

Original Research Article

Echocardiographic evaluation of diastolic dysfunction in type 2 diabetes mellitus without cardiac manifestations in rural hospital

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ABSTRACT

Background: Diabetes is the commonest metabolic disorder affecting the people all over the world. Objective of the study was to identify the diastolic dysfunction in type 2 diabetes mellitus patient to recognize the early involvement of heart.

Methods: This cross sectional study was conducted in tertiary care hospital cases of type II diabetes mellitus coming to our hospital and giving informed consent. Period of study was from September 2016 to February 2018. Consecutive type of non-probability sampling was used for the selection of study subjects. A total of 54 diagnosed patients of type II diabetes mellitus coming to our hospital and giving informed consent were included in the study.

Results: Prevalence of diastolic dysfunction was observed to be 44.4% in patients of type 2 diabetes mellitus without cardiac manifestations. Prevalence of diastolic dysfunction was seen in 47.4% males in comparison to 42.9% females. Prevalence of diastolic dysfunction was 11.1%, 77.3% and 80% in cases with disease duration of 0-5 years, 6-10 years and more than 10 years respectively. Prevalence of diastolic dysfunction was more in cases with poor glycaemic control i.e. hemoglobin A1c (HbA1c) value >8% as compared to cases with good glycaemic control.

Conclusions: There was an association between the prevalence of diastolic dysfunction with the increasing age. We had higher percentage of patients with diastolic dysfunction as duration of diabetes increased. Diastolic dysfunction was seen in 55.2% patients receiving oral hypoglycaemic agents (OHAs) as compared to 23.5% patients who were on insulin and 50% patients who were on both insulin and OHAs.

Keywords: Echocardiographic, Diastolic dysfunction, Type 2 diabetes mellitus, Glycemic control

INTRODUCTION

Diabetes is a syndrome of hyperglycemia and disturbances of carbohydrate, protein and fat metabolism associated with relative or absolute deficiencies in insulin secretion.¹

Diabetes is the commonest metabolic disorder affecting the people all over the world. According to World Health Organization (WHO) estimates, 422 million adults of age more than 18 years were living with diabetes in 2014, globally. South-east Asia and western pacific regions account for approximately half the diabetes cases in the

world. Diabetes caused 1.5 million deaths in 2012. Higher-than-optimal blood glucose was responsible for an additional 2.2 million deaths as a result of increased risks of cardiovascular and other diseases, for a total of 3.7 million deaths related to blood glucose levels in 2012.¹

As per 2014 WHO estimate, 422 million people in the world had diabetes – a prevalence of 8.5% among the adult population. The prevalence of diabetes has been steadily increasing since 3 decades and is growing most rapidly in low and middle-income countries. Associated risk factors like being overweight or obese are increasing. Diabetes is

an important cause of kidney failure, blindness, lower limb amputation and other long-term consequences that impact significantly on quality of life.¹

India has the largest number of people with diabetes. As per diabetes Atlas published by the international diabetes federation (IDF); there were an estimated 40 million persons with diabetes in India in 2007. The number has been predicted to rise to almost 70 million people by 2025.²

Indians are genetically more susceptible to diabetes mellitus compared to other races. Indians who have settled abroad also show increased prevalence to diabetes mellitus which indicates that environmental factors also play a role in incidence of diabetes. India will be having the largest number of diabetic subjects in the world by 2025 and one out of 5 diabetic subjects in the world will be an Indian. India is going to be the "Diabetic capital of the world".³

Subclinical abnormalities of left ventricular function are recognized in both type 1 and type 2 diabetes mellitus. Studies with Doppler echocardiography have confirmed the findings of abnormal diastolic function as an early indicator of cardiac involvement in asymptomatic patients with type 1 or type 2 diabetes mellitus. Diabetic subjects have been reported to develop congestive heart failure in the absence of hypertension, coronary heart disease or any known structural heart disease.⁴

The term 'diabetic cardiomyopathy' has been introduced for this condition. It has been suggested that microangiopathic lesions of the myocardium, altered composition and fibrosis of myocardial interstitium and accumulation of lipids in myocardial cells are involved in pathogenesis of diabetic cardiomyopathy.^{5,6}

