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Evaluation of Myocardial Performance in Hypertensive Patients with Type 2 Diabetes and Normal Ejection Fraction

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Abstract

Diabetes (DM) and hypertension (HT) cause changes in cardiac performance. Long-term diabetes and hypertension can lead to changes in cardiac contractility, reduced left ventricular efficiency and heart failure. The aim of this study is to evaluate the effect of the coexistence of diabetes mellitus and hypertension on left ventricular myocardial performance and structural changes. The study involved 45 patients with essential hypertension and type 2 diabetes (14 males and 31 females, their mean age was 53.28 ± 13.28 years), and 45 healthy subjects (10 males and 35 females, their mean age was 48.11 ± 13.07 years) as a control group. Transthoracic echocardiography was done for all patients. The echocardiographic measurements included: left ventricle internal diameter at end diastole (LVIDd), left ventricle internal diameter at end systole (LVIDs), peak velocity of early transmitral flow (E), peak velocity of late transmitral flow (A), ejection fraction (EF%), isovolumic relaxation time (IVRT), isovolumic contraction time (IVCT) and ejection time (ET) from which the ındex of myocardial performance (IMP) was calculated. Results revealed a significant change in the ratio (E/A) between patients and controls (−32.45%) with *p* value < 0.05, and the change in (LVIDd) and (LVIDs) between patients and control groups were (4.61%) and (0.754%) respectively with insignificant *p* value. The change in IMP was (44.65%), with *p* value < 0.05, and the change in ejection fraction (EF%) was (−1.49) with *p* value > 0.05. İn conclusion, diabetic patients with hypertension had an increase in IMP and reduced E/A indicating deterioration in cardiac performance despite normal ejection fraction and insignificant change in LV dimensions.

Keywords

Diabetes and Hypertension, Echocardiography, Index of Myocardial Performance

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1. Introduction

It has been well established that Type 2 diabetes mellitus (DM) is a major risk factor for cardiovascular events [1]. The coexistence of hypertension with diabetes markedly increases the risk and accelerates the course of cardiac disease, peripheral vascular disease, stroke, retinopathy, and nephropathy [2]. It has also been reported that impairment of left ventricular diastolic function can be present even without systolic changes [3]. Diabetes is often associated with arterial hypertension leading to diastolic dysfunction and unfavorable cardiovascular outcome [4].

Echocardiography is widely available, safe, portable, and capable of detecting important changes in many cardiac parameters that occur in heart diseases such as heart failure, or valvular diseases [5]. Doppler echocardiography is the most important clinical tool available for the diagnosis of diastolic dysfunction. Nowadays, the use of Doppler echocardiography has become common for noninvasive measurements such as transmital flow velocity, the isovolumic relaxation time (IVRT) and left atrial pressure [6].

An important index for the assessment of myocardial performance is the index of myocardial performance (IMP) that reflects global cardiac function [7]. It gives a good assessment of left ventricular dysfunction and its severity [8]. In the present work, we have demonstrated that patients with hypertension and diabetes can show changes in IMP, and E/A while their EF% is still within normal.

2. Patients and Methods

The study included 45 patients referred from the department of medicine with an established diagnosis of diabetes and essential hypertension (14 males and 31 females of mean age of 53.28 ± 13.28 years) and 45 healthy subjects volunteered for the study (10 males and 35 females with mean age of 48.11 ± 13.07 years). The study was conducted in compliance to the medical ethics rules and all participants have given their consent. The study was performed in the echocardiography unit of Baghdad Teaching Hospital/ Medical City/Baghdad.

The following procedures were carried out prior to the study: case history, electrocardiography (ECG), and chest X-ray.

The echocardiography machine used in this work was SONOACE X8 equipped with a transducer operating at (2-5 Hz). Left ventricular internal dimensions at end diastole (LVIDd) and end systole (LVIDs) were measured using M-mode echocardiography to asses left ventricular systolic function (ejection fraction). Pulse Doppler tracing of the transmitral flow was obtained from the apical four-chamber view during quiet respiration with the patients lying on the left lateral position. The early transmitral flow velocity E and the peak late velocity A were measured, from which E/A was calculated.

By using the apical view and adjusting the pulse Doppler tracing between mitral and aortic valves isovolumetric contraction time (IVCT), isovolumetric relaxation time (IVRT) and ejection time (ET) were measured. IMP was calculated using the equation:

IMP = (IVCT + IVRT)/ ET [7].

