ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 08, Issue, 02, pp.18886-18889, February, 2018

ORIGINAL RESEARCH ARTICLE

OPEN ACCESS

LEFT VENTRICULAR STRAIN IMAGING IN ASYMPTOMATIC PATIENTS WITH TYPE 2 DIABETES MELLITUS WITH OR WITHOUT HYPERTENSION

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ARTICLE INFO

Article History:

Received 11th November, 2017
Received in revised form
23rd December, 2017
Accepted 19th January, 2018
Published online 28th February, 2018

Key Words:

STE, strain

ABSTRACT

Background: Subclinical changes in LV function can be identified by quantifying myocardial strain. Early detection of diabetic heart disease is important for the timely interventions resulting in the prevention for the future development of heart failure.The aim of this study was to assess the ability of subtle differences in LV principal strains to characterize features of subclinical LV systolic dysfunction in patients with diabetes mellitus with or without systemic hypertension and apparently preserved LV systolic function.

Methods and results: 2-dimensional echocardiographic (2DE) images of the LV were acquired in apical 4-chamber and parasternal short-axis at the basal, mid, and apical levels in 150 subjects, including 60 healthy controls (52.62 yrs. ± 6.51) and 90 patients with diabetes mellitus (53.63yrs. ± 6.27) patients out of which 45 patients were hypertensive also. Using 2D strain software, end-systolic longitudinal strain (LS), radial strain (RS), and circumferential strain (CS) were measured in 18 LV segments. No significant differences in LVEF were noted between groups. In comparison with normal controls, peak LS, peak CS was markedly attenuated in the patients with diabetes mellitus patients with or without systemic hypertension. However, radial strain was not significantly different in the two groups.

Conclusion: In conclusion, the LV longitudinal and circumferential systolic and diastolic function were impaired,but the radial functions were preserved in patients with uncomplicated type 2 diabetes mellitus with or without systemic hypertension.

Citation: Dr. Meena, C. B. and Rajesh Kumar Pandey, 2018. "Left ventricular strain imaging in asymptomatic patients with type 2 diabetes mellitus with or without hypertension", *International Journal of Development Research*, 8, (02), 18886-18889.

INTRODUCTION

Defination of Diabetic cardiomyopathy is as left ventricular (LV) dysfunction that occurs independently of coronary artery disease and hypertension. It is important to detect diabetic heart disease earlier as timely life-style modifications and medical interventions could prevent or delay the subsequent development of heart failure which is considered one of major burdens for health insurance costs2.3, There are evidences that patients with early diabetic cardiomyopathy often have global diastolic dysfunction but preserved systolic function, reflected by a normal LV ejection fraction (EF).4 Early manifestation of diabetic LV systolic dysfunction can be appeared longitudinally, because subendocardial fibres are vulnerable to myocardial ischaemia, have a longitudinal trajectory. 5–7 Systemic hypertension is also an established risk factor for the development of asymptomatic left ventricular (LV) dysfunction and congestive heart failure., which is present in approximately 60% of patients with type 2 DM 8.Myocardial strain can identify Subclinical changes in LV function ,that is a dimensionless measurement of deformation, expressed as a fractional or percentage change from an object's original dimension. Two-dimensional (2D) speckle tracking has recently emerged as a novel echocardiographic technique for rapid, offline, bedside analysis of regional LV strains in the longitudinal, radial, and circumferential directions.9-11 Thus, the aim of this study was to measure LS, radial strain (RS), and circumferential strain (CS) in asymptomatic diabetic patients with or without systemic hypertentionusing 2DSTE, to determine which LV strain is preferentially impaired.

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MATERIALS AND METHODS

Study population

We included 90 consecutive patients with diabetes mellitus (53±6yrs, 22 female) and 60 age and sex matched healthy controls (52 ± 46yrs, 11fe male). Healthy subjects were predominantly hospital employee or their relatives and/or friends. Because ageing affects diastolic function, we selected control subjects in order to adjust the same range of age. Patients with established coronary artery disease, echocardiographic evidence of either regional or global wall motion abnormalities, valvularheart disease, diabetes mellitus and hypertrophic cardiomyopathy were excluded. Each study participant gave written, informed consent.