Diastolic dysfunction refers to a condition in which abnormalities in mechanical function are present during diastole.⁷ Abnormalities in diastolic function can occur in the presence or absence of a clinical syndrome of heart failure and with normal or abnormal systolic function. Therefore, whereas diastolic dysfunction describes an abnormal mechanical property, diastolic heart failure describes the clinical syndrome.⁸

Conceptually, diastole is the time period during which the myocardium loses its ability to generate force and shorten and returns to an unstressed length and force. By extension, diastolic dysfunction occurs when these processes are slowed, prolonged, or incomplete. Whether this time period is defined by the classic concepts of Wiggers or the constructs of Brutsaert, the measurements that reflect changes in this normal function generally depend on the onset, rate, and extent of ventricular pressure decline and filling and the relationship between pressure and volume or stress and strain during diastole.^{9,10} Moreover, if diastolic function is truly normal, these measurements must remain normal both during the stress of a variable heart rate, stroke volume, end-diastolic

volume, and blood pressure and at rest. This study aims at to identify the diastolic dysfunction in type 2 diabetes mellitus patient to recognize the early involvement of heart.

METHODS

This cross sectional study was conducted in Dr. Bhausaheb Sardesai Talegaon rural hospital (Maharashtra institute of medical education and research medical college), Talegaon Dabhade, Pune. Cases of type II diabetes mellitus coming to our hospital and giving informed consent were enrolled in the study. Period of study was from September 2016 to February 2018.

Sample size calculation

Consecutive type of non-probability sampling was used for the selection of study subjects. A total of 54 diagnosed patients of type II diabetes mellitus coming to our hospital and giving informed consent were included in the study.

Inclusion criteria

All cases of type II diabetes mellitus as per American Diabetic Association (ADA 2013) criteria without cardiac manifestations were taken for the study. Patients who were willing to give written informed consent and follow study related procedures.

Exclusion criteria

All hypertensive patients with or without medication.

All the cases ischemic heart disease on treatment.

All the cases of valvular heart diseases.

All cases of chronic kidney diseases.

All pregnant cases.

Any other disease/disorders interfering with the cardiac function.

Methodology

A total of 54 cases of type 2 diabetes mellitus with prior informed consent who clinically had no symptoms of cardiovascular involvement and blood pressure <130/80 mm Hg, with normal electrocardiography (ECG) were included in the study. The study group included both outpatients as well as in-patients. Detailed history along with other necessary information was recorded from all patients. The patients was examined for clinical symptoms. All the cases are subjected to following investigations: fasting and post meal blood sugar levels, glycosylated hemoglobin (HbA1c), fasting lipid profile, ECG in all 12 leads, chest x-ray posteroanterior (PA) view and 2D-echocardiography.

Operational definition

Diastolic dysfunction was considered to be present if any of the following findings were seen: E/A ratio <1 or >2, DT <150 or >220 ms, isovolumic relaxation time (IVRT) <60 or >100 ms, and E/e' ratio >15.^{11,12}

Statistical analysis

The quantitative data was represented as their mean±standard deviation (SD). Categorical and nominal data was expressed in percentage. The t-test was used for analyzing quantitative data, or else non-parametric data was analyzed by Mann Whitney test and categorical data was analyzed by using chi-square test. The significance threshold of p value was set at <0.05.

All analysis was carried out by using statistical package for the social sciences (SPSS) software version 21.

RESULTS

In present study, prevalence of diastolic dysfunction was observed to be 44.4% in patients of type 2 diabetes mellitus without cardiac manifestations. Out of 44.4% with diastolic dysfunction maximum prevalence was found in 51-60 years age group. A total of 8 (47.1%) patients out of 17 in this group had diastolic dysfunction. In patients in the age group 61-70 years, 85.7% patients had diastolic dysfunction while diastolic dysfunction was seen in 75% cases of age over 70 years. There was an association between the prevalence of diastolic dysfunction with the increasing age (p<0.01) (Table 1).

