Research Article

Study of systolic and diastolic dysfunction in normotensive asymptomatic patients with type 2 diabetes mellitus

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Abstract

The existence of diabetic cardiomyopathy has been proposed as an evidence for the presence of myocardial dysfunction in diabetic patients in the absence of ischaemia, valvular or hypertensive heart disease. Diastolic dysfunction has been described as an early sign of diabetic heart muscle disease preceding the systolic damage. To evaluate systolic and diastolic dysfunction in asymptomatic normotensive type 2 diabetes mellitus patients. A total of 50 patients with mean age of 50.12±7.75 years with male to female ratio being 1:0.85 were selected, and 50 age and sex matched controls were also included in the present study with mean SBP of 122.84±10.72 and DBP of 78.70±5.74. All the investigations were within normal limits except mean FBS of 142±9.94 and PPBS of 226±18.61. In systolic function the mean EF was 63.12 ± 6.19 and mean FS was 35.42 ± 5.03. The EF was < 50% in 3 (6%) patients, but were asymptomatic. The mean E/A ratio was 0.95±0.10 and 26 (52%) had E/A ratio of <1 as compared to 24 (48%)>1%. The mean IVRT was 87.94 ± 20.36, and mean DT of E was 180.68 ± 34.64. p-value of < 0.05 is statistically significant. LVDD is much more common than previously reported in subjects with well controlled type 2 diabetes mellitus who are free of clinically detectable heart disease. Conventional echocardiography is a simple test to detect early LVDD in type 2 diabetes mellitus patients.

Keywords: Asymptomatic; DT of E; E/A ratio; Ejection fraction; IVRT; LV diastolic dysfunction; LV systolic dysfunction; Normotensive.

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INTRODUCTION

Diabetes mellitus is a syndrome characterised by chronic hyperglycemia and disturbances of carbohydrate, fat and protein metabolism associated with absolute or relative deficiency in insulin secretion and/or insulin action. Diabetic subjects have been reported to develop congestive heart failure in the absence of coronary heart diseases, hypertension or any known structural heart disease. 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. This study aims at to identify the systolic and diastolic dysfunction in normotensive asymptomatic type 2 diabetes mellitus patient to recognise the early involvement of heart.

MATERIALS AND METHODS

Fifty patients who are normotensive, asymptomatic, type 2 diabetes were selected for the present study by Simple Random Sampling method during the study period of October 2013 to March 2014. All patients were evaluated for the left ventricular systolic and diastolic dysfunction.

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Sample size

Group I: Fifty cases of Type 2 Diabetes Mellitus.

Group II: Fifty healthy persons who are age and sex matched as controls.

Duration of study: October 2013 to March 2014.

Inclusion Criteria: Fifty patients with history of type 2 diabetes mellitus were taken up for the study.

Exclusion criteria

1. Patients with history of hypertension.
2. Patients with history of coronary artery disease.
3. Patients with any other acquired or congenital heart disease causing systolic and diastolic dysfunction.
4. Thyroid disorder.
5. Overt renal disease.
6. Patients with corpulmonale
7. Heart failure secondary to any cause.
8. Any other disease/disorders interfering with the cardiac function.

OBSERVATIONS AND RESULTS

Fifty patients who are normotensive asymptomatic type 2 diabetes were selected for the present study by Simple Random Sampling method during the study period of October 2013 to March 2014. All the patients were evaluated for left ventricular systolic and diastolic dysfunction. Fifty cases of age and sex matched controls were also studied.

