Sudan University for Science & Technology

College of Graduate Studies

Assessment of Echocardiographic Parameters among Hypertensive and Diabetic Sudanese Patients

تقييم معايير تخطيط صدى القلب لدى مرضى فرط ضغط الدم والسكري السودانيين

A Thesis Submitted for the Requirement of Ph.D. Degree in Medical Diagnostic ultrasound

BY:-

Mozdalifah Mohammed Saeed Elnaeem

Supervisor:

Prof.Dr.Caroline Edward Ayad Khilla

Co-Supervisor:

Dr. Mona Ahmed Mohammed

2022

بسم الله الرحمن الرحيم

وقل رب زدني علما

Acknowledgements

The completion of this study could not have been possible without advice of Prof. Caroline Edward Ayad my beloved thesis adviser. I would also like to thanks the Cardiologists in echocardiographic units at Elshaab hospital in Khartoum state for sitting on my panel and taking time to provide the final diagnosis of echocardiogram reports. Last but not the least I would like to thanks Dr. Mona Ahmed my co superviser in this study.

Dedication

I would like to dedicate my thesis

To my beloved parents, brothers and husband who were supported me always.

Abstract

The aims of this hospital-based study were to assess the 2D echocardiographic parameters in diabetic and hypertensive Sudanese patients and to correlate the findings with patients' age and body mass index (BMI)as well as to establish new equations to be used for prediction and early detection of changes helping for early diagnosis.

This study was carried out at Elshaab University Hospital- echocardiographic unit - Khartoum - Sudan, during the period extended from August 2016 to August 2019. 116 were diabetic and 101 were hypertensive and 100 subjects were considered as control group. Mean Ages was 44.5 ±11,1, 57.3 ±13.3, and 57.2± 13.1 and BMI was 24.7 ±8.5, 27.1 ±6.4, and 28.1 ±10.7, respectively for normal individuals, hypertensive patients, and diabetic patients. Pregnant ladies, patients with genetic disorders, patients with cardiac anomalies or any abnormalities were excluded. A well-designed data sheet was used ,the study variables were age , BMI and 2D echocardiographic parameters including Interventricular septal diameter (IVS), Left ventricular internal diameter in diastole(LVIDd), Left ventricular internal diameter in systole(LVIDs), Left ventricular posterior wall diameter in diastole(LVPWDd), Left ventricular posterior wall diameter in systole(LVPWDs),Left ventricular end diastolic volume (LVEDV), Left ventricular end systolic volume(LVESV), Left ventricular ejection fraction(LVEF), Left ventricular fraction shorten(LVFS), Left ventricular mass (LVM), Aortic root Diameter (AOD), Left Atrial diameters in systole (LADs), Left Atrial diameters in diastole (LADd), left atrial diameter to aortic diameter (LAD/AOD%). The data were statistically analyzed using IBM SPSS Statistics version 25. In addition to linear discrimination analysis. Machines used were: (XARIO200, SAMSUNG, MYLAB50XVISION CARDIOVASCULA) using high frequency applied Parasternal long and short-axis and apical window views (Two and four chambers) views.

In hypertensive patients results revealed that, the mean values of (LVPWDs) and the (LAD/AOD%) were increased with age (p-values =0.036 , 0.008), and the systolic blood pressure and (LVPWDd) were decreased with age (p-value= - 0.02 ,- 0.08). The increasing in (LVEF), (LVFS), (LVPWDs), and (AOD) (p-values = 0.013, 0.006, 0.015, and 0.002, respectively was associated with Age. However, the (LVPW) and (IVSD) were increased significantly with BMI (p-values = 0.015 and 0.021). There were significant associations between left ventricular volumes (LVED and LVES) with duration of hypertension (p-value= 0.000,0.000).In diabetic patients results showed an increasing in (LVIDs) and it was

significantly correlated with the increasing in BMI (p-value = -0.012).there was a correlation between blood sugar value and (AOD) (p-value = 0.026).Ejection fractionwas found to be declined in hypertensive and diabetic patients compared to normal values but remained within the normal range based on standard measurements, which should be greater than 55%.

Using a linear discriminates function, New equations substitutethe 2D echocardiography parameter resultsas normal, hypertensive, or diabetic by eloquent the patients age and height,

Normal = (Age × 0.34) + (Height × 0.71) + (EDV × -0.01) + (LVIDS × 4.88) + (ESV × 0.04) + (EF × .02) + (FS × 0.74) + (LVM × -0.01) -84.09.

Hypertensive = (Age × 0.48) + (Height × 0.75) + (EDV × -0.02) + (LVIDS × 7.87) + (ESV × 0.09) + (EF × 0.05) + (FS × 1.24) + (LVM × -0.04) -134.36

Diabetic = (Age × 0.41) + (Height × 0.75) + (EDV × 0.01) + (LVIDS × 5.35) + (ESV × 0.03) + (EF × 0.02) + (FS × 0.74) + (LVM × 0.01) -100.22.).

Equationswere recommended to be used to determine whether a patient was normal, hypertensive, or diabetic in addition to highlighting the impact of hypertension and diabetics on some key echocardiographic parameters related to Sudanese people'sof inimitable physical characteristics. These findings might help in detection of changes helping for early diagnosis.

المستخلص

هـ ف هـ ه الـ راسة إلي تق مـ غ ات تـ صـ القلـ ثـ ائـ ة الأعاد لـ الـ دان الـ ابـ ارتفاع ضغـ الـ م و مـ ضى الـ ور الـ ائج عـ الـ ضى ومـ شـ لة الـ كـ لـ إنـ اء معادلات جـ يـ ة لاسـ امها في الـ و الـ الـ ع الـ غ ات الـ ي تـ اع على الـ الـ .

أجـ هـ ه الـ راسة في مـ فى الـ ع الـ امعي – وحـ ة تـ صـ القلـ الـ م في الـ دان خلال الفـ ة الـ ة مـ أغـ 2016 إلى أغـ 2019. شـ لـ العـ ة 116 مـ اًا الـ و101 مـ اًا ارتفاع ضغـ الـ م واعـ 100 فـ د عة حاكـ ة لأشـ اص أصـ اء. ان مـ سـ الأعـ ار 44.5 ± 11.1 و57.3 ± 13.3 و 57.2 ± 13.1 و ان مـ شـ لة الـ 24.7 ± 8.5 و 27.1 ± 6.4 و 28.1 ± 10.7 للأفـ اد الـ ع ومـ ضى ارتفاع ضغـ الـ م ومـ ضى الـ على الـ الي. تـ اسـ عاد الـ ات الـ امـ والـ ضى الـ ي عاذ ن مـ اضـ ا ات وراثـ ة والـ ضى الـ ي عاذ ن مـ تـ هات في القلـ أو أ تـ هات أخـ . تـ اسـ ام ورقة بـ انات جـ ة الـ ، و اذ مـ غ ات الـ راسة هي العـ ومـ شـ لة الـ ومعاير تـ صـ القلـ ثـ ائـ ة الأعاد ا في ذلـ قـ الـ اجـ بـ الـ وقـ الـ الأ الـ اخلي في الانـ ا وقـ الـ الأ الـ اخلي في الانـ اض، قـ الـ ار الـ لفي للـ الأ في الانـ ا ، قـ الـ ار الـ لفي للـ الأ في الانـ اض، الـ الانـ ا ي لـ هاية الـ الأ والـ الانـ اضي الـ الأ ، نـ ة دفع الـ الأ والقـ ع الـ فع للـ الأ ، كـ لة الـ الأ ، قـ جـ ر الأبهـ ، قـ الأذيـ الأ في الانـ اض ، قـ الأذيـ الأ في الانـ ا ، قـ الأذيـ الأ إلى قـ الأبهـ . تـ تـ لـ الـ انات إحـ ائـ اً اسـ ام الـ مة الإحـ ائـ ة للعلـ م الاجـ ا ة الإصـ ار 25. الإضافة إلى الـ الـ ي. اذ الآلات الـ مة هي *:*أجهـ ة زور 200وسـ وما لاب 50اكـ فـ ، اسـ ام صـ در مـ لفة أخـ ت مـ خلال الـ ر وتـ الـ ر الـ القـ ي والـ ر القـ القـ ي وخلال القـ ة ذو الأرع غـ ف وخلال القـ ة ثـ ائـ ة الغـ ف والـ قة لات عالـ ة الـ دد.

أ هـ ت نـ ائج مـ ضى ارتفاع ضغـ الـ م زـ ادة مـ سـ قـ جـ ار الـ الا الـ لفي عـ الانـ اض وجـ ر الأبهـ مع تقـ م العـ (الـ االإحـ الـ ه هي*0.036*، 0.008) ، وانـ فاض ضغـ الـ م الانـ اضي وقـ جـ ار الـ الا الـ لفي عـ الانـ ا مع تقـ م العـ (الـ الإحـ الـ ه هي*0.02 –*،*0.08 –*). كاذ الـ ادة في الـ فع والقـ الـ ادث للـ الأ و قـ جـ ار الـ الأ الـ لفي عـ الانـ اض وجـ ر الأبهـ الاحـ الـ ة*0.013*و0.006و0.015و0.002 على الـ الي مـ تـ ة العـ . زاد قـ جـ ار الـ الا الـ لفي والـ ار بـ الـ معـ ا مع مـ شـ لة الـ (عـ الـ الاحـ الـ ة هي 0.015 و 0.021) ، وجـ ت ارتـ ا ات معـ ة بـ أحـ ام الـ الأ مع مـ ة ارتفاع ضغـ الـ م (عـ

ال الاحـ الـة = 0.000،0.000). أ هـ ت الـ ائج في مـ ضى الـ زادة في ق الـ الأ ع الانـ اض ووجـ أن هـ الـ ارتـا معـ مع مـ شد لة الـ (الـ ة الاحـ الـة = −0.012)، كـ لـ ارتـا بـ ة الـ في الـ م وقـ جـ ر الابهـ (الـ ة الاحـ الـة = 0.026). واهـ الـ ائج وهي انـ فاض القـ ع القـ ف للـ الأ لـ مـ ضى ارتفاع ضغـ الـ م ومـ ضى الـ مقارنة الـ الـ ة ولـ هـ لـا ضـ الـ اق الـ عي بـاءً على الـ اسات الـ اسة، والـي يـ غي أن تـ ن أكـ مـ 55٪.

اسـ ام الـ الـ ي، تـ إنـ اء معادلات جـ يـ ة تـ نـ ائج معايـ تـ صـ القلـ ثـ ائـة الأ عاد والعـ والـ ل ومـ خلال الـ ائج الـ أنه عي ام مـ اب ارتفاع ضغـ الـ م أو مـ ضى الـ وتـ :

الطبيعي = (العـ ×0.34) +(الارتفاع ×0.71)+ (0.04+ (4.88× القـ الـ اخلي للـ الأ في الانـ اض) +(0.01×حـ الـ الأ في الانـ ا) +(0.2 ×القـ ع انـ اض الـ الا) + القـ ع انـ اض الـ الأ ×0.74) +(كـ لة الـ الأ ×−0.01) −84.09

ارتفاع ضغط الدم=(العـ ×0.48) +(الارتفاع×0.75) +(حـ الـ الأ في الانـ ا ×−0.02) +(القـ الـ اخلي للـ الأ في الانـ اض×7.87) +(حـ الـ الا في الانـ اض ×0.09) +(القـ ع انـ اض الـ الا ×0.05) +(القـ ع انـ اض الـ الأ ×1.24) +(لة الـ الأ ×−0.04) −134.36.

السكري =(العـ ×0.41) +(الارتفاع×0.75) +(حـ الـ الأ في الانـ ا ×−0.01) +(القـ الـ اخلي للـ الأ في الانـ اض×5.35) +(حـ الـ الا في الانـ اض ×0.03) +(القـ ع انـ اض الـ الأ ×0.02) +(القـ ع انـ اض الـ الأ ×0.74) +(لة الـ الأ ×−0.01) −100.22.

تـ الـ صـ ة اسـ ام الـ عادلات لـ يـ ما إذا ان الـ ًا أو مـ ـًا ارتفاع ضغـ الـ م أو مـ ـًا ض الـ الإضافة إلى تـ ضـ ح تأثـ ارتفاع ضغـ الـ م ومـ ضى الـ على عـ معايـ تـ صـ القلـ الـ ئـ ة الـ علقة الـ داخـ الـ ي يـ عـ ن ائـ فـ ائـة خاصة بهـ . قـ تـ اع هـ ه الـ ائج في الـ ع الـ غـ ات الـ ي تـ اع في الـ .

List of Contents

List of Tables

List of Figures

Abbreviations

Abbreviation	Item of Abbreviation
AOD	Aortic diameter
APLAX	Apical long-axis
AP4CH	Apical 4-chamber
AP5CH view	AP5CH view
AR	Aortic Regurgitation
AV	Aortic valve
BART	Blue Away, Red Towards
BMI	Body max index
CF	Color Flow
CT	Computed tomography
CW	Continuous wave
DCM	Dilated Cardiomyopathy
DM	Diabetic Mellitus
EDV	End diastolic volume
ESV	End Systolic volume
HbA1c	Suboptimal glycemic control
HFNEF	Hypertrophic hearts failure with normal ejection fraction
HTN	Hypertension
IHD	Ischemic Heart disease
LA	Left atrium
LAD	Left atrial diameter
LV	Left ventricle
LVEDV	Left ventricular end diastolic volume
LVESV	Left ventricular end systolic volume
LVEF	Left ventricular ejection fraction
LVFS	Left ventricular fraction shorten
LVH	Left ventricular hypertrophy
LVIDd	Left ventricular internal diameter in diastole
LVIDs	Left ventricular internal diameter in systole
LVM	Left ventricular mass
LVOT	Left ventricular outflow tract

LVPWDd	Left ventricular posterior wall diameter in diastole
LVPWDs	Left ventricular posterior wall in systole
MHz	Mega hertz
M-Mode	Motion mode
MV	Mitral valve
MR	Mitral Regurgitation
NORRE	National organization reference ranges of echocardiography
PLAX	Parasternal long-axis
PSAX	parasternal short-axis
PW	Pulsed Wave
SC4CH	Sub-Costal 4-Chamber View
SD	Stander Deviation
SPECT	Positron emission computed tomography
SPSS	Statistically Package for the social sciences
STE	speckle tracking echocardiography
TDE	Tissue Doppler echocardiography
TDI	Tissue Doppler imaging
TVI	Tissue velocity imaging
TDE	Tissue Doppler echocardiography
2-D Echo	Two-Dimensional Echocardiography
2DSTE	Tw dimensional speckle tracking echocardiography
3-D Echo	Three dimintion echocardiography

CHAPTER ONE

CHAPTER ONE
INTRODUCTION

1. 1 Introduction:

Echocardiography is one of most commonly utilized imaging tool and has given experiences into pathophysiology and clinical implications in patients with hypertension and it can distinguish anatomical and useful changes effectively in a real-time, speedy, and reproducible way. Echocardiography is more sensitive for the detection of asymptomatic organ damage that can be used as a determinant of cardiovascular risk. So, it is important in the clinical management in selected hypertensive patients The pathophysiological mechanism includes insulin resistance and cascades of metabolic clutters and autonomic unsettling influences, which result in clinical phenotype of left ventricular hypertrophy (LVH), diastolic dysfunction, fibrosis, and restricted cardiac useful reserve. Aortic root dilatation and abnormal geometry of the outflow tract and sinuses play important pathophysiologic roles in aortic rout (AR)**.** (Health wise Staff - 2020).

There are four distinct patterns of left ventricular geometry in hypertension based on the relation between the cavity sizes and the wall thickness, therefore left ventricular geometry and function in hypertensive patients should be evaluate by echocardiography (Kim, Michael, et al – 1996),

Left ventricular ejection fraction is the percentage of blood that the ventricle ejects into the aorta during systole. Its value is estimated on the echocardiogram by mean of final systolic and diastolic volumes in the ventricles when independent associations of IGT with higher left ventricular (LV) relative wall thicknesses and LV mass/height (Schillaci G et al -2003).

Reduced systolic blood pressure had a lower LVEF .Heart failure is a pathophysiological state in which an abnormality in cardiac work results within the failure of the heart to pump blood beneath ordinary cardiac weights at a rate that meets the necessities of metabolizing tissues The left ventricle squeezes and pumps some of the blood in the ventricle out to body. A normal ejection fraction is more than 55%. This implies that 55% of the full blood within the left ventricle is pumped out with each pulse. There are many different problems that can cause heart failure with reduced ejection fraction such as High blood pressure by make heart works harder to pump against increased pressure, which weakens the muscle (Harkness,et al – 2020)

Effect of diabetic on LVH that the main finding of diabetic cardiomyopathy was LVH in the initial autopsy study (Rutter MK et al -2003**)**.