Echocardiography

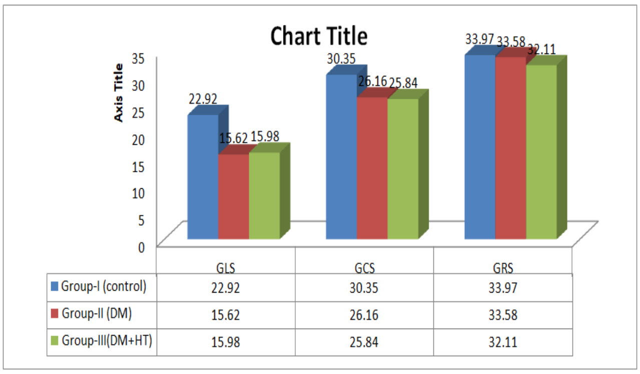
Transthoracic echocardiography was performed with the subjects at rest using standard techniques. A complete 2DE was performed in all patients, using a commercially available ultrasound transducer (IE-33, Phillips). Basic measurements included LV wall thickness by M-mode and LV diameter by 2D echocardiography. LV volumes and LVEF were measured using the modified biplane Simpson method as recommended by the American Society of Echocardiography Using commercially available 2D strain software ((IE-33, Phillips), the endocardial border in the end systolic frame was manually traced. A region of interest was then drawn to include the entire myocardium. Three consecutive cardiac cycles loops were recorded at end expiration. The frame rate was kept between 70 Hz and 100 Hz. Longitudinal, circumferential and radial strains were quantified in an 18-segment model using a novel speckle tracking system LS was measured in all 3 views, A4C, A2C and PSAX view. The software algorithm automatically segmented the LV into six equidistant segments and selected suitable speckles in the myocardium for tracking. Finally, the software automatically generated time-domain LV strain profiles for each of the six segments of each view, from which end-systolic strain was measured. The average value of strain at each level (basal, middle, and apical) and global strain obtained from averaging the strain values of 18 LV segments was calculated.

P value ≤0.05 were considered significant. The study was designed with 90% power to detect a significant difference in global LS between diabetic patients and control subjects with a α= 0.05. A difference in global LS between two groups of 3.0% was defined as clinically important, with an estimated SD of 3.0%. We calculated that at least 22 patients would be required in each group.

RESULTS

The study population consisted of 160 subjects divided in 3 groups.

Group I included normal control subjects (n=60). Group II included diabetic persons without hypertension subjects (n=45). Group III included diabetic persons with hypertensive subjects (n=45). Baseline characteristics of groups are shown in Table 1. No significant differences were found between the three groups in terms of age, sex or heart rate. Patients with systemic hypertension weighed significantly more than the control group (p < 0.001).Diabetic duration was non significant between group II &III. There was a significant higher systolic and diastolic blood pressure in patients in group III than the group I& II.



	GLS	GCS	GRS
Group-I (control)	22.92	30.35	33.97
Group-II (DM)	15.62	26.16	33.58
Group-III(DM+HT)	15.98	25.84	32.11

The basic echocardiographic parameters are listed in Table 2. No significant differences were found in LVEF and left ventricular internal dimensions between the diabetic patients and healthy controls but septal wall thickness and posterior wall thickness was significantly higher in group III as compared to group I & II.

