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Research Article

Probability of Heart Failure in Uncontrolled Hypertensive Patients

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Abstract: The main objective of this study was to detect the probability of heart failure (HF) in case of uncontrolled primary (essential) hypertensive (HTN) patients through the ejection fraction (EF) with age and gender, left ventricle hypertrophy (LVH) and left ventricle Diastolic dysfunction (LVDD) by using two dimensional (2D) ultrasound and echocardiography (Echo). The probability of HF or sign of it was detected by using echo for 100 uncontrolled primary HTN patients with difference ages less than 50 to 95 years, half of them was male and other half was female (50/50). An instrumentation that used for this study was my lab 50 and 60 from Esaote Company. The current manuscript studied the probability or sign of HF in low, high and normal EF, in normal LV, LVH with different grades, normal LV diastolic function and its different grades. The study showed that the EF was normal in all variables, that may lead to HF which may be developed to HF which called HF with normal EF or HF preserved EF (HFpEF). The study also showed although the EF was high for all variables, may be lead to Hypertrophic cardiomyopathy (HCM) which may be developed to HF if not well treated. Also the study demonstrated the probability of HF or sign of it, this probability may increase with increased the grades of LVH and LVDD.

Keyword: Heart Failure (HF), Hypertension (HTN), Ejection fraction (EF) and hypertrophy cardiomyopathy (HCM).

INTRODUCTION

There are at least 970 million people worldwide who have elevated blood pressure (hypertension), which associated with cardiovascular disease. In the developed world, about 330 million people have hypertension, as do around 640 million in the developing world. The World Health Organization rates hypertension as one of the most important causes of premature death worldwide and the problem is growing in 2025 it is estimated there will be 1.56 billion adults living with high blood pressure¹. Complications of hypertension are clinical outcomes that result from persistent elevation of blood pressure² Hypertension is a risk factor for all clinical manifestations of atherosclerosis since it is a risk factor for atherosclerosis itself^{3, 4, 5, 6,7} It is an independent predisposing factor for heart failure^{7, 8} Uncontrolled hypertensive with prolonged elevation of blood pressure BP more than 140/90 mm Hg can lead to a many changes in the myocardial structure, coronary vasculature, as well as conduction system of the heart. These changes in turn can lead to gradually development of left ventricular hypertrophy (LVH), coronary artery disease (CAD), various conduction system diseases, systolic and diastolic dysfunction of the myocardium. The complications that can manifested clinically are angina or myocardial infarction, cardiac arrhythmias (especially atrial fibrillation) and congestive heart failure (CHF) or **Heart failure (HF)**⁵.

Thus, the hypertensive heart disease is a term applied generally to heart diseases such as LVH that are caused by the direct or indirect effects of elevated BP and considered the leader to (HF), (CAD) and cardiac arrhythmias⁹. Although these diseases generally developed in response to chronically elevated BP, marked and acute elevation of BP can lead to accentuation of an underlying predisposition to any of the symptoms traditionally associated with chronic hypertension. Echocardiography has ability to assess the gross anatomy of heart , functions and its changes specially in HTN cases like HF by evaluation of Chambers , valves and there efficiency by detecting the EF of heart . an echocardiography (echo) can contribute and help in diagnosis of (HF)¹⁰.

According to the Framingham Study, hypertension accounts for about one quarter of heart failure cases n the elderly population, as many as 68% of heart failure cases are attributed to hypertension .Community-based studies have demonstrated that hypertension may contribute to the development of heart failure in as many as 50-60% of patients¹⁰ In patients (pts) with hypertension, the risk of heart failure is increased by 2-fold in men and by 3-fold in women¹¹ .

The prevalence of HTN in our society was increased more than one fourth of the Saudi adult population. We recommended aggressive management of HTN as well as screening of adults for HTN early to prevent its damaging consequences if left untreated. Public health awareness of simple measures, such as low salt diet, exercise ,and avoiding obesity , to maintain normal arterial blood pressure need to be implemented by health care providers¹².

