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Assessment of left ventricular mechanical Dyssynchrony in hypertensive patients

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Abstract
Objectives: To assess LV dyssynchrony in hypertensive patients with normal LV systolic function using Tissue Doppler Imaging (TDI) technique.
Methods: The study included 125 persons (100 patients and 25 persons as control group). All subjects underwent full history taking, complete clinical examination, echocardiographic examination for calculation of LV EDD and ESD by M mode, EF by Simpsons method, M mode and 2D eye balling, E/A, Maximum (T-S), (T-Q max), septal lateral delay by TDI
Results: Among study population 46 female (46.0%) and 54 male (54.0%) with mean age (53.530 ± 6.802), 52 patients (52%) were had proven left ventricular mechanical dyssynchrony. There is statistically significant positive correlation between HTN and LV mechanical dyssynchrony (P-value < 0.001).
Conclusion: Patients with systemic hypertension but without clinical heart failure often demonstrate LV systolic and diastolic dyssynchrony by TDI. The severity of dyssynchrony is significantly related to LV mass, left atrial volume, and LV remodeling. Systolic and diastolic dyssynchrony may identify hypertensive patient at risk for the development of heart failure either (systolic & diastolic), and who may benefit from more intensive hypertension control at an earlier stage in their disease process.

Keywords: left ventricular mechanical dyssynchrony, hypertension tissue Doppler imaging

Introduction
Hypertension (HTN or HT), also known as high blood pressure (HBP), is a long-term medical condition in which the blood pressure in the arteries is persistently elevated. High blood pressure usually does not cause symptoms. Long-term high blood pressure, however, is a major risk factor for coronary artery disease, stroke, heart failure, peripheral vascular disease, vision loss, and chronic kidney disease [1].
High blood pressure is classified as either primary (essential) high blood pressure or secondary high blood pressure. About 90–95% of cases are primary, defined as high blood pressure due to nonspecific lifestyle and genetic factors. Lifestyle factors that increase the risk include excess salt, excess body weight, smoking, and alcohol. The remaining 5–10% of cases are categorized as secondary high blood pressure, defined as high blood pressure due to an identifiable cause, such as chronic kidney disease, narrowing of the kidney arteries, an endocrine disorder, or the use of birth control pills [2].
Blood pressure is expressed by two measurements, the systolic and diastolic pressures, which are the maximum and minimum pressures, respectively. Normal blood pressure at rest is within the range of 100–140 millimeters mercury (mmHg) systolic and 60–90 mmHg diastolic. High blood pressure is present if the resting blood pressure is persistently at or above 140/90 mmHg for most adults. Different numbers apply to children. Ambulatory blood pressure monitoring over a 24-hour period appears more accurate than office based blood pressure measurement [3].
A normal left ventricle contracts synchronously with little more than 40 ms variation at the onset of electrical activation of the left ventricle, with very similar low variation in the timing of mechanical activation throughout the wall. Mechanical dyssynchrony refers to the abnormal prolongation of the timing of contraction or relaxation between the atrium and ventricle (atrioventricular dyssynchrony), between the right ventricle and left ventricle (interventricular dyssynchrony), or between different left ventricular (LV) segments (intraventricular or LV dyssynchrony) [4].

Aim of the study
The aim of the study was to assess LV dyssynchrony in hypertensive patients with normal LV systolic function using tissue Doppler Imaging technique.

Patients and methods
Study design
This is a prospective, randomized study that involved 100 patients referred to Cardiology Department Azhar Assiut University Hospital which were known to be hypertensive patients and 25 individuals with normal blood pressure were also included as a control group.
Exclusion criteria: Patients were excluded from the study if they were presenting with coronary artery disease or segmental wall motion abnormalities in echo, congestive heart failure, valvular heart disease (regurgitation more than mild or any degree of stenosis), congenital or primary myocardial and pericardial disease, renal insufficiency ≥ 1.5, Atrial fibrillation, pulmonary hypertension, diabetes mellitus.

