatment of our diabetics. The high incidence of morbidity and mortality due to heart disease in diabetics makes it imperative to use a screening test, which is readily available and affordable/cost effective for our patients like the echocardiogram.

CONCLUSION

The results from this study reinforce the vital role of echocardiogram to evaluate the diastolic functional parameters. Early diagnosis and therapeutic interventions in diabetes mellitus before the deleterious cardiac sequelae become established, modulate the cardiac metabolism and prevent congestive cardiac failure. Therefore early diagnosis is important to prevent the deleterious sequelae of the disorder to establish itself.

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