OBJECTIVES OF THE STUDY

The main objective of this study was to detect the probability of HF in case of uncontrolled HTN patients through:

- Correlation of EF with age and gender for uncontrolled HTN Pts.
- Correlation of EF with LVH for uncontrolled HTN Pts.
- Correlation of EF with LVDD for uncontrolled HTN pts.
- Correlation of LVH and LVDD.

MATERIALS AND METHODS

100 uncontrolled primary (essential) hypertensive patients were studied (distributed between female and male as 50% for each). It was collected by using special designed data collection sheet, from cardiology departments in Saudi Arabia in Taif hospitals during 10 months. Approved patients ethics performed for each patient. Echocardiography was performed by echo technologist for all cases to prevent inter skill results variation. The exclusion criteria were secondary hypertensive patients and patients scanned by non-intended echo technologist. The heart parts can be demonstrated more clearly by using two-dimensional (2D) echocardiography in the para-sternal , apical , suprasternal and subcostal position , using the protocol of echo which was established by British Society of Echocardiography Education Committee which state that for viewing the HF a long-axis view is used applying of this view was obtained by put the echo transducer (probe) in the left apicosternal position and provides detailed images of many parts of heart specially the left ventricle, aorta, left atrium, and mitral and aortic valves. Angling the beam towards the right also allows assessment of the right atrium, right ventricle and tricuspid valves. Rotating the transducer by 90° in the clockwise direction produces the short-axis view, which allows assessment of the left ventricle, papillary muscles, chordae tendineae and mitral valves. The four-chamber view demonstrates the ventricles, atria, and mitral and tricuspid valves. Rotation of the transducer allows two-chamber views of the heart and more detailed assessment of the aorta and aortic valves^{11, 12}. Also 2D-biplane Simpson's method for evaluation of (EF) was applied , due to that the 2D-biplane , 3D- triplane and 3 dimensional echocardiography (3DE) by 2 investigators were considered blinded to any clinical data. The echocardiography machine that used for this study was my lab 50 from Esaote Company with (2.5 MHz) phased Array (PA) transducer.

RESULTS

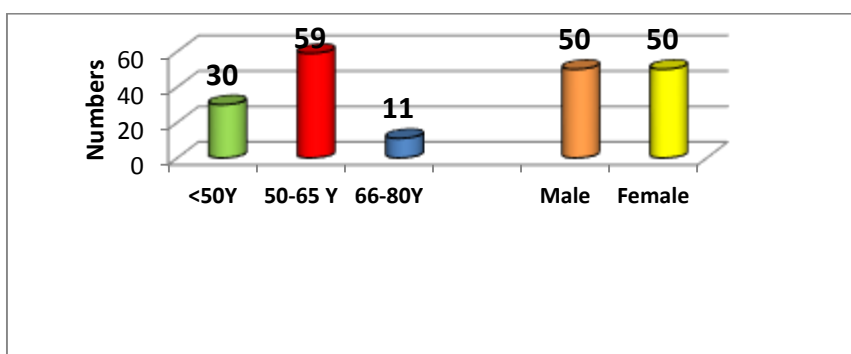


Figure1: Age groups and gender distribution of studied 100 uncontrolled hypertensive patients

Table 1: Ejection fraction of uncontrolled hypertensive patients

condition	Frequency	Percent
High (>75)	7	7.0
Normal(50-75)	90	90.0
Low (<50)	3	3.0
Total	100	100.0

Table 2 demonstrates the ejection fraction (EF) of studied sample. Ninety percent of uncontrolled hypertensive patients were of normal EF (50- 75). While 7% were with high EF (>75) and only 3% were of low EF (<50).

