

The Effect of Glysemic Control on Myocardial Performance Index in Patients with Type 2 Diabetes Mellitus

Tip 2 Diyabetli Hastalarda Glisemik Kontrolün Miyokard Performans İndeksine Etkisi

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Abstract

Purpose: Type 2 diabetes mellitus (DM) and poor glucometabolic control increase the risk of developing the heart failure. We aimed to investigate association between glysemic control and left ventricle myocardial performance index (MPI) in patients with type 2 DM and without known cardiac disease.

Material and Method: Left ventricular functions using conventional transthoracic and tissue doppler echocardiography were evaluated in 42 patients. Glysemic control is expressed as fasting plasma glucose (FPG) and hemoglobin A1c (HbA1c). The exclusion criteria were known cardiovascular system diseases, pulmonary diseases, endocrine diseases; anemia, history of angina pectoris, dyspnea, and peripheral edema.

Results: Forty two patients, men (40.5%) and women (59.5%) aged 37-57 years were included. There was no correlation between HbA1c and MPI, and FPG and MPI. Moreover, there was no correlation between glysemic control and ejection fraction (EF).

Conclusion: It was shown that ventricular abnormalities in diabetics without known heart disease and also elevated fasting glucose level are associated with risk of congestive heart failure. The Doppler index, MPI, allows both sistolic and diastolic performance to be estimated. In our study, left ventricular functions were similar between healthy controls and diabetics without known cardiac disease. We could not find any relationship between glysemic control and left ventricular dysfunction expressed by EF and MPI.

Key words: **Diabetes Mellitus, Type 2; Hemoglobine A1c protein, human.**

Özet

Amaç: Tip 2 diyabette, kötü glukometabolik kontrol kalp yetersizliği riskini artırır. Çalışmamızda, kalp hastalığı olmayan tip 2 diyabetlilerde glisemik kontrol- miyokard performans ilişkisini (MPI) araştırmayı amaçladık.

Gereç ve Yöntem: Tip 2 diyabetli 42 hastada sol ventrikül sistolik ve diastolik fonksiyonları standart transtorasik ve doku Doppler ekokardiyografi ile saptandı. Glisemik kontrol; açlık plazma glukozu (APG) ve hemoglobin A1c (HbA1c) ile ifade edildi. Bilinen kardiyovasküler, pulmoner sistem ile diyabet dışı endokrin hastalıklar, anemi, angina pektoris ve dispne anamnezi ile periferik ödem olan hastalar çalışmaya alınmadılar.

Bulgular: 37-57 yaş arasında, %40,5'i erkek, %59,5'u kadın toplam 42 hasta çalışmaya alındı. Hem HbA1c ile MPI arasında, hem de APG ile MPI arasında bir ilişki saptanmadı. Aynı zamanda glisemik kontrol ile EF arasında da bir ilişki yoktu.

Sonuç: Kalp hastalığı olmayan diyabetiklerde kardiyak fonksiyon bozukluğu gösterilmistir ve açlık plazma glukozu ile konjestif kalp yetersizliği riski ilişkilidir. MPI; hem sağ ventrikül hem sol ventrikül fonksiyonlarını gösteren bir Dopler indeksidir. Çalışmamızda, bilinen kalp hastalığı olmayan diyabetik hastalarla sağlıklı kontrol grubu arasında sol ventrikül fonksiyonları bakımından fark saptamadık; glisemik kontrol ile EF ve MPI ile ifade edilen sol ventrikül fonksiyonu arasında bir ilişki yoktu.

Anahtar kelimeler: **Diabetes mellitus, tip 2; Hemoglobin A1c proteini, insan.**

Introduction

Many epidemiological and clinical trials have shown that heart failure is associated with diabetes mellitus (DM) (1, 2). Patients with DM are at high risk left ventricular dysfunction (LVD), particularly in the presence of comorbid ischemia, hypertension, valvular heart disease and left ventricular hypertrophy (3, 4). However it was reported that even in the absence of such comorbidities left ventricular diastolic dysfunction (LVDD) may develop in most of the diabetic cases (5). LVDD may represent the first stage of diabetic cardiomyopathy, reinforcing the importance of early examination of diastolic ventricular function in individuals with diabetes (6)

Diabetic cardiomyopathy is a distinct entity seen in diabetic patients with congestive heart failure who have no angiographic evidence of coronary atherosclerosis and/or significant epicardial coronary artery stenosis (7). Some studies have shown a correlation between hyperglycemia and LVDD (8, 9). However some studies have found no correlation (10). Distinct systolic and diastolic dysfunction can be easily detected by conventional echocardiographic method. Conventional echocardiography is insufficient in detecting subclinical diabetic cardiomyopathy. Tissue Doppler echocardiography (TDE) is more sensitive in evaluation of regional myocardial systolic and diastolic functions separately (11, 12).

