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ORIGINAL ARTICLES

Early Detection of Right Ventricular Dysfunction by Myocardial Performance Index in Diabetic Patients

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Abstract:

In diabetes mellitus (DM) patients, left ventricular dysfunction is widely evaluated and established by conventional diagnostic methods, whereas right ventricular (RV) function is not sufficiently evaluated. The aim of this study was to assess the right ventricular function in type 2 diabetic patients by myocardial performance index (MPI) . In this cross-sectional study, 49 diabetic patients and 49 non-diabetic healthy volunteers were studied who were devoid of any other conditions that may influence the both systolic and diastolic function of the RV. In addition to 2D and M-mode evaluation, standard Doppler, pulsed tissue Doppler of both ventricles were performed. MPI was significantly ($p<0.05$) higher in diabetic patients compared to control group . Right ventricular early diastolic velocity (E') and late diastolic velocity (A'), E'/A' were significantly ($p<0.05$) lower in DM compared to control group. Myocardial performance index is a useful noninvasive tool for the detection of early right ventricular systolic and diastolic dysfunction in diabetic patients .

Introduction :

Diabetes mellitus is one of the most common endocrine disorders. The incidence of diabetes mellitus is continuously increasing and about 90% of patients of diabetes mellitus have type 2 diabetes mellitus .[1] Reports from the Framingham study and other studies have established diabetes as a strong risk factor for cardiovascular morbidity and mortality.[2-4] Diabetes mellitus has direct effects on the heart, independent of obstructive disease and hypertension and causes development of a specific cardiomyopathy.[5] Several studies using echocardiography have demonstrated deterioration in left ventricular diastolic properties in diabetic patients.[6-9]

RV function has proven to be of importance for risk stratification in heart failure and is associated with sudden death and exercise limitation .[10] RV function has not been studied in depth yet in diabetic patients although the RV has an important contribution to the overall cardiac function .[11] RV dysfunction especially diastolic dysfunction may play a role in diabetic cardiomyopathy.[10]

The majority of proposed methods of echocardiographic assessment of RV function are based on volumetric approximations of RV .Such approaches have inherent limitations ,first as volume related measures such as ejection fraction (EF) are load dependant; second because of the complex geometry of RV .[12] The issue of RV geometry is usually overcome using geometry -independent parameters such as tricuspid annular velocity and MPI .MPI is calculated using Doppler as the ratio of the isovolumic contraction and relaxation times to the ejection time which encompasses both systolic and diastolic functions.[13] In systolic dysfunction ,the isovolumic contraction time increases ,whereas the ejection time decreases and ,consequently , the MPI increases. In diastolic dysfunction, there is prolongation of isovolumic relaxation time that also results in an increased MPI .Tei et al.[14] proposed a Tei index (or myocardial performance index) ,obtained from Doppler time intervals, which allows simple noninvasive and non-geometric estimation of global ventricular functions. It has been found to have prognostic value for various cardiac conditions .Yeo et al.[15] reported Doppler right ventricular index to be a useful noninvasive parameter that correlates with symptoms and survival in patients with pulmonary hypertension .Data regarding RV performance in patients with diabetes are incomplete. Some studies have been shown right ventricular dysfunction. Myocardial dysfunction in patients with diabetes mellitus is not confined to the left ventricle, but also involves the right ventricle, and the impairment of RV function encompasses both systolic and diastolic abnormalities.[16]

Method:

This cross sectional study was conducted in the department of cardiology ,BSMMU from January 2013 to December 2013.Type 2 diabetic patients of 40-65 years of

age (>5 years of onset) based on their FBG,HbAIC ,2HABF were included . Based on these criteria a definitive sample was formed which consisted of 98 patients and divided into two groups .Group I: Type 2 (49) diabetic patients without any other condition which may influence structure and function of the right ventricle .Group II : Non-diabetic healthy volunteers (49) . Known case of systemic hypertension ,coronary artery disease ,valvular heart disease and arrythmia were excluded from the study .

All patients and control groups underwent echocardiographic examination.Complete two-dimensional ,M-mode and Doppler studies were performed having standard parasternal, apical and subcostal approaches with Vivid 7dimension.using multifrequency transducer.

