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Original Research Article

Detection and evaluation of left ventricular diastolic dysfunction in asymptomatic type 2 diabetic patients by conventional and tissue doppler imaging

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ABSTRACT

Background: Diabetic cardiomyopathy is characterised predominantly by diastolic dysfunction. While the traditional echocardiography provides only semiquantitative assessment of diastolic dysfunction, tissue Doppler imaging proved to be an effective technique for the quantification of subclinical diastolic dysfunction.
Methods: The current cross-sectional study was conducted in out-patient department of General Medicine, Tagore Medical College and Hospital for a period of 6 months. The study population comprised of 100 patients with type 2 diabetes mellitus including 39 male and 61 females. Echocardiography (using Siemens – Acuson NX3 Elite - system with TDI technology) was performed to all subjects in the left lateral position and 2D, M- mode, Doppler techniques were used. The early E wave corresponding to early ventricular filling and A wave which reflect a trial contraction were typically measured to assess the transmitral flow pattern. Systolic S' (Sa), early diastolic E (Ea) and the late diastolic velocities A' (Aa) were measured by tissue Doppler imaging.
Results: The E/A ratio ranged from 0.5 to 2 and E/Ea ratio ranged from 1.59 to 14.67. Around 23 patients and 54 patients were abnormal by E/A and E/Ea ratios respectively. Around 29 patients showed grade II diastolic dysfunction by tissue Doppler imaging
Conclusions: Prompt diagnosis of diastolic dysfunction help us to identify high risk patients who are likely to be benefitted by early therapeutic intervention. Tissue Doppler imaging may be a better tool in the identification of diastolic dysfunction especially grade II in comparison with the conventional echocardiography.

Keywords: Diastolic dysfunction, Pseudo-normal pattern, Tissue Doppler imaging

INTRODUCTION

Various studies have shown that the type 2 diabetes mellitus (T2DM) is associated with increased cardiovascular morbidity and mortality.[1] The diabetes is considered to be an important risk factor for cardiovascular related disease like heart failure, peripheral arterial insufficiency and microvascular complications.[2] It has found that as over 75% of all diabetic patients die from cardiovascular events.[3]

The mechanism involved in the association of diabetes and heart failure is still under research. The relation of higher risk of diabetes patients to atherosclerosis and microvascular dysfunction has been found.[4,5] Further other factors that attribute to the association are

deposition of interstitial myocardial fibrosis and specific neurohumoral dysregulations.[6-8]

In T2DM, the abnormalities in diastolic function, which is the early indication of diabetic cardiomyopathy is assessed by conventional methods, and also by tissue Doppler imaging (TDI). Doppler imaging is relatively new echocardiography tool and it is based on the measurement of wall motion velocities.[9-11] Many researches have shown that it is better suited for evaluating LV dysfunction and to assess the early impairment of cardiac performance in diabetic patients.[12,13] In its early stage, diabetic cardiomyopathy is characterized by left ventricular diastolic dysfunction (LVDD).[14]

The aim of the present study is to detection and evaluation of left ventricular diastolic dysfunction in asymptomatic T2DM patients by tissue doppler imaging.

METHODS

Study participants

The present study is a cross-sectional study. About 100 type 2 diabetes mellitus patients in the age group of 35 to 60 years who have attended general medicine out-patients department, Tagore Medical College and Hospital for a period of 6 months were selected for the study. The patients with valvular heart disease, ischemic heart disease, hypertensive heart disease, congestive heart failure and overt renal disease were excluded from the study.

Echocardiography (using Siemens – Acuson NX3 Elite - system equipped with TDI technology) was performed to all subjects in the left lateral position and 2D M- mode. Doppler techniques were used for measurement of the following parameters – left ventricular end-diastolic diameter (LVEDD), left ventricular end-systolic diameter (LVESD), ejection fraction (EF), left ventricle posterior wall (LVPW), left atrium (LA) size as well as exclusion of any wall motion abnormalities. Transmitral flow pattern was assessed using PW Doppler across the mitral inflow tract, two waves were measured: the early E wave corresponding to early ventricular filling and A wave which reflect atrial contraction were typically measured by placing a sample volume at the mitral leaflet tips in the four-chamber apical view. Tissue Doppler imaging of mitral annular velocity was obtained by placing a 5 mm sample volume over the lateral and septal mitral annulus. Systolic S' (Sa), early diastolic E (Ea) and the late diastolic velocities A' (Aa) were measured.[15]

Statistical analysis

All the data were analysed using SPSS version 20. The descriptive statistics like mean and standard deviation were performed for various variables. The ANOVA was performed to compare the mean values of different groups. The Mc Nemar test was done to compare the values of E/A and E/Ea among the same patients.

RESULTS

A total of 100 patients were selected for the present study among which 39 were male and 61 were female (Table 1).

Table 1: Gender wise distribution of patients.

