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Original Research Article

Prevalence of left ventricular diastolic dysfunction by echocardiography in type II diabetes mellitus patients

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ABSTRACT

Background: Epidemiological data indicates a greater risk of cardiovascular morbidity and mortality, particularly congestive heart failure in diabetic patients, compared with nondiabetic patients. Heart failure in many patients is due to left Ventricular Diastolic Dysfunction (LVDD), but its prevalence among diabetic adults is still not known, especially in the primary health care settings. Present study aims to evaluate the prevalence of LVDD by Echocardiography in Type II Diabetes Mellitus (DM).
Methods: Authors did a prospective study, from May 2012 to August 2014, in Department of Medicine, Dr. D. Y. Patil Hospital, Kolhapur which included 100 randomly selected patients of Type II DM. The diagnosis of Type II DM was done according to the criteria laid down by American Diabetes Association 2012. A detailed clinical history was taken using a structured questionnaire prepared by us and all patients were evaluated for left ventricular function by Echocardiography. Equipment used for echocardiography-Mind ray DC USG, Doppler machine Probe used-7.5MHz.
Results: On Echocardiography, Diastolic Dysfunction was found to be prevalent among individuals with Type 2 DM. Duration of DM and increasing age were found to be significantly associated with presence of Diastolic Dysfunction among individuals with Type 2 DM. Maximum number of patients were observed in the age group 51-60 years in our institute. 45% of the patients were asymptomatic, rest of the patients had predominantly cardiac symptoms.
Conclusions: It is essential to screen diabetic patients with Echocardiography at an early stage to prevent future cardiovascular complications.

Keywords: Cardiomyopathy, Diabetes mellitus, Diastolic dysfunction, Echocardiography

INTRODUCTION

According to the Indian Study on DM, India currently has 70 million people with DM.[1] and a study by American Diabetes Association reports that India will have the greatest increase in people diagnosed with diabetes by 2030.[2] This means by that time India will contribute to more than one fifth (20%) of the total Diabetes Mellitus population in the world. DM causes Diastolic Dysfunction through different mechanisms such as Myocyte hypertrophy, increased extracellular matrix, intramyocardial microangiopathy, impaired relaxation, increased passive diastolic stiffness and contractile dysfunction.[3]

Diastole is the process or phase where the heart, as a global operating chamber, relaxes and fills with blood in preparation for the next contraction.[4] Diastole is divided into four phases which are Isometric relaxation, Elastic recoil resulting in first rapid filling phase, Slow inflow phase and lastly Rapid filling phase (Atrial contraction).[5] Diastolic Dysfunction is any abnormality that causes

impaired relaxation, poor filling of LV, or loss of atrial contraction. One or more of these abnormalities results in increased LV pressures to achieve an adequate filling volume. This translates into ‘‘Diastolic Dysfunction”. In simple words inability of LV to fill to a normal volume at a normal pressure is Diastolic Dysfunction. Patients with heart disease frequently have abnormalities of systolic function. However, it is now well recognized that abnormalities of diastolic function play a major role in producing the signs and symptoms of heart failure.

About 30-50% of patients with heart failure have normal systolic function, implicating Diastolic Dysfunction as a major pathophysiologic abnormality.[4] The high prevalence of Diastolic Dysfunction is due to myocardial fibrosis. The most likely reason for this intimate association is the accumulation of advanced glycosylation products in the myocardium. In animal studies the presence of diabetes results in increased myocardial glycosylation end product receptor expression, increased cross linking of collagen and myocardial fibrosis. Hyperglycemia also increases the myocardial content of free radicals and oxidants, which decrease nitric oxide levels, worsen endothelial function and induce myocardial inflammation.