Group I: Type 2 diabetes mellitus patients

Group II: Normal patients (controls)

D. Control of diabetes. It was determined by glycated haemoglobin as (ADA 2006), Normal 4-6%, Good < 7%, Fair < 7-8%, Poor > 9% and above

Table 1: Showing diabetic status

Control	Group I	Group II
Normal	-	50 (100%)
Good	4 (8%)	-
Fair	16 (32%)	-
Poor	30 (60%)	-
Total	**50 (100%)**	**50 (100%)**

The mean glycated haemoglobin of Group I was 7.4800 and standard deviation of 0.6465 and t-test value 1.601. The mean glycated haemoglobin of Group II was 5.46 and standard deviation of 0.7879 with p value of < 0.01, which is statistically significant. About 60% (30 cases) of the patients had poor control. The mean of Group I SBP – 122.84 with SD – 10.72. The mean of Group I DBP – 78.70 with SD – 5.74. The mean of Group II SBP – 114.72 with SD – 6.36. The mean of Group II DBP – 75.90 with SD – 5.23 and shows p-value (2 tailed) of 0.001 and 0.001 which is statistically significance. F. Body Mass Index (BMI)

Table 2: Lipid profile

	Group	Mean	Standard Deviation	Standard Error Mean
Total cholesterol	Group I	192.30	15.4104	2.1794
	Group II	175.88	14.7560	2.0868
Total glycerides	Group I	122.04	15.7958	2.2339
	Group II	119.68	9.3665	1.3246
HDL	Group I	38.98	3.2039	0.4531
	Group II	40.54	2.2876	0.3235

	t-test for equality of means			
	t	df	Significance (2-tailed)	Mean difference
Total cholesterol	5.442	98	0.000	16.42
Triglyceride	0.909	98	0.366	2.36
HDL	-2.802	98	0.006	-1.56

In the present study, mean total cholesterol in Group I was 192.30 ± 15.41 as compared to 175.88 ± 14.7 in Group II. Mean triglyceride of 122.04 ± 15.79 as compared to 119 ± 9.3 and mean HDL level 38.98 ± 3.2 as compared to 40.54 ± 2.28. ECG had been taken in all the patients and were within normal limits. TMT was done in 21 diabetic patients who presented with history of chest pain which is not typical of angina. However, all 21 diabetic patients in the study group were negative for inducible ischaemia.

Table 3: Ejection Fraction (%)

	EJECTION FRACTION < 50%	Ejection fraction > 50%
Group I	3 (6%)	47 (94%)
Group II	-	50 (100%)

	Group	Mean	Standard Deviation	Minimum	MAXIMUM	P-VALUE
Ejection fraction	Group I	63.12	6.1995	48.00%	72.00%	0.006
	Group II	70.72	5.3032	62.00%	84.00%	

In the present study, the Group I shows mean of 63.12 ± 6.19 and in the group II shows mean of 70.72 ± 5.30 and p-value of 0.006 which is statistically significant. In the present study mean ejection fraction is relatively lower as compared to normals (Group II). Three (6%) patients in Group I showed EF < 50% of ejection fraction, but all were clinically asymptomatic. All the three patients had poorly controlled diabetic state and the duration of diabetes was > 8 years. And 47 (94%) had > 50% ejection fraction. The ranges varies from 48% to 72% in Group I and 62% to 84% in Group II.

Table 4: Isovolumetric Relaxation Time (IVRT)

	Group	Mean	Standard Deviation
IVRT (msec)	Group I	87.94	20.3675
	Group II	77.84	4.1471

		Group I	Group II
IVRT (msec)	< 60 msec	3 (6%)	-
	60-100 msec	21 (42%)	50 (100%)
	100+ msec	26 (52%)	-
Total	**50 (100%)**	**50 (100%)**	**50 (100%)**

In the present study, the mean and SD of IVRT in Group I was 87.94 ± 20.36 and mean and SD of Group II was 77.84 ± 4.14 and p-value being 0.001, which is statistically significant. Three (6%) patients had < 60 msec and 21 (42%) had between 60-100 msec and 26 (52%) had > 100 msec respectively.