Gender	Number
Male	39
Female	61
Total	100

There were a greater number of patients between age group of 41 to 60 (Table 2).

Table 2: Number of patients in different age groups.

Age groups	Number
35 to 40	13
41 to 50	35
51 to 60	52
Total	100

The Table 3 gives the various values of E/A ratio and E/Ea ratio among diabetic patients. The E/A ratio ranged from 0.5 to 2 with a mean value of 1.04±.33 and E/Ea ratio ranged from 1.59 to 14.67 with a mean value of 8.25±2.26.

Table 3: Measurements of E/A ratio and E/Ea ratio among diabetic patients.

Parameter	Minimum	Maximum	Mean±SD
E/A ratio	0.50	2.00	1.04±0.33
E/Ea ratio	1.59	14.67	8.25±2.26

When the gender wise analysis was done, there is no statistically significant difference ($p>0.05$) in the values of both the E/A ratio and E/Ea ratio between male and female (Table 4).

When a comparison was made to find the difference in different age groups, the results showed that there is no significant difference in the values of both the E/A ratio and E/Ea ratio between different age groups (Table 5).

By E/Ea ratio, 46 patients were normal, 25- Grade I, 29- Grade II, 0- Grade III. (Table 6).

When E/A ratio is taken into consideration, 77- normal, 20- Grade I, 0- Grade II, 3- Grade III (Table 7).

When conventional and tissue doppler echocardiography were taken into consideration, 31 patients showed normal. However, none of patients showed Grade I, II

and III by both the technique (Table 8) which is statistically significant.

Table 4: Gender wise measurements of E/A ratio and E/Ea ratio among diabetic patients.

Gender	Number	Parameter	Minimum	Maximum	Mean±SD	Significance value
Male	39	E/A ratio	0.51	2.00	1.07±0.38	p>0.05
		E/Ea ratio	4.57	13.60	7.74±1.92	
Female	61	E/A ratio	0.50	1.83	1.01±0.29	
		E/Ea ratio	1.59	14.67	8.57±2.40	

Table 5: Age groupwise measurements of E/A ratio and E/Ea ratio among diabetic patients.

Age group	Number	Parameter	Minimum	Maximum	Mean±SD	Significance value
35 to 40	13	E/A ratio	0.83	2.00	1.46±0.30	p>0.05
		E/Ea ratio	5.93	8.63	7.19±0.89	
41 to 50	35	E/A ratio	0.74	1.83	1.08±0.27	
		E/Ea ratio	5.29	12.75	8.78±1.98	
51 to 60	52	E/A ratio	0.50	1.51	0.91±0.23	
		E/Ea ratio	1.59	14.67	8.11±2.58	

Table 6: Number of diabetic patients in different grades by measurement of E/Ea ratio.

Grades	Number
Less than 8 (Normal)	46
8 to 9 (Grade I)	25
9 to 14 (Grade II)	29
Above 14 (Grade III)	0
Total	100

Table 7: Number of diabetic patients in different grades by measurement of E/A ratio.

Grades	Number
Normal	77
Less than 0.8 (Grade I)	20
0.9 to 1.5 (Grade II)	0
Above 1.6 (Grade III)	3
Total	100

Table 8: Comparison of measurements of E/A ratio and E/Ea ratio among diabetic patients.

		E/A measurement					Significance value
		Normal	Grade I	Grade II	Grade III	Total	
E/Ea Measurement	Normal	31	14	0	1	46	p<0.05
	Grade I	23	0	0	2	25	
	Grade II	23	6	0	0	29	
	Grade III	0	0	0	0	0	
	Total	77	20	0	3	100	

DISCUSSION

The elevated levels of blood sugar in diabetes patients is considered to be one of the causations of cardiovascular diseases.[16] Hyperglycaemia may lead to the formation of non-enzymatic glycation of tissue proteins, lipids, and deoxyribonucleic acid (DNA) to form irreversibly bound advanced glycated end products.[17]

These products may also be formed in heart tissues leading to various abnormalities. The LV diastolic dysfunction has been identified to be the first stage of the diabetic cardiomyopathy.[18] Hence it is advisable to evaluate LV diastolic dysfunction in diabetic individuals.

In the present study an attempt has been made to evaluate conventional versus tissue Doppler Echocardiography to identify the LV diastolic dysfunction in diabetes patients with no symptoms of heart failure. Many such similar studies have been conducted only in symptomatic non-diabetic individuals.

Currently Cardiac catheterization with simultaneous pressure and volume measurements is considered to the gold standard procedure for assessing LV diastolic dysfunction. The main drawback is that it is invasive procedure and cannot be performed in many patients. In recent days, the tissue doppler imaging has been used to find the LV diastolic dysfunction. However, its superiority with conventional echocardiography is still questionable.