Lipotoxicity due to elevation of free fatty acids associated with hyperglycemia and insulin resistance may also be a factor because free fatty acids and their oxidation products may be directly toxic to the myocardium and contribute to the development of diabetic cardiomyopathy.[6]

Heart failure is a clinical syndrome characterized by symptoms and signs of increased tissue/organ water and decreased tissue/organ perfusion. Standardized criteria to diagnose heart failure have been developed, perhaps the best validated of which come from the Framingham Study. Definition of the mechanisms that cause this clinical syndrome requires measurement of both systolic and diastolic function. When heart failure is accompanied by a predominant or isolated abnormality in diastolic function, this clinical syndrome is called diastolic heart failure. DD refers to a condition in which abnormalities in mechanical function are present during diastole. 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 DD describes an abnormal mechanical property, diastolic heart failure describes a clinical syndrome.[7]

Diastolic Dysfunction is a predictor of cardiovascular morbidity and mortality in the general population and is associated with a reduced exercise performance in asymptomatic subjects.[8] It is important to understand and recognize abnormalities of diastolic filling of the heart for proper diagnosis, prognosis, and institution of treatment. Doppler Echocardiography has become the gold standard tool for the assessment of diastolic function and left ventricular filling pressures.

Assessment of diastolic function is an integral part of an evaluation of cardiac function because it is seen that many patients with heart failure have a preserved LVEF. Currently Echocardiography is the best non-invasive way to evaluate diastolic function and to estimate filling pressure. M16mode, 2D, and Doppler Echocardiography are all helpful in evaluating diastolic function.

METHODS

Authors did a prospective study, from May 2012 to August 2014, in Department of Medicine, Dr. D. Y. Patil Hospital, Kolhapur which included 100 randomly selected patients of Type II DM. The diagnosis of Type II DM was done according to the criteria laid down by American Diabetes Association 2012. The main aim of our study was to know the prevalence of Left Ventricular Diastolic Dysfunction by Echocardiography in Type II DM patients and also to study the probable factors associated with LVDD for early detection, prevention and treatment of heart failure.

Author included Type II DM diagnosed patients and excluded patients having clinical and ECG (Electrocardiography) evidence of Ischemic Heart Disease, Cardiomyopathies, Valvular heart disease, Pericardial disease (chronic), Type I Diabetes Mellitus, Endomyocardial diseases, Infiltrative (amyloidosis) and Non infiltrative diseases (e.g., idiopathic and hypertrophic cardiomyopathy). All selected patients were evaluated for left ventricular function by Echocardiography. Equipment used for Echocardiography-Mind ray DC USG, Doppler machine, Probe used-7.5MHz. In 2 D- ECHO patient was evaluated for E Wave (cm/s), A Wave (cm/s), E:A Ratio, EF and LV Dimensions.

RESULTS

Total 100 randomly selected patients of Type II Diabetes Mellitus were evaluated for presence of Diastolic Dysfunction by Echocardiography. In our study, diastolic function was normal in 30% patients and 70% patients had DD among which 28% patients had Grade 1 DD, 24% patients had Grade 2 DD, 9% patients each of Grade 3 and 4 DD (Figure 1) (Table 1).

Table 1: Total number of diastolic dysfunction patients.

Presence of DD	No. of Patients	%
Absent	30	30%
Grade 1 DD	28	28%
Grade 2 DD	14	14%
Grade 3 DD	9	9%
Grade 4 DD	9	9%

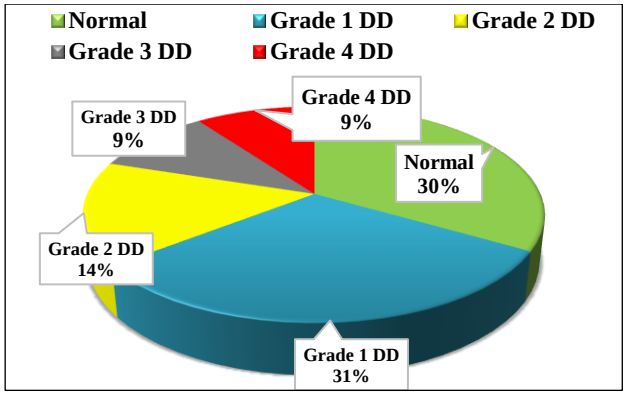

Figure 1: Total number of Diastolic Dysfunction patients.

About 64% were Male patients and 36% were Female patients in our study. Among male patients, diastolic function was normal in 31.25% patients, 68.75% patients had Diastolic Dysfunction. Among female patients, diastolic function was normal in 22.77% patients and 72.22% patients had Diastolic Dysfunction. (Table 2) (Figure 2).

