Assessment of left and right ventricular systolic function in type I diabetic patients by two-dimensional speckle tracking Echocardiography

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Abstract: Introduction: Diabetes mellitus (DM) may lead to diabetic cardiomyopathy which is defined as myocardial dysfunction independent of coronary artery disease (CAD) and hypertension. The pathogenesis of diabetic cardiomyopathy is multifactorial: hyperglycemia, increased free fatty acids, hyperinsulinemia, insulin resistance, and inflammatory cytokines change cellular metabolic pathways in cardiomyocytes and impair cardiac function. Speckle tracking Echocardiography is a new echocardiographic technique that allows a precise evaluation of myocardial function. This method is accurate, reproducible, and angle independent, and it enables a complete assessment of regional and global function in three directions. Aim of the work: is to assess left ventricular (LV) and right ventricular (RV) systolic function in type I diabetic patients using two-dimensional speckle tracking Echocardiography (2 D STE). **Material and methods:** fourty patients with type I DM with mean age 28.55±5.37 years & mean duration of diabetes is 16.5±5.3 years & mean HbA1C 8.2±1.2. All cases were recruited from the Endocrinology Clinic and internal medicine department in Al-Hussein University Hospital from October 2015 to September 2016 and 10 control subjects with mean age 26.6±3.66 years were prospectively evaluated. The 2D STE assessment of LV longitudinal strain and RV free-wall longitudinal strain was performed. **Results:** In diabetic group, left ventricular global longitudinal strain (LVGLS), and right ventricular free-wall global longitudinal strain (RVGLS) were significantly lower compared with the controls: LVGLS (-20.75 ± 1.88 vs.-22.6 ± 1.71, P= 0.007) and RVGLS (-30.22 ± 3.48 vs. -32.70 ± 2.91, P = 0.044). **Conclusion:** Type I DM is associated with subclinical LV systolic dysfunction and RV systolic function is worse in type I DM compared with control subjects which can be detected with 2 D STE. **Recommendations:** The STE technique should be combined with conventional echocardiography for follow up of ventricular function in diabetic patients.

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1. Introduction

Diabetes mellitus(DM) may lead to diabetic cardiomyopathy which is defined as myocardial dysfunction independent of CAD and hypertension[1]. The development of diabetic cardiomyopathy is associated with structural and functional cardiomyocyte alterations, coronary microangiopathy and autonomic neuropathy, which at first lead to hypertrophy and subclinical cardiac dysfunction and then to symptomatic heart failure[2]. The pathogenesis of diabetic cardiomyopathy is multifactorial: hyperglycemia, increased free fatty acids, hyperinsulinemia, insulin resistance, and inflammatory cytokines change cellular metabolic pathways in cardiomyocytes and impair cardiac function[3]. Previous studies have confirmed subclinical LV and RV systolic dysfunction in type II DM[4]. However, the pathophysiological mechanisms of myocardial impairment in type I DM are slightly different as they are related mainly to hyperglycemia and free fatty acids, whereas in type II DM, the main harmful factor is hyperinsulinemia and insulin resistance[5]. Few studies have evaluated LV systolic function using 2D STE in type IDM[6]. STE is a new echocardiographic technique that allows a precise evaluation of myocardial function. This method is accurate, reproducible, and angle independent, and it enables a complete assessment of regional and global function in three directions [7,8]. In contrast, TDI is angle dependent, prone to noises, less accurate, and able to assess limited region of tissue[7]. This study aimed to assess LV and RV systolic function in type I diabetic patients using two-dimensional speckle tracking Echocardiography.

