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Effect of Hypertension on the Left Atrium Using Tissue Doppler Imaging Echocardiography

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Abstract **Background:** left atrial enlargement plays a crucial role in increasing the risk of cardiovascular events. this is most of the time proceeded by left ventricular hypertrophy (LVH) which is caused by the effect of hypertension. **Aim:** evaluate LA function using tissue Doppler imaging of two-dimensional volumetric parameters in subjects with essential hypertension to establish the prognostic elements of arterial hypertension. **Patient and Methods:** cross-sectional analytic study. The study samples were obtained from the Al-Furat Teaching Hospital's Echocardiographic Consultation Unit in the Al-Najaf Governorate between 1st September 2023, and 20th April 2024. Sixty-eight known cases of hypertensive patients with age of (18-60 years old). All patients are males and females. Clinical evaluation, anthropometric assessments, Doppler echocardiography as well as TDI study were done for each one of them to assess the left atrial volumes and function. **Results:** the hypertensive patients show a significant difference in accordance with weight, height, age, and BSA (all $P<0.05$). At the same time, there was a significant difference in S and E wave parameters between patients with normal and abnormal LVM. However, all these parameters are abnormal in all patients with and without LVH. These parameters are abnormal according to the normal reference range. **Conclusion:** TDI with color-coded Q-analysis can detect the early LA wall abnormality caused by hypertension even before the obvious structural changes appear in LV and LA.

Key Words left atrial enlargement, LVH, hypertension, TDI

1. Introduction

One significant risk factor for cardiovascular mortality and events is left atrial (LA) hypertrophy [1], [2]. It has long been believed that the LA phasic function is unimportant. There are a growing number of studies demonstrating the reservoir and active pump function of LA [2]. The majority of researchers concur that hypertension is harmful [3]. Some investigations, however, do not entirely support this finding; the impact on these patients can be explained by left ventricular (LV) remodeling [4]. Frank-Starling is valid in the human heart as well and is dependent on variations in LV overload, arterial hypertension, and the systolic and diastolic LV characteristics, which can be altered under a variety of pathological circumstances [5]. Additionally, the increases in LA size and function are correlated with the degree of left ventricular dysfunction. The growth of the LA is a significant compensatory activity for changes in levels of the average pressure of the LA or the increased preload [6]. It is hypothesized that hypertension affects the size and functionality of the LA. In order to determine the predictive factors of arterial hypertension, the current study assessed LA function utilizing tissue Doppler imaging of two-dimensional volumetric parameters in participants with essential hypertension.

2. Methodology

A. Study Population

This is a cross-sectional analytic study. The study samples were obtained from the Al-Furat Teaching Hospital's Echocardiographic Consultation Unit in the Al-Najaf Governorate between 1st September 2023, and 20th April 2024. Known cases of hypertensive patients with age of (18-60 years old). All patients are males and females. Patients with diabetes mellitus or coronary artery disease, significant valvular disease, a history of atrial or ventricular arrhythmias, previous cardiac surgery, implanted device, or any other chronic diseases (e.g. chronic liver disease, chronic kidney failure, etc.), and Obese patients (BMI greater than 30 kg/m²) were excluded from this study. The echocardiographic pa-

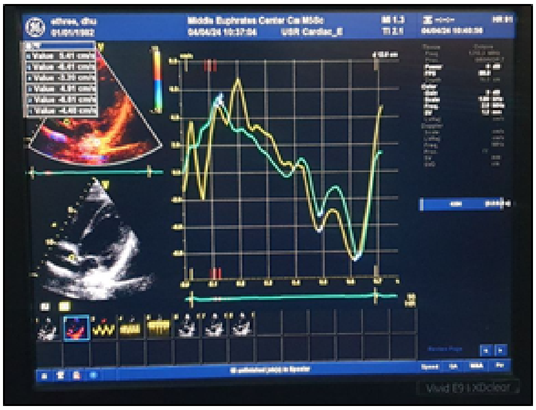

Figure 1: TDI with Q-analysis of LA

rameters were taken by the same doctor independently of the clinical data. The statistical analysis is carried out by using SSPS V21 Anthropometric measures (height and weight) were measured and ECG was done in all participants. Body mass index (BMI) was calculated for each patient.

B. Echocardiography

The 2D, pulse wave Doppler, and tissue Doppler with Q-analysis in every subject were performed using a transducer that was attached to the ultrasound machine. A three-lead ECG was continuously obtained during the echocardiography evaluation. For conventional Doppler echocardiographic evaluations, the American Society of Echocardiography's guidelines have been followed [7]. The transducer was positioned at the apex beat level in the fifth intercostal space at the mid-clavicular line for obtaining a four-chamber apical view, with the indicator pointing in the direction of the left flank. Consequently, the following parameters were measured; S´, E´, A´ by tissue Doppler with color-coded Q-analysis. Using a parasternal long-axis view, the transducer was placed between nipples with the indicator pointing toward the right shoulder, the following parameters were measured; IVS, LVEDV, and LVPW to obtain LVM. Following the guidelines provided by the American Society of Echography (ASE), the left ventricular mass (LVM) was measured and computed using Devereux's formula. A body surface area indexed LVM (LVMI) of greater than 115 g/m2 in men and greater than 95 g/m2 in women was considered left ventricular hypertrophy (LVH). It was feasible to differentiate between the concentric LVH if RWT $\geq$ 0.42 and the eccentric LVH if RWT $<$ 0.42 based on the relative wall thickness (RWT), which was determined by the 2 LVPW/LVEDV.