Table 1: Association of age with diastolic dysfunction.

Age distribution	Diastolic dysfunction		Total, N (%)
	Absent, N (%)	Present, N (%)	
≤40	7 (87.5)	1 (12.5)	8 (100.0)
41-50	11 (100.0)	0 (0.0)	11 (100.0)
51-60	9 (52.9)	8 (47.1)	17 (100.0)
61-70	2 (14.3)	12 (85.7)	14 (100.0)
>70	1 (25.0)	3 (75.0)	4 (100.0)
Total	30 (55.6)	24 (44.4)	54 (100.0)

P value <0.01.

Prevalence of diastolic dysfunction was seen in 47.4% males in comparison to 42.9% females. The difference was however statistically non-significant (p=0.78) (Table 2).

Prevalence of diastolic dysfunction was 11.1%, 77.3% and 80% in cases with disease duration of 0-5 years, 6-10 years and more than 10 years respectively. Statistically it was significant as we had higher percentage of patients with diastolic dysfunction as duration of diabetes increased (p<0.01) (Table 3).

Prevalence of diastolic dysfunction was more in cases with poor glycaemic control i.e. HbA1c value >8% as compared to cases with good glycaemic control (71.4% versus 27.3%; p<0.01) (Table 4).

Table 2: Association of gender with diastolic dysfunction.

Gender	Diastolic dysfunction		Total, N (%)
	Absent, N (%)	Present, N (%)	
Female	20 (57.1)	15 (42.9)	35 (100.0)
Male	10 (52.6)	9 (47.4)	19 (100.0)
Total	30 (55.6)	24 (44.4)	54 (100.0)

P value=0.78.

Table 3: Association of duration of diabetes with diastolic dysfunction.

Duration of diabetes (years)	Diastolic dysfunction		Total, N (%)
	Absent, N (%)	Present, N (%)	
0-5	24 (88.9)	3 (11.1)	27 (100.0)
6-10	5 (22.7)	17 (77.3)	22 (100.0)
>10	1 (20.0)	4 (80.0)	5 (100)
Total	30 (55.6)	24 (44.4)	54 (100.0)

P value <0.01.

Table 4: Association of glycaemic control with diastolic dysfunction.

HbA1c levels (%)	Diastolic dysfunction		Total, N (%)
	Absent, N (%)	Present, N (%)	
≤8	24 (72.7)	9 (27.3)	33 (100.0)
>8	6 (28.6)	15 (71.4)	21 (100.0)
Total	30 (55.6)	24 (44.4)	54 (100.0)

P value <0.01.

No association was observed between type of treatment and prevalence of diastolic dysfunction (p=0.27). Diastolic dysfunction was seen in 55.2% patients receiving OHA as compared to 23.5% patients who were on insulin and 50% patients who were on both insulin and OHAs (Table 5).

Table 5: Association of treatment with diastolic dysfunction.

Management	Diastolic dysfunction		Total, N (%)
	Absent, N (%)	Present, N (%)	
Both insulin+OHA	4 (50.0)	4 (50.0)	8 (100.0)
Insulin	13 (76.5)	4 (23.5)	17 (100.0)
OHA	13 (44.8)	16 (55.2)	29 (100.0)
Total	30 (55.6)	24 (44.4)	54 (100.0)

P value=0.27.

DISCUSSION

Epidemiological data indicate that there is a significant relationship between diabetes and cardiovascular disease. Diabetic cardiomyopathy has been proposed as an independent cardiovascular disease and left ventricular diastolic dysfunction may represent the first stage of diabetic cardiomyopathy.

Various studies have shown the evidence of left ventricular diastolic dysfunction in normotensive, type 2 diabetic patients. However, the exact causes and mechanisms remain unclear. Impairment of diastolic function of left ventricle are more common than systolic dysfunction. Hence it has to be evaluated in early stage of disease.

In this study we evaluated left ventricular function by m-mode, 2-D echo and colour Doppler studies in type 2 diabetes patients. 54 patients who are asymptomatic type 2 diabetes were selected for the present study by consecutive type of sampling. All patients were evaluated for the left ventricular diastolic dysfunction.

