Left ventricular function in patients with uncomplicated well-controlled diabetes mellitus

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Abstract

Background: Recent findings indicate that symptomatic heart disease in patients with diabetes mellitus predicts poor prognosis, but cardiac involvement may occur before clinical manifestation. Diastolic dysfunction may be the first stage of diabetic cardiomyopathy. Objective: The aim of this study was to evaluate the cardiovascular function in patients with DM in early stages. Methods: we studied a group of 62 patients, males and females, aged between 51 and 65 years old, with well-controlled DM; they were investigated using transthoracic echocardiography (TTE). Two dimensional, pulsed Doppler techniques were used to assess the systolic and diastolic function for left ventricle (LV). Results: none of the patients had any clinical signs of cardiac involvement, nor ECG or TTE systolic function impairment. There are significant differences between DM patients and control group for peak A velocity (0.72 ± 0.19 vs 0.56 ± 0.29, P=0.05) and E/A ratio (1.03 ±0.29 vs 1.51 ± 0.26, P = 0.01) which account for filling impairment of LV. Conclusions: the analysis of DM heart disease, mainly at a pre-clinical level, is important in all the cases as an asymptomatic patient may have diastolic dysfunction which can be treated and should be closer observed.

Keywords: diabetes mellitus, ultrasound, cardiovascular function

Introduction

The cardiovascular prognosis in patients with diabetes mellitus (DM) is worse than in non-diabetic individuals. More than half of the patients with type 2 diabetes mellitus have autonomic neuropathy which involves, among other, the cardiovascular system. Heart rate variability is reduced in DM patients, associated with a poorer cardiovascular prognosis and increased risk of stroke.
[1,2]. Left ventricular (LV) diastolic impairment may be the first stage of diabetic cardiomyopathy; diabetic cardiomyopathy is now recognized as a distinct entity that may lead to heart failure independent of other heart diseases such as hypertension or coronary heart disease. Diastolic dysfunction alone refers to echocardiographic features of an abnormal LV relaxation pattern without clinical heart failure. Diastolic heart failure refers to a clinical syndrome of heart failure with a preserved LV ejection fraction [3,4].

The prevalence of diabetic cardiomyopathy is about 30% in middle-aged type 2 diabetic patients. Left ventricular diastolic dysfunction and cardiac dysautonomia are often associated and may be asymptomatic [1]. The early detection of cardiac involvement in DM is clearly desirable, both for optimal treatment and for implementation of preventive measures in the early stages of the disease [1,5].

Our study was designed to analyze the prevalence of cardiac involvement in patients with diabetes mellitus but no signs of heart disease.

Materials and methods

Patients with diabetes mellitus

Sixty two patients (30 women and 32 men), aged between 51 and 65 years old were studied, according to the following inclusion criteria: uncomplicated and well-controlled DM, assessed by laboratory findings, including HbA1c; age < 65 years; normal chest radiographs and normal left ventricular systolic function at echocardiography. In all cases, rest ECG was normal.

Exclusion criteria: chronic renal failure, malignancy, pregnancy, high blood pressure, ischemic or rheumatic heart disease, cardiomyopathy or congenital heart disease, and any other systemic diseases which could affect the heart.

Controls

For comparison, 55 healthy subjects (25 women and 30 men), with a mean age of 54 ± 12.8 years, age-matched and sex-matched, were used as control subjects.

Study protocol

Echocardiographic methods

Transthoracic echocardiography was carried out using an ALOKA alpha 10 Premiere device with a 2.5/3.5 MHz transducer, with patients in the left lateral decubitus position. Left ventricular diameters (EDD: left ventricular end diastolic diameter, ESD: left ventricular end systolic diameter), end diastolic septal thickness and posterior wall thickness were measured in the parasternal long axis view, according to the criteria of the American Society of Echocardiography [6]. Left ventricular ejection fraction (EF) was calculated with a modified Simpson formula from apical two and four chambers views.

Pulsed Doppler transmitral flow velocity profile was obtained from the apical four chamber view, and the sample volume was positioned at the tip of the mitral valve leaflets (fig 1). The following parameters were evaluated for diastolic function: peak E (peak transvalvular flow velocity in early diastole); peak A (peak transvalvular flow velocity in late diastole); E/A ratio; deceleration time (DecT) in ms (time measured between peak E velocity and the point where the deceleration slope of the E velocity crosses the baseline) (fig 2); isovolumic relaxation time (IVRT) (time elapsed between aortic valve

![Fig. 1. Pulsed Doppler transmisitral flow velocity profile obtained from the apical four chamber view with the sample volume was positioned at the tip of the mitral valve leaflets](image1)

![Fig. 2. Calculation of the deceleration time (DecT).](image2)
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Closure and mitral valve opening. E/A ratio between 1 and 2 was defined as normal [7].

Statistical analysis

Continuous variables were expressed as mean (SD). Differences were tested for significance by unpaired Student’s t test. Upper and lower 95% confidence limits for each variable were calculated from the two tails of the Student’s t test distribution. We compared the results with the control group. A p value <0.05 was considered significant. Pearson correlation coefficients were used to explore linear relationships between the study variables.

Ethical issues

All patients and control subjects gave consent to participate in the study, which was approved by the local Ethics Committee.

Results

Table 1 shows the demographic characteristics of both patients and controls.

The main values of echocardiographic parameters were comparable in both DM patients and controls (table 2). In particular, mean values of ejection fraction were comparable in both groups. There were no significant differences also for: left ventricular systolic and diastolic diameters, for left ventricular mass and for wall thickness.

We did not find pericardial effusion or any significant valvular involvement.

Of the Doppler parameters, evaluating left ventricular diastolic filling, late peak flow (peak A) velocity was significantly higher in DM patients than controls (p<0.05), while early peak flow (peak E) was reduced, but not significantly, if compared with normal controls. The E/A ratio was significantly lower in DM patients (p<0.01).

DecT and IVRT are prolonged in DM group, but the differences were statistical significant only for IVRT.

We found moderate significant correlations (r=0.42, p=0.05) between mean duration of disease, expressed in years, and trans-mitral late diastolic velocity flow (A wave) and E/A ratio, but not with IVRT.

The changes in left ventricular filling (peak A wave velocity, E/A ratio and IVRT) significantly correlated with fasting plasma glucose levels, HbA1 levels and the duration of disease (r=0.49, 0.56, 0.70, respectively). E/A ratio significantly correlated with the systolic blood pressure (r=0.66).

Discussion

The diastolic changes observed in DM patients mainly regards the relaxation phase, resulting in an increase of atrial contribution to filling (peak A) and a decrease of early diastolic filling (peak E) [1, 4, 8].

Although the physiopathology of diabetic cardiomyopathy is still under debate, it is widely accepted that it is multifactorial and involves more than metabolic control or autonomic neuropathy alone [3, 4, 9]. Suboptimal glucose control has been associated with abnormal LV relaxations, along with renal microvascular disease, arte-
Diastolic dysfunction without clinical signs of heart failure is the first stage of diabetic cardiomyopathy and should be carefully evaluated in all diabetic patients, regardless of the presence or absence of other complications.

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