

## Comparison between Echocardiography and Electrocardiography in the Detection of Left Ventricular Hypertrophy in Hypertensive Patients in Azadi Teaching Hospital in Kirkuk City

*Dilshad Sabir Mohammed, Mohammed Ali Khalaf, Asaad Mubark Jabar*

*Department of Medicine, College of Medicine, Kirkuk University*

### **Abstract:**

**Background:** Left ventricular hypertrophy is an important complication of hypertension and is considered an important risk factor for cardiovascular morbidity and mortality.

**Objectives:** To estimate the frequency of left ventricular hypertrophy (LVH) in our hypertensive population, to compare between electrocardiography and echocardiography in the detection of left ventricular hypertrophy and to study the main risk factors for its development.

**Patient and Method:** One hundred twenty five hypertensive patients underwent standard electrocardiographic (ECG) and echocardiographic (echo) examination using internationally accepted formula for the detection of left ventricular hypertrophy.

**Result:** The echo (echocardiographic) finding of LVH was seen in 103 patients (82.4%). The geometrical types of left ventricular hypertrophy (LVH), as detected by echo were as follow concentric left ventricular hypertrophy (LVH) was present in 63 patients (50.4%), eccentric LVH was present in 27 patients (21.6%) and concentric remodeling was present in 13 patients (10.4%). The ECG detects LVH in 58 patients (46.4%). Comparing ECG with echo for detection of LVH shows that ECG has a lower sensitivity and specificity than echo. There was no statistically significant difference regarding age, gender, duration of hypertension, history of diabetes mellitus (DM) or ischemic heart diseases (IHD), family history of IHD, smoking or obesity. There was a statistically significant association between high blood pressure (uncontrolled hypertension) and the presence of LVH.

**Conclusion:** It was found that there is high prevalence of LVH in our hypertensive patients and echo is more sensitive and specific for detection of LVH. Since most of our patients have uncontrolled hypertension we recommend aggressive management of hypertension to reach the target level of blood pressure.

**Key words:** Left ventricular hypertrophy, Echocardiography, Electrocardiography, Azadi teaching hospital

### **Introduction:**

Hypertension with its concomitant risks of cardiovascular and kidney diseases are a serious public health problem worldwide<sup>(1, 2)</sup>. It is also ranked third as a cause of disability-adjusted life years and contributes significantly to global mortality<sup>(3, 4)</sup>. People with untreated and uncontrolled hypertension often run the risk of developing complications such as Left ventricular hypertrophy,

cardiomegaly, congestive heart failure, retinopathy, cerebrovascular disease and renal insufficiency<sup>(5)</sup>.

Left ventricular hypertrophy is an adaptive response to the increased after load in hypertension and therefore serves to normalize wall stress. However it has been shown to be a strong independent predictor of cardiovascular morbidity and

mortality<sup>(6-9)</sup>. Left ventricular hypertrophy is associated with increased risk of ventricular dysrhythmia, coronary artery disease, myocardial infarction, stroke, heart failure and peripheral vascular disease<sup>(10)</sup>.

Several investigators have focused attention on improving methods for detection of left ventricular hypertrophy, assessing its effect on cardiac function and defining its relation to myocardial ischemia and sudden death<sup>(11, 12, 13)</sup>.

Investigators also evaluated the role of antihypertensive treatment in the regression of left ventricular hypertrophy and its beneficial outcome on cardiovascular events<sup>(14,15)</sup>.

Among the several methods for the diagnosis of left ventricular hypertrophy, the least expensive and the most easily to interpret method is electrocardiography which present high specificity, although it has low diagnostic sensitivity. It remains a broadly complementary test in medical practice as well as in population studies and is useful in the analysis of regression of hypertrophic process<sup>(16,17)</sup>.

Echocardiography is now widely available for determining left ventricular mass; it is time and cost-effective, specific, ideal for serial measurement function follow up and more sensitive than electrocardiography<sup>(18)</sup>.

Echocardiography also gives information regarding the pattern of left ventricular geometry which is of prognostic importance and the presence of diastolic dysfunction which is an early abnormality in the evolution of hypertensive left ventricular hypertrophy<sup>(19)</sup>.

Echocardiography is useful in assessing different types of left ventricular geometric adaptation to increased cardiac load, the characteristics of concentric hypertrophy are increase in

both left ventricular mass and relative wall thickness, whereas that of eccentric are increase mass and a relative wall thickness $<0.45$ . Remodeling is said to be concentric when thickness increase with respect to radius but without an increase in left ventricular mass. Concentric hypertrophy appears to carry the highest risk; eccentric hypertrophy is an intermediate risk while concentric remodeling is probably associated with smaller risk<sup>(20)</sup>.