Methods

All patients in this study were subjected to:

Full history taking: with stress on symptoms of coronary artery disease, heart failure, renal insufficiency, and medication taking for treatment of hypertension.

Careful Clinical examination: Include (general, local) with emphasis on sign of CHF and vital data include measure of blood pressure. Patient should be seated quietly for at least 5 minute in chair rather than on a examination table, with feet on the floor and arm supported at heart level. An appropriate sized cuff (cuff bladder encircling at least 80%of the arm) should be used to ensure accuracy at least 2 measurement should be made. The definition of normal in JNC7is SBP<120, DBP<80. The SBP>140, DBP>90 is consider uncontrolled.

Twelve-leads surface ECG: To assess QRS duration and criteria suggestive of ischemia.

Conventional echocardiography examination: echocardiography *was performed with the patient in the left lateral position for* measurement of LV EDD and ESD by M mode in parasternal short axis (*LVEDD: left ventricle end diastolic diameter ESD: end systolic diameter)*

- Calculation of ejection fraction by Simpsons method, M mode and 2D eye balling
- Calculation of LV mass using the following formula; (LV mass=0.8×{1.04(LVIDd+PWTd+SWTd)3-(LVIDd) [5].

The LV mass is indexed to body surface area (BSA) (g/m2) and height (g/m) [6].

Trans mitral Doppler to measure peak of E-wave velocity and peak A-wave velocity. Normal filling is generally characterized by an E/A ratio of 0.75-1.5.

Tissue Doppler: Used for assessment LV dyssynchrony as follow: [7].

Onset of QRS to the peak systolic velocity (T-S) on pulsed tissue Doppler in apical 4 chamber (septal and lateral walls) in basal and mid segment.

Maximum (T-S) was measured as the maximum difference of (TS) between any two opposing LV walls.

Maximum interval between onset of QRS complex to onset of systolic velocity (T-Omax).

Difference in (T-S) between the septal and lateral wall (septal-Lateral) delay.

LV dyssynchrony cut point of 40 mess was selected for both (T-Q) max and septal-lateral delay [8].

Assessment of left ventricular diastolic dyssynchrony from measuring time interval from onset of the QRS to peak (e') velocity. (e') Less than (3.5cm/s) in hypertensive population in manner incremental to clinical and echocardiography data [9].

Statistical analysis

The data were collected & have been analyzed using SPSS (Statistical Package for Social Science). Data have been presented using the Mean and Standard deviation then both groups & compared using the t-test for independent sample means and the chi-square tests.

The following tests were done

- X= Mean.
- SD= Standard deviation.
- T test for independent samples.
- ANOVA= Analysis of variance.
- X2 = Chi square test.
- Post Hoc test.
- P value> 0.05= Non-significant (NS) P value< 0.05= Significant (S)
- P value< 0.01= Highly significant (HS)

Results

Baseline demographic data

The study was conducted on 125 individuals who presented to the echocardiography unite at Azhar Asyut University Hospital & 100 of them known to have hypertension 54 male(54%) and 46 female(46%) with mean age 53.530 ± 6.802. All patients were treated by anti-hypertensive drugs. The study was started in November 2017 and was terminated in Augusts 2018.

* The Individuals were divided into two groups according to blood pressure by JNC7 classification.

Group I: Will include 100 patients, 54 male (54%) while 46 female (46%) with mean age (53.530 ± 6.802) known to be hypertensive with no clinical manifestations suggestive of heart failure.

Group II: Will include 25 individuals, 14 of them were males (56%) while 11 of them were females (44%) with mean age (53 ± 4.537) known to be normotensive with normal echo and normal ECG was used as control group**.**

Characteristics according to echo data

Table 1: In this table comparison between study populations as regard Septal-lateral delay by using the cut off value of (40 ms) which is used as definition of mechanical dyssynchrony. There were 53 cases (53%) in group I having mechanical dyssynchrony while in group II dyssynchrony was 6 cases (6%) having mechanical dyssynchrony with a highly significant difference between them (P-value <0.009).