The left ventricular ejection fraction parameter is a valuable index to estimate the follow-up of patients lower left ventricular ejection fraction (LVEF) had same effect for Diabetic patients (Bregagnollo et al -2000) and (LVEF) and LV end-diastolic and end-systolic volumes (LVEDV and LVESV, respectively) are commonly used as clinical parameters reflecting global LV systolic performance or LV remodeling. **((**Kahan et al -2005) , (P. Gaudron et al -1993**))**

A normal ejection fraction is more than 55%. This means that 55% of the full blood within the left ventricle is pumped out with each pulse. There are many different problems that can cause heart failure with reduced ejection fraction such as Cardiomyopathy(A disease of the heart muscle) it effect that heart muscle is weakened, which affects its ability to pump properly and High blood pressure(Elevated pressure in arteries) by make heart works harder to pump against increased pressure, which weakens the muscle . **(**McGhie et al -1991).

One of the most common complications of high blood pressure is coronary artery disease. There is no atheroma in the pulmonary arteries unless there is pulmonary hypertension, implying that pressure plays a key role in the development of atherosclerotic lesions. Nonetheless, the significance of large vessel coronary heart disease as a complication of hypertension has most likely been overlooked. In the general population, mild pressure elevation is common .The predominant clinical issue in this large population is coronary heart disease, not stroke .Stroke and heart failure are the most common complications of extreme blood pressure rise Hypertension was found to be the most common cause of heart failure in the Framingham study, however this is due to inadequate detection and treatment of hypertension 30–50 years ago Hypertension has overtaken ischemic heart disease as the leading cause of death in the United States As a cause of heart failure, hypertension is currently second only to ischemic heart disease.The two illnesses, however, frequently coexist.High blood pressure causes beneficial compensatory hypertrophy at first, but subsequently decompensating leads to heart failure.This decompensating could potentially be caused by a myocardial infarction.Changes in the structure .Hypertension is characterized by an increase in left ventricular mass.Although the number of cardiac myocyte cells does not grow, there is cell hypertrophy.There is also a lot of interstitial alteration and fibroblast growth.Although myocyte make up 70% of the typical heart mass, they only make up 25% of the cell content.Small vessel structural alterations are similar to those reported in other tissues in response to pressure elevation, with increased wall thickness and relative reduction in diameter. Small vessel structural changes in response to pressure elevation are similar to those reported in other tissues, with increased wall thickness and relative lumen reduction.The hemodynamics of coronary arteries and smaller arterioles, on the other hand, differ from those of other organs.Although flow is greatest during diastole, the pressure curve of the epicardial coronary arteries follows that of the proximal aorta, with which they are connected.Extrinsic pressure is exerted on the smaller intracardiac arteries by contracting cardiac muscle, feeding pressure, and pressure within the ventricular cavity.A growing mass of myocardium, made up of bigger cells with higher collagen deposition around them, necessitates more blood supply, resulting in relative ischemia.When the epicardial veins get obstructed during exercise, it may indicate ischaemia.When the epicardial arteries do not narrow during exercise, it may indicate ischemia.Myocardial failure develops as a result of compensatory hypertrophy, with increased subendocardial ischemia and fibrosis.The constriction of the major epicardial arteries causes further ischemia.Dilatation of the smaller arterioles distal to the lesion usually compensates for stenosis of less than 70%.The flow reserve is reduced when the small distal arteries are hypertrophied and subjected to higher extrinsic pressure from hypertrophied myocardial, as well as rising ventricular pressure.At lower workloads, ischemia develops.In an already impaired vulnerable hypertrophied heart, occlusion of a major artery may further damage heart muscle and induce overt failure.Several hormonal and neurogenic variables have been suggested as possible contributors to these alterations.The reduction in morbidity and mortality is a significant benefit. When the epicardial arteries do not narrow during exercise, it may indicate ischemia.Myocardial failure develops as a result of compensatory hypertrophy, with increased subendocardial ischemia and fibrosis.The constriction of the major epicardial arteries causes further ischemia.Dilatation of the smaller arterioles distal to the lesion usually compensates for stenosis of less than 70%.The flow reserve is reduced when the small distal arteries are hypertrophied and subjected to higher extrinsic pressure from hypertrophied myocardial, as well as rising ventricular pressure.At lower workloads, ischemia develops.In an already impaired vulnerable hypertrophied heart, occlusion of a major artery may further damage heart muscle and induce overt failure.Several hormonal and neurogenic variables have been suggested as possible contributors to these alterations.The reduction in morbidity and mortality is a significant benefit. Hypertrophic cardiomyopathy might cause confusion, despite the fact that other distinguishing signs should be visible on echocardiogram.The concentrically hypertrophied ventricle dilates over time, resulting in so-called (confusingly) eccentric hypertrophy.Changes in haemodynamics. Increased heart rate and stroke volume have been recorded in young persons with established hypertension who have normal peripheral resistance.Increased peripheral resistance (from smaller resistance vessels) and loss of compliance (increased stiffness) of big arteries are associated with an increase in mean and pulse pressure, primarily due to systolic elevation .Endothelial dysfunction contributes to flow regulation by preventing the coronary endothelium from producing enough nitric oxide.The reserve of the coronary arteries declines.Compliance of myocardium (ventricular distensibility).(BERKIN et al -2001).

Inflammation, autoimmunity, and metabolic stress are all influenced by genetic and environmental risk factors.These conditions alter -cell mass and/or function, causing insulin levels to become insufficient to respond to insulin demands, resulting in hyperglycemia levels high enough to diagnose diabetes.Genetic and environmental risk factors, as well as gene–environment interactions, can have a direct impact on -cell mass and/or function in some cases.Chronic high blood glucose levels, regardless of the pathogenesis of diabetes, are linked to micro vascular and macro vascular problems, which increase morbidity and death in diabetics.This paradigm views -cell death and/or malfunction as a required component of all diabetes types.(Skyler et al – 2017)

The Normal Values of Echocardiographic Parameters in Relation to Age in a Healthy Japanese Population study (PAULO ROBERTO et al -2002) found that normal values of echocardiographic measurements were reported for the first time in a large Japanese population; several systolic and diastolic parameters varied with age.These findings give critical reference values that can be used in both ordinary clinical practice and clinical trials.Unfortunately, there is no specific distribution of Echocardiographic values, particularly Ejection Fraction, for diagnosing the early stages of various diseases that impact the heart, which is one of the body's critical organs.During hypertension and diabetes as chronic diseases,

1.2 The Problem of study:

There is a slight hesitancy in taking definitive measurements of echocardiographic parameter distributions mainly left ventricular fraction .This study will aid in the early detection of any changes in Echocardiographic parameters from normal range of percentages for hypertensive and diabetic patients using Echo cardiography as a simple and noninvasive procedure , which may lead to heart complications and eventually cardiac failure by established equations which were for each group which will applied with the cardiologist to identify if the patient were normal, hypertensive or diabetic by having the value of the some variables and substitute them in equations; so were helping in their early diagnosis using linear discriminant functions.

1.3 Study Objectives:

1.3.1 General Objective:

The objective of this study was assessment of hypertensive and diabetic patients echocardiographic parameters compared with normal subjects for Sudanese in order to established mean values of them, correlate them between all groups and demographic characteristics include age and body max index in order to detects their effects on them and identify if the patient were normal, hypertensive or diabetic by having the value of the some variables and substitute them in equations so were helping in their early diagnosis by 2D echocardiography .

1.3.2 Specific objectives:

To find out the mean values of a Body size characteristics include age and body max index and echocardiographic parameters for normal subjects, hypertensive and diabetic patients

To find out Association between all parameters of study with body characteristics include (Age and BMI) for all groups (normal subjects, hypertensive and diabetic patients).

To find out the Association of the mean values of all echocardiographic parameters for hypertensive and diabetic patients compared with normal subjects.

To Compare left ventricular dimensions and mass for normal subjects and hypertensive and diabetic patients

To find out left ventricular volumes and Ejection fraction of hypertensive and diabetic patients compared with normal values

To correlate between the Aorta and left atrium diameters for all groups (normal subjects, hypertensive and diabetic patients)

To established equations which were for each group which will applied with the cardiologist to identify if the patient were normal, hypertensive or diabetic by having the value of the some variables and substitute them in equations; so were helping in their early diagnosis using linear discriminant functions.

1.4 Overview of the study:

This study consist of five chapters with chapter one is an introduction which include introduction about the topic ,the problem of study, objectives of the study and over view of study ,chapter two concern with the theoretical background and previous studies, chapter three about material and methods ,chapter four include the results of analysis and chapter five include discussion, conclusion and Recommendations

CHAPTER TWO

Chapter Two

Theoretical Background and Previous Studies

2.1 Theoretical Background:

2.1.1 Anatomy of normal heart:

Heart has two upper and two lower chambers. The upper chambers, the right and left atria, receive incoming blood. The lower chambers, the more muscular right and left ventricles, pump blood out of the heart. The heart valves, which keep blood flowing in the right direction, are gates at the chamber openings. (Betts, J. Gordon et al -2014)

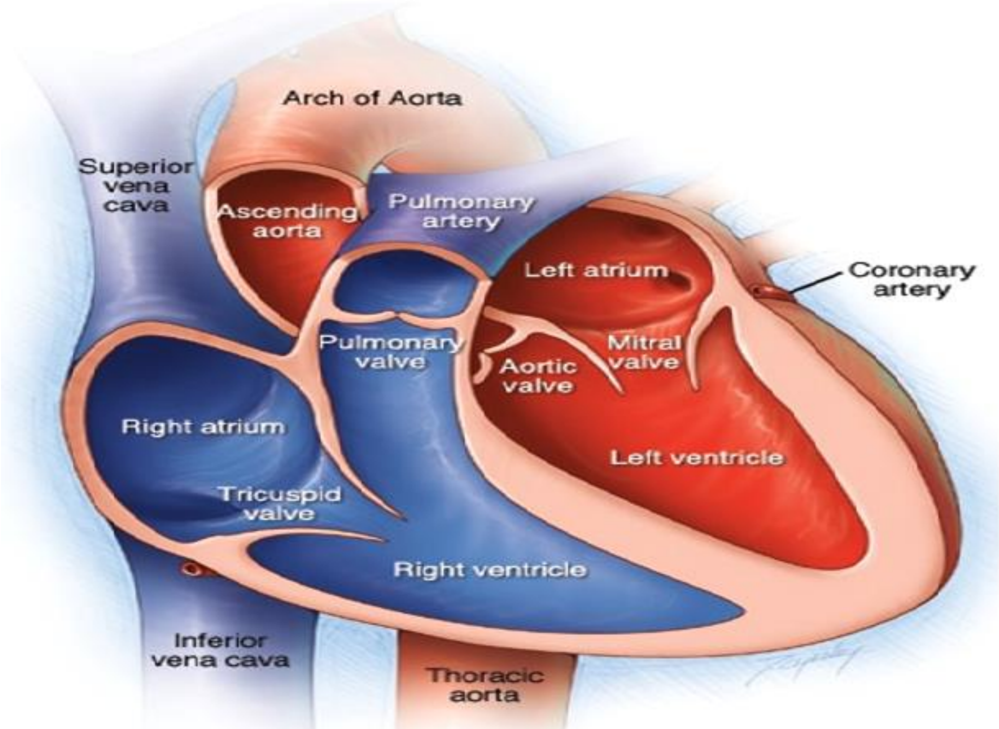


Figure 2.1: Show Chambers and valves of the heart [Anderson, RM-2012**]**

2.1.2 The heart functions:

As a pump and acts as a double pump in the cardiovascular system to provide a continuous circulation of blood throughout the body. This circulation includes the systemic circulation and the pulmonary circulation. Both circuits transport blood but they can also be seen in terms of the gases they carry. The pulmonary circulation collects oxygen from the lungs and delivers carbon dioxide for exhalation. The systemic circuit transports oxygen to the body and returns relatively deoxygenated blood and carbon dioxide to the pulmonary circuit Blood flows through the heart in one direction, from the atria to the ventricles, and out through the pulmonary artery into the pulmonary circulation, and the aorta into the systemic circulation. The pulmonary artery (also trunk) branches into the left and right pulmonary arteries to supply each lung. Blood is prevented from flowing backwards (regurgitation) by the tricuspid, bicuspid, aortic, and pulmonary valves. The function of the right heart right atrium, from the body via the superior vena cava , blood, in the inferior vena cava and from the coronary sinus and pump it, through the artery in pulmonary circulation where carbon dioxide can be exchanged for oxygen in the lungs. This happens through the passive process of diffusion. In the left atrium via the pulmonary vein. It is then pumped into the left ventricle through the bicuspid valve and into the aorta for systemic circulation. Eventually in the systemic capillaries exchange with the tissue fluid and cells of the body occurs; oxygen and nutrients are supplied to the cells for their metabolism and exchanged for carbon dioxide and waste products systemic capillaries to be used by the cells in their metabolic processes, and carbon dioxide and waste products will enter the blood. The ventricles are stronger and thicker than the atriums, and the muscle wall surrounding the left ventricle is fatty than the wall surrounding the right ventricle due to the higher force needed to pump the blood through the systemic circulation uninterrupted venous flow to the heart, interrupted venous flow that would otherwise occur at each ventricular systole. Right heart, is to collect de-oxygenated right atrium, from the body via the superior vena cava , inferior vena cava and from the coronary sinus and pump it, through the tricuspid valve, via , through the semilunar pulmonary valve pulmonary artery in the pulmonary circulation where carbon dioxide can for oxygen in the lungs. This happens through the passive. In the left heart oxygenated blood is returned to the left atrium via the pulmonary vein. It is then pumped into the left ventricle through the bicuspid valve and into the aorta for systemic circulation. Eventually in the systemic capillaries exchange with the and cells of the body occurs; oxygen and nutrients are supplied to the cells for their metabolism and exchanged for carbon dioxide and waste products In this case, oxygen and nutrients exit the systemic capillaries to be used by the cells in their metabolic processes, and carbon dioxide and waste products will enter the blood. The ventricles are stronger and thicker than the atriums, and the muscle wall surrounding the left ventricle is fatty than the wall surrounding the right ventricle due to the higher force needed to pump the blood through systemic circulation. Atria facilitate circulation primarily by allowing uninterrupted venous flow to the heart, preventing the inertia **. [**Anderson et al -2012**]**

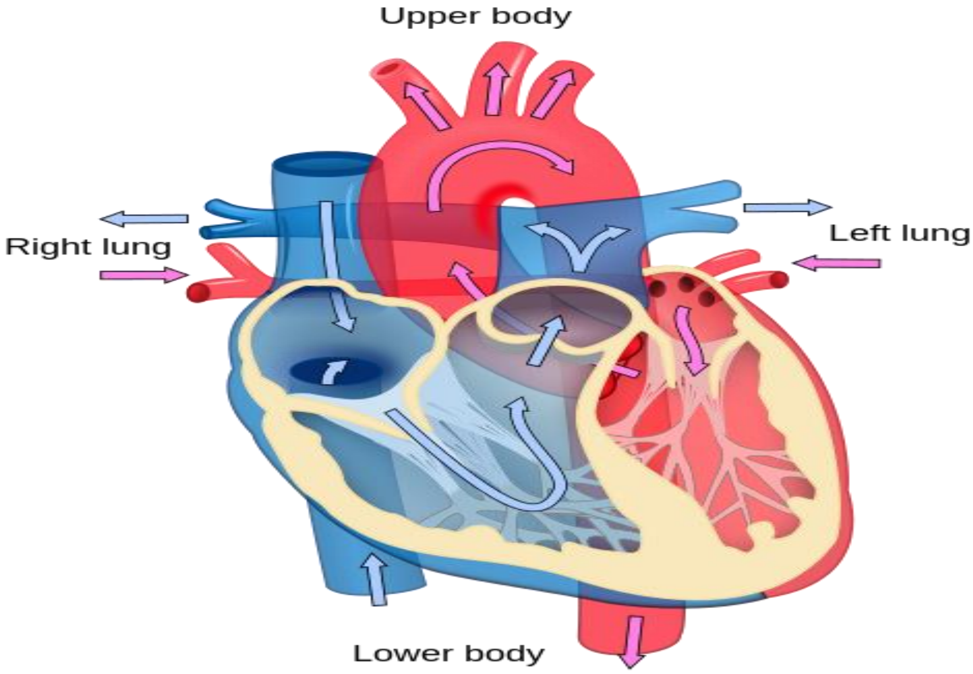


Figure 2.2: show Blood flow diagram of the human heart. Blue components indicate deoxygenated blood pathways and red components indicate oxygenated pathways **[**Anderson, RM-2012**]**

2.1.3 The common cardiac complications:

2.1.3.1 Ischemic Heart disease (IHD):

Also known as coronary heart disease occurs when the blood flow to the heart muscle is reduced because of a partial or complete blockage of the arteries supplying it with blood. If we consider the coronary arteries to be a system of tubes, as they progressively become blocked it means that the liquid flowing through them, in this case blood, does not reach its destination, the heart, correctly.