Diastolic dysfunction

In present study, diastolic dysfunction was measured by echocardiography. Diastolic dysfunction was considered to be present if any of the following findings were seen: E/A ratio <1 or >2, DT <150 or >220 ms, IVRT <60 or >100 ms, or E/e' ratio >15.^{11,12}

We observed diastolic dysfunction in 44.4% of our patients. This prevalence of diastolic dysfunction was almost comparable with other studies as shown in Table 6.

Table 6: Comparison of diastolic dysfunction with other studies.

Studies	Percentage of diastolic dysfunction
Patil et al ¹³	54.33
Fawad et al ¹⁴	48
Kumar et al ¹⁵	41
Poirier et al ¹⁶	60
Faden et al ¹⁷	64
Markuszewski et al ¹⁸	43
Present study	44.4

Age

In the present study, age of the patients ranged from 30 year and onwards with majority of the patients are belonged to 4th-6th decades. Mean age of the present study was 46.7 years. The results were comparable to that of Shrestha et al and Randhawa et al.^{14,19}

Out of 44.4% with diastolic dysfunction maximum prevalence was found in 51-60 years age group. A total of 8 (47.1%) patients out of 17 in this group had diastolic

dysfunction. In patients in the age group 61-70 years, 85.7% patients had diastolic dysfunction while diastolic dysfunction was seen in 75% cases of age over 70 years (p<0.01).

Our results are comparable with Fawad et al and Kumar et al in which there was 66% and 73% respectively prevalence of diastolic dysfunction in age group of 50-59 years.^{14,15} In age group above 70 years each patient had diastolic dysfunction (100%) in present study similar to the studies by Fawad et al and Kumar et al.^{14,15}

Gender

Prevalence of diastolic dysfunction was seen in 47.4% males in comparison to 42.9% females. The difference was however statistically non-significant (p=0.78). Our results are comparable to that of Patil et al with 57.2% of female patients having diastolic dysfunction as compared to 68.2% males.²⁰

Duration of diabetes

Prevalence of diastolic dysfunction was 11.1%, 77.3% and 80% in cases with disease duration of 0-5 years, 6-10 years and more than 10 years respectively. Statistically it was significant as we had higher percentage of patients with diastolic dysfunction as duration of diabetes increased (p<0.01).

Our results are comparable to that of Patil et al which also observed a significant association between diastolic dysfunction and diabetes duration.¹³

Treatment

When the treatment profile was evaluated, most of the patients were on OHA or OHA with insulin, most of the subjects had poor glycemic control and reasons are multifactorial viz. poor compliance of the patient with reference to treatment, lifestyle modifications, inadequate doses and poor regular check-up. In our study, no association was observed between type of treatment and prevalence of diastolic dysfunction (p=0.27). Diastolic dysfunction was seen in 55.2% patients receiving OHA as compared to 23.5% patients who were on insulin and 50% patients who were on both insulin and OHAs. Our results were comparable to that of Madhumathi et al who found comparable incidence of diastolic dysfunction among various treatment groups.²¹

Glycemic control

In present study showed that 42% subjects had HbA1c >8% which indicated poor glycemic control. Prevalence of diastolic dysfunction increased gradually with the rise in HbA1c levels. It was showed that 71.4% patients had diastolic dysfunction with HbA1c level >8% which was comparable with Patil et al study which showed that

81.57% of diastolic dysfunction in patients with HbA1c level above 7.5%.¹³

Our results are also comparable to that of Chandravanshi et al and Suresh et al who also observed a significant association between diastolic dysfunction and glycemic control.^{22,23}

CONCLUSION

It was concluded that there was an association between the prevalence of diastolic dysfunction with the increasing age. Statistically it was significant as we had higher percentage of patients with diastolic dysfunction as duration of diabetes increased ($p < 0.01$). No association was observed between type of treatment and prevalence of diastolic dysfunction ($p = 0.27$). Diastolic dysfunction was seen in 55.2% patients receiving OHA as compared to 23.5% patients who were on insulin and 50% patients who were on both insulin and OHAs.

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