By using an apical four-chamber view, TDI with Q-analysis mode is activated. Regions of interest were placed at the mid-septal and mid-lateral walls of LA to measure the S wave, E wave, and A wave.

C. Statistical Analysis

In this cross-sectional study, statistical analysis was performed using the statistical package SPSS for Windows (version 21, SPSS Inc., Chicago, IL, USA). Data analyzed as per group I with normal LVM (total: n=27) compared with group I1 for patients with abnormal LVM (total: n=41) were shown as mean ± SD. Continuous variables were compared using independent sample t-tests. A P value $<$ 0.05 was adopted to indicate statistical significance [8].

Demographic data	Hypertensive patients (n=68) mean±SD	P- value
Age (years)	47.85±8.95	0.00001*
Height (cm)	164.26±8.74	0.0003*
Weight (kg)	87.94±15.68	0.0020*
BSA	1.99±0.20	0.000001*

Table 1: Demographic data

Q- analysis	normal LVM (n=27) mean±SD	Abnormal LVM (n=41) mean±SD	**P- value**
S wave (average)	9.48±1.98	7.77±1.92	0.001*
E wave (average)	-8.786±2.193	-7.30±1.94	0.008*
A wave (average)	-11.002±2.24	-10.86±2.43	0.826
Lateral S wave	6.71±1.62	5.33±1.612	0.002*
Septal S wave	5.55±1.604	4.88±1.270	0.007*
Lateral E wave	-5.88±1.80	-4.79±1.684	0.019*
Septal E wave	-5.80±1.22	-5.03±1.12	0.014*
Lateral A wave	-7.63±1.97	-7.43±2.078	0.707
Septal A wave	-6.75±1.565	-6.88±1.673	0.762

Table 2: Tissue Doppler parameters regarding to LVM

3. Results

A. Demographic Characteristics

Demographic characteristics of the population are given in Table 1. The mean age of subjects was 47.85 years and the results show a significant difference in age between the hypertensive people (p=0.00001). weight, height, and BSA also show a significant difference between hypertensive people (p= 0.002, 0.0003, and 0.000001 respectively).

On the other hand, Table 2 shows that the mean of the S wave in mid-septal, mid-lateral, and the average of it was significantly higher in patients with abnormal LVM than those with normal LVM (p<0.05). the mean of the E wave in mid-septal, mid-lateral, and the average of it was significantly higher in patients with abnormal LVM than those with normal LVM. The mean of A wave in mid-septal and mid-lateral and the average of it did not significantly differ between the two groups.

4. Discussion

The demographic data of our study differ significantly in hypertensive patients and this means that these parameters play an important role in developing hypertension. Age-related physiological changes include endothelial dysfunction and increasing arterial stiffness, both of which have a role in the development of hypertension [9]. Those who are taller typically have higher blood pressure than those who are shorter. This association is explained by the fact that in taller individuals, there is a greater hydrostatic pressure generated between the heart and the brain, necessitating higher blood pressure in order to provide appropriate cerebral perfusion. A higher body mass index (BMI) and body weight are linked to a higher risk of hypertension. Being overweight causes a number of physiological alterations, including insulin resistance, endothelial dysfunction, and an increase in sympathetic nervous system activity, all of which have a role in the development of hypertension [10]. BSA has a positive correlation with blood pressure and is determined using height and weight. Blood pressure is often greater in people with larger BSAs than in people with smaller BSAs [11].

There was a significant difference in S and E wave parameters between patients with normal and abnormal LVM. However, all these parameters are abnormal in all patients with and without LVH. These parameters are abnormal according to the normal reference range that we obtained from multiple resources which said that the control group has S wave (lateral and septal) were (8.44±2.41, -8.57±2.48) respectively. The E wave (lateral and septal) were (-8.57±2.48, -6.80±1.82) respectively and the A wave (lateral and septal) was (-7.86±2.17, -6.80±1.9) respectively [12]. free wall LA peak systolic velocity was significantly lower in both groups of hypertensive patients with and without LVH [13]. the difference in the atrial velocities at different sites was attributed to an atrial free-wall motion higher than that of the bounded IAS [14]. This indicates that even when there are no structural or functional changes in LV, we can detect the subtle changes in LA caused by hypertension and precede other changes. Patients with hypertension and LVH experience preclinical LV diastolic dysfunction; however, hypertension also induces early alterations in LV and LA dynamics before the onset of LVH. Thus, it is clinically crucial to accurately quantify their impact on LV systolic and diastolic function in a subclinical condition in order to prevent the development of overt cardiovascular illnesses. Before the overt signs of left ventricular hypertrophy (LVH) manifest [15]. TDI using color-coded Q wave analysis in this study can identify subtle changes in myocardial dysfunction that are not detectable with traditional echocardiography.

5. Conclusion

it was concluded that when seeing left ventricular hypertrophy was a predictive factor for abnormal parameters in LA when using a 2D echocardiograph, while TDI by Q-analysis revealed that we can identify any abnormality in the LA wall even when LVM is normal in hypertensive patients. This is important to prevent the development of any future structural changes in the heart that are caused with time by hypertension.

Ethics Approval and Consent to Participate

All patients had given informed consent, and the study design was approved by the Department of Physiology, Faculty of Medicine, University of Kufa (Department of Echocardiography) Al-Furat Teaching Hospital, Najaf, Iraq.

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Conflict of interest

The authors declare no conflict of interests. All authors read and approved final version of the paper.

Authors Contribution

All authors contributed equally in this paper.

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