The myocardial performance index (MPI), a doppler index of global cardiac function, is independent of heart rate, blood pressure and LV geometry and is applicable to both left and right heart function. The MPI allows both systolic and diastolic performance to be estimated (13, 14). In this study, we aimed to investigate the relationship between glysemic control (expressed by fasting plasma glucose and hemoglobin A1c) and MPI in type 2 DM who had no clinical evidence of heart disease.

Materials and Methods

Forty-two type 2 diabetic patients who had no hypertension and coronary artery disease and 42 healthy volunteers were enrolled to the study. Diabetic patients were selected according to ADA (American Diabetes Association) criteria (15). Patients and controls had normal physical examination, normal blood pressure and normal electrocardiography. Cases with history of coronary artery diseases (CAD), angina pectoris, clinical findings of CAD or abnormal echocardiographic findings like hypokinesia, were excluded from the study. Patients with evidence of microvascular (retinopathy, peripheral neuropathy and nephropathy) or macrovascular (CAD, peripheral vascular

disease, cerebrovascular accidents) complications were also excluded. At least 8 hours FPG (fasting plasma glucose) and HbA1c were used as marker of glysemic regulation. FPG was measured with the method of glucose oxydase in Olympus 2700 AU autoanalyser; HbA1c was measured with turbidimetric method in same machine. The height, body weight and waist circumference of all patients were measured. All patients gave their informed consent to participate in our study. Our study was approved by the local committee.

Echocardiography. Transthoracic echocardiography was performed using an Acuson C256 echocardiography system with a 3.5-MHz transducer probe. Left ventricular mass index was calculated after left ventricular mass was calculated with Penn-convention formula. Mitral inflow was recorded with the transducer in the apical 4-chamber view. The Doppler sample volume was placed between the tips of the mitral leaflets during diastole with the pulsed wave Doppler beam aligned as perpendicular as possible to the plane of the mitral annulus. Left ventricular outflow velocity curve was recorded from the apical long-axis view with the sample volume positioned just below the aortic valve. Time intervals for calculating the myocardial performance index (Tei index) were measured from mitral inflow and left ventricular outflow recordings using the Formula $(ICT + IRT)/ET$. The valsalva manoeuvre was used in assesment of diastolic dysfunction to exclude pseudonormal patern. (ICT: isovolumic contraction time, IRT:isovolumic relaxation time, ET: ejection time) Left ventricular ejection fraction (EF) was estimated by the Simpson method using apical 4-chamber views of left ventricular end-systolic volume and end-diastolic volume values.

Statistical analyses. All analyses were performed with GraphPad Prisma V.3 package programme. In data evaluation, the defining statistical methods (mean, standard deviation, frequency distribution) were used. The Pearson correlation test was used for determination of the relationship between variables. The independent t test was used in comparison of the binary group besides. $P < 0.05$ value was considered to be statistically significant.

Results

The laboratory, clinical and demographic characteristics of patients and controls were summarized in Table 1 and were similar in both groups. The mean duration of diabetes of 42 patients was 7.1 ± 5.8 years. Current treatment was oral antidiabetic in 71.4% of patients and insülin in 28.6%.

Table I. Baseline Clinical-Demographic Characteristics of the Patients (n= 42) and Controls (n= 42).

Characteristics	Patients	Control	P
Age	48.8±6.1	48.6 ±6.2	ns
Gender (M/F)	17/25	17/25	ns
Body mass index (BMI)	26.2±4.3	27±3.2	ns
Smoking (%)	31	35	ns
Fasting plasma glucose (mg/dl)	206.7±89.9	90±8	<0.01
Hemoglobine A1C (%)	8.7±2.2	5±0.8	<0.01
Total cholesterol (mg/dl)	195.1±44.5	195±43.8	ns
Triglycerides (mg/dl)	167.3±102.2	165±100.5	ns
HDL (mg/dl)	50.4±13.8	50±12.9	ns
LDL(mg/dl)	111±35.8	110.8±36	ns
Sistolic pressure (mmHg)	115.7±7.39	113± 8	ns
Diastolic pressure(mmHg)	69.3±5.79	71.55±8.31	ns
Heart rate	69.7±3.48	69.67±8.06	ns

ns:nonsignificant.

There were no significant difference between left ventricular echocardiographic parameters of patients and controls (Table II).

Table II. Echocardiographic Parameters of the Patients and Controls.