Results were expressed as mean values with standard deviations and the difference as percentage. The comparison between the values for both groups was tested by paired student's t-test and p value < 0.05 was considered as the level of significance. Negative percentage indicates the value of control group is higher than patients group.

3. Results

The change in transmitral early velocity (E) between patients and control group was (−3.041%) which was insignificant (p value > 0.05). The late (active) filling velocity (A) was higher in patients than control by (46.33%) with significant p value < 0.01. The change in the ratio (E/A) between patients and controls is (−32.45%) with p value < 0.05, (**Table 1**)

The changes in LVIDd and LVIDs between patients and controls was (4.61%) and (0.75%) respectively with insignificant p values > 0.05 (**Table 2**).

The change in IVCT between patients and controls was (28.53%), the changes in IVRT and ET were (10.34%) and (−15.83%) respectively, all were significant (p values < 0.05). Consequently the change in IMP was (44.65%) and strongly significant (p value < 0.05). the difference in EF% between patients and controls was small (−1.49%) with insignificant (p value >0.05) (**Table 3**).

Table 1. Doppler echocardiography showing change % for (E, A and E/A) between control and patients groups.

Parameter	Control Mean ± SD	Patients Mean ± SD	Change %= [(P-C)/C]×100	*p*-Value
E (cm/s)	72.98 ± 12.83	70.76 ± 9.815	−3.041	>0.05
A (cm/s)	57.116 ± 8.225	83.573 ± 13.709	46.33	<0.01
E/A	1.288 ± 0.224	0.871 ± 0.189	−32.45	<0.05

Table 2. Change % for LVIDd and LVIDs between control and patients groups.

Variable	Control Mean ± SD	Patients Mean ± SD	Change % = [(P-C)/C] × 100	*p*-Value
LVIDd (mm)	4.77 ± 0.45	4.99 ± 0.77	4.61	>0.05
LVIDs (mm)	3.18 ± 0.503	3.204 ± 0.78	0.754	>0.05

Table 3. Doppler echocardiography showing change % for (IVCT, IVRT, ET, IMP, and EF%).

Variable	Control Mean ± SD	Patients Mean ± SD	Change % = [(P-C)/C] × 100	*p*-Value
IVCT (ms)	55.51 ± 12.95	71.35 ± 32.67	28.53	<0.05
IVRT (ms)	78.42 ± 19.23	86.53 ± 19.26	10.34	<0.05
ET (ms)	310.37 ± 43.62	261.22 ± 46.66	-15.83	<0.05
IMP	0.435 ± 0.095	0.622 ± 0.1933	44.65	<0.05
EF%	67.08 ± 4.658	66.08 ± 5.53	-1.49	>0.05

4. Discussion

Diabetes mellitus (DM) is an established risk factor for cardiovascular diseases [9] such as the development of congestive heart failure [10]. It has been suggested that impairment of left ventricular (LV) function in patients with DM is resulted from concomitant risk factors such as hypertension (HT) or to diffuse peripheral and coronary atherosclerosis [11].

Results of this study show a decrease in the ratio E/A for patients in comparison with normal subjects. The decrease in the ratio of E/A is more related to the late filling (A wave) and it may be caused by reduced transmitral filling during the period of early filling (E wave) and a consequent compensatory action by the left atrium causing an increase in the velocity of late filling (A wave), which is consistent with a previous study by Jennifer *et al.* 2001 [12]. This can be attributed to the impaired glycemic control, microangiopathy or interstitial accumulation of collagen with increased fibrosis in the myocardium [13].

The change in LV chamber size (LVIDd and LVDs) was small and insignificant (**Table 2**). These results together with the insignificant change in EF% (or almost no change) indicate that the myocardium is still within acceptable contractility with partially impaired performance appeared on diastolic dysfunction E/A and IMP. However the effect on EF% can be seen more clearly during heavy exertion [2].

The impairment in the myocardial performance appeared clearly from the value of IMP as it is a sensitive indicator of cardiac performance because when impaired performance exists, the addition of two increased values (IVCT and IVRT) divided by a decreased value of ET will make the effect more apparent. Thus IMP will increase with the increase in the myocardial stiffness.

5. Limitations

We did not know the type of hypertensive drug taken by each patient such as beta blocker or ACE or combination of more than one drug may influence the results. We also did not include the severity of diabetes and hypertension which can influence the cardiac performance. According to the design of the study the concomitant effect of both diseases compared to normal was studied so the effect of either disease alone was not analyzed.

6. Conclusion

A reduction in E/A and an increase in the value of IMP indicate deterioration in the cardiac performance even if there is no significant alteration in LV size and normal ejection fraction.

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