2. Material and methods

A prospective study was done on 40 Patients recruited from endocrinology clinic and internal medicine department of Al-Hussein University Hospital with mean age 28.55±5.37 years & mean duration of diabetes is 16.5±5.3 years & mean HbA1C 8.2±1.2 from October 2015 to September 2016 and 10 control subjects with mean age 26.6±3.66 years were evaluated, the study included patients with type I DM with left ventricular ejection fraction (LVEF) ≥ 53% by conventional Echocardiography& normal resting ECG. The study excluded patients with type II DM, hypertension, history or symptoms of CAD or regional wall motion abnormality suggestive of CAD, valvular heart disease, atrial fibrillation, congestive heart failure, cardiomyopathy, congenital heart disease, endocrine disease other than DM, renal failure or poor Echo window. All of them were subjected to full history taking, general and local clinical examination and 12 lead resting surface ECG. All examinations were performed using a commercially available equipment (Philips iE33 X Matrix ultrasound machine) using "S5-1"&"X5-1" matrix array transducers equipped with STE technology. All images were digitally stored from three cardiac cycles a standard parasternal and apical views. All analyses were performed offline. Echocardiographic examination was done to all the study population including Two-dimensional echocardiography to measure LVESD, LVEDD from parasternal long axis view and EF was calculated using biplane Simpson method according the last American society of echocardiography recommendation. Tricuspid plane systolic excursion (TAPSE) from apical 4 chamber (4CH), RV fractional area change (FAC) in 4CH view[9]. 2) 2D Speckle tracking echocardiography study: The patients were examined in the left lateral decubitus position in respiration at rest, and the evaluation was obtained in a calm exhalation to minimize translational motions of the heart. In compliance with the stated recommendations, the standardized 17-segment LV model was used for a detailed evaluation of the LV segments by all the applied methods[10]. Each patient was studied in apical long axis, 2 and 4 chamber views with the examination synchronized with at least one ECG lead. In order to set an adequate timing for the beginning and end of a systolic ejection phase, the flow in the left ventricular outflow tract was registered, and subsequently the beginning (aortic valve opening - AVO) and end (aortic valve closure- AVC) of the LV ejection phase were indicated. From the above projections, we registered the B-mode second harmonic sequence with a frame rate setting optimized for the specific method (optimal frame rate 70s-1, range between 40-100s-1). Automated delineation of endocardial borders was obtained through marking the mitral annulus level and at the apex on each digital loop. And apical 4 chamber view was taken for later analysis of the right ventricle; Automated delineation of endocardial borders was obtained through marking the tricuspid annulus level and at the apex on the digital loop[9]. All data were collected and statistically analyzed using Chi-square test using SPSS (Statistical package for social science) software.

3. Results

The present study included 40 cases with type I DM. The number of males in the studied patients was 21 patients (52.5%), while the female number was 19 patients (47.5%) & 10 control subjects (5 males & 5 females) that shown in table (1). Clinical characteristics are shown in Table (1) Mean diabetes duration was (16.5±5.3) years. Mean HbA1c level in the diabetic group was 8.2±1.2%. All patients were treated with insulin. There were no significant differences between groups regarding Age, SBP, DBP, heart rate as shown in table (1). Standard echocardiographic parameters are summarized in Table (2) LVEDD, LVESD & LVEF did not differ between groups. RV functional parameters did not differ between groups as summarized in table (2). As shown in table (3), 2D speckle tracking analysis showed left ventricular GLS and right ventricular GLS were significantly lower in diabetic group compared with control group as LVGLS (-20.75±1.88 vs.-22.6±1.71, P=0.007) and RVGLS (-30.22±3.48 vs.-32.70±2.91, P=0.044). As in figure 1, there was good correlation between diabetes duration and reduction of LVGLS (r=0.61, P=<0.001). As in figure 2, there was moderate correlation between diabetes duration and reduction of RVGLS (r=0.35, P=<0.002). As shown in figure 3 and 4 there was moderate correlations between Hb A1C, reduction of LVGLS (r=0.4, P=0.01) & RVGLS (r=0.326, P=0.04).