	Patients	Control	P
LV EDD (cm)	4.5±0.45	4.6±0.2	ns
IVS (cm)	1.04±0.25	1.04±0.19	ns
PW (cm)	1.02±0.13	1.02±0.15	ns
LV EF (%)	61.64±5.69	62±5.2	ns
LV MASS (gr)	189.1±56.1	191±54	ns
LV MI (gr/ m ²)	106.3±27.2	105±27.3	ns
MPI	0.37±0.07	0.37±0.05	ns

LV: left ventricle; LVEDD: left ventricle end-diastolic diameter; IVS: interventricular septum thickness; PW: posterior wall thickness; EF: ejection fraction; MI: mass index; MPI: myocardial performance index; ns: nonsignificant.

There was no relationship between left ventricular function parameters and age, duration of diabetes, FPG or HbA1c (Table III).

Table III. Correlations of Age, Duration of Diabetes, FPG and Hemoglobine A1c with Echocardiographic Parameters.

		LV EDD	IVS	PW	MPI	LV MASS	LV MI	EF
Age	r	-0.285	0.167	0.184	0.097	-0.022	0.048	0.2
	p	0.068	0.291	0.243	0.54	0.891	0.762	0.204
Duration of diabetes	r	-0.132	0.126	0.199	0.125	0.05	0.058	0.05
	p	0.406	0.425	0.207	0.431	0.753	0.717	0.752
FPG	r	-0.06	0.033	0.02	0.036	0.028	0.114	-0.125
	p	0.704	0.837	0.901	0.819	0.861	0.472	0.429
HBA1c	r	0.104	0.082	0.11	-0.005	0.128	0.203	-0.12
	p	0.513	0.605	0.489	0.976	0.419	0.197	0.449

LV: left ventricle; EDD: left ventricle end-diastolic diameter; IVS: interventricular septum thickness; PW: posterior wall thickness; EF: ejection fraction; MI: mass index; MPI: myocardial performance index.

Discussion

Diastolic dysfunction has been documented in uncomplicated tip 2 DM, even in subjects with impaired glucose tolerance, suggesting that LV diastolic dysfunction represents the earliest clinical manifestation of cardiac dysfunction in diabetes (16, 17). In our study, left ventricular functions were similar between healthy controls and diabetics without known cardiac disease. Diabetes is also characterized by metabolic abnormalities that have been implicated a possible mechanism of heart failure, including hyperglycemia itself. In a cohort study involving nearly 50.000 patients with diabetes, a clear association between glucose control and heart failure was demonstrated, with an %18 increased risk for heart failure with each %1 increase in HbA1c (18). In Yazıcı et al's study ; diastolic LV functions were related to HbA1c level in type 2 diabetic patients without CAD, HT and LVH (19) In a study which enrolled normotensive patients with new onset type 1 diabetes, it was concluded that an increased glysemic control reflected by HbA1C was significantly correlated with left ventricular diastolic function improvement. (20)

Elevated fasting glucose level in older adults with DM is associated with risk of congestive heart failure in both those with and without myocardial infarction/coronary heart disease. It has been showed that both right and left ventricular abnormalities were detected in diabetic patients without clinically evident heart disease. However, no significant correlations were found between echocardiographic parameters and indexes of diabetic control (plasma glucose and HbA1c) (21). It was reported that there was no correlation between left ventricular diastolic dysfunction and metabolic control (expressed by HbA1c) (22). The MPI, a doppler index of global cardiac function, is applicable to both left and right heart function. The MPI allows both sistolic and diastolic performance to be estimated (13, 14). In our study; we could not find any relationship between glysemic control and MPI. And there were no significant differences on left ventricular functions between diabetics and healthy controls.

The duration of diabetes did not correlate with diastolic function. This result does not mean that duration of the disease is not relevant but probably that the severity of glysemic impairment has a greater influence or LV function than the duration of diabetes (23).

Study limitations. Postprandial glucose (PPG) is important risk factor for diabetic complications. The association between PPG and cardiovascular complications was demonstrated (25, 26). The main limitation of this study is the lack of available data on PPG. The PPG can be associated with MPI in the early stages of diabetic cardiomyopathy. An important limitation of our study is just using resting electrodagriographic parameters for ruling out coronary artery disease. Another limitation of this study is the small number of patients.

In conclusion, LVDD may develop in early stage of type 2 DM in the absence of comorbidities such as HT and ischemia. In our study, left ventricular functions were similar between healthy controls and diabetics without known cardiac disease. We could not find any effect of glysemic control on left ventricular functions. So; it can be assumed that glysemic control has limited affect on diabetic cardiomyopathy. These findings suggest that there may be other factors involved with left ventricular dysfunction in type 2 DM.

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