DISCUSSION

Epidemiological data indicate a greater risk of cardiovascular morbidity and mortality particularly heart failure, in diabetic patients compared to non-diabetic patients. Diabetic cardiomyopathy has been proposed as an independent cardiovascular disease and left ventricular diastolic dysfunction may represent the first stage of diabetic cardiomyopathy. Several studies have shown the evidence of left ventricular systolic and diastolic dysfunction in asymptomatic, normotensive, type 2 diabetic patients. However,the exact causes and mechanisms remains unclear. Sanderson et al. and Shapiro et al. suggest that impairment of diastolic function of left ventricle, i.e. its filling abnormalities are far more common than systolic dysfunction. In the present study an attempt has been made to evaluate left ventricular function by m-mode, 2-D echo and colour Doppler studies in Type 2 diabetes patients and it was compared with the normal subjects. Fifty patients who are normotensive asymptomatic type 2 diabetes were selected for the present study by Simple Random Sampling method during the study period of April 2004 to March 2006. All patients were evaluated for the left ventricular systolic and diastolic dysfunction. In the present study age of the patients ranged from 36 years to 60 years with mean age of 50.12 years and SD 7.752. Majority of the patients are belonged to 4^{th} and 5^{th} decades. Mean age of the present study was comparable to that of Paul Poirie et al., Abdul Khaliq M.H. et al. and John K. Boyer et al. As all the studies mentioned above as well as present study included only Type 2 Diabetes mellitus the mean age was almost identical. It can be observed that majority of the patients were males in the present study. This is comparable to that of Paul Poirie et al., Abdul Khaliq M.H. et al. and John K. Boyer et al. The present study has mean duration of 6.58 years and SD 1.91, which is slightly more than that of Paul Poirie et al., Abdul Khaliq M.H. et al. and John K Boyer. However, the difference was not statistically significant. The mean SBP was 122.84 and DBP was 78.70. This was comparable to BP recordings of Paul Poirie et al., Abdul Khaliq M.H. et al. and John K. Boyer et al. As all the studies mentioned above including the present study were aimed at evaluation of left ventricular dysfunction among normotensive diabetic patients, the mean BP is within normal range. The present study group had mean of 26.08 ± 1.74 with p-value of 0.001, which is statistically significant. The mean BMI in studies by Paul Poirie et al., Abdul Khaliq M.H. et al. and John K. Boyer et al. were slightly more than that of the present study and the difference is not statistically significant. It could be due to ethnicity, racial difference and genetic makeup of the individuals. Majority of Type 2 DM patients in Indian subcontinent are non-obese, the mean BMI in the present study is 26.08 ± 1.740. The study by Abdul Khaliq M.H. et al. showed the mean FBS of 203 ± 51 and mean PPBS of 261 ± 56. However, the results could not be compared due to various factors, such as mode of diabetic management, duration of diabetics, etc. which in turn dependent on various factors including genetics and environmental factors. In the present study, LV systolic function was assessed by using ejection fraction and fractional shortening as important parameters through m-mode and 2D echocardiography, left ventricular ejection fraction and fractional shortening has been calculated and analysed. The present study shows mean of 63.12 ± 6.19 with p-value of 0.009 which is statistically significant. The present study is comparable to that of Paul Poirie et al., Abdul Khaliq M.H. et al. and John K. Boyer et al. who showed mean ejection fraction of 65%, 58% and 64% respectively. In the present study, 3 (6%) patients had significantly decreased ejection fraction of < 50%. However Abdul Khaliq M.H. et al. had 18 (28%) patients with ejection fraction < 50%. This could be due to various reasons which have already been discussed. The present study shows mean of 35.42 ± 5.03. The present study is comparable to that of Abdul Khaliq M.A. et al., John K. Boyer and Rajesh Rajput et al. who showed mean fractional shortening of 33.0 ± 8.6 and 32.7 ± 5.32 and 29.06 ± 9.2 respectively. The p-value of > 0.05 is not statistically significant. In the present study, the mitral E shows mean of 67.32 ± 6.22, mitral A shows mean of 70.72 ± 7.42. E/A ratio shows mean of 0.95 ± 0.10 with p-value of 0.001 which is statistically significant. 26 patients had E/A ratio of < 1 constituting 52% of study group. Twenty-four patients had E/A ratio > 1. E/A < 1 was very sensitive and specific indicator of LV diastolic