Table 1. that shows baseline characteristics between diabetic and control groups

Parameters	Patients(N=40)	Control(N=10)	P
Age	28.55 ± 5.37	26.60 ± 3.66	0.28
Gender (male)	21 (52.5%)	5 (50.0%)	0.289
SBP	120.88 ± 10.31	120 ± 6.67	0.089
DBP	71 ± 7.36	71.5 ± 7.47	0.849
HR	71 ± 8.8	71.8 ± 8.1	0.8
Duration of Diabetes (years)	16.5 ± 5.3	N/A	N/A
Hb A1 C	8.2 ± 1.2	N/A	N/A

N/A=not applicable

Table 2. Comparison of some conventional echocardiographic parameters between control and patients groups

Parameters	Patients	Control	P value
LVEDD	4.46 ± 0.52	4.57 ± 0.63	0.563
LVESD	2.9±0.4	3.04 ±0.53	0.347
EF	64.22 ± 3.3	62.9±4.95	0.313
TAPSE	2.4 ± 0.19	2.49 ± 0.19	0.162
FAC	46.67 ± 6.4	47.04 ± 3.64	0.864

Table 3. Comparison of some strain parameters between control and patients groups

Parameters	*Patients*	*Control*	*P*
LVGLS	**– 20.75 ± 1.88**	**– 22.60 ± 1.71**	**0.007***
RVGLS	**– 30.22 ± 3.48**	**– 32.70 ± 2.91**	**0.044***

*Highly significant

There was statistically significant difference between the two groups as regard LVGLS & RVGLS.

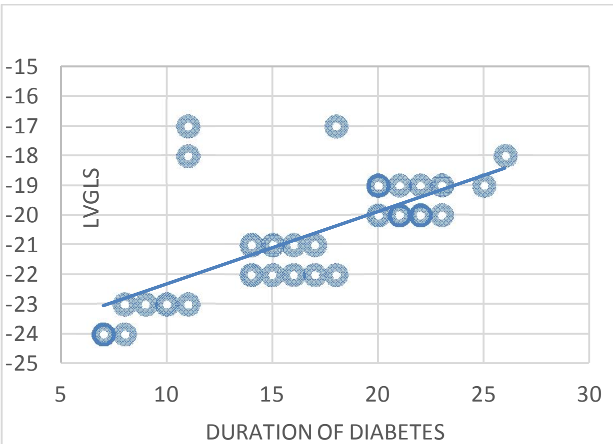

Figure 1. There was a positive correlation between LVGLS and the duration of diabetes

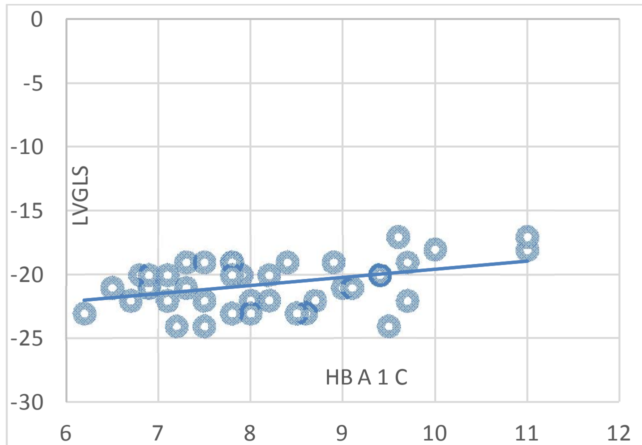

Figure 3. There was a positive correlation between LVGLS and the HbA1c level

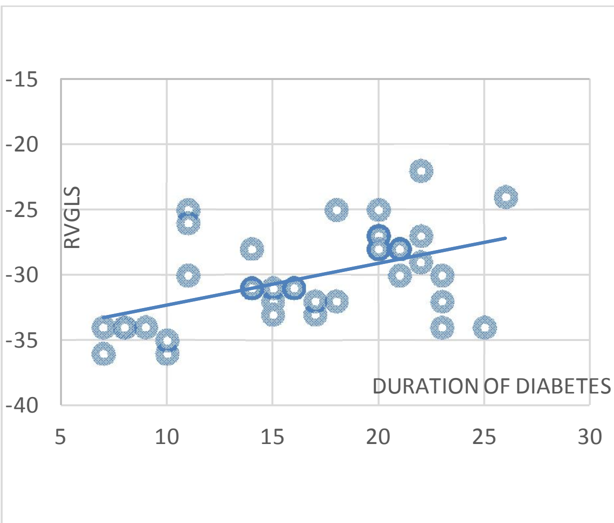

Figure 2. There was a positive correlation between RVGLS and the duration of diabetes

