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The impact of left ventricular thickness in hypertensive heart disease on right ventricular function: An Echocardiographic Strain Study

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Abstract
Background:*In spite of heart remodeling such as left ventricular hypertrophy affects both left and right ventricles due to ventricular interdependence; still a few studies had examined the outcomes of these effects on right ventricle and usually focusing on left ventricle.*
Objective:*To study the effect of left ventricular hypertrophy on right ventriclefunction using echocardiographic right ventricular strains.*
Patient and Methods:
A case control study of total 200 subjects was done. One hundred (61 male and 39 female) Patientswith systemic hypertension were compared with one hundred (57 male and 43 female) apparently healthy control subjects aged from (40-60) years.These groups were subjected to a detailed history, blood pressure measurement, ECG,anthropometry measurements,list of investigations, and echocardiographic study.
Results: *The mean of IVSd was (11.13±1.46) mm in hypertensive group and was (9.42±0.68) mm in control group and there was statically significant difference between the two groups (P value < 0.001).*
The mean 2D-RVGLS was (- 20.12 ± 3.80) % in hypertensive patients versus (- 25.90 ± 2.18) in normal subjects, the P value was 0.001 and there was significant difference between the two groups.
Conclusions: *RV longitudinal strain is significantly impaired in hypertensive patients group and strongly correlates with heart remodeling*
Key words*: Right ventricle, hypertension, longitudinal strain*

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I. Introduction

The right ventricle (RV) or the forgotten chamber is multi-compartmental in orientation with a complex structural geometry(1). Although the focusing in cardiology was placed on left heart physiology and pathology in the past, there is a growing body of evidence for the importance of the RV especially the maintenance of normal body hemodynamics, exercise capacity in chronic heart failure and survival in patients with valvular heart disease(2).

Arterial Hypertension is a major public health problem due to its high prevalence globally(3). Hypertensive heart disease is the cardiomyopathy which result from myocardium response to the mechanical stress from elevated blood pressure , the influences of neurohormones , growth factors, and cytokines and then leads to variety of abnormalities includes left ventricular hypertrophy (LVH), systolic and diastolic dysfunction, and their clinical complication including arrhythmias and heart failure (4,5).

In echocardiography studies, a comprehensive assessment of the right ventricle should be performed using multiple acoustic windows and different image techniques(6,7).The Two Dimensions Speckle Tracking Echocardiography (2DSTE) is a novel non-invasive echocardiographic method to calculate myocardial deformation in standard grey-scale images in which every little piece of myocardium in echocardiography image has its own unique pattern of speckles(8,9,10).

II. Patients and methods

A case control study was carried out during the period from July (2016) to April (2018) at Ibn Al-Bytar Cardiac center , Baghdad in cooperation with department of physiology / college of medicine / university of Baghdad .

The total number of hypertensive patients and apparently healthy control subjects were (200) of either sex (118 male and 82 female), their age range from (40 – 60) year; they were divided into two groups: (1) One hundred (61 male and 39 female) Patientswith systemic hypertension were compared with (2) one hundred (57 male and 43 female) apparently healthy control subjects. These groups were subjected to a detailed history, blood pressure measurement, ECG,anthropometry measurements,list of investigations, and echocardiographic study.All subjects informed to be included in this study, according to Local Ethical Committee of Ministry of Health, Iraq.All subjects with Ischemic heart diseases, heart failure, valvular and congenital heart diseases, cardiac arrhythmias, and acute or chronic renal or liver diseases were excluded from this study.

Echocardiography was performed for all subjects using aVivid E9® system (GE Vingmed; Hortoen, Norway) with M5Sc Cardiac Sector 5 MHz transducer under observation of specialist echocardiographer. The examination position of all subjects during echocardiographic examination was left lateral decubitus position, to bring the heart forward to the chest wall and lateral to the sternum, as recommended by the American Society of Echocardiography (ASE) and the European Association of Cardiovascular Imaging (EACVI) (11).Three ECG leads wire connected to electrodes adhered to patient chest wall and 3 cardiac cycles images were obtained.The right ventricular focused apical 4 chambers view (RV- focused) was selected for measuring right ventricular longitudinal strains using two-dimensional speckle tracking.

III. Results

This is a case control study in which 200 subjects were involved aged (40 -60) years; the first group includes 100 hypertensive patients (50% of total subjects) with mean age (50.65±4.22) years, the male - female percentage was (61%) for male and (39%) for female.

The second group includes 100 apparently healthy subjects (50% of total subjects) with mean age (48.38± 3.44) years, the male - female percentage was (53%) for male and (47%) for female.