### **Aim of the study:**

The aim of this study is to estimate the frequency of left ventricular hypertrophy in our hypertensive population, to compare the accuracy of electrocardiography and echocardiography for detection of left ventricular hypertrophy and to study the main risk factors for its development.

### **Patients and Methods:**

This study included 125 hypertensive patients attending outpatient clinic at Azadi Teaching Hospital (ATH) in Kirkuk City for the period from March 2013 to September 2013. They were (66) males and (59) females.

The study population included patients firmly diagnosed to have essential arterial hypertension with or without treatment. Patients with previous myocardial infarction, sinus node disease, dilatation aneurysm of the left ventricle, Wolff–Parkinson–White syndrome (WPW) syndrome, electrical blockade of the right and left bundle of His, ventricular or supraventricular tachycardia, cardiac pacemaker use and patients with ECG or echo of inadequate technical quality were excluded from the study. A standard structured questionnaire was used for each patient included; socio-demographic data were recorded, a thorough and detailed

history was taken with focus on the presence or absence of heart related symptoms, duration of hypertension and drugs used for the treatment. General examination was done for each patients, vital signs obtained, blood pressure was measured using standard well-calibrated mercury-based sphygmomanometer, weight and height recorded and body mass index (BMI) was calculated by dividing weight (Kg) by square of height (m). Classification of obesity was done according to WHO criteria, a body mass index  $\geq 30$  Kg/m<sup>2</sup> was used as index of obesity<sup>(21)</sup>.

Electrocardiography (ECG) was done for every patient and interpreted, ECG criteria for determining left ventricular hypertrophy recorded according to Sokolow-Lyon criteria<sup>(22)</sup>:

Sin V1+R in V5 or V6 > 3.5 mV or R in V5 or V6 > 2.5 mV

Echocardiography was performed by one experience operator using Philips system with 2.5-3.5 MHZ transducer according to the recommendations of American Society of Echocardiography. The left ventricular mass (LVM) was calculated using the formula:

$LVM = [(diastolic\ thickness\ of\ IV\ septum\ diastolic\ thickness\ of\ posterior\ wall\ of\ LV) \times 3] \times 1.04 \times 0.8 + 0.6$

Normal values for LVM in male is <259 gm and in female <166gm<sup>(23)</sup>.

Relative wall thickness (RWT) was calculated according to the formula:

$RWT = 2 \times posterior\ wall\ thickness / LV\ end\ diastolic\ dimensions$ <sup>(24)</sup>.

The geometric pattern of LVH was considered to be concentric when there is increase in both LVM and RWT, Eccentric when LVM is increased and  $RWT < 0.45$ , concentric remodeling when normal LVM is associated with increased RWT<sup>(25)</sup>.

Statistical analysis was done using

Chi Square test and a level of significance was set at p-value <0.05.

### **Results:**

Table 1 shows that out of the (125) patients (23) were in the age group (30-49), (57) in the age group (50-59) and (45) patients were above (60) years. Of the (125) patients (59) were female and (66) were male, (43) patients have their hypertension for less than 5 years, (32) have hypertension for (5-9) years and (50) patients have hypertension for more than 10 years.

Table 2 shows that of the (125) patients studied, (29) patients (23.2%) have history of DM, (29) patients (23.2%) have a positive history of IHD, (57) patients (45.6%) have a positive family history of IHD, (80) patients (64%) were obese, (101) patients (80.8%) have some form of treatment for their hypertension and (98) patients (78.4%) had elevated blood pressure on examination.

Table 3 shows that echo finding of LVH was prevalent in (103) patients (82.4%). Regarding the geometrical type of LVH as detected by echo, concentric LVH was present in (63) patients (50.4%), eccentric LVH was present in (27) patients (21.6%) and concentric remodeling was present in 13 patients (10.4%).

Table 4 shows that ECG detects LVH in 58 patients (46.4%). Comparing ECG with echo for detection of LVH, the table shows that ECG has (44.6%) sensitivity and (54%) specificity in detection of LVH. The percentage of ECG positive cases among LVH proven by echo is (44.7% or 46 out of 103 echo detected cases).

Table 5 shows that ECG detects eccentric type of LVH in (58) patients (46.4%), and comparing ECG with echo

for detection of eccentric type of LVH shows that ECG has (55.6%) sensitivity and (56.1%) specificity in detection of eccentric type of LVH.