Table 1. Baseline characteristic in patients with healthy and diabetes subjects

S.N.	Variables	Group-I (control)	Group-II (DM)	Group-III (DM+HT)	P-value		
					(I&II)	(I&III)	(II&III)
1	Age	52.62 ± 6.51	53.56 ± 5.53	53.82 ± 6.15	0.565	0.564	0.465
2	Gender	1.18 ±0.39	1.20 ± 0.40	1.02 ±0.15	0.023	0.028	0.025
3	Systolic BP	125.90 ± 8.73	126.49 ± 6.73	151.24 ± 7.40	0.354	<0.01	<0.01
4	Diastolic BP	81.30 ± 7.09	80.84 ± 4.27	92.31 ± 6.61	0.43	<0.01	<0.01
5	HR(bpm)	74.23 ± 8.94	72.84 ± 9.27	74.62 ± 9.49	0.624	0.643	0.676
6	Diabetic duration	N/A	6.4 ± 1.4	6.9 ± 2.2			0.565

Statistical Analysis

Data were expressed as mean ± SD. Statistical Analysis was performed using the SPSS Statistical software (SPSS v.20 for windows, SPSSI nc., Chicago, IL, USA). For any parameter, independent t-test and ANOVA were used to compare variables between different groups. The chi square test and Fisher' exact test were used for categorical variables. Linear regression analysis, with Pearson 'coefficient, was used to estimate correlation between continuous variables.

There were decreased early diastolic velocity (E), early diastolic annular velocity (E') in the diabetic group, resulting in a higher E/E' compared with subjects. Thetransmitral E/A and E/E' ratio impaired in the diabetic patients compared those in the control. the base-, mid-, and apical-LV levels were significantly lower in diabetic patients(group II & III) as compared were significant Globle LV longitudinal, radial and circumferential strain are shown in table 3 Global and regional LS at with control subjects.

Table 2. The basic echocardiography parameters

S. N.	Variables	Group-I (control)	Group-II (DM)	Group-III(DM+HT)	P-value(I&II)	P-value(I&III)	P-value (II&III)
1	IVS	8.58 ± 0.66	9.09 ± 1.54	10.28 ± 1.75	0.72	<0.01	<0.01
2	PW	8.42 ± 0.64	8.30 ± 1.53	10.07 ± 1.60	0.64	<0.01	<0.01
3	LVIDD	43.74 ± 4.03	45.55 ± 4.83	44.43 ± 4.90	0.133	0.143	0.165
4	LVIDS	22.90 ±2.35	23.05 ± 2.17	22.67 ± 2.19	0.719	0.754	0.65
5	LVMI	52.89 ± 3.32	54.87 ± 6.96	60.95 ± 11.81	0.85	<0.01	<0.01
6	E(cm/sec.)	66.87 ± 7.59	62.22 ± 5.63	63.96 ± 5.83	0.041	0.044	0.054
7	A(cm/sec.)	63.42 ± 5.21	70.73± 10.07	69.69 ± 10.56	<0.01	<0.01	<0.34
8	E/A	1.06 ± 0.15	0.89 ± 0.12	0.91 ± 0.14	<0.01	<0.01	<0.32
9	E'	9.27 ± 0.99	7.03 ± 1.40	7.16 ± 1.62	<0.01	<0.01	<0.42
10	E/E'	7.26 ± 0.99	9.48 ± 2.18	9.45 ± 2.34	<0.01	<0.01	<0.12
11	LVEF	58.13 ± 2.48	58.24 ± 2.45	58.24 ± 2.89	0.96	0.95	0.97

Table 3. Comparisonof left ventricular strain between groups

S. N.	Variables	Group-I (control)	Group-II (DM)	Group-III (DM+HT)	P-value (I&II)	P-value (I&III)	P-value (II&III)
1	GLS	22.92 ± 1.49	15.62 ± 2.28	15.98 ± 2.30	<0.01	<0.01	<0.45
2	GCS	30.35 ± 2.60	26.16 ± 2.70	25.84 ± 3.47	<0.01	<0.01	<0.37
3	GRS	33.97 ± 2.22	33.58 ± 2.20	32.11 ± 2.13	0.487	0.454	0.412

Global LS in control subject was 22.92±1.49 as compared with group II (15.62 ± 2.28) and group III (15.98 ± 2.30).there were not significant difference between group II & III. The CS was also significantly lower in diabetic patients (group II & III), resulting inasignificant reduction in global CS. While globlal radial strain(GRS)did not show significant difference between all three groups.