Groups	Sep-Lat DELAY	
	Mean ± SD	P-value
Group I	36.160 ± 25.270	0.009
Group II	53.540 ± 40.180	

Table 2: In this table comparison between study populations as regard Left ventricular mass shows that there is statistically highly significant difference between them as (P-value <0.001).

Groups	LV mass	
	Mean ± SD	P-value
Group I	224.670 ± 49.840	<0.001
Group II	130.760 ± 20.274	

Table 3: In this table comparison between study populations as regard LVEDD , LVESD , posterior wall thickness and LV septum in diastole as a marker of LVH shows that there are statistically highly significant difference between as (value<0.001)

Groups	LVEDD	
	Mean ± SD	**P-value**
Group I	4.922 ± 0.466	<0. 001
Group II	4.264 ± 0.387	
Groups	LVESD	
	Mean ± SD	P-value
Group I	3.309 ± 0.516	0.006
Group II	3.004± 0.362	
Groups	PW	
	Mean ± SD	P-value
Group I	11.441 ± 1.931	<0.001
Group II	7.912 ± 0.860	
Groups	IVS	
	Mean ± SD	P-value
Group I	11.589 ± 1.966	<0.001
Group II	7.956 ± 1.159	

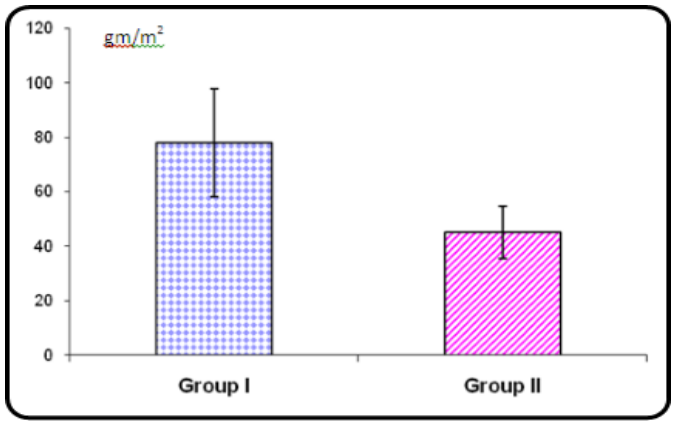

Fig 1: Comparison between the two groups regarding left ventricular mass index to BSA showing highly statistical significance difference between both groups (p value <0.001).

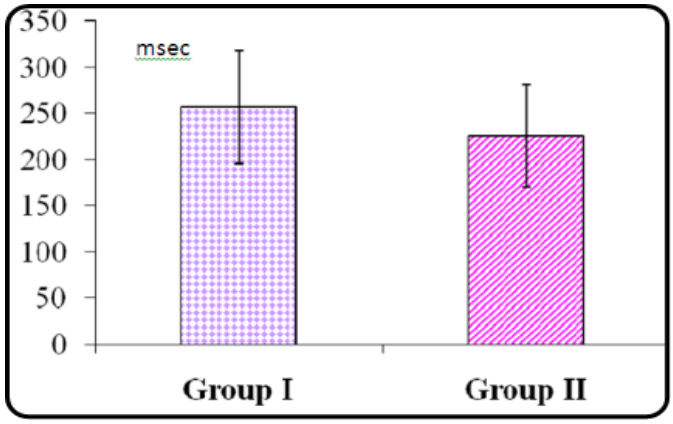

Fig 2: Comparison of (T-S) in lateral wall among the study groups, there was systolic time delay was more among group I with statistical significance difference between both groups (P value <0.05).