In (Table 6), Regarding the factors associated with LVH, there was no statistically significant difference regarding age, gender, duration of hypertension, history of DM or IHD, positive family history of IHD, smoking or obesity. There was a statistically significant association between high blood pressure (uncontrolled hypertension) and the presence of LVH. It was found that the performance of ECG was bad for diagnosing LVH in

general in fact a positive ECG diagnosis of LVH is less predictive than its negative finding in such a highly selected sample, (Table 4). When ECG was used to diagnose a special type of LVH, namely eccentric type. The validity parameters were slightly improved (increased sensitivity and specificity). The predictive value of positive test decreased to as low as (25.9%) (since the prevalence of eccentric type was lower than the prevalence for LVH in general), while the negative predictive value increased to (82.1%).

**Table (1):** Frequency distribution of the study sample by age, gender and duration of hypertension.

Age group (years)	No.	%
30-49	23	18.4
50-59	57	45.6
60+	45	36.0
Total	125	100.0
Gender		
Female	59	47.2
Male	66	52.8
Total	125	100.0
Duration of hypertension		
<5 years	43	34.4
5-9 years	32	25.6
>10 years	50	40.0
Total	125	100.0

**Table (2):** The relative frequency of selected clinical characteristics among study participants.

Positive findings (total examined = 125)	No.	%
DM	29	23.2
Positive past history of IHD	29	23.2
Positive family history of IHD	57	45.6
Obese	80	64.0
On treatment for HT	101	80.8
High blood pressure	98	78.4

**Table (3):** Prevalence rate of selected positive findings of Echocardiography.

Positive findings (total examined = 125)	No.	%	95% confidence interval for prevalence rate (%)
Any type of LVH detected by Echo	103	82.4	(75.7 - 89.1)
Concentric LVH detected by Echo	63	50.4	(41.6 - 59.2)
Eccentric LVH detected by Echo	27	21.6	(14.4 - 28.8)
Concentric remodeling LVH detected by Echo	13	10.4	(5 - 15.8)

**Table (4):** Validity parameters for ECG diagnosis of LVH.

	LVH detected by Echo (final diagnosis)		
	Positive	Negative	Total
LVH detected by ECG			
Positive	46	12	58
Negative	57	10	67
Total	103	22	125

Sensitivity %	44.7	Accuracy %	44.8
Rate of false negative %	55.3	PPV%	79.3
Specificity %	45.5	NPV%	14.9
Rate of false positive %	54.5		

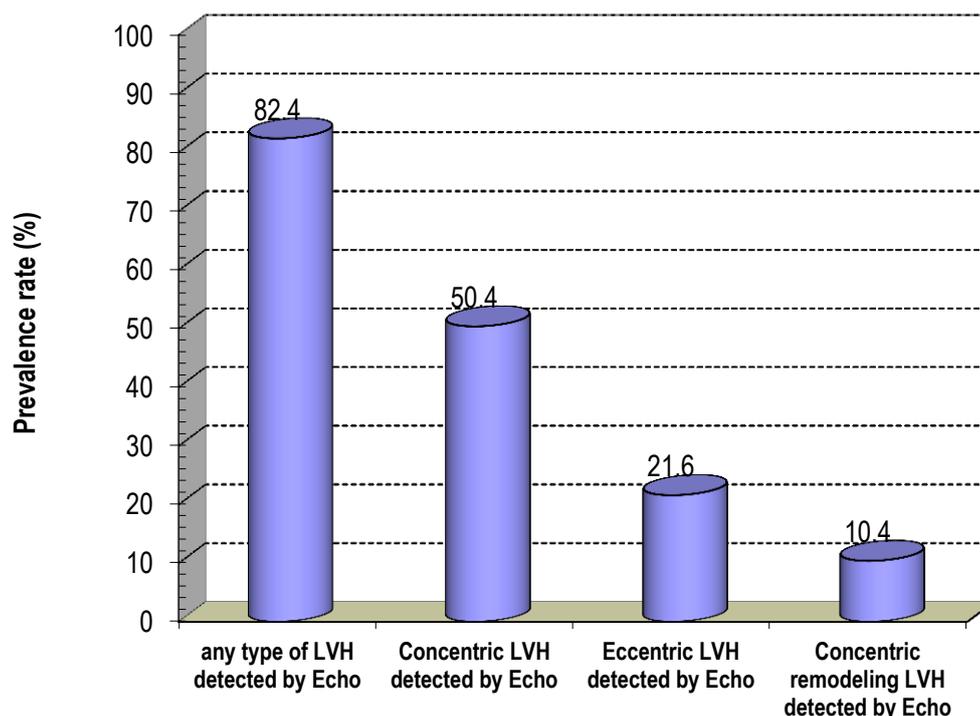
**Table (5):** Validity parameters for ECG diagnosis of eccentric type LVH.