2.1.3.2 Cardiomyopathy:

Is a chronic disorder that occurs when the heart weakens and can no longer pump sufficient amounts of blood Although there are several types of cardiomyopathy, the most common form is dilated cardiomyopathy, in which the heart enlarges to compensate for its inability to pump blood effectively. By dilating, or enlarging, the heart holds and pumps a higher volume of blood. In addition, the enlarged heart might temporarily increase the force of each heartbeat or elevate the heart rate (number of heart beats per minute) to continue pumping an increased amount of blood. Because the body compensates for dilated cardiomyopathy, the disease may have no symptoms initially. As the condition worsens, the heart may perform normally when a person is resting but may cause symptoms during periods of exercise or psychological stress. Dilated cardiomyopathy is a common cause of congestive heart failure, the Symptoms of congestive heart failure include **,** Dyspnea (shortness of breath)**,**Orthopnea (shortness of breath while lying down)**,**Edema (swelling of feet, ankles, legs, or abdomen)**,**Palpitations (awareness of one's own heartbeat);Lung congestion & Fatigue. Although most cases of dilated cardiomyopathy result from unknown causes, known causes include : Myocarditis (inflammation of the heart's walls),Ischemia (lack of oxygen in the heart),a previous heart attack, Severe coronary artery disease, Heart valve disease, Chronic alcohol abuse, Chemotherapy drugs, High blood pressure, Arrhythmias (disturbances of the heart's rhythm or rate) &Autoimmune illnesses (such as lupus or rheumatoid arthritis).A physician diagnoses dilated cardiomyopathy after a physical examination. He or she may check for shortness of breath during exercise and weakness. The physician may also hear rales, or wet crackles, through a stethoscope, indicating fluid in the lungs. To confirm the diagnosis, the physician may order tests, including: Blood tests, Chest x-ray, Echocardiogram, Electrocardiography (ECG) & Cardiac catheterization and angiography. A physician may recommend that the patient first make lifestyle changes, including: Rest adequately, Control weight, Stop smoking, Consume alcohol moderately, Exercise moderately , Limit sodium in the diet and may also prescribe medications to control the symptoms of heart failure that can accompany dilated cardiomyopathy, including: Angiotensin-converting enzyme (ACE) inhibitors Anticoagulants**,** Beta-blockers**,** Calcium channel blockers**,** Digitalis**,** Diuretics**,** Nitrates &Vasodilators**.** Patients with persistent, severe dilated cardiomyopathy despite medical therapy are candidates for placement of an implantable cardiac defibrillator (ICD) to prevent sudden cardiac death. Patients with severe congestive heart failure that is associated with dilated cardiomyopathy may require a heart transplant. **[**Opens tax, Heart Anatomy & physiology -2020**]**

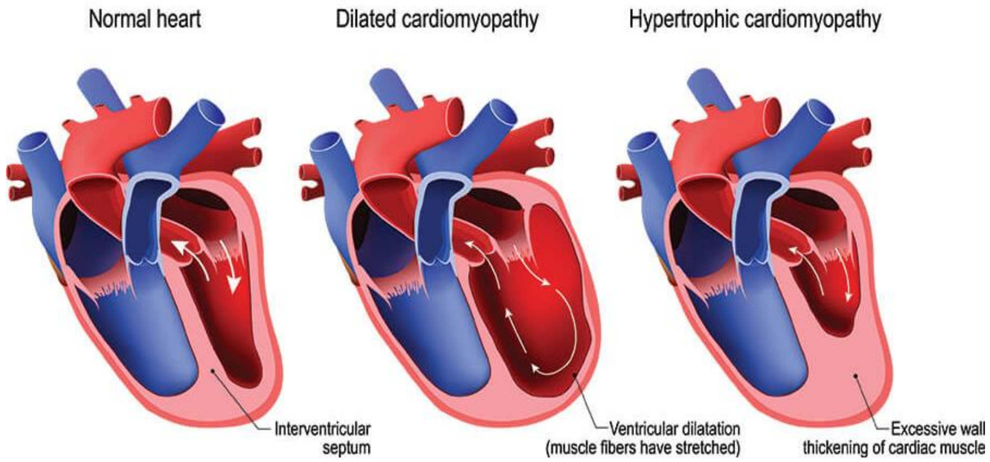


Figure 2.3 show: types of Cardiomyopathy. [Opens tax, Heart Anatomy & physiology -2020**]**

2.1.4 Echocardiography:

An echo is a test that uses sound waves to produce live images of the heart. The image called an echocardiogram. This test is noninvasive procedure which allows the doctor to monitor how the heart and its valves are functioning. It includes different types of techniques such as 2D & 3D transthoracic echocardiogram, Stress Echocardiogram, Fetal, 3D speckle tracking and

Doppler tissue echocardiography. Echocardiography can be used to detect whether the heart muscle is moving normally and how much blood the heart is pumping out with each beat. This procedure can also detect abnormalities in the heart's structure, such as defective heart valves, birth defects (such as holes in the walls between the heart's chambers), and enlargement of the heart's walls or chambers, as occurs in people with high blood pressure, heart failure, or impairment of the heart's muscular walls (cardiomyopathy). **[** Jae-Hwan Lee-2015 **]**

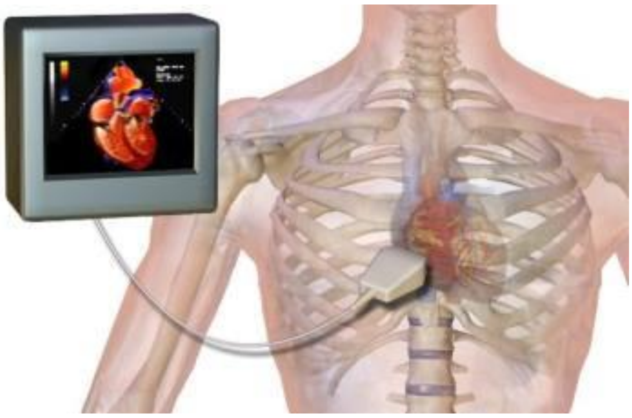


Figure 2.4: Shows Echocardiogram (Illustration) [Samanthi-2018]

Echocardiography can also be used to detect pericardial effusion, in which fluid accumulates between the two layers of the sac that envelops the heart (pericardium), and constrictive pericarditis, in which scar tissue forms throughout the pericardium. It also detects dissection of the aorta, a tearing within the layers of the wall of the aorta.

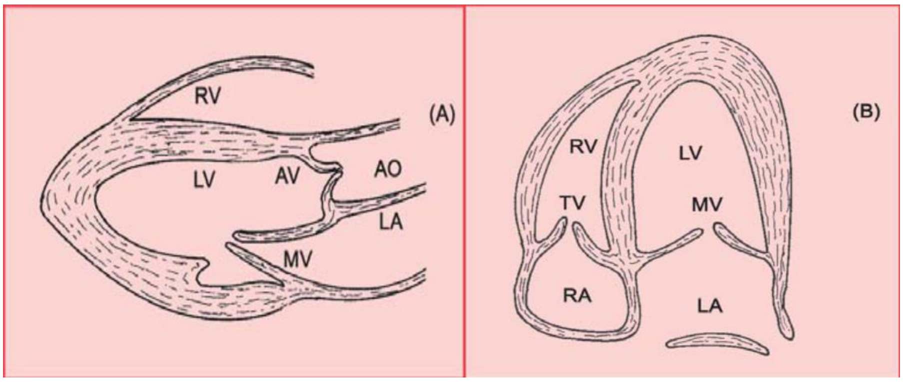
Figure 2.5: show Echocardiography examination [Thomas casino et al -- 2021]

2.1.4.1 Types of Echocardiography:

The Modalities of Echo Include the following modalities of echo are used clinically conventional echo involved Two-dimensional echo (2-D echo) & Motion-mode echo (M-mode echo). Doppler echo involved Continuous wave (CW) Doppler**,** Pulsed wave (PW) Doppler & Color flow (CF) Mapping**.** Different echo modalities are not mutually exclusive but complement each other and are often used together. All of them follow the same principle of ultrasound but differ with respect to the manner in which reflected sound waves are collected and analyzed.

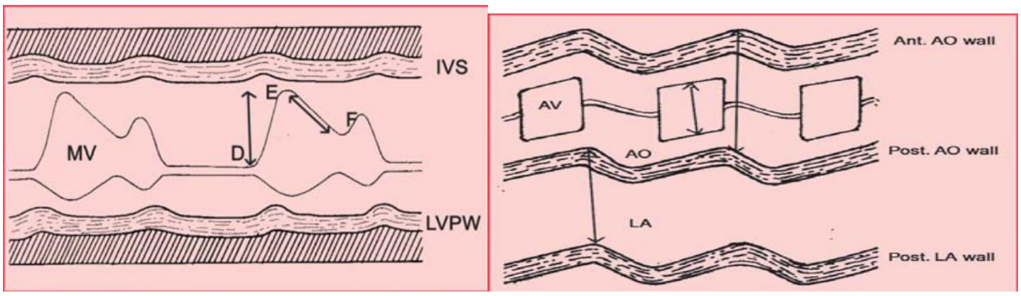
2.1.4.1.1 Conventional Echo:

Include Two-Dimensional Echo (2-D Echo) when Ultrasound reflected from a tissue interface distorts the piezoelectric crystal and generates an electric signal. The electric signal produces a dot (spot) on the display screen. The density and position of the dot (spot) is determined by nature and depth of the tissue studied. To create a 2-D image, the ultrasound beam has to be swept across the area of interest. Ultrasound is transmitted along several (about 90-120) scan lines over a wide (about 90°) arc and many (about 20-30) times per second. The combination of reflected ultrasound signals builds up an image on the display screen. Production of images in quick succession creates a 'real-time' image of moving structures. Any image frame can be frozen, studied on the screen or printed out on thermal paper or X-ray film. 2-D echo is useful to evaluate the anatomy of the heart and the relationship between different structures. Intracardiac masses and extra cardiac pericardial abnormalities can be noted. The motion of the walls of ventricles and cusps of valves is visualized. Thickness of ventricular walls and dimensions of chambers can be measured and stroke volume, ejection fraction and cardiac output can be calculated. 2-D image is also used to place the 'cursor line' for M-mode echo and to position the sample volume' for Doppler echo. Motion-Mode Echo (M-mode Echo), to create a M-mode image, ultrasound is transmitted and received along only one scan line. This is obtained by applying a cursor line to the 2-D image and aligning it perpendicularly to the structure being studied. For this, the transducer is angulated till the cursor line is perpendicular to the image. Since only one scan line is imaged, M-mode echo provides substantially greater sensitivity than 2-Decho for recording moving structures. It produces a graph of depth and strength of reflection against time. Motion and thickness of ventricular walls, changing size of cardiac chambers and opening and closure of valves is better displayed. Simultaneous ECG recording facilitates accurate timing of cardiac events. Similarly, the flow pattern on color flow. **[** Jae-Hwan Lee-2015**]**



A B

Fig 2.6: show Two-dimensional echo (2-D echo):A. Parasternal long-axis (PLAX) view. Apical 4-chamber (AP4CH) view. Continuous Wave (CW) Doppler: CW Doppler transmits and receives ultrasound Continuously. It can measure high velocities [Williamsburg-2021**]**



A B

Fig. 2.7: show Motion-mode echo (M-mode echo):A. Mitral valve (MV) level. B Aortic valve (AV) level [Williamsburg-2021**]**

Figure 2.8: show image of Two-Dimensional Echocardiography [Jae-Hwan Lee-2015**]**

2.1.4.1.2 Doppler ultrasonography:

Shows the direction and velocity of blood flow and thus can detect turbulent flow due to narrowing or blockage of blood vessels. Color Doppler ultrasonography shows the different directions of blood flow in different colors. Doppler ultrasonography and color Doppler ultrasonography are commonly used to help diagnose disorders affecting the heart and the arteries and veins in the trunk, legs, and arms. Because these procedures can show the direction and rate of blood flow in the chambers and blood vessels of the heart, they enable doctors to evaluate the structure and function of these parts. For example, doctors can determine if the heart valves open and close properly, if and how much they leak when closed, and if blood flows normally. Abnormal connections between an artery and a vein or between heart chambers can also be detected. Any upper limit and is not hindered by the phenomenon of aliasing. However, CW Doppler cannot precisely localize a signal which may originate anywhere along the length or width of the ultrasound beam (Fig. 2.).This Doppler modality is used for rapid scanning of the heart in search of high velocity signals and abnormal flow patterns. Since the Doppler frequency shift is in the audible range, the audio signal is used to angulate and rotate the transducer in order to obtain the best visual display. CW Doppler display forms the basis for placement of “sample volume” to obtain PW Doppler spectral tracing's Doppler is used for grading the severity of Valvular stenosis and assessing the degree of Valvular regurgitation. Intracardiac left-to-right shunt such as through a ventricular sepal defect can be quantified. Using CW Doppler signal of tricuspid valve inflow, the pulmonary arterial pressure can be estimated. **[** Williamsburg-2021**]**

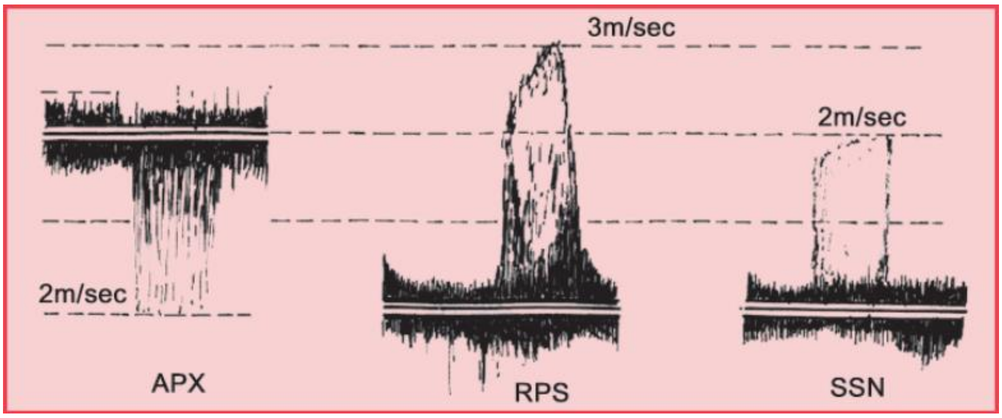


Fig.2.9: Show Continuous wave (CW) Doppler signal from a stenosis aortic valve. Maximum velocity 3 m/sec. **[** Williamsburg-2021**]**

Pulsed Wave (PW) Doppler**:** PW Doppler transmits ultrasound in pulses and waits to receive the returning ultrasound after each pulse. Because of the time delay in receiving the reflected signal, which limits the rate of sampling, it cannot detect high velocities. At velocities exceeding 2 m/sec., there occurs a reversal of flow known as the phenomenon of aliasing. However, PW Doppler provides better quality spectral tracings than CW Doppler, which are more useful for calculations (Fig. 2.4).PW Doppler modality is used to localize velocity signals and abnormal flow patterns picked up by CW Doppler and color flow mapping, respectively. The mitral valve inflow signal is used for the assessment of left ventricular diastolic dysfunction. The aortic valve outflow signal is used for the calculation of stroke volume and cardiac output.

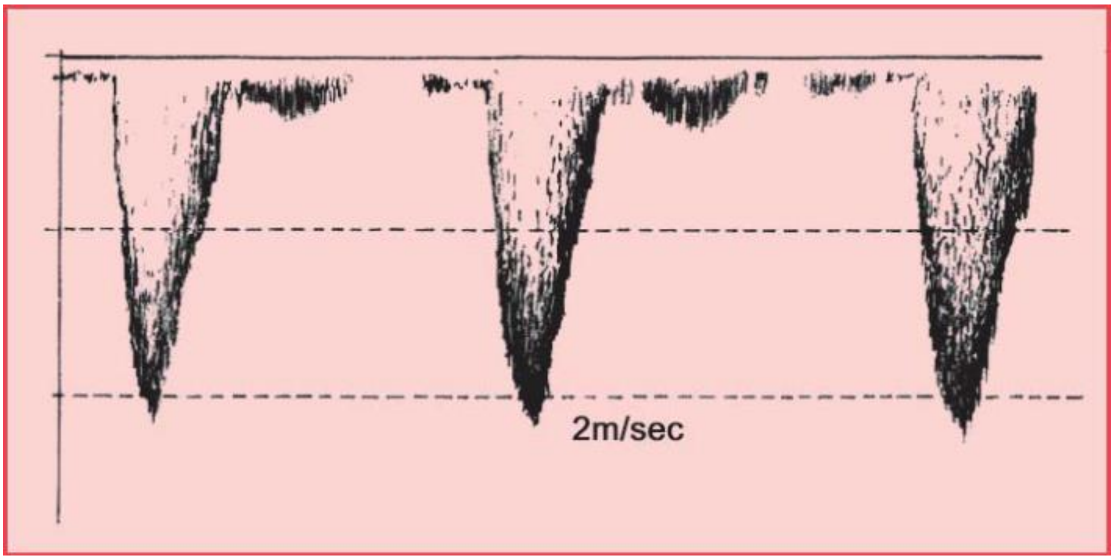


Fig. 2.10: Show Pulsed wave (PW) Doppler signal from a stenosis aortic valve. Maximum velocity 2 m/sec [Williamsburg-2021**]**

Color Flow (CF) Mapping: Color flow mapping is an automated 2-D version of PW Doppler. It calculates blood flow velocity and direction at multiple points along a scan line. A number of scan lines are used during CF mapping. The velocity and direction information is color-encoded and superimposed on the 2-D image (Fig. 12).