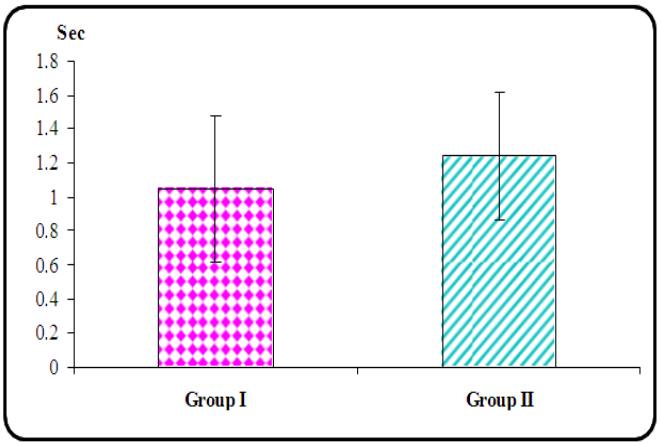

Fig 3: Comparison between two groups as regarding diastolic dysfunction represented by E/A ratio, there was significant difference between the two groups (p value <0.005)

Discussion

In our study, we found that LV mechanical dyssynchrony occurs frequently in patients with hypertension even without clinical evidence or echo criteria of CHF more than in normal population (p value <0.001). The proportion of hypertensive patients without CHF who were found to have LV mechanical systolic dyssynchrony (defined as Septal-Lateral delay > 40ms) was 52%, also diastolic dyssynchrony was significantly higher in LVH group than normal group.

These results were in agreement with those obtained by *Yang et al., (2008)* [7] who examined 42 hypertensive patients without evidence of CHF for the presence of LV dyssynchrony by TDI using (Septal-Lateral delay) parameter. In their study, 46% of patients had mechanical dyssynchrony using Septal-Lateral delay >40ms.

In the study done by *Chang et al., (2009)* [10] who reported that both systolic and diastolic mechanical dyssynchrony using TDI parameter are common findings among asymptomatic hypertensive patients. However, in their study the proportion of asymptomatic hypertensive patients with mechanical dyssynchrony was less than that obtained in our study, that is, 21% of patient had diastolic dyssynchrony and 24% had systolic dyssynchrony.

In a study done by *Yu et al., (2007)* [11] which used Tissue Doppler Technique (TDI) to examine 92 of patients with diastolic and systolic heart failure, systolic asynchrony was observed in 39% of patients with normal LV systolic function & having congestive heart failure (ie. diastolic heart failure).

In the study done by *Wang et al., (2007)* [12] which used Tissue Doppler Imaging (TDI) to examine 60 patient with DHF (LVEF >50%), 60 with SHF, and 35 control subject. They found that Left ventricular systolic dyssynchrony was observed in 33% patients. Left ventricular dyssynchrony in patient with preserved systolic function, 66% of whom were hypertensive.

In the study done by *Jianwen et al., (2007)* [13] also found- in

agreement with this study- that out of 60 patients without systolic HF examined for the presence of systolic and diastolic dyssynchrony and Age-matched control group of 35 subject that systolic dyssynchrony is present in 40% and was associated with significantly worse LV systolic function.

In contrast to the results of this study done by *Cheuk- Man and his colleagues in (2007)* [14] which used Tissue Doppler Technique (TDI) To examine 373 heart failure patient 128 with SHF, 92 with DHF and 100 normal subject found that patients with DHF had significantly lower systolic dyssynchrony than patients with systolic HF (39.1% versus 56.9%, p value =0.003). However, in their study the presence of hypertension in the DHF group was not among their inclusion criteria, this may explain the difference in results.

In the same study done by Cheuk-Man *et al., (2007)* [14] reported that systolic and/or diastolic dyssynchrony was common in 61% of patients with DHF despite of normal ejection fraction.

Conclusion

Patients with systemic hypertension but without clinical heart failure often demonstrate LV systolic and diastolic dyssynchrony by TDI.

The severity of dyssynchrony is significant related to LV mass, left atrial volume, and LV remodeling. Systolic and diastolic dyssynchrony may identify hypertensive patient at risk for the development of heart failure either (systolic & diastolic), and who may benefit from more intensive hypertension control at an earlier stage in their disease process.

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