	Positive	Negative	Total
LVH detected by ECG			
Positive	15	43	58
Negative	12	55	67
Total	27	98	125

Sensitivity %	55.6	Rate of false negative %	44.4
Specificity %	56.1	Rate of false positive %	43.9
Accuracy %	56	PPV%	25.9
NPV%	82.1		

**Table (6):** Factors associated with a final diagnosis of LVH.

	Total	LVH detected by Echo		
	No.	No.	%	P value
<b>Gender</b>				0.26
Female	59	51	86.4	
Male	66	52	78.8	
<b>Age group (years)</b>				0.86
30-49	23	19	82.6	
50-59	57	48	84.2	
60+	45	36	80.0	
<b>Duration of hypertension (years)</b>				0.36
<5	43	34	79.1	
5-9	32	29	90.6	
10+	50	40	80.0	
<b>Smoking habit</b>				0.65
Non-smoker	68	57	83.8	
Smoker	57	46	80.7	
<b>DM</b>				0.54
Negative	96	78	81.3	
Positive	29	25	86.2	
<b>Positive past history of IHD</b>				0.24
Negative	96	77	80.2	
Positive	29	26	89.7	
<b>Positive family history of IHD</b>				0.35
Negative	68	58	85.3	
Positive	57	45	78.9	
<b>Obesity</b>				0.65
Negative	45	38	84.4	
Positive	80	65	81.3	
<b>LVH detected by ECG</b>				0.4
Negative	67	57	85.1	
Positive	58	46	79.3	
<b>On treatment for HT</b>				0.18
Negative	24	22	91.7	
Positive	101	81	80.2	
<b>High blood pressure</b>				0.032
Normal	27	26	96.3	
Positive	98	77	78.6	



**Figure (1):** Bar chart showing the prevalence rate of selected positive findings of Echocardiography.

### **Discussion:**

Electrocardiographically detected LVH is associated with increased risk for cardiovascular disease morbidity and mortality<sup>(26-30)</sup>. Recently, echocardiographically detected LVH has also been shown to carry a poor prognosis<sup>(31-33)</sup>. Subjects with echocardiography proved LVH are at increased risk for several forms of cardiovascular disease including: coronary heart disease,<sup>(32)</sup> congestive heart failure,<sup>(34, 35)</sup> stroke, total cardiovascular disease,<sup>(33)</sup> and ventricular arrhythmias<sup>(36)</sup>. All studies reveal that the ECG is a poor screening test for LVH identifying smaller fraction of LVH than echo.

In this study echo evidence of LVH and remodeling was found in 82.4%. Similar result was found in life study (60-86%)<sup>(37)</sup>. Other studies showing abnormal LV geometry in (72%) of

patient<sup>(38,39)</sup>. Regarding geometric patterns of LVH in this study concentric hypertrophy was most common then eccentric hypertrophy and the least common was concentric remodeling and this also was found in similar other studies<sup>(38, 40)</sup>. Some studies focused on the relationship between the geometric types of LVH and cardiovascular morbidity and mortality, Micheal et al. found increase in cardiovascular morbidity and mortality in concentric type of LVH<sup>(41)</sup>. We found that echo evidence of LVH was higher in females than males although not statistically significant and this is similar to other study<sup>(43)</sup>.

In this study; most 76(60.8%) patient had concentric LVH and only 27(21.6%) had eccentric LVH. This is same to the fact that hypertension causes of LVH more and more

common than volume over load (eg. valve diseases) in our study the pressure over load was the most common cause of concentric LVH<sup>(44)</sup>. Regarding the factors associated with LVH, there was a statistically significant association between high blood pressure (uncontrolled hypertension) and the presence of LVH, which is consistent with various other studies<sup>(44)</sup>.

ECG has low sensitivity and specificity for diagnosis of LVH<sup>(42)</sup>. This study reveals that the ECG is a poor screening test for LVH, identifying a surprisingly small fraction of persons with echocardiographic hypertrophy. It was found that out of 58(46.4%) patient having ECG LVH ; echo evidence of LVH found in 46(36.8%) patient the specificity of ECG criteria was (56%) which is consistent with various other studies<sup>(44)</sup>.

### **Conclusion:**

In this study, it was found that there is high prevalence of LVH in the hypertensive patients and echo is more sensitive and specific for detection of LVH. Since most of our patients have uncontrolled hypertension, aggressive management of hypertension is recommended to reach the target level of blood pressure.

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