Two-dimensional, M-mode echocardiography was performed in order to measure left and right ventricular dimension and left ventricular ejection fraction by modified Simpsons biplane method. Conventional Doppler echocardiography is used to measure left and right ventricular parameters of diastolic function: early (E) and late (A) peak diastolic velocity, E/A ratio.

Tissue Doppler echocardiography

In apical four-chamber view, the tissue Doppler sample volume was placed at the level of right ventricular lateral tricuspid annulus at or 1 cm within the insertion sites of the leaflets. The peak systolic myocardial velocity (Sm),peak early diastolic myocardial velocity (Em), and late diastolic myocardial velocity (Am) at the time of atrial contraction were determined . MPI is defined as the ratio of isovolumic time divided by ET, or [(IVRT + IVCT)/ ET].The values of the LV index <.69 and for the RV <.55 are considered normal.[17]

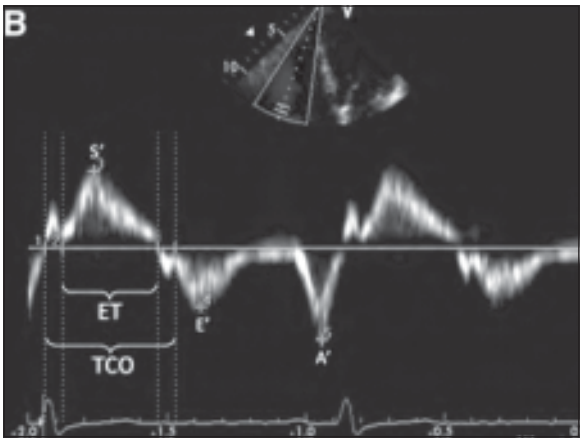

Fig.-1: *Calculation of right ventricular myocardial performance index by pulse tissue Doppler .The tricuspid (valve) closure opening time (TCO) encompasses isovolumic contraction time, ejection time (ET) and isovolumic relaxation time.*

All pulsed Doppler tissue imaging parameters were measured on 4-6 consecutive heart cucles and mean value was calculated .

Prior to the commencement of this study ,the research protocol was approved by the Institutional Review Board(IRB) of BSMMU, Dhaka . Statistical analysis was performed using SPSS package 16.0 (SPSS Inc, Chicago, Illinois, USA). Categorical data was expressed in percentage or number. Parametric data was expressed in mean ± SD. Parametric data was evaluated by student t test. Categorical data was evaluated by Chi square test. Significance was defined by p value d" 0.05.

Results:

A total of 98 patients were included in this study .Majority 29 (59.2%) patients in group I belonged to age 50-60 years and in group II 25 (51%) patients belonged to age <50 years . The mean age was 53.76±6.24 years in group I and 53.2±6.31 years II. The mean age difference was not statistically significant (p>0.05) between two groups (table I). Almost two third 32(65.3%) patients were male in group I and 23 (46.9%) in group II. The sex difference was not statistically significant (p>0.05) between two groups (table II). The mean LVEF was found 66.5±5.3 in group I and 64.8±6.4 in group II. Mean RVFAC was found 44.9±4.8 in group I and 45.5±5.7 in group II. Mean E/A ratio was 1.48±0.4 in group I and 1.04±1.9 in group II(table III). The mean E' was found 0.10±0.05 m/s in group I and 0.15±0.03 m/s in group II. Mean A' was 0.12±0.2 m/s in group I and 0.14±0.6 m/s in group II. Mean E'/A' was 0.67±0.44 in group I and 1.24±0.35 in group II. Mean Sm was 0.143±0.016 m/s in group I and 0.137±0.017 m/s in group II. Mean MPI was 0.57±0.04 in group I and 0.53±0.02 in group II. Sm difference was not statistically significant (p>0.05) but other were statistically significant (p<0.05) between two groups (table IV).