By convention, velocities towards the transducer are displayed in shades of red and those away in shades of blue. This is known as the BART rule: Blue Away, Red Towards. Higher velocities are shown in progressively lighter color shades, or as changes of hue. Low velocities are dull and dark while high velocities are bright and light. Above a threshold velocity, a reversal of color occurs which is the counterpart of aliasing on PW Doppler. Areas of high turbulence or regions of flow acceleration are depicted in green. An inadequate echo window, malalignment of the transducer, a weak flow signal and low gain setting are some of the causes of a missed (false negative) color flow map. This echo modality is used to screen for high velocity signals and abnormal flow patterns from regurgitant valves and left-to-right shunts. Areas of turbulence can be precisely localized and the Doppler beam can be aligned accordingly. Color flow mapping also provides quantitative information. The area of a color flow jet corresponds to the degree of Valvular regurgitation and the width of the jet across a shunt approximates the size of the sepal defect. **[** Williamsburg-2021**]**

2.1.4.1.3 The Echo Windows:

Conventional echocardiography is performed from the anterior chest wall (precordium) and is known as transthoracic echo. Echocardiography can also be performed from the esophagus which is known as Transesophageal echo. For transthoracic echo, the subject is asked to lie in the semi recumbent position on his or her left side with the head elevated. The left arm is tucked under the head and the right arm lies along the right side of the body. This position enlarges the 'windows' through Which echocardiography can be performed while most of the heart is masked from the ultrasound beam by ribs and lungs? Better images are obtained during expiration when there is least 'air tissue' interface. Ultrasound is transmitted from a transducer or probe having a frequency of 2.5 to 3.5 MHz for echo in adults. This frequency is used to study deep seated structures because of better penetration. A transducer frequency of 5.0 MHz is suitable for pediatric echo since the heart is more superficial in children. Ultrasound jelly is applied on the transducer and it is placed on the chest at the site of an "echo window". Most of the time, the left parasternal and apical windows are routinely used. The transducer has a line or dot to help orient it into the correct position for obtaining different echo views. The transducer is variably positioned for different echo images, angulated to bring into focus the structure of interest and rotated to fine-tune the image. Standard positions on the chest wall are used for placement of the transducer which are called "echo windows" (Fig. 13). These are: Left parasternal, Apical, Sub-costal, Right parasternal& Suprasternal.

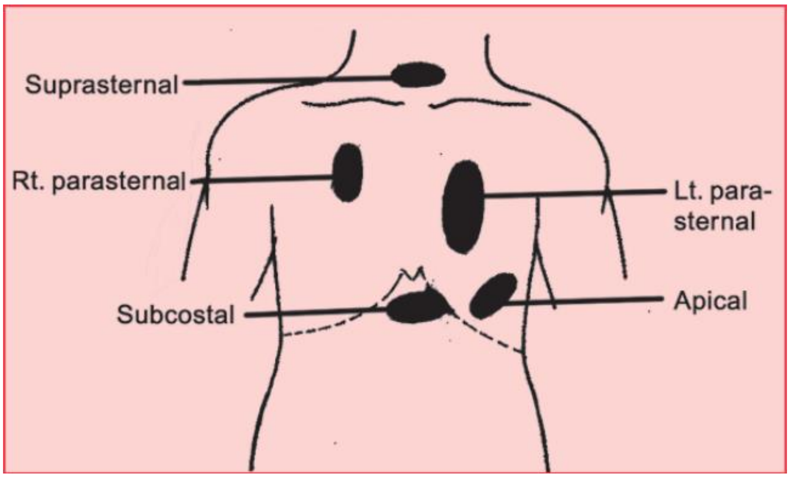


Fig.2.11: show The various echo “windows [Williamsburg-2021**]**

Standard transducer positions are important for two main reasons: Penetration by ultrasound is good without much masking of image or absorption of ultrasound by Ribs and lungs & Standardized echo images can be compared with Studies performed by different observers or on Different occasions. In transthoracic echocardiography (the most common type), the transducer is handheld and placed on the chest over the heart. The examiner places gel on the chest under the transducer to help transmit the sound waves into the chest. The transducer is connected to a computer that displays an image on a monitor and stores the image digitally. By varying the placement and angle of the transducer, doctors can view the heart and nearby major blood vessels from various angles and thus get an accurate picture of heart structure and function. During various portions of the examination, people will need to hold their breath for about 10 seconds to ensure clear images are obtained. Transthoracic echocardiography is painless and takes 20 to 30 minutes. Sometimes doctors use a portable ultrasonography machine at the person's bedside in order to determine specific information quickly. Often portable technology is used when people are receiving care in an emergency department or intensive care unit.

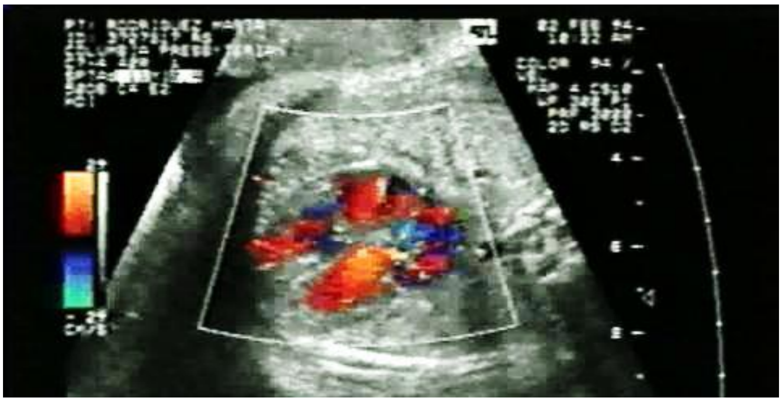


Figure 2.12: Show Transthoracic Echocardiography[Jae-Hwan Lee-2015**]**

Doctors use ultrasound to visualize the heart’s size, shape and movement on a screen. The technique does not provide a view of the arteries, so we cannot tell whether or not they are obstructed, but it does provide very important information regarding heart function. If the patient has suffered a large infarction the damaged area of the heart will move abnormally. Hence ultrasound can be used to estimate the size of an infarction and its repercussions on the heart muscle. It also helps us to determine whether the valves are working correctly or if there are any other complications secondary to the heart attack.

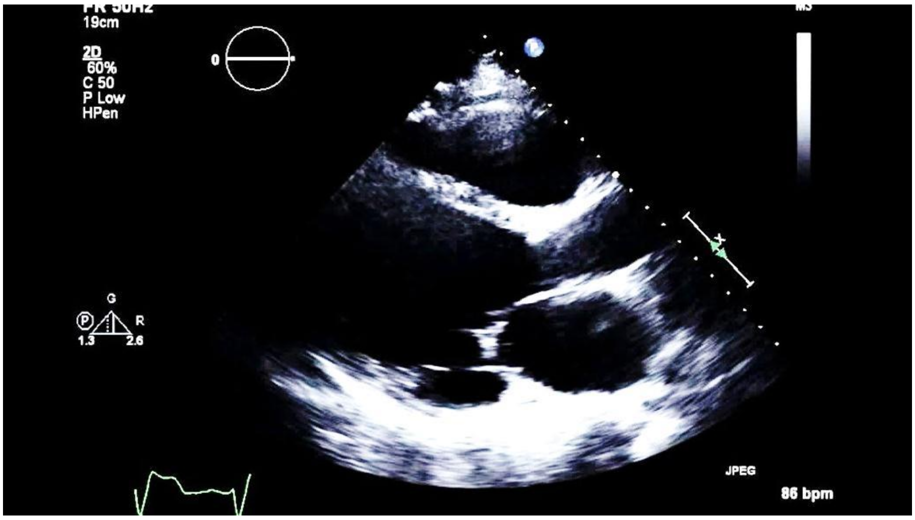


Figure 2.13: showed Ischemic Cardiomyopathy 2D Echocardiogram [Discovered Echo-2017**]**

Although the echocardiographic examination is usually recommended as a second-line study in the evaluation of hypertensive patients, it is one of most commonly used imaging modality and has given insights into pathophysiology and clinical implications in patients with hypertension. It can detect anatomical and functional changes easily in a real-time, quick, and reproducible manner. Echocardiography is more sensitive for the detection of asymptomatic organ damage that can be used as a determinant of cardiovascular risk. So, it is important in the clinical management in selected hypertensive patients. Because echocardiography can detect cardiac morphologic and hemodynamic change caused by systemic arterial hypertension, echocardiography is a powerful tool for the evaluation of target organ damage, which is essential for the evaluation of cardiovascular risk. Although echocardiography is not an essential first-line imaging study, echocardiography is an excellent tool for the assessment of future cardiovascular risks. Because of its non-invasiveness and easy accessibility, it is also a widely and most commonly used imaging modality in the cardiology practice. However, conventional echocardiography has many pitfalls in the interpretation of several echocardiographic parameters. To overcome this limitation, physicians should be aware of the pitfalls of conventional echocardiographic parameters. Second, doctors should analyze and interpret echocardiographic findings in conjunction with other findings from physical examination and routine examinations. Third, it is worthwhile for medical practitioners to learn other newer echocardiographc modalities. Aside from conventional echocardiographic modalities, newer echocardiographic methods including tissue Doppler imaging, strain echocardiography, or three-dimensional echocardiography also have been introduced to evaluate hypertensive patients providing valuable information about the extent of cardiac damages thus helping us to give better treatment. In addition Early detection of diabetic heart disease is important for the timely interventions resulting in the prevention for the future development of heart failure. Subclinical left ventricular (LV) systolic dysfunction may be identified by a reduction in longitudinal function, which can be assessed using 2D speckle tracking echocardiography (STE). In addition to diastolic dysfunction, subclinical LV longitudinal dysfunction is preferentially and frequently observed in asymptomatic diabetes patients with normal LVEF. 2DSTE has the potential for detecting subclinical LV systolic dysfunction and might provide useful information of the risk stratification in an asymptomatic diabetic population. **[** Discovered Echo-2017**]**

Transthoracic echo may be technically difficult to perform in the following situations: Severe morbid obesity mapping can be timed in relation to the cardiac cycle, Chest wall deformity & Emphysema or lung fibrosis Parasternal Long-Axis View (PLAX View)Transducer position: left sternal edge ; 2nd - 4th i-c space Marker dot direction: points towards right shoulder. [Williamsburg-2021]

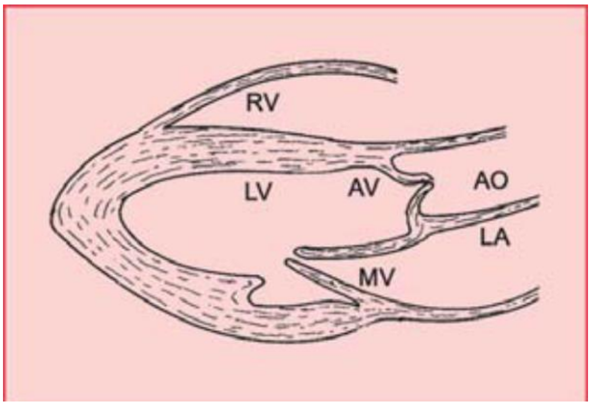


Fig 2.14: Show the parasternal long-axis(PLAX) view Structures seen: ascending aorta aortic valve ,left atrium ,mitral valve, left ventricle ,IV septum,LVposterior wall, right ventricle[Williamsburg-2021**]**

2.1.4.2. Stages for subsequent echo views:

2.1.4.2.1 Parasternal Short-Axis Views:

Transducer position: left sternal edge; 2nd – 4th i-c space Marker dot direction: points towards left shoulder (90° clockwise from PLAX view) By tilting the transducer on an axis between the left hip and right shoulder, short-axis views are obtained at different levels, from the aorta to the LV apex. This angulation of the transducer from the base to apex the heart for short-axis views is known as "bread loafing Short axis sections are taken at the following levels: pulmonary artery level, aortic valve level, mitral valve level, papillary muscle level and ventricular level

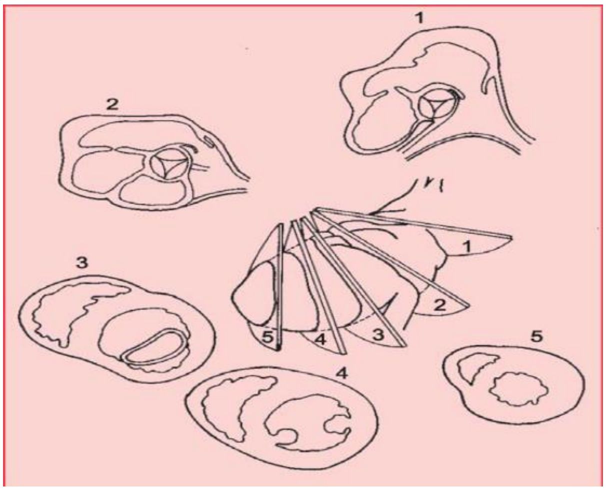


Fig.2.15: The parasternal short-axis (PSAX) views[Williamsburg-2021**]**

2.1.4.2.2 Apical 4-Chamber View:

Transducer position: apex of the heart Marker dot direction: points towards left shoulder (AP4CH View) (Fig. 18)

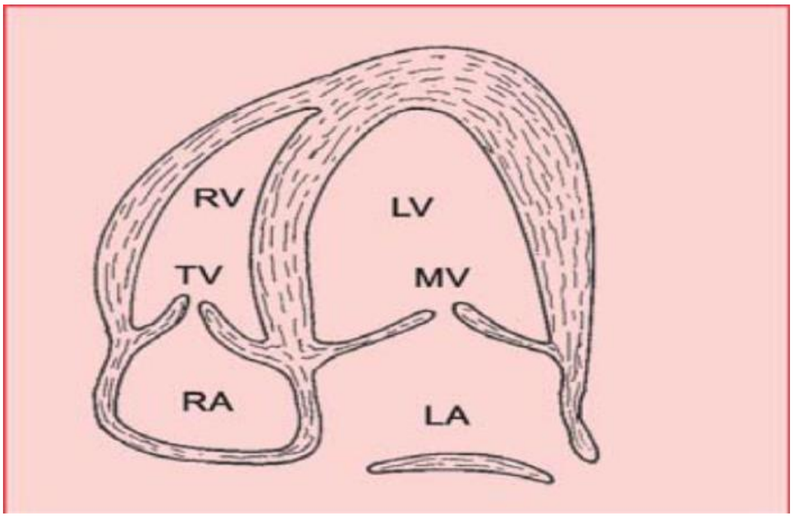


Fig 2.16: Apical 4-chamber (AP4CH) view Structures seen:right and left ventricle, right and left atrium, mitral and tricuspidvalves, IA septum and IV septum, left ventricula apex and LV lateral wall. [Williamsburg-2021**]**

2.1.4.2.3 Apical 5-Chamber View:

Transducer position: same as AP4CH view Marker dot direction: same as AP4CH view is obtained from the AP4CH view by slight anterior angulation of the transducer towards the chest wall. The 5th chamber added is the left ventricular outflow tract (LVOT) Structures seen: Same as AP4CH view +aortic valve and ascending aorta.

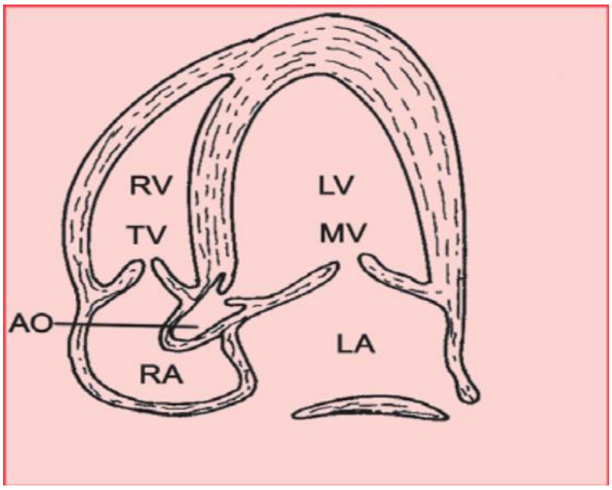


Fig 2.17: Apical 5-chamber (AP5CH) view[Williamsburg-2021**]**

2.1.4.2.4 Apical 2-Chamber View

Transducer position: apex of the heart Marker dot direction: points towards left side of neck (45° anticlockwise from AP4CH view)Structures seen: LV anterior wall LV inferior wall.

