

Detection of the Early Cardiac changes of hypertension by Echocardiography

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Summery:

Background: Hypertension causes changes on the cardiac performance, and this effect is more profound on the LV where systolic high pressure is present.

Patients and Methods: We studied 30 patients (14 females and 16 males of average age of 54.8 ± 13.5) with hypertension and 20 normal individuals, the control group (age range 45.6 ± 17.8 , 11 females and 9 males). Measurements of early filling velocity E, late filling velocity A at atrial contraction and ejection fraction were taken, also isovolumetric relaxation, and contraction times and ejection times were taken. MPI myocardial performance index was calculated.

Results: Results shows a significant increase in the isovolumetric relaxation time IRT (30%), were IRT for the patients group was (105.4 ± 20.8) compared to (73 ± 6.86) for the normal group. The late velocity A (42%), were A for the patients group was (89.28 ± 18) compared to (51.1 ± 18) for the normal group. Ejection time ET (26%), were ET (438.2 ± 88) for the patients group compared to (324 ± 34) for the normal group. And the ratio A/E (41%), were A/E for patients group (1.33) compared to (0.78) for the normal group. While no significant change was observed on ejection fraction (EF %), isovolumetric contraction time (ICT), early velocity E, and myocardial performance index (MPI).

Conclusion: Diastolic function impairment was found to occur earlier than systolic function impairment in hypertensive patients.

Key words: Hypertension, Echocardiography, Myocardial performance index (MPI).

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Introduction:

The left ventricle is one of the heart chambers, which receives blood from left atrium (LA) during ventricular diastole and ejects blood into the systemic arterial circulation during ventricular systole 1. The non invasive assessment of left ventricular function is an intensely pursued goal. Evidence is gathering that diastolic dysfunction is a major cause of cardiac symptoms and may precede the onset of impaired systolic and diastolic function in several disorders 2.

Hypertension is a major risk factor for cardiovascular morbidity and mortality, as it increases the work of the heart 3. Blood pressure (both systolic and diastolic B.P) increase with age. The average B.P is about (80/60) mmHg at birth and rises slowly throughout childhood. It increases in the adolescence and is often in the region of (120/70) mmHg. A further increase in blood pressure for people in middle age (140/80) mmHg is common. Systolic B.P often continues to rise into old ages as the aorta becomes increasingly rigid. It is

also reported that the younger age males have higher pressure than females but this tendency is reversed after the age of 45 4. Assessment of global myocardial performance by a single index has been suggested as an appealing alternative to the individual assessment of systolic and diastolic left ventricular (LV) function 5. In 1995, Tei and colleagues 6 proposed a Doppler -derived time interval index, which was defined as the sum of isovolumetric contraction time and relaxation time divided by ejection time. This myocardial performance index (MPI) can be obtained easily from mitral inflow and LV outflow velocity time intervals with good reproducibility, and independent from LV geometry and heart rate 7. MPI is used to assess left ventricular function. It is a quantitative estimation of combined left ventricular systolic and diastolic function 8, 9. It correlates well with invasive measures of systolic and diastolic LV function 10, and has been reported to correlate better with patient outcome than conventional echocardiographic parameters in various myocardial diseases 11. In this work we are investigating and comparing several echocardiographic parameters in an attempt to find the most sensitive parameter/s which enables us to detect the early changes in the myocardial muscle, concentrating on the index of myocardial performance and the ejection fraction as they are commonly used in the cardiac disease diagnosis.

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Material and Method:

In this study patients with hypertension were chosen. This study was conducted in Baghdad teaching hospital/Eachocardiography unit for the period from april/2008 till September/2008. A total of 50 subjects were included in the study, 30 patients with an established diagnosis of hypertension (H group), 14 females and 16 males with mean age (54.8±13.5) years old, their blood pressure was not under control at the time of examination, and control group of 20 subjects with no past history or current evidence of hypertension, (C group), 11 females and 9 males with mean age (45.6±17.8) years old. The clinical characteristics are shown in (Table 1).

All subjects underwent a complete echocardiographic examination using (Philips ultrasound system with 3 MHz transducer). M-mode two dimensional and Doppler echocardiographic examination were under taken.

Pulsed Doppler tracing of the transmitral flow velocity curve were obtained from the apical four-chamber view during quite respiration with the patients lying on the left lateral position. Measurements of the early filling velocity E and A peak velocity at atrial contraction, and peak E-velocity/peak A-velocity ratio (E/A) were done, these two parameters (E,A) are very good indicators for diastolic performance 12. In apical view at aortic valve isovolumetric contraction time (ICT), isovolumetric relaxation time (IRT) and ejection time (ET) were measured from the interval between two mitral inflow periods (Fig 1), several investigators used MPI to assess left ventricle function, most of them showed that MPI gives a good assessment of left ventricular dysfunction and its severity 13. MPI then was determined as (ICT+IRT)/ET. The dimension of LV were recording during diastole and systole to estimate ejection fraction (EF %).