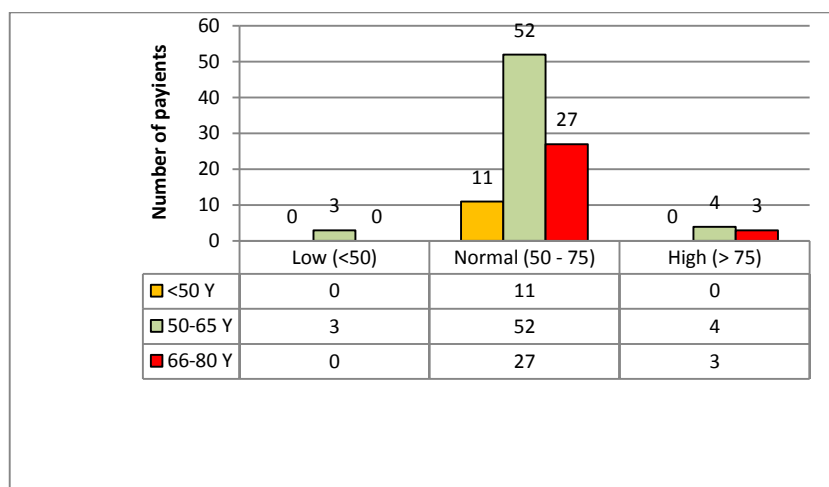


Fig.2: Ejection fraction according to age groups

Figure 2 Demonstrates:

- The distribution of EF of studied sample in age group. The normal EF (50-75) were 100% in age <50 year While 90 % in age group (66-80) and 88.1% in age group (50-65).
- The low EF (<50) of studied sample was represented 5.1% in age group (50-65) year and 0 % in both age groups <50 and (66-80) year.
- The High EF of studied group was 10% in age group (66-80) year while 6.8% in age group (50-65) years and 0% in age <50 year.

Table 2: Ejection fraction groups distributed by gender

Gender	Ejection fraction groups						Total	P value of difference
	Low (<50)		Normal (50-75)		High (>75)			
Male	1	2%	46	92 %	3	6 %	50 100%	*P=0.76 NS
Female	2	4%	44	88%	4	8 %	50 100%	
Total	3	3%	90	90%	7	7%	100 100%	

Likelihood ratio

Table 3 Demonstrates:

- The distribution of EF of studied sample in gender. The percentage of normal EF (50-75) were 92% in male which was more than in female 89%
- The low EF of studied sample was represented 4% in female which was more in male 2%
- The high EF of studied group was 8% in female which was more than male 6%.

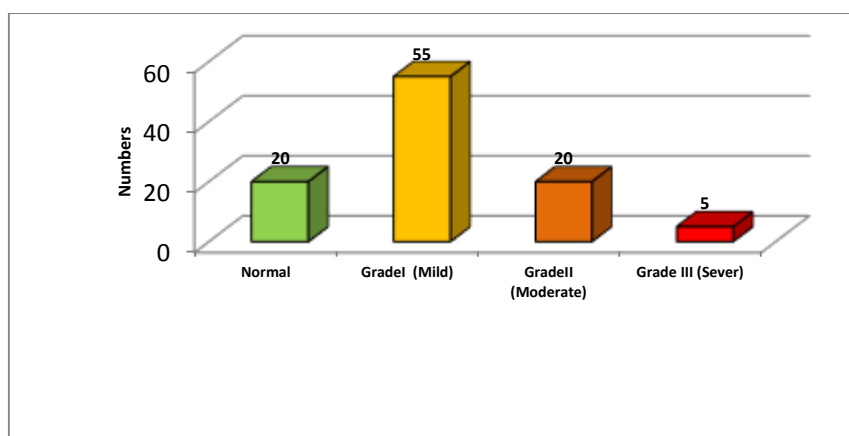


Fig.3: Frequency of LVH groups of 100 uncontrolled hypertensive patients

Figure 3 demonstrates the frequency of LVH of 100 uncontrolled HTN patients which represented 20% normal, 55% were grade I, 20% were grade II and 5% were grade III.

