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Assessment of Diastolic Dysfunction among Asymptomatic Type 2 Diabetes Mellitus Patients using 2-D Echocardiography and Tissue Doppler Imaging

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Abstract

The prevalence of diabetes is rapidly rising in all parts of the world, reaching epidemic proportions. The situation is worse in developing countries like India. Cardiac complications contribute as a major cause of morbidity and mortality in diabetic patients. Diastolic dysfunction is one of the earliest indicators of cardiac involvement in diabetes. Detection of this diastolic dysfunction early can help to formulate a better strategy for management of patients. Earlier treatment might delay the progression to grave cardiac complications, which may significantly reduce the morbidity and mortality in the patients. Various methods of echocardiography are available for detection of diastolic dysfunction. More sensitive and newer techniques like Tissue Doppler imaging have better prospects for evaluation of cardiac function, due to their better sensitivity in detecting early changes.

Key words: Diabetes mellitus, diastolic dysfunction, Tissue Doppler echocardiography.

Introduction

The incidence of diabetes mellitus (DM) is increasing worldwide. Diabetes mellitus is reaching potentially epidemic proportions in India, with around 72 million people affected with diabetes[1]. The morbidity and mortality due to diabetes and its complications is enormous, and pose significant healthcare burdens on, both, families and society.

The risk of cardiovascular diseases is increased in patients of diabetes mellitus and they also contribute to a significant proportion of morbidity and mortality among the diabetic patients. Clinical, epidemiological and pathological studies attribute the increased occurrence of clinical congestive heart failure in diabetic subjects to diabetic cardiomyopathy, which could take the form of diastolic and/or systolic left ventricular dysfunction. Left ventricular diastolic dysfunction represents the earliest, pre-clinical, manifestation of diabetic cardiomyopathy, preceding systolic dysfunction and evolving to symptomatic heart failure. Studies have reported a high prevalence of pre-clinical diastolic dysfunction among subjects with DM, ranging from 43% to 70%[2,3] being much more common than left ventricular systolic dysfunction[3]. The prevalence of diastolic dysfunction increases with longer duration of diabetes. There was a linear progression of diastolic dysfunction with the increased age group[4]. Thus, LV diastolic dysfunction may represent the earliest stage of diabetic cardiomyopathy and timely diagnosis of this entity can be vital in the management of patients. So far, very few population-based studies have been carried out in India, to demonstrate the prevalence of diastolic dysfunction among diabetic subjects.

The objective of our study was to determine whether there is any association between diastolic dysfunction and type 2 DM, even in asymptomatic subjects. We used various modalities of echocardiography (namely E/A ratio, LA volume index, deceleration time, IVRT) to diagnose diastolic dysfunction in diabetic patients and compared their sensitivity. More sensitive methods are useful for early diagnosis of diastolic dysfunction among diabetic patients and institution of treatment, thus helping in reducing morbidity, and improving the outcome of diastolic HF.

Material and methods

This case-control prospective, observational study was conducted out at the SN Medical College and Hospital, Agra. A total of 100 cases were selected, based on the random sampling criteria. Complete history and physical examination of all patients was done and findings were recorded. Various methods were used to assess diastolic dysfunction in type 2 diabetic patients with the help of echocardiography (E/A ratio, LA volume index, deceleration time, IVRT, annular velocity by Tissue Doppler technique - E/e' ratio). We also compared these modalities for detecting diastolic dysfunction.

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Inclusion criteria

Asymptomatic and previously diagnosed cases (duration of diabetes less than 5 years) of diabetes mellitus.

Exclusion criteria

Subjects with evidence of coronary artery disease (CAD), valvular disease, hypertensive patients, other known causes of diastolic dysfunction like hypothyroidism, restrictive cardiomyopathy, constrictive pericarditis, etc., were not recruited to the study.

Results

Table I: Diastolic dysfunction determined by E/A ratio.

Grade	No.	Mean	SD	f value	p value	SEm ±	CD at 5%
I	32	0.83	0.21	42.590	< 0.0001*	0.021	0.06
II	12	1.25	0.13				
III	6	1.76	0.42				
Normal	50	1.19	0.19				

Table I shows that when E/A ratio was used, it was seen than 50 out of 100 patients had diastolic dysfunction. When compared with patients with normal cardiac function, this value was significant (p value < 0.0001). Grade I diastolic dysfunction was found in 32 patients, grade II in 12 patients and grade III in 6 patients.

Table II: Diastolic dysfunction determined by LA volume index.