2.1.4.2.5 Sub-Costal 4-Chamber View (SC4CH View):

For subcostal view, the position of the subject is different from that used to obtain parasternal and apical views. The subject lies supine with the head held slightly low(no pillow). With the feet on the bed, the knees are slightly elevated (with pillow). Better images are obtained with the abdomen relaxed and during inspiration. Transducer position: under the xiphisternum Marker dot position: points towards left shoulder structures seen: same as in AP4CH view. The subcostal view is particularly useful when transthoracic echo is technically difficult because of severe obesity, chest wall deformity, emphysema or pulmonary fibrosis. The following structures are better seen from the subcostal view than from the apical 4-chamber view: inferior vena cava and hepatic veins descending abdominal aorta interatrial septum pericardial effusion

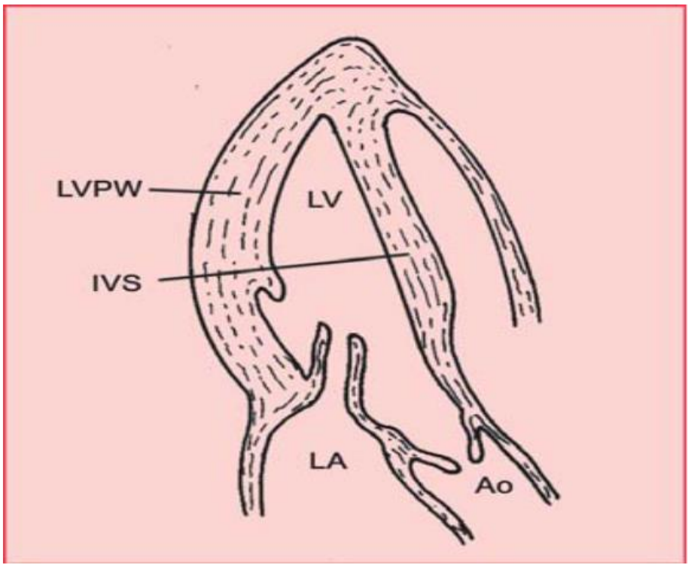


Figure 2.18 : Apical long-axis (APLAX) view [Williamsburg-2021**]**

2.1.4.2.6 Suprasternal View:

For suprasternal view, the subject lies supine with the neck hyperextended by placing a pillow under the shoulders. The head is rotated slightly towards the left. The position of arms or legs and the phase of respiration have no bearing on this echo window. Transducer position: suprasternal notch Marker dot direction: points towards left jaw Structure seen: arch of aorta.

2.1.4.2.7 Right Parasternal View:

For right parasternal view, the subject lies in the semi recumbent position on his or her right side. The right arm is tucked under the head and the left arm lies along the left side of the body. In other words, this position is the mirror-image of that used for the left parasternal view. Transducer position: right sternal edge; 2nd-4th i-c space Marker dot direction: points towards left shoulder Structures seen: aortic valve and ascending aorta**[** Williamsburg-2021**]**

2.1.4.3.Transesophageal echo Principle:

During echocardiography, a balance has to be struck between tissue penetration and image resolution. Low frequency transducers used for transthoracic echo have good penetration (less attenuation) but relatively poor resolution. On the other hand, high frequency transducers have poor penetration (more attenuation) but better resolution.

Anatomically speaking, the esophagus in its midcourse is strategically located posterior to the heart and anterior to the descending aorta. This provides an opportunity to examine the heart and related structures with a high frequency transducer positioned in the esophagus for better image resolution. The technique is known as Transesophageal echo **.**Trans esophageal echocardiography can be used if doctors need to obtain greater clarity or to analyze the aorta or structures at the back of the heart (particularly the left atrium or left ventricle). For this procedure, a small flexible tube with an ultrasound transducer at the tip is passed down the person's throat into the esophagus so that the transducer lies just behind the heart. Because this procedure is uncomfortable, the person is sedated and the throat is numbed with an anesthetic spray. Trans esophageal echocardiography is also used when regular echocardiography is difficult to do because of obesity, lung disorders, or other technical problems or when doctors are looking for specific diseases, such as endocarditis of the mitral valve or aortic valve or a clot within the heart. Intracardiac echocardiography is a rare type of echocardiography that is done when a person is having a procedure on the heart such as a procedure to repair an atrial sepal defect (hole in the heart). For intracardiac echocardiography, a small flexible tube with an ultrasound transducer at the tip is passed from a blood vessel in the groin directly into a chamber of the heart. The person having this procedure is usually sedated. Intracardiac echocardiography is used when doctors need to obtain detailed pictures of the heart that cannot be obtained using transthoracic or Trans esophageal echocardiography.

2.1.4.3.1 Transesophageal echo Technique:

The transducer is mounted onto a scope similar to that employed for upper gastrointestinal endoscopy and advanced to various depths in the esophagus. By maneuvering the transducer and the angle of ultrasound beam from controls on the handle, different views of the heart are obtained. This 'back-door' approach to echocardiography has both advantages and disadvantages.

2.1.4.3.2 Advantages of Transesophageal echo :

Useful alternative to transthoracic echo if the latter is technically difficult due to obesity, chest wall deformity, emphysema or pulmonary fibrosis, Useful complement to transthoracic echo because of better image quality and resolution. This is because of two reasons: Lack of interference between the ultrasound beam and ribs and Greater proximity to the heart and therefore the ability to use higher frequency probe with better image resolution and Useful supplement to transthoracic echo which cannot examine the posterior aspect of the heart for left atrial appendage, descending aorta and pulmonary veins.

2.1.4.3.3 Disadvantages:

It is an invasive procedure which is uncomfortable to the patient, more time consuming and carries a small risk of complications such as esophageal trauma, arrhythmias and laryngo-bronchospasm, It requires short-term sedation, oxygen administration and ECG monitoring since there are chances of hypoxia, arrhythmia and angina , Rarely, respiratory depression or allergic reaction may occur due to the sedative. It is contraindicated in presence of dysphagia, esophageal varies, unstable cervical arthritis and severe pulmonary disease, The trans esophageal echo (TOE) views are significantly different from standard transthoracic echo views and have to be learnt separately, It would be beyond the scope and against the philosophy of this book to understand and learn these views in detail , Nevertheless the indications for TOE are duly mentioned at appropriate places as and we go through the chapters of the book.

2.1.4.3.4 Myocardial Contrast Imaging:

Techniques are being developed to improve assessment of myocardial perfusion, viability and function by use of sonicated radiographic contrast materials. Coronary flow can then be estimated by time-intensity curves of sonodensity.

2.1.4.3.5 Tissue Characterization:

In this method, different radiofrequency values are assigned to tissues that are ischemic, viable and nonfunctional. Analysis of reflected frequencies can differentiate. Acute from chronic ischemia. Better visualization of the endocardial surface will improve assessment of dynamic function and wall motion.

2.1.4.3.6 Echo Technology:

Using computer software, 3-D representation of the left ventricle structure and function can be assessed. This avoids certain geometrical assumptions about the LV shape particularly if it has been distorted by prior infarction. Serial LV volumetric measurements in Valvular regurgitation (MR, AR) can help proper timing of corrective surgery. Sonicated radiographic contrast materials. Coronary flow can then be estimated by time-intensity curves of sonodensity.

2.1.4.3.7 Tissue Characterization:

In this method, different radiofrequency values are assigned to tissues that are ischemic, viable and nonfunctional. Analysis of reflected frequencies can differentiate

Acute from chronic ischemia. Better visualization of the endocardial surface will improve assessment of dynamic function and wall motion

2.1.4.3.8 Tissue Doppler echocardiography (**TDE**):

Is a medical ultrasound technology, specifically a form of echocardiography that measures the velocity of the heart muscle (myocardium) through the phases of one or more heartbeats by the Doppler effect (frequency shift) of the reflected ultrasound. The technique is the same as for flow Doppler echocardiography measuring flow velocities. Tissue signals, however, have higher amplitude and lower velocities, and the signals are extracted by using different filter and gain settings.

2.1.4.3.9 Tissue Doppler imaging (TDI) and **tissue velocity imaging (TVI)** :

Are usually synonymous with TDE because echocardiography is the main use of tissue Doppler. Like Doppler flow, tissue Doppler can be acquired both by spectral analysis (spectral density estimation) as pulsed Doppler and by the autocorrelation technique as color tissue Doppler (duplex ultrasonography). While pulsed Doppler only acquires the velocity at one point at a time, color Doppler can acquire simultaneous pixel velocity values across the whole imaging field. Pulsed Doppler on the other hand, is more robust against noise, as peak values are measured on top of the spectrum, and are unaffected of the presence of clutter (stationary reverberation noise).Pulsed wave spectral tissue Doppler has become a universal tool that is part of the general echocardiographic examination. Like any other echocardiographic measurement, measures by tissue Doppler should be interpreted in the context of the whole examination. The velocity curves are in general taken from the base of the mitral annulus at the insertion of the mitral leaflets, in the sepal and lateral points of the four chamber view, and eventually the anterior and inferior points of the two-chamber views. For the right ventricle it is customary to use the lateral point of the tricuspid annulus only. Averaging peak velocities from the sepal and lateral point has become common, although it has been shown that averaging all four points mentioned above, gives significantly less variability. The method measures annular velocities to and from the probe during the heart cycle. Annular velocities summarize the longitudinal contraction of the ventricle during systole and elongation during diastole. Peak velocities are commonly used. Systolic function: Peak systolic annular velocity of the left ventricle is as close to a contractility measure as you can get by imaging (bearing in mind that any imaging method only measures the result of fibre shortening, without measuring myocyte tension). S' has become a reliable measure of global function. It shares the advantage of annular displacement, that it is reduced also in hypertrophic hearts with small ventricles and normal ejection fraction

(HFNEF), which is often seen in Hypertensive heart disease, Hypertrophic cardiomyopathy and Aortic stenosis.Peak tricuspid annular systolic velocity has become a measure of the right ventricular systolic function. Diastolic function .As the ventricle relaxes, the annulus moves towards the base of the heart, signifying the volume expansion of the ventricle. The peak mitral annular velocity during early filling, e' is a measure of left ventricular diastolic function, and has been shown to be relatively independent of left ventricular filling pressure. If there is impaired relaxation (Diastolic dysfunction), the velocity decreases. After the early relaxation, the ventricular myocardium is passive, the late velocity peak is a function of atrial contraction. During the two filling phases, blood flow from the atrium to the ventricle, corresponding to the annular velocity phases. The flow is driven by the pressure difference between atrium and ventricle, this pressure difference is both a function of the pressure drop during early relaxation and the initial atrial pressure. In the right ventricle this is not an important principle, as the right atrial pressure is the same as central venous pressure which can easily be assessed from venous congestion. **[**Michael J. Shea et al- 2019**]**

2.2 Previous Studies:

There were different previous studies related to this study include the following:

Masao Daimon et al (2008) were studied 2 D echo cardiography about about Normal Values of Echocardiographic Parameters in Relation to Age in a Healthy Japanese Population found that Normal values of echocardiographic measurements in a large Japanese population are reported for the first time; several systolic and diastolic parameters varied with age. These results provide important reference values that should be useful in routine clinical practice as well as in clinical trials.

Seisyou Kou et al (2014) were studied 2 D echo cardiography about Echocardiographic reference ranges for normal cardiac chamber size which was found out no gender differences in age or cholesterol levels, Compared with men, women had significantly smaller body surface areas, and lower blood pressure, Quality of echocardiographic data sets was good to excellent in the majority of patients, Upper and lower reference limits were higher in men than in women , the reference values varied with age(These age-related changes persisted for most parameters after normalization for the body surface area) and this study provides useful two-dimensional echocardiographic reference ranges for cardiac chamber quantification which highlight the need for body size normalization that should be performed together with age-and gender-specific assessment for the most echocardiographic parameters.

Ahmed Mohamed et al (2016) were studied 2 D echo cardiography about normal reference values of echocardiographic measurements in young Egyptian adult which was performed on 1,364 healthy adults aged 18–35 years, related to gender, showed males had significantly larger left ventricular volumes, interventricular septum, posterial wall dimeters and mass (LVEDD, LVESD, IVSd, PWd, LV mass, LA anteroposterior diameter and aortic root diameter ($p < 0.0001$ for each), LV ejection fraction was higher in females ($p = 0.008$) but there was no difference regarding right ventricular dimeter (RVd)($p = 0.118$) and Based on their results they proposed normal reference values for young Egyptian adults and Estimation of local reference values is important to define normalcy. The main difference from international values was a higher upper reference limit for LV mass especially in females and relatively smaller LA dimensions in young Egyptians.

Richard B. Devereux et al (2012) studied 2 D echo cardiography about Normal Limits in Relation to Age, Body Size and Gender of Two-Dimensional Echocardiographic Aortic Root Dimensions in Persons ≥15 Years of Age,found out aortic root diameter is larger in men and increases with body size and age and Regression models incorporating body size, age and gender are applicable to adolescents and adults without limitations of previous monograms.

R.BradStammM.D (1982) studied 2 D echo cardiography about which concern with two-dimensional echocardiographic measurement of left ventricular ejection fraction revealed the measured EF in patients with a kinetic segments yielded a greater standard error of the mean, although correlations remained adequate when compared to the normal patient population, the EF from patients with poor quality as compared to good quality echo studies had a slightly greater standard error, but correlations were little affected thus biplane formulae for calculating EF yield better correlations, but are available from fewer patients than single-plane formulae and An estimate of EF was sufficiently accurate for most clinical situations and was available in 98% of the patients and The presence of abnormal wall motion or a poor quality 2DE study increased the standard error slightly, but had little effect on correlation with contrast ventriculogram**.**

Shota Fukuda et al (2012) were studied 2 D echo cardiography about normal Values of Real-Time 3-Dimensional Echocardiographic Parameters in a Healthy Japanese Population found out the mean values in men and women were include left ventricular sizes decreased with age, whereas LV mass index did not change, left atrium (LA) sizes slightly increased with age thus the results of the present study support the use of RT3DE for the diagnosis and management of cardiovascular disease**.**

Marwick (2003) were studied 2 D echo cardiography about Techniques for comprehensive two-dimensional echocardiographic assessment of left ventricular systolic function found out the LV size is very large or very small, and at the extremes of heart rate, Normal values of LV volumes by 2D echocardiography. Variation of ejection fraction include EDV & ESV is 111 (22) for men & 80(12) for women, 34 (12) for men & 29 (10) for women respectively by Biplane Simpson's, 112 (27) for men & 89 (20) for women

Cuspidi et al (2017) were studied 2 D echo cardiography about Clinical and prognostic value of hypertensive cardiac damage in the PAMELA were found that for left ventricular dimensions for hypertensive patients similar to normal limits based on normal subjects and stander reference ranges

Kou et al (2014) studied 2 D echo cardiography about Echocardiographic reference ranges for normal cardiac chamber size were found that LVM consider large with them (p-value 0.000) due to effect of hypertension systolic blood pressure is more important and the wall stress is a key factor influencing left ventricular hypertrophy development

SA. I. McGhie et al (1991) were studied Radionuclide assessment of ventricular function and risk stratification after myocardial infarction found that prognostic utility of LVESV in patients with stable coronary artery disease was also detailed to be prevalent to that of left ventricular ejection fraction (LVEF) or left ventricular end diastolic volume (LVEDV)

Iarussi D et al (2001) performed 2 D echo cardiography study concerned with Association of left ventricular hypertrophy and aortic dilation in patients with acute thoracic aortic dissection were Found that Left ventricular hypertrophy may be considered a risk factor for aortic enlargement

La Canna et al (2020) were studied 2 D echo cardiography about New and old echographic parameters in heart failure showed left ventricular ejection fraction for hypertensive patients is low if compared with normal subjects but consider with in border line of normal limit of stander reference.

Kozakova et al (2017) were studied 2 D echo cardiography about impact of glycemic control on aortic stiffness, left ventricular mass and diastolic longitudinal function in type 2 diabetes mellitus were found that HbA1c levels are positively associated with LV mass and aortic stiffness, both of which show a negative independent impact on early diastolic velocity through an increase in afterload , T2DM patients with suboptimal glycemic control (HbA1c $\geq$ 6.5%)

have lower diastolic and systolic LV longitudinal performance, together with increased aortic stiffness and a higher prevalence of LV hypertrophy

Harkness et al (2020) performed study about Normal reference intervals for cardiac dimensions and function for use in echocardiographic practice: a guideline from the British Society of Echocardiography showed that the current guidance provides robust reference intervals for use in day-to-day practice in UK echo labs and This report contains guidance only and should also be used in conjunction with clinical assessment and interpretation so the reference intervals within should not be used as the sole reason for making clinical decisions for individual patients.

Health wise Staff (2020) were studied 2 D echo cardiography about Heart Failure with Reduced Ejection Fraction (Systolic Heart Failure) were found that 55% of the total blood in the left ventricle is pumped out with each heartbeat and many different problems cause heart failure with reduced ejection fraction such as Cardiomyopathy (A disease of the heart muscle) it effect that heart muscle is weakened, which affects its ability to pump properly

CHAPTER THREE

Chapter Three
Materials and Methods

3.1 Type of study:

Cohort prospective study

3.2 Materials: include:

Machines: The requested echocardiography applied in different types of machines include mainly:

3.1.2 1 X Mylab50XVISION Appendix C 1

3.1.2.2 AR10200 APPENDIX C2

3.1.2.2 SAMSUNG Appendix No C3

3.3 Population Selection:

This hospital-based study was carried out at Elshaab Teaching Hospital in echocardiographic unit in Khartoum -Sudan during the period extended from 2016 to 2019 for population which were already diagnosed before application of echocardiographic examination written in their request forms and excluded any Pregnant women, patients with genetic disorders, with cardiac anomalies or any abnormalities but include three types of population classified in to:

Healthy subjects: whose diagnosed without any congenital or other diseases mainly with normal blood pressure and Blood sugar.