dysfunction. In the present study more than half of the patients had LV diastolic abnormalities inspite of relatively normal LV systolic function and absence of cardiac symptoms. The present study is comparable to that of Paul Poirie et al., Abdul Khaliq M.H. et al. and John K. Boyer who showed the mean E/A ratio of 0.72 ± 0.13, 0.9 ± 0.2 and 0.95 ± 0.29, respectively. Zarich et al. and Papillolec et al. reported that diabetics who had normal ejection fraction had evidence of diastolic dysfunction in the form of decreased E/A ratio. They too found that LV fractional shortening was normal in all subjects who had decreased E/A ratio among diabetics. In the present study, the late atrial filling wave (A) was significantly increased, probably due to elevated LV filling pressure secondary to impaired relaxation among diabetic individuals. The diastolic abnormalities in diabetic patients most likely to indicate reduced LV compliance secondary to small vessel disease, infiltrative myocardial process, metabolic derangement or a combination of the three. In the present study, the isovolumetric relaxation time (IVRT) showed mean and SD of 87.94 ± 20.36 as compared to IVRT mean of Paul Poirie et al. and John K. Bayer et al. show 109 ± 11 msec and 79 ± 14 msec respectively and p-value of < 0.05 which is statistically significant. The prolongation of IVRT more than 100 msec is a significant indicator of early LV diastolic dysfunction. In the present study, 26 patients had IVRT of > 100. All these patients also had E/A ratio of < 1. IVRT was within normal range in 21 patients and it was < 60 msec in 3 patients who also had coexisting LV systolic dysfunction with ejection fraction of <50%. Similarly, Hiramatsu K., Ohara N. et al. and Papillolec et al. showed in their studies that diabetic patients had greater isovolumetric relaxation time. In the present study, the deceleration time of E (DT of E) showed mean of 180.68±34.64 as compared to Paul Poirie et al., John K. Boyer et al. and Gani Balraktari et al. who showed 224 ± 51, 208 ± 44 and 173.88 ± 20.81, respectively. The p-value <0.05 which is statistically significant. Prolongation of DT of E more than 200 msec is a significant indicator of early LV diastolic dysfunction. In the present study, DT of E was > 200 msec in 23 (46%) patients. All these patients had E/A < 1 and IVRT > 100 msec suggestive of early diastolic dysfunction. Twenty-five patients (50%) had DT of E between 150 msec to 200 msec. Two patients had DT of E < 150 msec suggestive of severe LV diastolic dysfunction. Both these patients had coexisting LV systolic dysfunction also. In the present study, echocardiographic evidence of LV diastolic dysfunction among asymptomatic type 2 diabetes mellitus patient was recognised in more than 50% of patients and systolic dysfunction was seen in 6% of patients.

CONCLUSIONS

1. LV diastolic dysfunction is commonly seen in asymptomatic normotensive Type 2 DM patients.
2. Alteration of E/A ratio < 1 is a sensitive and specific indicator of early diastolic dysfunction.
3. LV systolic dysfunction was also seen in a small number of asymptomatic normotensive Type 2 DM which may point towards high prevalence of silent cardiac muscle disease in asymptomatic Type 2 DM.
4. LV diastolic dysfunction is a marker of evolving heart disease among diabetics. LV diastolic dysfunction in asymptomatic normotensive patients with type 2 DM without evidence of coronary heart disease is significantly higher than previously suspected.
5. Conventional echocardiography is a simple economical test for detecting LV dysfunction in type 2 normotensive, asymptomatic, diabetes mellitus patients.

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