Grade	No.	Mean	SD	f value	p value	SEm ±	CD at 5%
I	30	32.44	3.65	43.984	< 0.0001*	0.443	1.24
II	11	32.67	4.16				
III	6	36.83	11.43				
Normal	53	23.04	3.58				

Table II shows that using LA volume index, diastolic dysfunction was seen in 47 out of 100 patients. Among them, 30 patients had grade I diastolic dysfunction, 11 patients had grade II and 6 patients had grade III diastolic dysfunction. Again, on comparing this with patients having normal cardiac function, the p value was significant (p value < 0.001).

Table III shows that deceleration time detected diastolic dysfunction in 44 out of 100 patients. The p value was significant when compared to patients having normal cardiac function (p value < 0.001). Out of 48 patients, 31 had grade I, 8 patients had grade II and 5 patients had grade III diastolic dysfunction.

Table III: Diastolic dysfunction determined by deceleration time

Grade	No.	Mean	SD	f-value	p-value	SEm±	CD at 5%
I	31	271.06	30.94	66.943	<0.0001*	2.80	7.84
II	8	178.42	9.95				
III	5	135.50	25.23				
Normal	56	205.52	29.03				

Table IV: Diastolic dysfunction determined by IVRT.

Grade	No.	Mean	SD	f value	p value	SEm ±	CD at 5%
I	33	94.44	17.91	16.533	0.0001*	1.34	3.75
II	12	71.17	7.32				
III	7	60.17	11.34				
Normal	48	83.32	11.10				

Using IVRT, diastolic dysfunction was seen in 52 out of 100 patients. 33 patients had grade I, 12 had grade II, and 7 patients had grade III diastolic dysfunction. On comparing this with patients having normal cardiac function, the p value was significant (p value < 0.001).

Table V: Diastolic dysfunction determined by E/e' ratio (septal).

Grade	No.	Mean	SD	f value	p value	SEm ±	CD at 5%
I	41	12.04	1.62	143.88	< 0.0001*	0.15	0.42
II	12	15.15	0.80				
III	6	18.32	0.48				
Normal	41	7.93	1.58				

Table V shows the distribution of diastolic dysfunction using tissue Doppler technique (where E/e' ratio was used) to calculate the diastolic dysfunction. It was seen that, by using this technique, 59 patients had diastolic dysfunction. Among the patients, 41 patients had grade I diastolic dysfunction

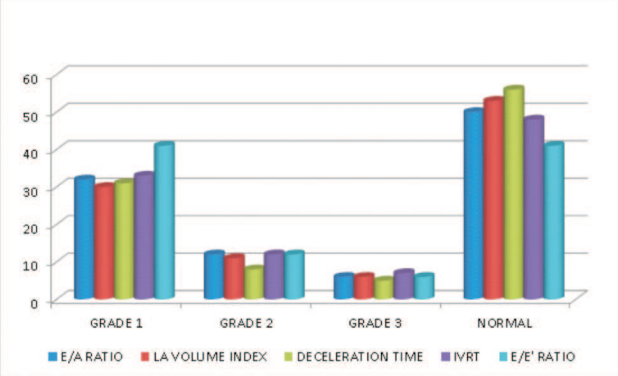

Fig. 1: *Showing diastolic dysfunction as detected by various modalities.*

(mean 12.04), 12 patients had grade II diastolic dysfunction (mean 15.15), 6 patients had grade III diastolic dysfunction (mean 18.32) and rest 41 patients had normal diastolic dysfunction.

Table VI shows a comparison of the various modalities of echocardiography for detecting diastolic dysfunction in diabetic patients, as compared to tissue Doppler technique.

Table VI: Comparison of various modalities in detecting diastolic dysfunction.

Modality	Number of patients	Number of patients detected by E/E'	z value	p value
E/A	50	59	4.0856	0.0012
LA Volume index	47	59	6.5108	0.0175
Deceleration time	44	59	7.1247	0.0121
IVRT	52	59	2.1478	0.03145

Discussion

India is the diabetes capital of the world with 72 million Indians having diabetes; every fifth diabetic in the world is an Indian[1]. It also leads in the prevalence of metabolic syndrome, as well as obesity. The prevalence of diabetes in India is around 8.8%[1]. 20 million Indians are either obese or abdominally obese, with children being the prime targets and by 2025, the expected number would be 68 million[5]. Cardiac involvement in diabetes is fairly common and diastolic dysfunction is the earliest marker of cardiac complications in diabetes. The pathogenesis of this left ventricular (LV) dysfunction in diabetic subjects is not clearly understood. Diabetic cardiomyopathy has been proposed as an independent cardiovascular disease, and many mechanisms, such as microvascular disease, autonomic dysfunction, metabolic disorders, and interstitial fibrosis, have been suggested as causative factors[6].