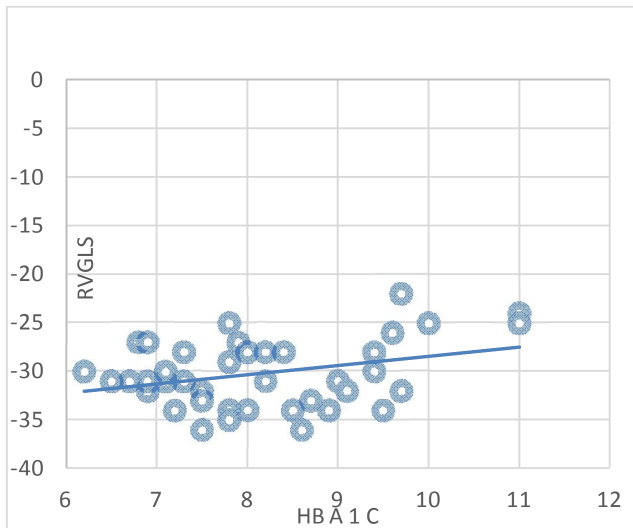

Figure 4. There was a positive correlation between RVGLS and the HbA1C level

4. Discussion

This study found that LVGLS is significantly lower in diabetic group than in control group denoting that type I DM is associated with subclinical LV systolic dysfunction and this finding is concordant with the result of. **(Nakai et al., 2009)**[11]

Also, this is in agreement with the result of **(Labombarda et al., 2014)**[12] in which the Longitudinal left ventricular strain was impaired in type I diabetes children and adolescents by 2D speckle strain. Also, this is concordant with the result of **(Jedrzejewska et al., 2016)**[13] that demonstrated left and right ventricular systolic function impairment in type I diabetic young adults assessed by 2D speckle tracking echocardiography. And the result of **(Abdel-Salam et al., 2016)**[14] in their study, they reported early changes in longitudinal deformation indices in young asymptomatic patients with type I diabetes mellitus was assessed by speckle tracking echocardiography. Our study found that RV systolic function is worse in type I DM compared with control group. and this finding is concordant with the result of **(Kosmala et al., 2007)**[15] in which subclinical right ventricular dysfunction in DM was assessed using strain/strain rate.

And in agreement with the result of **(Jedrzejewska et al., 2015)**[13] that evaluated Left and right ventricular systolic function impairment in type I diabetic young adults assessed by 2D speckle tracking echocardiography. They found that RVGLS were significantly lower compared with the control group.

In our Study, there was a positive correlation between the reduction of the GLS of both Left and right ventricles using 2 D STE and the duration of diabetes. This finding is concordant with the result of **(Nakai et al., 2009)**[11] as they found that diabetes duration was the only independent confounder for the reduction of GLS. but our study finding is discordant with the result of **(Jedrzejewska et al., 2016)**[13] as they found that there is no relationship between the reduction of LVGLS and diabetes duration and they assumed that was due to glycemic control of the whole diabetes duration was relatively good and this might partially explain the lack of the relationship of the diabetic duration and the reduction of LVGLS & RVGLS.

In our Study, there was a positive correlation between reduction of LV and RV GLS using 2 D speckle tracking Echocardiography and the level of HbA1C and this finding is concordant with the results of (**Labombarda et al., at 2014)**[12] and discordant to the result of (**Jedrzejewska et al., at 2016**)[13] they did not find any relationship between systolic or diastolic parameters and HbA1c. And also, the finding is discordant with results of (**Di Cori et al., at 2007)**[16] who did not observe any correlation between HbA1c and LV LS or diastolic parameters, and **(Kim et al., 2010)**[17] may be explained by the fact that HbA1c reflects the glucose level of only 4 preceding months. and it cannot show the relationship of glycaemiccontrol with cardiac function in long disease duration diabetic patients.

5. Conclusion

This study concluded that type I DM is associated with subclinical LV & RV systolic dysfunction compared with control subjects which can be detected with 2D STE. It is recommended that all type I DM should be repeatedly subjected to 2D STE to detect subclinical LV and RV systolic dysfunction for early diagnosis before overt clinical diabetic cardiomyopathy.

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