Hypertensive patients: whose already diagnosed with hypertension (elevated blood sugar) and requested for echocardiography with their clinical histories in request forms and most of them for follow up as medical check and Diabetic complications **Diabetic patients**: whose already diagnosed with Diabetice Melitus (elevated blood sugar) and requested for echocardiography with their clinical histories in request forms and most of them for follow up as medical check and Diabetic complications

3.4 Sample Size:

The sample size was for all groups (normal subjects, hypertensive and diabetic patients) from the patients whose requested for echocardiography examinations was include 317 for all groups (100 were normal,101 were hypertensive patients and 116 were diabetic patients) with their age range between 30-90 calculated according to formula:

$$n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2}$$

$$n = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} = 384.16$$

where: n = the sample size, z = stander error associated with the chosen level of confidence (1.96), p = estimated percent in the population, q = 100-p and e = acceptable sample error. (Calculater.net -2022)

3.5 Method of data collection:

3.5.1 Data collection Technique:

the patients during the exam done by cardiologist lie in supine position and turned in to his left side with his/her arm elevated and rest under head using high frequency applied Parasternal long , short-axis (PLAX & PSAX) and apical window (PA2CH, PA4CH (Two and four chambers)views which calculated by Teichholz's M-Mode of 2D echocardiography and Aortic root, diameter which measured in Anterior aortic root to posterior aortic root (leading edge to leading edge),Left Atrial at end-diastole

3.5.2 Variables used to collect the data:

A well-designed Data sheet was used to collect the data of all groups include different variables of study classified into main two categories:

Body Characteristics: Include Age and BMI

3.5.3 Echocardiographic parameters:

All 2D echocardiographic parameters in systole and diastole include left ventricular dimensions: Interventricular septal diameter, left ventricular internal diameter, left ventricular poster wall diameter (IVS, LVID, LVPWD), left ventricular volumes (LVEDV&LVESV), Ejection fraction and fraction shorten (EF, FS), left ventricular mass (LVM) and Aortic Diameter (AOD), and left atrial diameter (LAD).

3.5.4 Classification of Variables of study:

All variables of study divided in to seven categories for hypertensive and diabetic groups compared with normal subject include:

The Mean±SD values of body characteristics (age and body max index) and echocardiographic parameters Association between all parameters of study with body characteristics include (Age and BMI) for all groups (normal subjects, hypertensive and diabetic patients). Association of all echocardiographic parameters for hypertensive patients compared with normal subjects by significant test using t-test for Equality of Means Comparing left ventricular dimensions and mass for normal subjects and hypertensive and diabetic patients Association of left ventricular volumes and Ejection fraction of hypertensive and diabetic patients compared with normal values correlation between the Aorta and left atrium diameters for all groups (normal subjects, hypertensive and diabetic patients) scatter plot show the distribution of the classes(normal, hypertension and diabetic) as a result of classification using linear discriminant functions.

3.5.5Method of Data Analysis:

The data were statistically analyzed using IBM SPSS Statistics version 25. Categorical variables were expressed as numbers and percentage and were analyzed using chi-square test. Continuous variables were expressed as mean ± SD and analyzed using Student's t-test and ANOVA test. Correlations were analyzed using Pearson's correlation coefficient (r). A probability value p-value less than 0.05 were considered statistically significant and a p value less than 0.0001 were considered highly significant

In addition to linear discrimination to established equations for each group to differentiate between normal and hypertensive or diabetic patients**.**

3.6 Ethical Approval:

The Research was approved by all relevant ethics committees.

CHAPTER FOUR

Chapter Iv

Results and Analysis

Results and analysis:

The Results of all variables in study were classified in to two categories include Results and analysis for hypertensive patients compared with normal subjects and compression of results of diabetic patients with the normal subjects as following:

Table 4.1: Showed the Mean±SD values of body characteristics (age and body max index) and echocardiographic parameters.

Variables	Normal Subjects	Hypertensive group	Diabetic group
Age	44.5±11.1	57.3±13.1	57.2±13.1
Weight	64.5±13.7	79.4±22.7	79.5±23.3
Height	158.7±11.0	170.7±11.7	169.5±19.0
BMI	24.7 ± 8.5	27.1±6.4	28.1±10.7
IVSD	0.92±0.58	1.21±1.05	1.98±9.74
LVPWd	0.91±0.55	1.13±0.81	1.10±0.61
LVIDd	3.78±1.11	5.58±4.10	5.51±3.86
LVEDV	83.60±42.44	122.59±59.73	122.78±57.79
LVPWs	1.13±0.61	1.06±0.50	1.32±1.16
LVIDS	2.41±0.82	3.75±1.39	3.75±1.33
LVESV	37.44±22.19	59.62±46.77	60.63±44.37
LVEF	64.79±8.62	55.12±14.38	55.39±14.10
LVFS	34.99±6.48	29.75±9.49	29.87±9.29
LVM	89.41±49.68	101.00±29.75	212.84±106.57
AOD	2.41±0.78	2.95±2.78	3.11±3.10
LAD	2.93±1.06	4.04±3.70	3.99±3.49
LA_AO	1.35±0.34	1.44±0.43	1.43±0.41

Table 4.2: Showed Association between all parameters of study with body characteristics include (Age and BMI) for all groups (normal subjects and hypertensive patients).

Parameters	Hypertensive patients				Normal subjects			
	Age		BMI		Age		BMI	
	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value
Duration	0.042	0.286*	0.237	0.169				
IVSD	0.258	0.161	0.054	0.272	0.704	0.056	0.919	0.015
DIASTOLE	0.63	0.069	0.683	0.059	0.556	-0.086	0.452	0.11
SYSTOLE	0.577	-0.08	0.84	0.029	0.599	-0.077	0.888	-0.021
LVIDd	0.691	-0.057	0.256	0.162	0.508	-0.097	0.741	0.048
LVPWd	0.887	-0.02	0.011	0.352*	0.093	-0.243	0.886	0.021
EDV	0.669	-0.061	0.143	0.208	0.426	-0.116	0.53	-0.092
ESV	0.185	-0.189	0.02	0.326*	0.532	-0.091	0.66	-0.064
EF%	0.308	0.146	0.068	-0.258	0.93	0.013	0.233	-0.174
FS%	0.177	0.192	0.033	-0.299*	0.967	0.006	0.121	-0.224
LVIDS	0.249	-0.164	0.062	0.263	0.876	-0.023	0.405	0.122
LVPWs	0.804	0.036	0.013	0.347*	0.917	0.015	0.064	0.266
AOD	0.48	-0.101	0.188	-0.187	0.88	0.022	0.045	0.288*
LAD	0.48	-0.101	0.625	-0.07	0.685	0.059	0.482	0.103
AO/LA %	0.954	0.008	0.388	0.123	0.046	0.286*	0.005	0.398*
LVM	0.496	0.097	0.409	0.118	0.672	-0.062	0.024	0.323*

Table 4.3: Showed Association between all parameters of study with body characteristics include (Age and BMI) for diabetic patients.

Parameters	Diabetic patients				Normal subjects			
	Age		BMI		Age		BMI	
	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value
Duration	0.154	0.102	0.056	0.551				
IVSD	0.056	0.552	-0.046	0.629	0.704	0.056	0.919	0.015
DIASTOLE	-0.104	0.270	0.020	0.833	0.556	-0.086	0.452	0.11
SYSTOLE	0.018	0.851	-0.029	0.761	0.599	-0.077	0.888	-0.021
LVIDd	-0.074	0.432	0.138	0.143	0.508	-0.097	0.741	0.048
LVPWd	-0.037	0.700	0.131	0.165	0.093	-0.243	0.886	0.021
EDV	0.047	0.618	-0.102	0.284	0.426	-0.116	0.53	-0.092
ESV	-0.089	0.349	-0.061	0.522	0.532	-0.091	0.66	-0.064
EF%	-0.020	0.836	-0.024	0.800	0.93	0.013	0.233	-0.174
FS%	0.031	0.747	-0.051	0.593	0.967	0.006	0.121	-0.224
LVIDS	0.185*	0.048	-0.017	0.859	0.876	-0.023	0.405	0.122
LVPWs	0.149	0.114	-0.012	0.901	0.917	0.015	0.064	0.266
AOD	-0.094	0.317	-0.029	0.760	0.88	0.022	0.045	0.288*
LAD	0.026	0.786	0.062	0.513	0.685	0.059	0.482	0.103
AO/LA %	0.154	0.102	0.056	0.551	0.046	0.286*	0.005	0.398*
LVM	0.056	0.552	-0.046	0.629	0.672	-0.062	0.024	0.323*

Table 4.4: Showed Association of all echocardiographic parameters for hypertensive patients compared with normal subjects by significant test using t-test for Equality of Means .

Independent Samples Test between normal subjects and hypertensive patients		
Variables	t-test for Equality of Means	
	t	p-value
IVSD	2.424	.016
LVPWd	2.259	.025
LVIDd	4.295	.000
LVEDV	5.364	.000
LVPWs	.929	.354
LVIDS	8.374	.000
LVESV	4.323	.000
LVEF	13.988	.000
LVFS	12.893	.000
LVM	11.858	.000
AOD	1.922	.056
LAD	2.925	.004
LA/AO	1.737	.084

Table 4.5: Showed Association of all echocardiographic parameters for Diabetic patients compared with normal subjects by significant test using t-test for Equality of Means .

Independent Samples Test between normal and diabetic		
	t-test for Equality of Means	
	T	p-value
IVSD	1.093	.275
LVPWd	2.359	.019
LVIDd	4.382	.000
LVEDV	5.623	.000
LVPWs	1.460	.146
LVIDS	8.795	.000
LVESV	4.769	.000
LVEF	5.828	.000
LVFS	4.641	.000
LVM	10.702	.000
AOD	2.218	.028
LAD	2.961	.003
LA/AO	1.539	.125

Table 4.6: Comparing left ventricular dimensions and mass for normal subjects and hypertensive and diabetic patients

Parameter	Hypertensive patients	P-value	Normal subjects	Diabetic patients	P-value
IVSD cm	1.2 ± 1.1	0.016	0.9 ± 0.6	2.4 ± 1.8	0.018
LVIDd cm	5.6 ± 4.1	0.000	3.8 ± 1.1	5.5 ± 3.9	0.000
LVPWd/cm	1.1 ± 0.8	0.025	0.9 ± 0.5	1.1 ± 0.6	0.019
LVPWs/cm	1.1 ± 0.5	0.385	1.1 ± 0.6	1.4± 1.2	0.096
LVM/ g	218.6 ± 110.7	0.000	89.4 ± 49.7	212.8 ± 106.6	0.000

Table 4.7: Showed relation of Diastolic and Systolic blood pressure for hypertensive and normal subjects**.**

Parameter	Hypertensive group	Normal group	P-value
	Mean ± SD	Mean ± SD	
DIASTOLE /mmHg	84.2 ± 12.9	78.2 ± 5.5	0.000
SYSTOLE/mmHg	125.1 ± 24.2	118.4 ± 6.6	0.008

Table 4.8: Showed association of left ventricular volumes and Ejection fraction of hypertensive and diabetic patients compared with normal values

Parameter	Hypertensive patients	P-value	Normal subjects	Diabetic patients	P-value
LVEDV ml	122.6 ± 59.7	0.000	74.4 ± 45.5	122.8 ± 57.8	0.000
LVESV ml	59.8 ± 46.7	0.000	37.4 ± 22.2	59.6 ± 45.2	0.000
LVEF %	55.1 ± 14.4	0.000	64.8 ± 8.6	55.1 ± 14.2	0.000

Table 4.9: Showed correlation between the Aorta and left atrium diameters for all groups (normal subjects, hypertensive and diabetic patients)

Parameter	Hypertensive patients	P-value	Normal subjects	Diabetic patients	P-value
AOD cm	3.1 ± 3.3	0.031	2.4 ± 0.8	3.1 ± 3.1	0.028
LAD cm	4.0 ± 3.7	0.004	2.9 ± 1.1	4.0 ± 3.5	0.003

Table 4.10: Showed correlation between the Duration & Blood pressure and all echocardiographic parameters for hypertensive patients

Correlations	Duration		DIASTOLE		SYSTOLE	
	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value
IVSD	0.529	0.000	-0.067	0.641	-0.044	0.761
LVIDd	0.079	0.58	-0.021	0.885	0.061	0.671
LVPWd	-0.042	0.77	0.076	0.597	-0.026	0.858
EDV	-0.113	0.429	0.204	0.15	0.105	0.464
ESV	-0.063	0.659	0.087	0.542	-0.03	0.834
EF%	-0.048	0.739	-0.044	0.76	0.155	0.278
FS%	0.004	0.98	-0.038	0.789	0.169	0.237
LVIDS	-0.04	0.781	-0.051	0.723	-0.119	0.404
LVPWs	0.065	0.648	0.103	0.471	-0.055	0.702
AOD	-0.061	0.671	-0.09	0.528	0.167	0.242
LAD	-0.036	0.803	-0.167	0.242	-0.06	0.673
AO/LA %	0.131	0.361	-0.088	0.537	-0.222	0.117
LVM	-0.073	0.611	-0.015	0.92	-0.069	0.631

Table 4.11: Showed correlation between the Duration & Blood sugar and all echocardiographic parameters for hypertensive patients

Correlations	Duration		Blood Sugar	
	Pearson Correlation (r)	P-value	Pearson Correlation (r)	P-value
Age	0.259	0.069	-0.26	0.068
Weight	0.056	0.699	0.188	0.191
Height	0.099	0.493	0.111	0.444
BMI	-0.007	0.963	0.125	0.385
IVSD	-0.096	0.508	0.073	0.612
LVIDd	0.183	0.202	0.096	0.506
LVPWd	-0.134	0.354	-0.019	0.897
EDV	-0.173	0.229	0.079	0.584
ESV	-0.09	0.533	0.102	0.48
EF%	-0.069	0.635	-0.196	0.173
FS%	-0.134	0.352	-0.146	0.311
LVIDS	-0.027	0.851	-0.246	0.086
LVPWs	-0.271	0.057	0.037	0.799
AOD	0.209	0.144	-0.314	0.026
LAD	0.134	0.353	-0.132	0.361
AO/LA %	0.082	0.571	0.142	0.326
LVM	-0.007	0.961	0.026	0.86

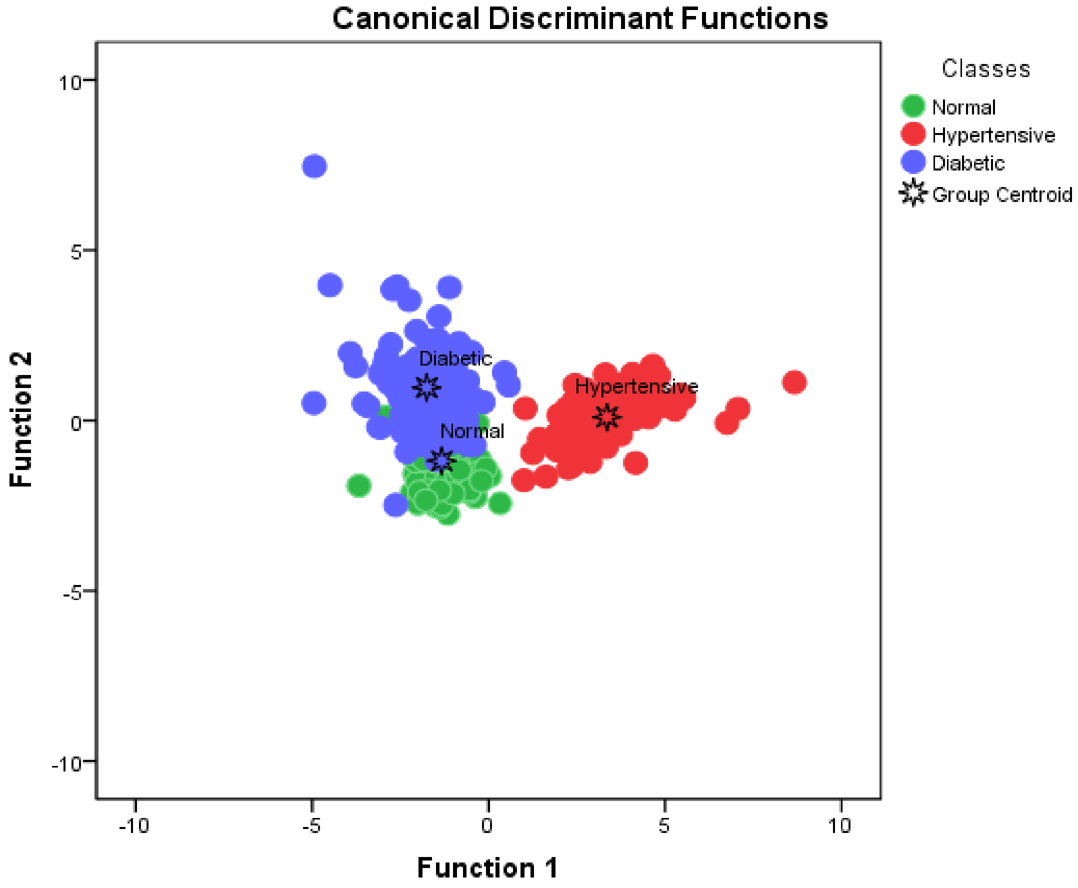


Figure 4.1: Showed scatter plot show the distribution of the classes(normal, hypertension and diabetic) as a result of classification using linear discriminant functions