In our study, 100 asymptomatic patients of diabetes mellitus were taken and evaluated for diastolic dysfunction with the help of echocardiography using various modalities. Most of the patients were in the 40 - 60 years age group. Among the 100 patients, 67 were male and 33 were females. We also compared the sensitivity of various modalities in detecting the diastolic dysfunction.

When E/A ratio was used, it was seen than 50 out of 100 patients had diastolic dysfunction. Using LA volume index, diastolic dysfunction was seen in 47 out of 100 patients. Deceleration time detected diastolic dysfunction in 44 out of 100 patients. Using IVRT, diastolic dysfunction was seen in 52 out of 100 patients (Table I).

On using tissue Doppler technique (E/E' ratio), diastolic dysfunction was seen in 59 out of 100 patients (Table V). The number was significantly higher than that with other modalities. On comparing the sensitivity of E/E' with other modalities (namely E/A ratio, LA volume index, deceleration time, IVRT) in detecting the diastolic dysfunction (Table VI), it was seen that in all cases the p value was found to be statistically significant (p value < 0.05). Thus, tissue Doppler technique was the most sensitive in detecting diastolic dysfunction, compared to other modalities.

Kibar and co-workers (2009)[7] also demonstrated that TDI of the septal corner of mitral annulus provides better estimation of diastolic dysfunction than PW Doppler parameters. A study done by Shreshta *et al* (2009)[8], in 100 asymptomatic type 2 diabetes mellitus, LVDD was found in 71 subjects of whom 60 had impaired relaxation and 11 had a Pseudo-normal pattern of ventricular filling detected by Doppler echo, which included Valsalva Maneuver.

Patil *et al*[9] studied 127 asymptomatic diabetic patients and found diastolic dysfunction in 67 (54.33%). Burji *et al*[4] found that diastolic dysfunction was present in 32 (64%) of the patients. Diastolic dysfunction was more common among female sex (68.18%) compared to male (60.17%). Fawad Randhawa *et al*[10] studied 150 consecutive patients with type 2 diabetes mellitus having normal blood pressure and normal resting electrocardiography and without any symptoms of heart failure. Diastolic dysfunction was seen in 48% of patients. These results were similar to that found in our study.

Mitrovska *et al*[11] (2014) reported that Tissue Doppler Imaging (TDI) is a new technique, able to record early changes of subclinical ventricular diastolic dysfunction and potentially identifies diabetic patients who may benefit from earlier treatment in order to prevent heart failure. They found statistically significant difference between TDI and PW Doppler (E/E´ vs E/A) in diabetic ($Z = -3.17$, $p < 0.001$) and control group ($Z = -2.4$, $p < 0.003$). There was no significant difference in E/A between the groups ($Z = 0.0$, $p < 1.0$). But, TDI identified significantly lower E´ ($Z = 2.11$, $p < 0.03$) and higher E/E´ ($Z = -2.12$, $p < 0.03$) in diabetic vs control group ($Z = -2.12$, $p < 0.03$).

Thus, TDI proved to be more accurate than conventional Doppler for detecting impaired diastolic function in patients with type 2 diabetes mellitus. TDI detected diastolic dysfunction in 59% (59 of 100) diabetic patients with Normal Ejection Fraction. TDI was a more reliable technique to identify early disturbances of both LV relaxation and stiffness. TDI unmasks the presence of subclinical LV diastolic dysfunction in asymptomatic diabetic patients with higher frequency than PW Doppler.

Summary and conclusion

The objective of the present study was to assess diastolic dysfunction in asymptomatic type 2 diabetes mellitus patients and to compare conventional method with tissue Doppler imaging for assessment of diastolic dysfunction.

Diastolic dysfunction was seen very commonly, even in asymptomatic patients of diabetes mellitus (59% in our study).TDI (E/E' ratio) was the most sensitive technique for the detection of diastolic dysfunction as compared to other conventional modes of echocardiography. Thus, tissue Doppler imaging can be used for early diagnosis of diastolic dysfunction in diabetic patients. This early diagnosis will definitely help in lowering the burden, as well as preventing cardiac complications. During the last 20 years, there have been marked changes in the field of diastology and echocardiography. Still, larger studies and more advancement in TDI technique is needed for early detection of diastolic dysfunction to fully address this aspect of diabetes.

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