Table 3: Frequency of LVH distributed by EF

Variable	Variable grades	Ejection fraction groups			Total	P
		Low (<50)	Normal (50-75)	High (>75)		
LVH groups	Normal	0 0%	19 95%	1 5%	20 100%	0.07 NS*
	Grade I (Mild)	1 1.8%	49 89.1%	5 9.1%	55 100%	
	Grade II (Moderate)	0 0%	19 95%	1 5%	20 100%	
	Grade III (Sever)	2 40%	3 60%	0 0%	5 100%	
Total		3 3%	90 90%	7 7%	100 100%	

Table 3 demonstrates the distribution of LVH according the EF as following:

- Normal LV studied sample were 95% of normal EF while 5 % of high EF and 0% of low EF.
- Grade I LVH patients were represented 89.1% of normal EF while 9.1% were high EF and only 1.8% was low EF.
- Grade II LVH patients were represented 95% were normal EF while 5% were high EF and 0% were low EF.
- Grade III LVH was distributed in this stage 60% of them were normal EF while 40% were low EF and 0% were high EF.

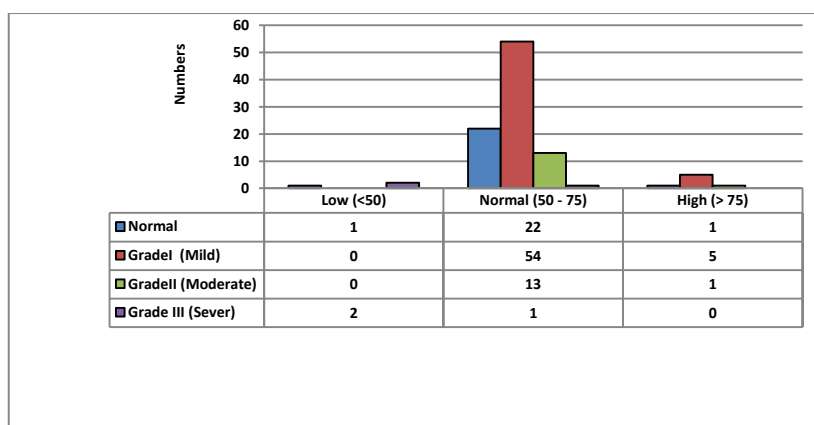


Fig. 4: Relation between LVDD and Ejection fraction

Figure 4 demonstrate the EF group distributed by LVDD as cause of HTN as following:

- Normal LV of studied group were 91.7% of normal EF while 4.2% were low and high EF
- Grade I of LVDD of studied sample were 91.5% of normal EF while 8.5% were high EF and 0% were low EF.
- Grade II of LVDD of studied sample were 92.9% of normal EF while 7.1% were high EF and 0% were low EF.
- Grade III of LVDD of studied sample were 66%.7 were low EF while 33% were normal EF and 0% were high EF.

DISCUSSION

In this study more than half of studied sample that (100 pts) were 59% in age between (50-65) years. While 30 % were in age <50 years and only 11% were in age between (65-80) years. They were 50 % male and 50 female. This mean that most of uncontrolled HTN of the studied sample were above 50 and lower than 66 years of total ages or that means few pts were in age <50 and >80 years. The affected range was 50-65 years. This study is somewhat similar to the study performed by Christopher et al in 2005¹³, who showed that the middle age of HTN disease among his sample was 66-69 years, and also showed there were no differences in the extent or type of hypertension treatment between the controlled and uncontrolled hypertensive groups. The study showed that, the probability of HF or sign of it through EF, the low EF is considered indicator of inability of heart muscle to pump blood. the low EF of studied sample that can be indicates to sign of HF or affected their heart was 3%. The percentage obtained by studied sample was a few because the HTN was already treated, but not controlled (uncontrolled) and there are more factors can contributed in that like type of medication, life style and management of life. The more percentage of EF of studied sample was normal (90%). This percentage also may be represented sign of HF because there is a type of HF with normal EF called HFpEF due to diastolic dysfunction which was discussed more in figure 7 and confirm that the studied samples were uncontrolled HTN and lots of them complained of LVDD. **American Heart association (AHA) 2015¹⁴, reported that** more than three quarters of patients with heart failure (HF) have antecedent hypertension. Hypertension appears to play an especially important role in HF associated with a preserved ejection fraction (EF) >0.50 (HFPEF). No proven specific therapy exists for HFPEF, but treatment of systolic hypertension in the elderly (the group at greatest risk for developing HFPEF) reduces the risk of developing HF by about one half. The current issue of *Circulation* contains an important analysis of the Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT) on the effect of the initial drug used to treat hypertension on