DISCUSSION

The results of the present study have demonstrated the presence of subclinical myocardial systolic and diastolic dysfunction in patients with type 2 diabetes mellitus with or without Hypertension. Despite a normal LV mass, LV volume, and LVEF, the diabetic population showed impairment of LV longitudinal strain and circumferential strain but preserved radial strain. we observed that global LSs was significantly reduced in diabetic patients, compared with the normal range obtained from our control group of age-matched subjects. In addition, global CS were also reduced in diabetic patients, a finding which is in agreement with a previous magnetic resonance imaging study (Fang et al., 2004). Diabetes is known to be associated with the development of heart failure even without the presence of co-existing coronary artery disease or hypertension.

Thus, the identification of early manifestations of diabetic heart disease would allow the institution of timely medical interventions to prevent the development of heart failure (Helle-Valle, 2005; Nakai et al., 2006) Although diastolic dysfunction has been described as an early stage in diabetic heart disease progression in patients with normal LVEF, isolated diastolic dysfunction is usually rare, and when present, it often associated with subclinical systolic dysfunction (Rovner, 2006; Helle-Valle , 2005; Wang, 2008) Systolic dysfunction might be initially apparent in the longitudinal direction, because subendocardial fibres, which are the ones more vulnerable to myocardial is chaemia and fibrosis, are longitudinally oriented (Geyer et al., and Kannel, 1974). Several studies have demonstrated that subclinical systolic longitudinal dysfunction can be identified using tissue Doppler imaging in patients with hypertension, diabetes, and diastolic dysfunction (Henein, 1999; Fang et al., 2004).

The presence of diabetes mellitus was an independent predictor of LV longitudinal strain, systolic SR, and diastolic SR on multiple linear regression analysis. The pathogenesis of diabetic cardiomyopathy is likely to be multifactorial, including microvascular disease, altered myocardial metabolism, and structural changes in the myocardium with increased fibrosis. Increasingly, evidence is emerging on the role of myocardial liptoxic injury from lipid oversupply. Visceral adipose tissue insulin resistance leads to increased myocardial fatty acid delivery and uptake, with associated myocardial triglyceride accumulation (Reisner, 2004; Greenbaum, 1981; Voigt et al., 2003). Previous epidemiologic studies have demonstrated an increased prevalence of diabetes mellitus in heart failure populations, and this increased prevalence has been seen in particular in patients with heart failure and normal LVEF.19 Both Fang et al 26 and Vinereanuet a 27 demonstrated decreased LV longitudinal function but a compensatory increase in radial function in diabetic patients. However both studies could only assess the effect of diabetes mellitus on LV longitudinal and radial functions in a few, limited myocardial segments, and circumferential myocardial function was not evaluated. However, LVEF is a relatively insensitive measure of LV systolic function compared to strain and SR imaging, especially in the context of subclinical LV systolic dysfunction (Fang et al., 2003; Rovner et al., 2006; Nishikage et al., 2008) Because the LV myocardial architecture is a complex array of longitudinally and circumferentially orientated fibers located predominately in the epicardium /endocardium and mid-wall, respectively (Reisner et al., 2004). Multidirectional analyses of longitudinal, circumferential, and radial function have allowed understanding of regional LV myocardial functional changes in patients with subclinical diabetic heart disease study.

Limitations of this study is that the study size was relatively small so that results cannot be extrapolated to the general diabetic population. This study did not rule out definitively the possibility of epicardial coronary artery stenos is but invasive coronary angiography was not justified in these patients, because it was not clinically indicated.

Conclusions

Our study shows that LVEF is not a sensitive indicator for the detection of subclinicalsystolic dysfunction.

Preferential strain reduction was observed in the longitudinal and circumferential direction, prior to the development of systolic dysfunction in diabetic patients. Now wide spread availability of echocardiography and the ease of use with 2D speckletracking might allow serial assessments of patients with diabeticheart disease to monitor disease progression.

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