Table-I

Age distribution of the study patients (n=98)

Age (in years)	Group-I (n=49)		Group-II (n=49)		P Value
	n	%	n	%	
<50	14	28.6	25	51.0	
50-60	29	59.2	14	28.6	
>60	6	12.2	10	20.4	
Mean±SD	53.76±6.24		53.2±6.31		0.659[ns]

Data were analyzed using unpaired t-test and presented with Mean±SD
P value was not significant (>0.05)
Group I: Diabetic
Group II: Non diabetic
n=Number of subjects
ns=not significant

Table-II

Distribution of the study patients by sex (n=98)

Sex	Group-I (n=49)		Group-II (n=49)		P Value
	n	%	n	%	
Male	32	65.3	23	46.9	0.066^{ns}
Female	17	34.7	26	53.1	

Data were analyzed using chi square test
P value was not significant (>0.05)
n=Number of subjects
ns=not significant

Table-III

Distribution of the study patients by conventional echocardiographic variables (n=98)

2D echo variables	Group-I (n=49) Mean±SD	Group-II (n=49) Mean±SD	P Value
LVEF	66.5±5.3	64.8±6.4	0.156^{ns}
RVFAC	44.9±4.8	45.5±5.7	0.568^{ns}
E/A ratio (tricuspid inflow)	1.48±0.4	1.04±1.9	0.116^{ns}

Data were analyzed using unpaired t-test and presented with Mean±SD
P value was not significant (>0.05)
Group I: Diabetic
Group II: Non diabetic
n=Number of subjects
ns=not significant

Table-IV

Distribution of the study patients by RV tricuspid annulus (n=98)

RV tricuspid annulus	Group-I (n=49) Mean±SD	Group-II (n=49) Mean±SD	P value
E' m/s	0.10±0.05	0.15±0.03	0.001^{s}
A' m/s	0.12±0.02	0.14±0.6	0.029^{s}
E'/A'	0.67±0.44	1.24±0.35	0.001^{s}
Sm (m/s)	0.143±0.016	0.137±0.017	0.092^{ns}
MPI	0.57±0.04	0.53±0.02	0.001^{s}

Data were analyzed using unpaired t-test and presented with Mean±SD
P value was not significant (>0.05)
Group I: Diabetic
Group II: Non diabetic
n=Number of subjects
ns=not significant

Discussion:

The right ventricle has important contribution to the overall cardiac function but data regarding the RV function in diabetics are still rather incomplete . Present study was focused on to myocardial performance index for the assessment of RV function in diabetic patient. In present study the results revealed that mean age was found 53.76±6.24years in group I and 53.2±6.31years in group II. The mean age was almost similar between two groups ,which are closely resembled with Abdelaziz . [16]

In this series it was observed that almost two third (65.3%) patients were male in group I and 46.9% in group II .Sex difference was not statistically significant (p<0.05) between two groups.Abdelaziz found male 60.0% in group I and 55.0% in group II ,which is comparable with the current study .

In this current study it was observed that the mean LVEF and mean RVFAC were almost alike between two groups.In this study it was observed that tricuspid inflow parameter (E/A ratio) were almost similar between two groups.Tayyareci[5] showed the similar changes .It indicates that conventional Doppler had failed to detect RV diastolic dysfunction .

About the RV tricuspid annulus it was observed in this current series that E' ,A',E'/A' were significantly (p<0.05) lower in group in group I and MPI were significantly (p<0.05) higher in group I . Elshahed et al . [11]observed that RV basal segment Sm,Em,Am were significantly lower in the diabetic group than in the control group . Abdelaziz[16] showed right ventricular myocardial performance index (MPI) was significantly higher in diabetic group .Kosmala et al . [18] demonstrated subclinical RV dysfunction by the strain/ strain rate technique in diabetics.Wang et al . [19] determined which echocardiographic variables best correlated with RV ejection fraction as assessed by cardiac magnetic resonance imaging and found that right ventricular fractional area (RVFAC) change , MPI , isovolumic acceleration were the best correlated variables

Conclusion:

Type 2 diabetes mellitus is associated with right ventricular diastolic and systolic dysfunction . Tissue Doppler imaging is a useful tool to detect early impairment of right ventricular diastolic and systolic dysfunction in patients with type II diabetes mellitus. These alterations in myocardial function may be attributed to ventricular interdependence as well as to the uniform effect of diabetes to the cardiac function.

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