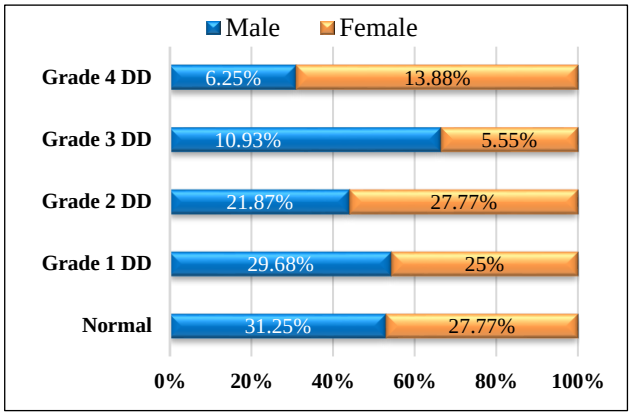

Figure 2: DD in relation to sex distribution.

Table 2: DD in relation to Sex distribution.

Sex	Total no. of patients	Normal	Grade 1 DD	Grade 2 DD	Grade 3 DD	Grade 4 DD
Male	64	20 (31.25%)	19 (29.68%)	14 (21.87%)	7 (10.93%)	4 (6.25%)
Female	36	10 (27.77%)	9 (25%)	10 (27.77%)	2 (5.55%)	5 (13.88%)
Total	100	30 (30%)	28 (28%)	14 (14%)	9 (9%)	9 (9%)

Figures in parenthesis denote percentage. 14% patients in our study, were in 31-40 years age group, 32% were in 41-50 years age group, 36% were in 51-60 years age group and 18% in 61-70 years age group. Among 31-40 years age group, diastolic function was normal in 71.42% patients, 28.57% patients had Diastolic Dysfunction. Among 41-50 years age group, diastolic function was normal in 31.25% patients, 68.75% patients had Diastolic Dysfunction. Among 51-60 years age group, diastolic function was normal in 22.22% patients, 77.77% patients had Diastolic Dysfunction.

Among 61-70 years age group, diastolic function was normal in 11.11% patients, 88.88% patients had Diastolic Dysfunction and maximum number of Grade 4 DD was seen in this age group (Table 3) (Figure 3).

Table 3: DD in relation to age distribution.

Age (Years)	No. of Patients	Normal	Grade 1 DD	Grade 2 DD	Grade 3 DD	Grade 4 DD
31-40 Years	14 (14%)	10 (71.42%)	2 (14.28%)	1 (7.14%)	1 (7.14%)	0
41-50 Years	32 (32%)	10 (31.25%)	10 (31.25%)	10 (31.25%)	0	2 (6.25%)
51-60 Years	36 (36%)	8 (22.22%)	14 (38.88%)	10 (27.77%)	3 (8.33%)	1 (2.77%)
61-70 Years	18 (18%)	2 (11.11%)	2 (11.11%)	3 (16.66%)	5 (27.77%)	6 (33.33%)
Total	100	30 (30%)	28 (28%)	14 (14%)	9 (9%)	9 (9%)

Minimum age in our patients was 31 years and the maximum age observed was 70 years. Maximum numbers of patients observed were in the 51-60 years age group. The Chi-square or Fisher's exact test was used to test for equality of proportions between groups, $p < 0.05$ was considered statistically significant.

Figures in parenthesis denote percentage.

(Chi-square= 43.21, Degrees of freedom=12, p-value=0.00002079).

This association of Age distribution is statistically significant for Diastolic Dysfunction (p=0.00002079).

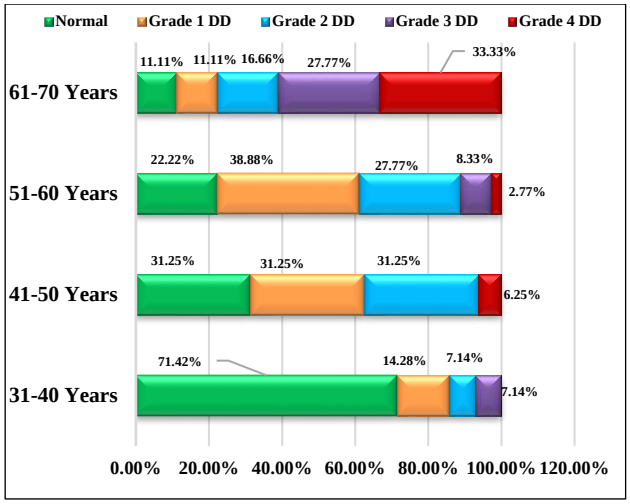

Figure 3: DD in relation to age distribution.