the subsequent risk of HF requiring hospitalization stratified by EF. Also a few percentages that were represented by high EF was (7 %) and that may be they affected with hypertrophic cardiomyopathy, because also if not well treated will developed to HF. The studies carried by Daniel et al, 2005¹⁵ agree with the current study, in that normal ejection fraction may lead to heart failure. They reported that a large proportion of patients who present with symptoms of heart failure have a left ventricular ejection fraction within the normal range. Although some have postulated that ventricular systolic function is impaired, most investigators have concluded that the fundamental abnormality in these patients is a disorder of diastolic (rather than systolic) function, and in fact, these patients are frequently referred to as having diastolic heart failure. Do most patients with heart failure and a normal ejection fraction have diastolic dysfunction? Patients with HFNEF are generally elderly women who have associated hypertension, diabetes, and/or coronary artery disease.⁶ These comorbid conditions have been linked to myocardial hypertrophy, ischemia, and/or interstitial fibrosis, each of which can prolong relaxation and increase passive myocardial stiffness. However, the coexistence of disorders known to affect these aspects of diastole is not sufficient to establish that diastolic dysfunction is the cause of heart failure when it occurs in patients with a normal ejection fraction.

The normal LV from hypertrophy was 20 % of studied sample. LVH grade I represented 55 %, grade II were 20 % and grade III were 5 %. in this study most patient sample had grade I LVH and grade III was the lowest percentage , the study of Assis Costa et al reported that LVH was detected in 83 patients (83%), of whom 56 (67.4%) had the concentric pattern and 27 (32.6%) the eccentric pattern of LVH. Normal LV from hypertrophy were represented 95% of normal EF .that means either a lot of uncontrolled HTN pts were really normal or free HF compared the percentage of low EF were 0% which means no pt with low EF or there were affected by type of HF (HFpEF) . This result also confirmed by William and Davis *et al.*¹⁶ 2010 as they reported that More than three quarters of patients with heart failure (HF) have antecedent hypertension.1 Hypertension appears to play an especially important role in HF associated with a preserved ejection fraction (EF) >0.50 (HFPEF). No proven specific therapy exists for HFPEF, but treatment of systolic hypertension in the elderly (the group at greatest risk for developing HFPEF) reduces the risk of developing HF by about one half 222. Also the normal LV from hypertrophy were represented 5 % of high EF which may be if not treated well develop to HF. LVH grade I was represented 89% of normal EF while 9.1% of high EF and 1.8% of low EF .That means there is few probability of LVH grade I pts had sign of HF or affected heart muscle and it ability to pump blood while there were a lot of pts with LVH grade I had either really normal (free HF) or had sign of HF type (HFpEF).And 9.1 % of high EF may be also developed from (HCM) to HF if no treated well. LVH grade II was 95% of normal EF while 5 % of high EF and 0 % of low EF. Although the percentage of LVH grade II were 0 % of low EF which was considered there was no HF may be the lot of pts were represented by LVH grade II and normal EF either really normal (free HF) or they had affected heart muscle and its ability to pump blood which is may be indicated to sign of HF. While grade II of LHV with high EF were 5% may be also considered them had sign of HF or affected heart muscle if not treated well from (HCM) .LHV grade III was 60 % of normal EF while 40 % of low EF and 0 % of High EF. That means a lot of percentage were normal EF which may be considered had HF with normal EF or (HFpEF).While there was no probability of HF due to low EF and only 40% had high EF in LVH grade III which may be also affected with sign of HF if not treated well from (HCM). Also noted the percentage of LVH increased with increasing the grades of LVH. In Concentric left ventricular hypertrophy brings deterioration of systolic longitudinal, circumferential, and radial myocardial deformation in hypertensive patients with preserved left ventricular pump function by Yukio Mizuguchi, et al in January¹⁷ 2010 reported Furthermore, association between HT with LVH and deterioration to isolated diastolic HF is well recognized and . It has been reported that longitudinal LV shortening is first impaired in elderly