In the present study, the Grade II results are highly variable between the two techniques. The Grade II diastolic dysfunction, which is also called as pseudo-normal pattern, is very difficult to diagnose.[19]

The pulmonary vein doppler is helpful but sometimes difficult to read, most often detected by other parameters like left ventricular hypertrophy, history etc. The advent of tissue doppler has made the diagnosis of Grade II diastolic dysfunction easier now.

The results of the present study have shown that both the techniques have identified the LV dysfunction in diabetic patients except with few discrepancies.

In certain studies, the tissue doppler imaging is found to be more sensitive than the conventional doppler. However, some studies have shown that both the techniques did not differ significantly.[20]

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REFERENCES

1. Emerging Risk Factors Collaboration. Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies. The Lancet. 2010 Jun 26;375(9733):2215-22.
2. Gu K, Cowie CC, Harris MI. Mortality in adults with and without diabetes in a national cohort of the U.S. population, 1971-1993. Diabetes Care. 1998;21(7):1138-45.
3. Bertoni AG, Hundley WG, Massing MW, Bonds DE, Burke GL, Goff DCJr. Heart failure prevalence, incidence, and mortality in the elderly with diabetes. Diabetes Care. 1998 Jul 1;21(7):1138-45.
4. Shehadeh A, Regan TJ. Cardiac consequences of diabetes mellitus. Clin Cardiol. 1995;18:301-5.
5. Asbun J, Villarreal FJ. The pathogenesis of myocardial fibrosis in the setting of diabetic cardiomyopathy. J Am Coll Cardiol. 2006;47:693-700.
6. Asbun J, Villarreal FJ. The pathogenesis of myocardial fibrosis in the setting of diabetic cardiomyopathy. J Am Coll Cardiol. 2006;47:693-700.
7. Ashrafian H, Frenneaux MP, Opie LH. Metabolic mechanisms in heart failure. Circulation. 2007; 116:434-48.
8. From AM, Scott CG, Chen HH. The development of heart failure in patients with diabetes mellitus and pre-clinical diastolic dysfunction a population-based study. J Am Coll Cardiol. 2010;55:300-5.
9. Sutherland GR, Stewart MJ, Groundstroem KW, Moran CM, Fleming A, Guell-Peris FJ, et al. Color Doppler myocardial imaging: a new technique for the assessment of myocardial function. J the Am Society of Echocardiogr. 1994 Sep 1;7(5):441-58.
10. Donovan CL, Armstrong WF, Bach DS. Quantitative Doppler tissue imaging of the left ventricular myocardium: validation in normal subjects. Am Heart J. 1995;130(1):100-4.
11. Rodriguez L, Garcia M, Ares M, Griffin BP, Nakatani S, Thomas JD. Assessment of mitral annular dynamics during diastole by Doppler tissue imaging: comparison with mitral Doppler inflow in subjects without heart disease and in patients with left ventricular hypertrophy. Am Heart J. 1996;131(5):982-7.
12. Dokainish H. Tissue Doppler imaging in the evaluation of left ventricular diastolic function. Curr Opin Cardiol. 2004;19(5):437-41.
13. Khouri SJ, Maly GT, Suh DD, Walsh TE. A practical approach to the echocardiographic evaluation of diastolic function. J. Am. Soc Echocardiogr. 2004;17(3):290-7.
14. Bonito PD, Cuomo S, Moio N, Sibilio G, Sabatini D, Quattrin S, et al. Diastolic dysfunction in patients with non-insulin-dependent diabetes mellitus of short duration. Diabetic medicine. 1996 Apr;13(4):321-4.
15. Schiller NB, Shah PM, Crawford M, DeMaria A, Devereux R, Feigenbaum H, et al. Recommendations for quantitation of the left ventricle by two-dimensional echocardiography. J Am Soc Echocardiogr. 1989 Sep 1;2(5):358-67.
16. Kannel WB, Hjortland M, Castelli WP. Role of diabetes in congestive heart failure: the Framingham study. Am J Cardiol. 1974;34(1):29-34.
17. Brownlee M. Advanced protein glycosylation in diabetes and aging. Annu Rev Med.1995;46:223-34.
18. Ojji D, Parsonage W, Dooris M, Adebiyi A, Oladapo O, Adeleye J, et al. Left ventricular diastolic function in normotensive type-2 diabetic subjects. J National Medical Association. 2008 Sep 1;100(9):1066-72.
19. Boyer JK, Thanigaraj S, Schechtman KB, Pérez JE. Prevalence of ventricular diastolic dysfunction in asymptomatic, normotensive patients with diabetes mellitus. Am J Cardiol. 2004 Apr 1;93(7):870-5.
20. Ommen SR, Nishimura RA, Appleton CP, Miller FA, Oh JK, Redfield MM, et al. Clinical utility of Doppler echocardiography and tissue Doppler imaging in the estimation of left ventricular filling

pressures: a comparative simultaneous Doppler-catheterization study. Circulation. 2000 Oct 10;102(15):1788-94.

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