About 45% patients in our study, had diabetes duration of 6months to 3 years, followed by 28% patients which have diabetes duration of 3years to 5 years, 17% patients had diabetes duration of >5 years, whereas 10% patients were newly detected. Among newly detected diabetes group, diastolic function was normal in 80% patients, 20% patients had Diastolic Dysfunction. Among diabetes duration of 6 months to 3 years group, diastolic function was normal in 28.88% patients, 71.11% patients had Diastolic Dysfunction. Among diabetes duration of 4 years to 5 years group, diastolic function was normal in 25% patients, 75% patients had Diastolic Dysfunction. In patients of duration of >5 years group, diastolic function was normal in 11.76% patients, 88.23% patients had Diastolic Dysfunction among which 11.76% patients had Grade 1 Diastolic Dysfunction, 29.41% patients had Grade 2 Diastolic Dysfunction, 23.52% patients each of Grade 3 and 4 Diastolic Dysfunction (Table 4) (Figure 4).

Table 4: DD in relation to duration of DM.

Duration of diabetes	No. of patients	Normal	Grade 1 DD	Grade 2 DD	Grade 3 DD	Grade 4 DD
Newly Detected	10 (10%)	8 (80%)	1 (10%)	1 (10%)	0	0
6 months to 3 years	45 (45%)	13 (28.88%)	17 (37.77%)	12 (26.66%)	1 (2.22%)	2 (4.44%)
3 years to 5 years	28 (28%)	7 (25%)	8 (28.57%)	6 (21.42%)	4 (14.28%)	3 (10.71%)
More than 5 years	17 (17%)	2 (11.76%)	2 (11.76%)	5 (29.41%)	4 (23.52%)	4 (23.52%)
Total	100	30 (30%)	28 (28%)	14 (14%)	9 (9%)	9 (9%)

The Chi-square or Fisher's exact test was used to test for equality of proportions between groups p <0.05 was considered statistically significant.

Figures in parenthesis denote percentage.

(Chi square =30.07, Degrees of freedom=12, p-value=0.002724).

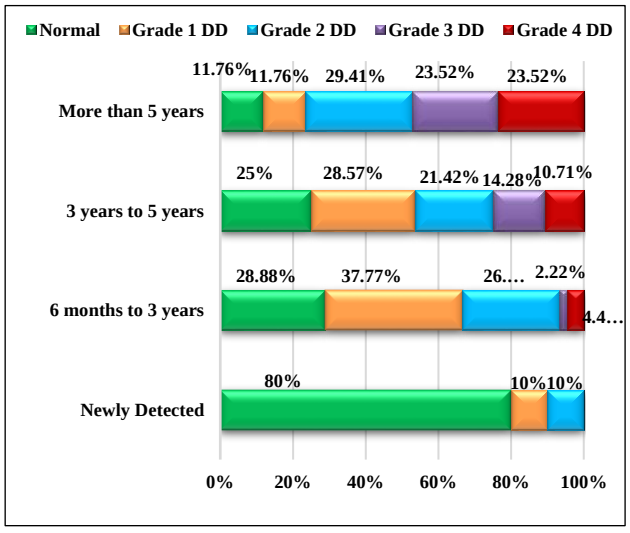

Figure 4: DD in relation to duration of DM.

This association of Duration of diabetes is statistically significant for Diastolic Dysfunction (p=0.002724).

Author study, 55% patients were asymptomatic, 23% patients had dyspnea on exertion and 22% patients had chest pain.