normal individuals and in patients with hypertrophic cardiomyopathy and preserved LV ejection fraction. Therefore, it is clinically important to accurately evaluate not only LV diastolic function but also mechanics of LV myocardial contraction in patients with HT and LVH. Recently, the development of two-dimensional (2D) strain imaging has facilitated the simple and angle-independent measurement of LV myocardial deformation in the longitudinal, circumferential, and radial directions. In the present study, we recorded regional LV myocardial strain and strain rate curves in the 3 directions and LV torsion and torsion rate curves in patients with HT using 2D strain imaging, and investigated features of LV myocardial three-dimensional contraction abnormalities in the presence of LVH, particularly concentric hypertrophy, to speculate the background of isolated diastolic heart failure. LVDD was distributed 24% normal, 59 % grade I, 14% grade II and 3% grade III. The percentage of normal LV function were 91.7% of normal EF and equal 4.2% in high and low EF . That means the probability of sign of HF can be considered due to the type of HF (HF with normal EF) or (HFpEF) and 4.2% that represented high and low Ef also may be indicated to sign of HF according to previous reasons. LVDD grade II were 91.5% of normal EF while 8.5% of high EF and 0% of low EE. The means the same previous discussion. LVDD grade III were 33.3% of normal EF while were 66.7% of low EF and 0% of high EF. That means the same pervious discussion according to EF and noted the probability of sign HF may be increased with increased the grades of LVDD. Same result for the variable of study was in Diastolic Dysfunction: A link between hypertenntion and heart failure by Sophie Lanlande and Johnson in 2009¹⁸. They reported Diastolic heart failure is a clinical syndrome characterized by the symptoms and signs of heart failure, a preserved ejection fraction and abnormal diastolic function. Diastolic heart failure is also referred to as heart failure with normal ejection fraction or heart failure with preserved ejection fraction. The majority of patients with heart failure and preserved ejection fraction have a history of hypertension. Hypertension induces a compensatory thickening of the ventricular wall in an attempt to normalize wall stress, which results in LV concentric hypertrophy, which in turn decreases LV compliance and LV diastolic filling Some of my opinion agrees in New Concepts in Diastolic Dysfunction and Diastolic Heart Failure: Part I Diagnosis, Prognosis, and Measurements of Diastolic Function By *et al* in¹⁹ 2002 Reported Diastolic heart failure is a clinical syndrome characterized by the symptoms and signs of heart failure, a preserved ejection fraction (EF), and abnormal diastolic function. From a conceptual perspective, diastolic heart failure occurs when the ventricular chamber is unable to accept an adequate volume of blood during diastole, at normal diastolic pressures and at volumes sufficient to maintain an appropriate stroke volume. These abnormalities are caused by a decrease in ventricular relaxation and/or an increase in ventricular stiffness. Diastolic heart failure can produce symptoms that occur at rest (New York Heart Association [NYHA] class IV), symptoms that occur with less than ordinary physical activity (NYHA class III), or symptoms that occur with ordinary physical activity (NYHA class II). Diastolic heart failure can occur alone or in combination with systolic heart failure. In patients with isolated diastolic heart failure the only abnormality in the pressure-volume relationship occurs during diastole, when there are increased diastolic pressures with normal diastolic volumes. When diastolic pressure is markedly elevated, patients are symptomatic at rest or with minimal exertion (NYHA class III to IV). With treatment, diastolic volume and pressure can be reduced, and the patient becomes less symptomatic (NYHA class II), but the diastolic pressure-volume relationship remains abnormal.

CONCLUSION AND RECOMMENDATION

Echocardiography has become routinely used in the diagnosis, management, and follow-up of patients with any suspected or known heart diseases. It is one of the most widely used diagnostic tests in cardiology. It can provide a wealth of helpful information, including the size and shape of the heart

(internal chamber size quantification), pumping capacity, and the location and extent of any tissue damage. An Echocardiogram used to estimate the heart function such as a calculation of the ejection fraction, and diastolic function (how well the heart relaxes). This study showed the probability of sign of HF in low, high and normal EF in uncontrolled HTN with normal LV and LV function and also deference grades of them.

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