Demographic data comparisons of the studied groups are demonstrated in Table 1

Table 1: Comparison between hypertensive and normotensive groups regarding demographic data

Parameters	Patients (N=100) Mean ± SD	Control (N=100) Mean ± SD	P value
Age (year)	50.65±4.22	48.38± 3.44	**0.236**
Weight (kg)	83.01±11.62	77.03±10.48	**0.002**
Height (cm)	172.94±4.65	1.69±9.56	**0.723**
BMI (kg/m^2) *	29.51±3.140	26.89±3.08	**0.001**
BSA(m^2) **	1.96±0.19	1.92±0.17	**0.138**
Heart rate(beats/min)	76±9	71±6	**0.067**
SBP (mmHg) ***	139.70±11.15	121.50±8.52	**0.001**
DBP(mmHg)******	84.00±4.13	70.95±5.11	**0.001**

* Body mass index ** Body surface area *** Systolic Pressure****Diastolic Blood Pressure
P Value = 0.05 sig

Table 2: Comparison between hypertensive and normotensive group regarding M-Mode echocardiographic left ventricular linear parameters

Parameter	Patients (N=100) Mean ± SD	Control (N=100) Mean ± SD	P value
IVSd(mm) *	11.13±1.46	9.42±0.68	< **0.001**
LVPWd (mm) **	10.96±1.07	9.22±0.62	**0.001**
LVEF (%)***	63.55±2.40	65.88±2.78	**0.125**

* Interventricular septum thickness at diastole **Left ventricular posterior wall dimension
***Left ventricular Ejection Fraction P Value = 0.05 sig

As shown in table 2, regarding IVSd ; the hypertensive group had a mean (11.13±1.46) mm and the control group had a mean (9.42±0.68) mm with statistically significant difference (P value < 0.001) , while regarding LVPWd ; the hypertensive group had a mean (10.96±1.07) mm and the control group had a mean (9.22±0.62) mm with statistically significant difference (P value = 0.001) . The mean LVEF was (63.55±2.40) % in hypertensive group, while the mean LVEF was (65.88±2.78) in normotensive control group and the p value was 0.125.

Table 3 : Comparison between hypertensive and normotensive group regarding two dimensional right ventricular speckle tracking strains

Parameters	Patients (N=100) Mean ± SD	Control (N=100) Mean ± SD	P value
2D - RVGLS % *	- 20.12 ± 3.80	- 25.90 ± 2.18	**0.001**
* Two dimensional right ventricular global longitudinal strain P Value = 0.05 sig			

Table 3 demonstrates Global right ventricular strain using two dimensional speckle tracking echocardiography in the two studied groups.
The mean 2D-RVGLS was (- 20.12 ± 3.80) % in hypertensive patients versus (- 25.90 ± 2.18) in normal subjects, the P value was 0.001 and there was significant difference between the two groups.

Discussion

In the current study, hypertensive patient group had significantly higher Interventricular septum and left ventricular posterior wallthickness over control group. The fact of left ventricular hypertrophy in hypertensive patient had been well established(12). This result of left ventricular hypertrophy was in agreement with the result of Cuspidi and his coworker in their review paper, so they made analysis for 30 studies and demonstrated one of the largest database on echocardiographic LVH prevalence in hypertensive population of 37 700 patients from different studies . The main finding of their work was that 36 - 41% of both treated and untreated hypertensive patients had alterations in cardiac structure (12). The more likely explanation for developing LVH in hypertensive patients is because hypertension increases hemodynamic load on the LV, which make LV remodels in an attempt to compensate wall stress and regulate myocardial oxygen consumption (13). Diez and Frohlich demonstrate that the mechanisms responsible for progression to hypertrophy include not only a response to increase hemodynamic load from elevated blood pressure but also the effects of neurohormones such as catecholamines, renin-angiotensin system, endothelins, cytokines, and certain growth factors by increasing cardiomyocyte size , enhancing myocardial fibrosis , and increasing interstitial and perivascular collagen deposition (4,14).

The clear prognostic importance of RV function in various diseases has encouraged investigations about new echocardiographic methods for accurate diagnosis of RV function(15).

Two dimensional speckle tracking echocardiography is a novel technique of cardiac imaging for measuring cardiac motion quantification depends on frame to frame tracking of ultrasonic speckles in gray scale 2D images. 2D STE overcomes most of the limitations present in conventional echocardiography and tissue Doppler imaging, because it is angle and load independent, thus allowing accurate quantification of regional and global myocardial function (16).

In this study both global and free wall longitudinal RV strains were significantly decreased in hypertensive patient group compared to normotensive control group.

Our observations extend and complement previously published data suggesting that longitudinal RV strain is impaired in patients with hypertensive heart disease(17, 18) . Our findings suggest significant impairment of RV systolic function in these patients, despite the absence of clinical manifestation of systolic dysfunction as assessed by more traditional parameters of systolic performance such as fractional area shortening, TAPSE and tissue Doppler.

These observations reinforce the fact that speckle tracking technology is more sensitive and superior to conventional echocardiographic functional parameters of RV systolic function and are further supported by findings of a cardiovascular magnetic resonance imaging which considered as gold standard for RV assessment (19) .

Conclusions

Our study revealed that RV longitudinal strain was significantly impaired in hypertensive patients group and strongly correlates with heart remodeling.

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