Among patients who were asymptomatic, diastolic function was normal in 31% cases, 27% cases had Grade 1 Diastolic Dysfunction whereas 20% cases had Grade 2 Diastolic Dysfunction and 22% cases had Grade 3 or 4 Diastolic Dysfunction. In patients complaining of dyspnea on exertion, diastolic function was normal in 35% cases, 22% cases had Grade 1 Diastolic Dysfunction whereas 39% cases had Grade 2 Diastolic Dysfunction and 4% cases had Grade 3 or 4 Diastolic Dysfunction. In patients with chest pain, diastolic function was normal in 23% cases, 36% cases had Grade 1 Diastolic Dysfunction whereas 18% cases had Grade 2 Diastolic Dysfunction and 23% cases had Grade 3 or 4 Diastolic Dysfunction. Among patients with mild retinopathy, diastolic function was normal in 36% cases, 24% cases had Grade 1 Diastolic Dysfunction whereas 32% cases had Grade 2 Diastolic Dysfunction and 8% cases had Grade 3 or 4 Diastolic Dysfunction. Patients having moderate retinopathy, diastolic function was normal in 23% cases, 23% cases had Grade 1 Diastolic Dysfunction whereas

27% cases had Grade 2 Diastolic Dysfunction and 27% cases had Grade 3 or 4 Diastolic Dysfunction.

Patients with severe retinopathy, 42% cases had Grade 1 Diastolic Dysfunction whereas 29% cases had Grade 2 Diastolic Dysfunction and 29% cases had Grade 3 or 4 Diastolic Dysfunction. Among patients without retinopathy, diastolic function was normal in 36% cases, 30% cases had Grade 1 Diastolic Dysfunction whereas 17% cases had Grade 2 Diastolic Dysfunction and 17% cases had Grade 3 or 4 Diastolic Dysfunction.

DISCUSSION

Author studied 100 randomly selected patients of Type II Diabetes Mellitus. They were evaluated for presence of Diastolic Dysfunction by Echocardiography. None of the patients had history of previous heart disease.

Author study, maximum patients were in 51-60 years age group comprising of 36% sample size. 64% patients were Male and 36% were female. Male preponderance was more among diabetic. Study by Patil MB et al9 had 56% males and 44% females. Most of the subjects were between 50-59 years of age and comprised 40 % of sample size.

Study by Kosmala W et al, showed 60% male population and 40% female population.[10] Most patients were observed in 50-55 years age group. In our study, diastolic function was normal in 30% patients and 70% patients had Diastolic Dysfunction among which 28% patients had Grade 1 Diastolic Dysfunction, 24% patients had Grade 2 Diastolic Dysfunction, 9% patients each of Grade 3 and 4 Diastolic Dysfunction. Dikshit NM et al, had 66% incidence of Diastolic Dysfunction in diabetic patients. Study by Shrestha NR and Sharma SK et al, Vinereanu D et al, had similar findings to our study.[11-13]

Author study among newly detected diabetes group, diastolic function was normal in 80% patients, 10% patients had Grade 1 Diastolic Dysfunction whereas 10% patients had Grade 2 Diastolic Dysfunction. Among diabetes duration of >5 years group, diastolic function was normal in 11.76% patients, 11.76% patients had Grade 1 Diastolic Dysfunction whereas 29.41% patients had Grade 2 Diastolic Dysfunction and 23.52% patients had Grade 3 or 4 Diastolic Dysfunction.

Patil VC et al, showed that duration of diabetes had direct relation to prevalence of Diastolic Dysfunction. More the duration more was the prevalence. Patil VC et al, showed that most patients had duration of diabetes of more than 10 years Masugata H et al, also had increased Diastolic Dysfunction with advancing duration of diabetes.[14,15]

Author study, 55% patients were asymptomatic, 23% patients had dyspnea on exertion and 22% patients had chest pain. Galderisi M et al, had 50% asymptomatic patients and in his study commonest symptom was dyspnea.[7,16]

CONCLUSION

Myocardial involvement in diabetes may occur early in the course of disease, initially impairing early diastolic relaxation and when more extensive, it causes decreased myocardial contraction. More frequent incidence of heart failure in diabetics even in the absence of any other underlying heart disease, leads to presumption that diabetes mellitus unfavourably affects the heart muscle by its complications.

Diastolic Dysfunction seems to be a prognostic marker in our diabetic patients who have no prior cardiac illness. Aging individuals, female population, duration of diabetes, presence and severity of hypertension were determinants for the occurrence of Diastolic Dysfunction. There was correlation of Diastolic Dysfunction with retinopathy as well. However, further study may through more light in this particular area. Early diagnosis and treatment of diabetic cardiomyopathy may improve systolic and diastolic functions of heart.

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