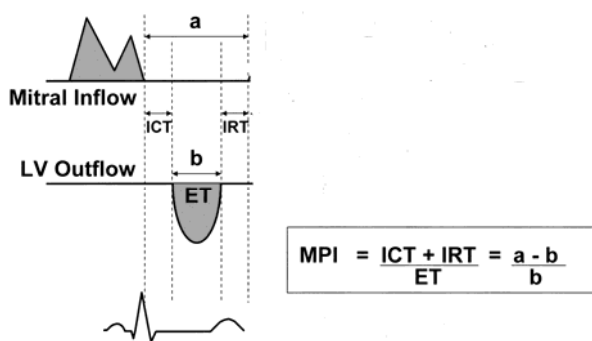


Figure 1: Derivation of the MPI from Doppler tracings of mitral inflow and LV outflow
a=time between filling periods; **b =** ejection time (ET)

All values were expressed as mean value with standard deviation ±1. The comparison between the mean values for both groups was tested by paired student's t-test, (Table 2). P-value < 0.05 was considered as the level of significant.

Results:

The characteristics of study population are shown in (Table 1). Results in table 2 reveal a significant increase in IRT (30%) for hypertensive patients (105.4±20) compared with control group (73±6.68). The rate A/E is also higher in patients group (1.33) than control group (0.78), this increase is attributed to change in A wave {(89.28±18) for patients group compared to (51.1±5.17) for normal group}, rather than E wave, as the change in E wave is very small (3.7%), (Table 2).

The isovolumetric relaxation time (IRT) has shown a significant increase compared with control group (30%) in contrast with the isovolumetric contraction time (ICT) which dose not show a significant difference from control group (3.1%) (Table 2) .

It was expected that we did not observe a significant change in the ejection fraction (EF) (6%) nor in the myocardial performance index (MPI) (2%) (Table 2), the low change in the latter belongs to the significant increase in ejection time (26%) as MPI= (ICT+IRT)/ET.

Table 1: Clinical characteristics of the study population

	Control group	Hypertensive group
Gender	11 Female, 9 Male	14 Females, 16 Males
Age(years)	45.6±17.8	54.8±13.5
Height(cm)	165.1±7.15	165±8
Weight(kg)	72.7±8.69	81.73±14.5
Body surface area(m ²)	1.81±0.13	1.97±0.2
Systolic blood pressure(mmHg)	125±10	161.3±12.4
Diastolic blood pressure(mmHg)	82±7.8	111.3±18.8
Heart Rate(beats/min)	73.9±5.76	81.53±7.5

Table 2: Cardiac function parameters in control (average of 20) and hypertensive (average of 30)

Cardiac parameters	Control group	Hypertensive group	Change %	P-value*
Ejection fraction (EF%)	80±3	75±10	6	NS
Early velocity (cm/sec) (E)	64.9±8.34	67.03±12.56	3.7	NS
Late velocity (cm/sec) (A)	51.1±5.17	89.28±18.08	42	S
Early velocity /Late velocity(A/E)	0.78±0.07	1.33±0.14	41	S
Isovolumetric contraction time(ms) (ICT)	60.1±7.43	62.06±9.46	3.1	NS
Isovolumetric relaxation time(ms) (IRT)	73±6.86	105.4±20.8	30	S
Ejection time (ms) (ET)	324±34.63	438.2±88.21	26	S
myocardial performance index (MPI)	0.38±0.03	0.39±0.11	2	NS

P<0.05 considered significant(S) *

Discussion:

It is well known that hypertension results in cardiac overload. This overload is more profound on the LV where systolic high pressure is present. The cardiac muscle can tolerate this overload for a certain period of time; this depends on the severity and the period of the disease. In long term uncontrolled hypertension cardiac muscle changes are inevitable; these changes including hypertrophy or dilatation, depending on the severity of the disease and the patients cardiac muscle previous disease such as myocardial infarction 14.

Our goal in echocardiography is to detect these changes and/or cardiac performance as early as possible, or we may go further to know the type and damage inflicted to the cardiac muscle caused by hypertension. Several cardiac parameters can be measured by echocardiography which can indicate cardiac performance. Such parameters or indicators are related with systolic performance such as EF% and ICT, or diastolic performance such as (E/A) the ratio of early to late LV filling and IRT 7.

Results of this study show that all patients has ejection fraction within normal i.e. more than 50% this indicate that the heart still has unimpaired systolic performance while the ratio A/E is increased higher than normal for both old age and the younger patients less than 50 years old. This may indicate diastolic function impairment. The increase in the ratio of A/E is more related to the late filling (A wave) and it may be caused by poor transmitral filling during the period of early velocity (E wave)

and a consequent compensatory action by the cardiac atrial muscle appeared as the increase in the late filling (A wave). It is also evident that there is a significant increase in the IRT (30%) which is also related with the diastolic performance. The increases in either IRT and/or ICT may be considered as indicators of cardiac dysfunction as observed in a previous study 15. It appears that the cardiac muscle dysfunction can be observed more readily on the diastolic performance rather than on systolic parameters. In our results the changes in EF and MPI were not significant (Table 2); the reasons may be attributed to the significant increase in ejection time (26%) [as MPI = (ICT+IRT)/ET] and/or to the short disease duration, meaning that major changes have still not occurred in the cardiac muscle; this may be supported by our observation that the changes usually occurred in the diastolic performance but not in systolic performance, because the cardiac muscle always tried to maintain the best blood circulation in the body. This compensatory action can be seen as an increase in late mitral inflow (A wave) to compensate the smaller blood volume transferred during early mitral inflow (E wave). It can also be seen as an increase in IRT to allow more blood transfer during the period of LV muscle relaxation.

It appears to be that the early effects of cardiac function impairments in hypertensive patients can be observed in diastolic function rather than in systolic function.

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