Table 4.10: Showed Confusion matrix show the result of classification using measured values versus the original classes. Accuracy = 89.6% of original grouped cases correctly classified, Sensitivity = 91.2 %
Specificity = 87.3%

Classes			Predicted Group Membership			Total
			Normal	Hypertensive	Diabetic	
Original	Count	Normal	**89**	0	13	102
		Hypertensive	1	**100**	0	101
		Diabetic	19	0	**95**	114
	%	Normal	**87.3**	.0	12.7	100.0
		Hypertensive	1.0	**99.0**	.0	100.0
		Diabetic	16.7	.0	**83.3**	100.0

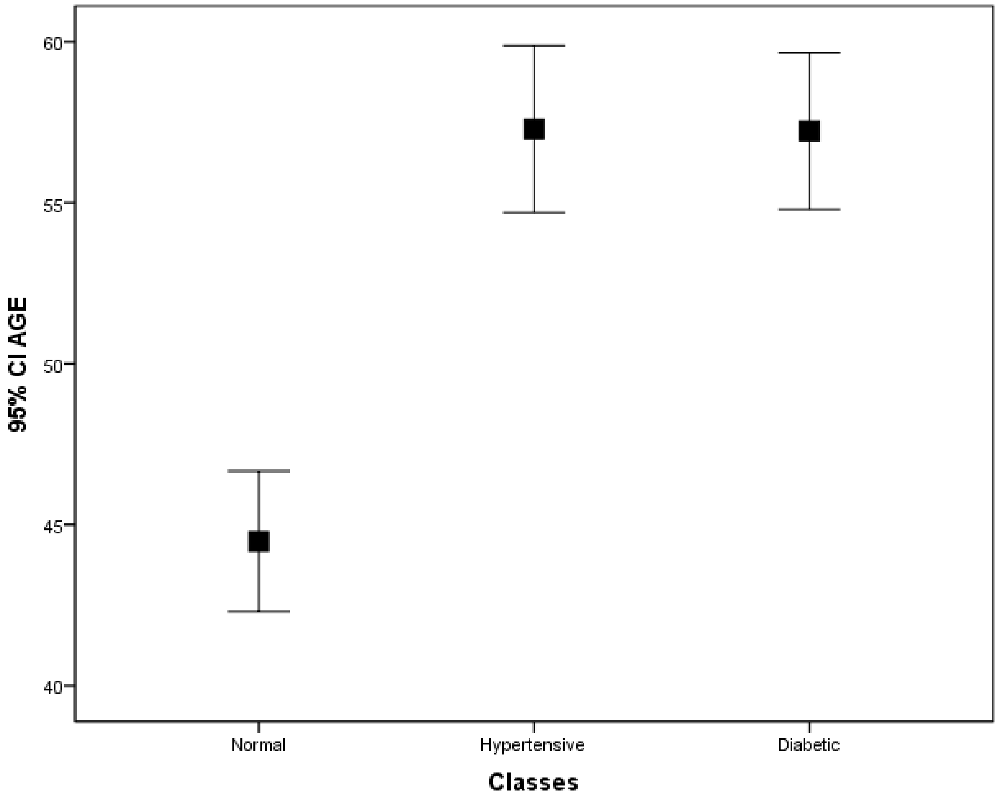
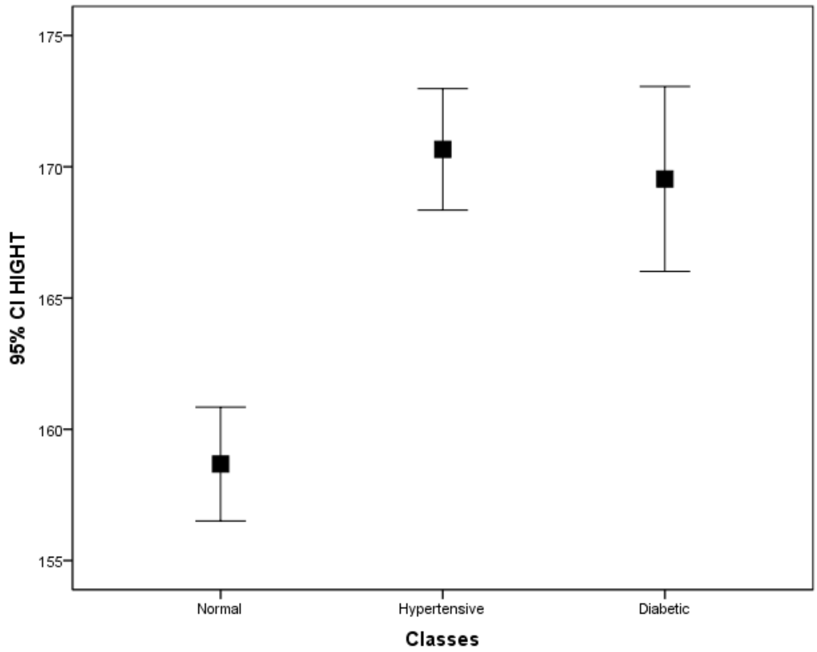
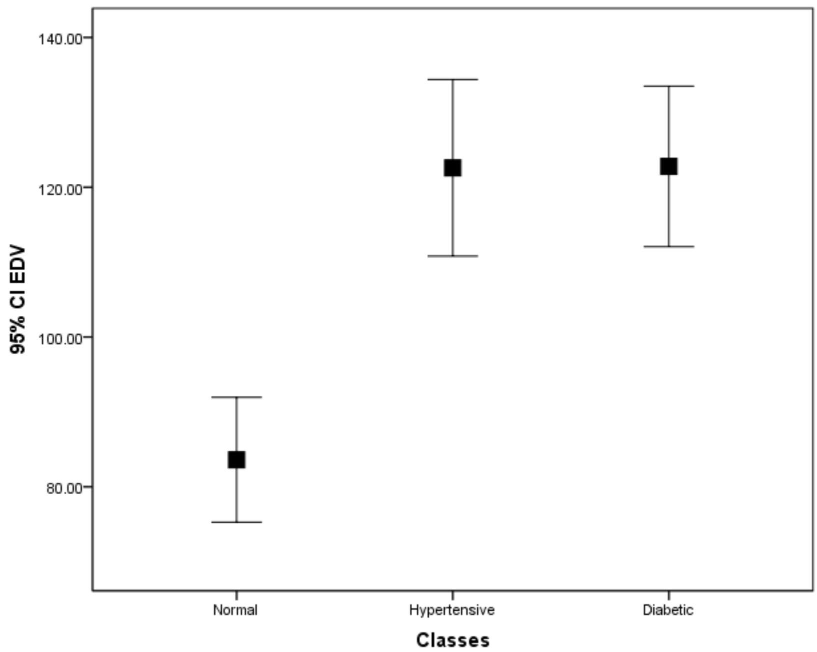
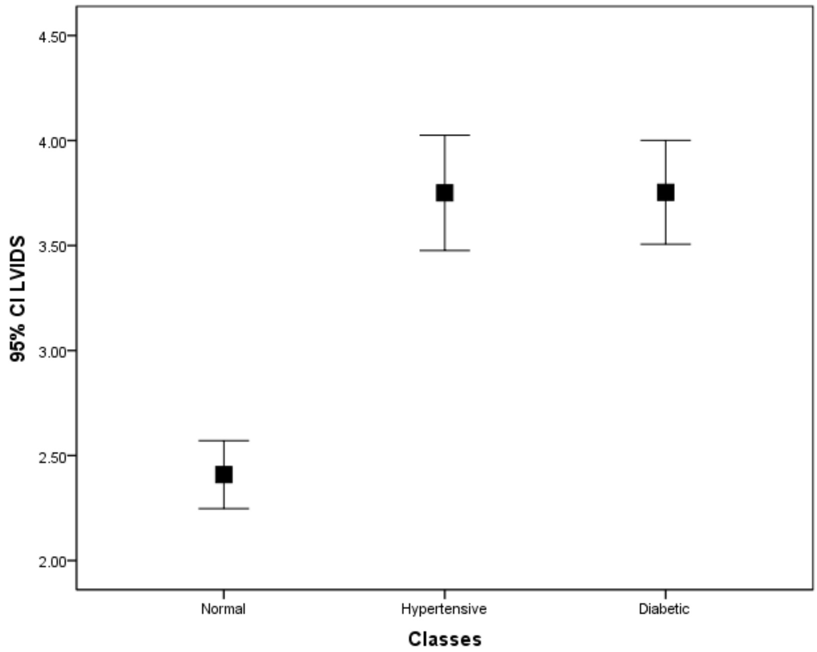
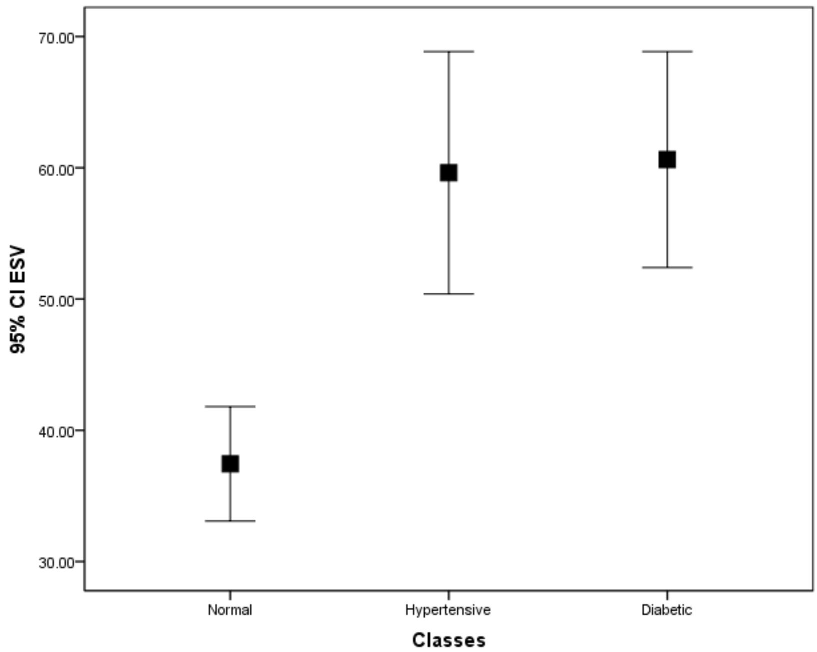


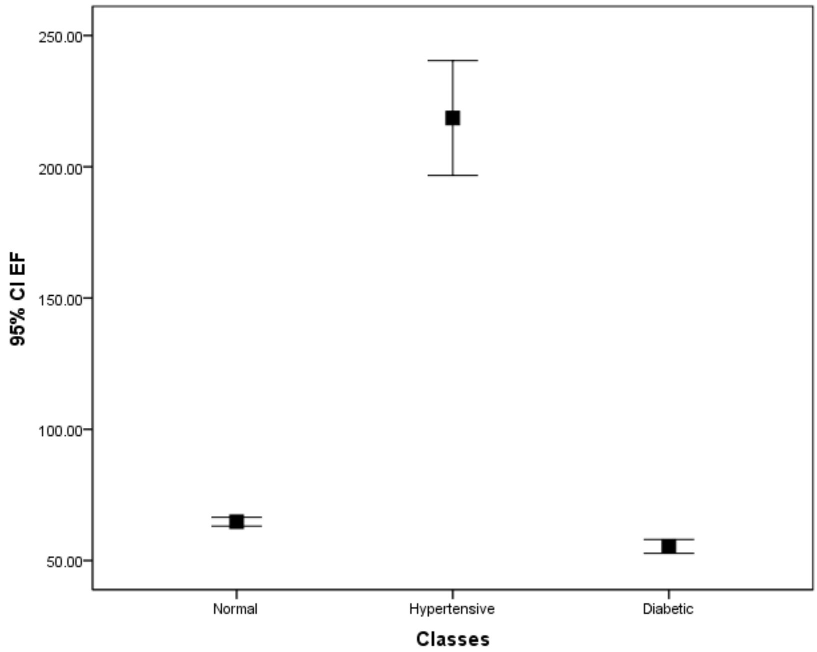
Figure 4.2 : Showed error bar plot show the power of Age in discriminating normal, hypertensive and diabetic from each other's

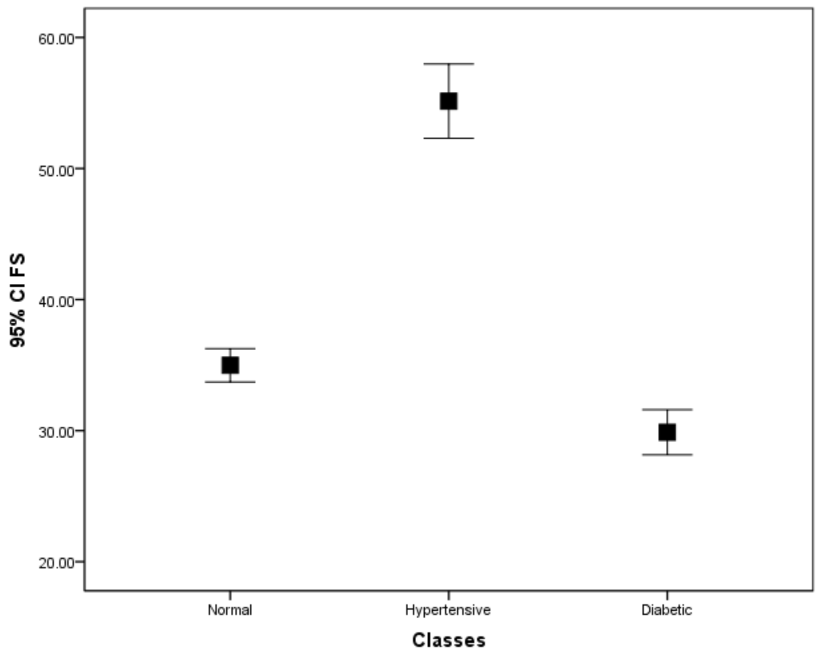

175
170
165
160
155
95% CI HIGHT
Normal
Hypertensive
Diabetic
Classes

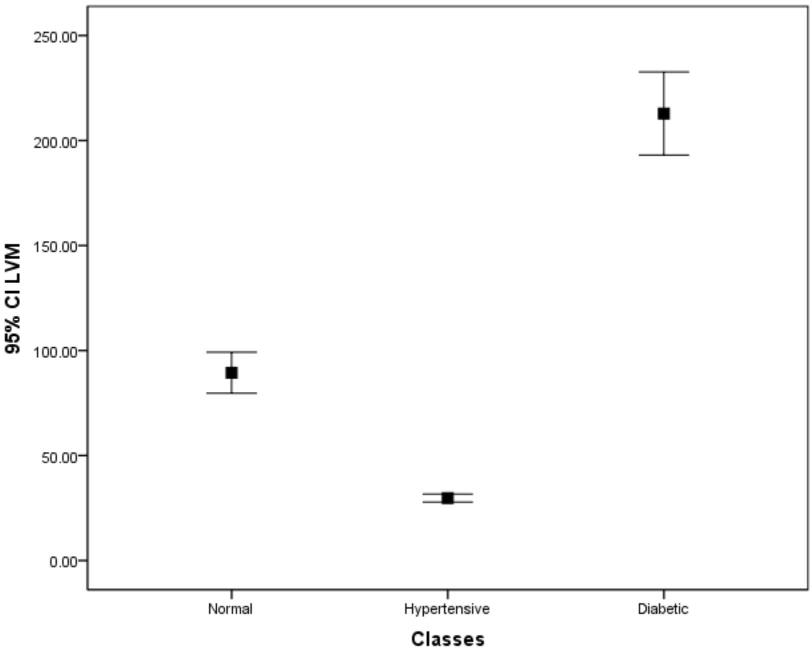

140.00
120.00
100.00
80.00
95% CI EDV
Normal
Hypertensive
Diabetic
Classes


4.50
4.00
3.50
3.00
2.50
2.00
95% CI LVIDS
Normal
Hypertensive
Diabetic
Classes


70.00
60.00
50.00
40.00
30.00
95% CI ESV
Normal
Hypertensive
Diabetic
Classes


250.00
200.00
150.00
100.00
50.00
95% CI EF
Normal
Hypertensive
Diabetic
Classes


60.00
50.00
40.00
30.00
20.00
95% CI FS
Normal
Hypertensive
Diabetic
Classes


250.00
200.00
150.00
100.00
50.00
0.00
95% CI LVM
Normal
Hypertensive
Diabetic
Classes

CHAPTER FIVE

Chapter Five

Discussion, Conclusion and Recommendations

5. 1 Discussion:

This study evaluated two dimensional echocardiographic parameters for Sudanese adult hypertensive and diabetic patients compared with normal subjects in order to provide the effects of these diseases on them through the following results:

The mean values of body characteristics include age for normal subjects, hypertensive and Diabetic patients were 44.5±11.1, 57.3±13.1 and 57.2±13.1 and body max index were 24.7 ± 8.5, 27.1±6.4 and 28.1±10.7 respectively. But the mean values of all echocardiographic parameters respectively include: interventricular septum thickness in diastole (IVSd) per cm were 0.92±0.58 , 1.21±1.05 and 1.98±9.74, Left ventricular posterior wall thickness in diastole (LVPWd) in cm were0.91±0.55, 1.10±0.61and 1.13±0.81,left ventricular internal diameter in diastole per cm (LVIDd) 3.78±1.11, 5.58±4.10 and 5.51±3.86,left ventricular end diastolic volume per ml (LV EDV) 83.60±42.44, 122.59±59.73 and 122.78±57.79, left ventricular posterior wall in systole per cm (LVPWs) 1.13±0.61, 1.06±0.50 and 1.32±1.16, left ventricular internal diameter in systole per cm (LVIDS) 2.41±0.82, 3.75±1.39 and 3.75±1.33, left ventricular end systolic volume per ml (LVESV) 37.44±22.19, 59.62±46.77 and 60.63±44.37, left ventricular ejection fraction percentages(LVEF) 64.79±8.62, 55.12±14.38 and 55.39±14.10, , left ventricular ejection fraction percentages (LVFS) 34.99±6.48, 29.75±9.49 and 29.87±9.29, Left ventricular mass per g(LVM) 89.41±49.68, 101.00±29.75and 212.84±106.57, Aortic diameter per cm (AOD) 2.41±0.78, 2.95±2.78 and 3.11±3.10, Left atrial diameter per cm (LAD) 2.93±1.06, 4.04±3.70 and3.99±3.49 and Left atrial to Aortic ratio (LA_AO) were1.35±0.34, 1.44±0.43 and 1.43±0.41.(Table 4.1)

In relation of age with echo cardiographic parameters for hypertensive patients there was significant association of the left ventricular poster wall diameter in diastole (LVPWd) and Systole which were decreased with age (P-values= -0.08 and – 0.02) respectively but left ventricular posterior wall diameter in systole (LVPWDs) and Aortic to left atrial diameter ratio (AOD/LAD%) were increased with age (P-values =0.036 and 0.008) respectively .But for the normal subject only Left ventricular internal diameter in systole (LVIDs),Ejection fraction(LVEF)and Aortic Diameter(AOD) were increased with age(Table 4.2) and these results are similar with some previous studies include study done by (Masao Daimon, MD1et al 2008)) which mentioned several systolic and diastolic parameters varied with age such as Aortic root diameter, LV wall thickness, and LV mass slightly increased with age), (Seis you Kou et – 2014) results from the reference values which varied with age. These age-related changes persisted for most parameters after normalization for the body surface area. Other Similar result done by (Richard B. Devereux et al -2012) which reflect that aortic root diameter is increases with age) and (Shota Fukuda-2012) proved that Left atrial (LA) sizes slightly increased with age. Body max index had a signifignat association with only the systole (Systole increased with BMI, P-value = 0.029) for hypertensive patient and for the normal patients also there was significant relation of BMI with the systole in addition to Left ventricular posterior wall diameter in diastole was increased with BMI , p-values = 0.021 for each one) (Table 4.2) .other Similar result done by (Richard B. Devereux et al -2012) which reflect that aortic root diameter is increases with body size. But the Body size and age had no significant association with all parameter for diabetic patients (Table 4.3).

In relation of all echocardiographic parameters for hypertensive patients compared with normal subjects for equality of means there were significant results of them include Interventricular septum thickness in diastole (IVSd) p-value= 0.016 , Left ventricular posterior wall thickness in diastole (LVPWd)P-value =0.025 ,l Left atrial diameter (LAD) P-value 0.004 and there were highly significant results of left ventricular internal diameter in diastole (LVIDd), left ventricular end diastolic volume (LVEDV), left ventricular internal diameter in systole (LVIDS), left ventricular end systolic volume (LVESV), left ventricular ejection fraction percentages(LVEF), left ventricular fraction shorten percentages(LVFS) p-values = 0.000 for each one .(Table 4.4)

There were significant results in relation of all echocardiographic parameters for diabetic patients compared with normal subjects for equality of means include Left ventricular posterior wall thickness in diastole (LVPWd)P-value =0.019 , Left atrial diameter (LAD) P-value 0.003 and there were highly significant results of left ventricular internal diameter in diastole (LVIDd), left ventricular end diastolic volume (LVEDV), left ventricular internal diameter in systole (LVIDS), left ventricular end systolic volume (LVESV), left ventricular ejection fraction percentages(LVEF), left ventricular fraction shorten percentages(LVFS) p-values = 0.000 for each one .(Table 4.5)

Comparing left ventricular dimensions and mass for hypertensive and diabetic patients compared with normal subjects include (IVSD cm, LVIDd cm, LVPWs/cm and LVM/ g) for both groups were greater than the means values for normal subjects, statistically these differences are significant (P-values < 0.05) except Left ventricular posterior wall thickness in systole (P-values were 0.385 for hypertensive group and 0.096 for diabetic group) (Table 4.6) which similar to the result done by (Kou et al – 2014), (Healthwise Staff-202.) and (Harkness et al -2020) Echocardiographic reference ranges for normal cardiac chamber size which proved (LVM consider large with them(p-value 0.000) (table 4.3) due to effect of hypertension systolic blood pressure is more important and the wall stress is a key factor influencing left ventricular hypertrophy development) also evidence in this study by high systolic blood pressure for hypertensive patients than normal subjects) which reflect the mean values of diastolic pressure/mmHg and systolic blood pressure/mmHg for hypertensive patients is greater than the means values for normal subjects, statistically this differences are highly significant (P-values < 0.0001) (Table 4.7).But the diabetic group due to myocardial hypertrophy which affect in LVH (left ventricular hypertrophy)

The means values of the Left ventricular volumes EDV (End diastolic volume) and ESV (End systolic volume)for hypertensive and diabetic patients were greater than the means values for normal subjects, statistically (p-value 0.000) so this differences are highly significant (P-values < 0.001).But the mean values of left ventricular ejection fraction were less than the means values for normal subjects, statistically these differences are highly significant (P-values < 0.001) (Table 4.8) but it considers with in border line of normal limit of stander reference done by (Harkness-2020) due to elevated pressure in arteries which make heart works harder to pump against increased pressure and weakens the muscle for hypertensive patients mainly in addition and this results is similar to other studies done by (Health wise Staff-2020)and(La Canna – 2020) found out that Heart Failure With Reduced Ejection Fraction affect in 55% of the total blood in the left ventricle is pumped out with each heartbeat and many different problems cause heart failure with reduced ejection fraction such as Cardiomyopathy (A disease of the heart muscle) it effect that heart muscle is weakened, which affects its ability to pump properly).

The mean values of Aorta and left ventricular diameters for hypertensive and diabetics patients were more than the means values for normal subjects, statistically these differences are significant (P-values < 0.05) (Table 4.9) because left ventricular hypertrophy increased risk of adjusted cardiovascular events. Similar results done by (Iarussi D et al-2001) and LA dysfunction is highly associated with left ventricular diastolic dysfunction (McGhie-1991) .

There were significant associations between left ventricular volumes (LVED and LVES) with duration of hypertension (p-value= 0.000,0.000).In diabetic patients results showed an increasing in (LVIDs) and it was significantly correlated with the increasing in BMI (p-value = -0.012).there was a correlation between blood sugar value and (AOD) (p-value = 0.026) (Table 10 & Table 11).

Using linear discriminant function we can identify if the patient were normal, hypertensive or diabetic by having the value of the following variables: age, height, EDV, LVIDS, ESV, EF, FS and LVM (Figure 4.1, 4.2 and Table 4.10) and substitute them in the below equation; the vote will be for the higher score as follows:

Normal = (Age × 0.34) + (Height × 0.71) + (EDV × -0.01) + (LVIDS × 4.88) + (ESV × 0.04) + (EF × .02) + (FS × 0.74) + (LVM × -0.01) -84.09

Hypertensive = (Age × 0.48) + (Height × 0.75) + (EDV × -0.02) + (LVIDS × 7.87) + (ESV × 0.09) + (EF × 0.05) + (FS × 1.24) + (LVM × -0.04) -134.36

Diabetic = (Age × 0.41) + (Height × 0.75) + (EDV × 0.01) + (LVIDS × 5.35) + (ESV × 0.03) + (EF × 0.02) + (FS × 0.74) + (LVM × 0.01) -100.22

5.2 Conclusion:

The left ventricular posterior wall diameter in diastole (LVPWd) and Systolic blood pressure, left ventricular posterior wall diameter in systole (LVPWDs) and Aortic to left atrial diameter ratio (AOD/LAD%) were increased with age for hypertensive patients and left ventricular internal diameter in systole (LVIDs), Ejection fraction (LVEF)and Aortic Diameter (AOD) were increased with age for normal subjects. Body max index had a signifignat association with only the systole (Systole increased with BMI for hypertensive patient and for the normal patients also there was significant relation of BMI with the systole in addition to Left ventricular posterior wall diameter in diastole was increased with BMI.But there were no significant association of age and body max index with all parameter for diabetic patients.

The mean values of left ventricular dimensions, volumes , mass and Aortic and left atrial diameters for hypertensive and diabetic patients were greater if compared with normal subjects due to effect of hypertension systolic blood pressure is more important and the wall stress is a key factor influencing left ventricular hypertrophy development) but due to myocardial hypertrophy which affect in LVH (left ventricular hypertrophy) foe the diabetic group, But) .The mean values of left ventricular ejection fraction were less than the means values for normal subjects but it considers with in border line of normal limit of stander reference due to elevated pressure in arteries which make heart works harder to pump against increased pressure and weakens the muscle for hypertensive patients mainly

There were highly significant results of established independent mean values of echocardiographic parameters for hypertensive and diabetic patients compared with normal subject for equality of means except left ventricular posterior wall in systole (LVPWs), Aortic diameters (AO) and left atrial to aortic ratio LA _ Ao in addition of Interventricular septum in diastole (IVS d) for diabetic patient only.

The researcher established equations for each group which will be applied with the cardiologist to identify if the patient were normal, hypertensive or diabetic by having the value of some variables and substitute them in equations so were helping in their early diagnosis.

5.3 Recommendations

The researcher recommends some recommendations include:

- Any diabetic or hypertensive patient should apply 2D echocardiographic examination for each visit with his/her cardiologist doctor which provide the effect of the diseases on echocardiographic parameters which will lead to serious cardiac complications such as ischemic heart disease, cardiomyopathy and finally heart failure.
- It is better for cardiologist to record the echocardiographic images with all measurements in echocardiographic machines for follow up of the patients and for purpose of future researches.
- The echocardiographic cardiologist should apply new methods of echocardiography such as tissue doppler and speckle trace echocardiography if the patient needed as possible in addition to two diminution echocardiograms.
- Better if there is chance of providing samples data base in order to make selection of data easy in order to include all important variables of study such as type of Diabetice …ect.

References

A I McGhie J T Willerson, J R Corbett,"Radionuclide assessment of ventricular function and risk stratification after myocardial infarction," Circulation, vol. 84, no. 3 Suppl, pp. I167–I176, 1991.

Allan Harkness, Allan, Liam Ring,Daniel X Augustine,David Oxborough, "Normal reference intervals for cardiac dimensions and function for use in echocardiographic practice: a guideline from the British Society of Echocardiography." Echo research and practice 7.1 (2020): G1-G18

Atul Luthra, Echo made easy, 1st Edition,ISBN 81-8061-436-'

'/402005

02.

E A Bregagnollo [1], K Okoshi, B B Matsubara, P J Tucc "End-systolic pressure-diameter relation of the left ventricle during transient and sustained elevations of blood pressure." Arquivos brasileiros de cardiology 75 (2000): 26-32

Johnson Francis, "Progressive left ventricular dysfunction and remodeling after myocardial infarction. Potential mechanisms and early predictors," Circulation, vol. 87, no. 3, pp. 755–763, 1993.

Giuseppe Schillaci , Leonella Pasqualini, Gaetano Vaudo, Graziana Lupattelli, Matteo Pirro, Fabio Gemelli, Michele De Sio, Carlo Porcellati, Elmo Mannarino, Effect of body weight changes on 24-hour blood pressure and left ventricular mass in hypertension: a 4-year follow-up. Am J Hypertensin 2003;16:634–639

Healthwise Staff, Heart Failure With Reduced Ejection Fraction (Systolic Heart Failure),August 31, 2020 , university of michigan health available at https://www.uofmhealth.org/health-library/tx4090abc

Jae-Hwan Lee & Jae-Hyeong Park, Role of echocardiography in clinical hypertension, Clinical Hypertension journal 21, article NO 9 (2015).

Kim, Mary,M. Chiara Cavallini,Joseph E. Schwartz,Thomas G. Pickering and Richard "Effect of hypertension on aortic root size and prevalence of aortic regurgitation." Hypertension 28.1 (1996): 47-52

Kozakova ,Morizzo ,Fraser AG[3]Kozakova ,Morizzo ,Fraser AG'Palombo , Impact of glycemic control on aortic stiffness, left ventricular mass and diastolic longitudinal function in type 2 diabetes mellitus. Cardiovascular diabetology, 2017,16(1), pp.1-10

Iarussi D ,carocu ,galdreci,cavino,Dialito,Bossone,Divities,and catrofu, Association of left ventricular hypertrophy and aortic dilation in patients with acute thoracic aortic dissection. Angiology. 2001;52(7):447-455

Opens tax, Heart Anatomy & physiology, Medicine Libaretexts Journal, Aug 30, 2020 page 754

Martin K Rutter , Helen Parise, Emelia J Benjamin, Daniel Levy, Martin G Larson, James B Meigs, Richard W Nesto, Peter W F Wilson, Ramachandran S Vasan,Impact of glucose intolerance and insulin resistance on cardiac structure and function: sex-related differences in the Framingham Heart Study. Circulation 2003;107:448–454

Samanthi, Difference Between EKG and Echocardiogram, August 23, 2018

Thomas Cascino , MD, MSc, Michigan Medicine, University of Michigan;Michael J. Shea ,Cardiovascular Disorders - available at Echocardiography - Edition (msdmanuals.com) ,Last full review/revision Jul 2021

Thomas Kahan1, Lennart Bergfeldt ,"Left ventricular hypertrophy in hypertension: its arrhythmogenic potential." Heart 91.2 (2005): 250-256

Williamsburg, Dilated Cardiomyopathy, Advanced cardiovascular institute journal, 2021, 5215Monticello Ave, suite A VA23188, 1-757-229-1440

Web sites :

https://pdfs.semanticscholar.org/0c62/42c07ef6d57fba7ef18a0a4b4d34d8bd941.pdf1.https://academic.oup.com/ehjcimaging/article/15/6/680/2403412 https://www.sciencedirect.com/science/article/pii/S1110260815300363

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3462295/https://www.sciencedirect.com/science/article/abs/pii/0002870382906512

https://www.researchgate.net/publication/221858240_Normal_Values_of_Real-Time_3

https://heart.bmj.com/content/89/suppl_3/iii2.short

https://www.nature.com/articles/hr2016153

https://academic.oup.com/ehjcimaging/article-abstract/15/6/680/2403412

https://journals.sagepub.com/doi/abs/10.1177/000331970105200702

https://link.springer.com/article/10.1186/s12933-017-0557-z

https://erp.bioscientifica.com/view/journals/echo/7/1/ERP-19-0050.xml

https://www.nature.com/articles/nrdp201758

https://europepmc.org/article/med/1884482

https://www.google.com/search?q=+Ischemic+Cardiomyopathy+2D+Echocardiogram&tbm=isch&ved=2ahUKEwi4x_jCkKv5AhUKqRoKHQyxA5QQ2

https://www.bing.com/search?q=16.+Sample+Size+Calculato&cvid=1965af0a92034f11b6261352f76e9933&aqs=edge..69i57.2025j0j4&FORM=ANAB0

Appendices

Appendix A

Data collection sheets

Data collection sheet for normal subjects

NO	AGE/YR	GENDER	HIGHT/CM	WEIGHT/KG	BMI/KG/CM2	IVSD/CM/	SYSTOLE	DISTOLE	views	LVID/CM	LVPWd/cm/	LVIDS/CM	LVPWD//CM	ESV/ML	EDV/ML	EF %	FS	AOD/CM	LAD/CM	LA/AO%	LVM/G

Data collection sheet for hypertensive patients

NO	AGE/YR	GENDER	HI-GHT/CM	WE-IGHT/KG	BMI/KG/CM2	IVSD/CM/	SY-STOLE	DI-STOLE	views	LVID/CM	LVPWd/cm/	LVIDS/CM	LVPWD//CM	ESV/ML	EDV/ML	EF %	FS	AOD/CM	LAD/CM	LA/AO%	LVM/G

Data collection sheet for diabetic patients

NO	AGE/	GE-	HI-GHT	WE-IGHT/	BMI/	IVSD/	SY-STOLE	DI-STOLE	BL-OOD-	TY-	LVID	LVPW/	LVID	LVPWD//CM	ESV	EDV	EF	FS	AOD//	LAD/CM	LA/AO	LVM
	YR	DER	/CM	KG	KG/CM	CM			SUG	SCAN	D/CM	D/CM	S/CM		/ML	/ML	/%	/%	CM		/%	/G

Appendix B

B.1 Samples of some Echocardiographic images for normal subjects

Image 1

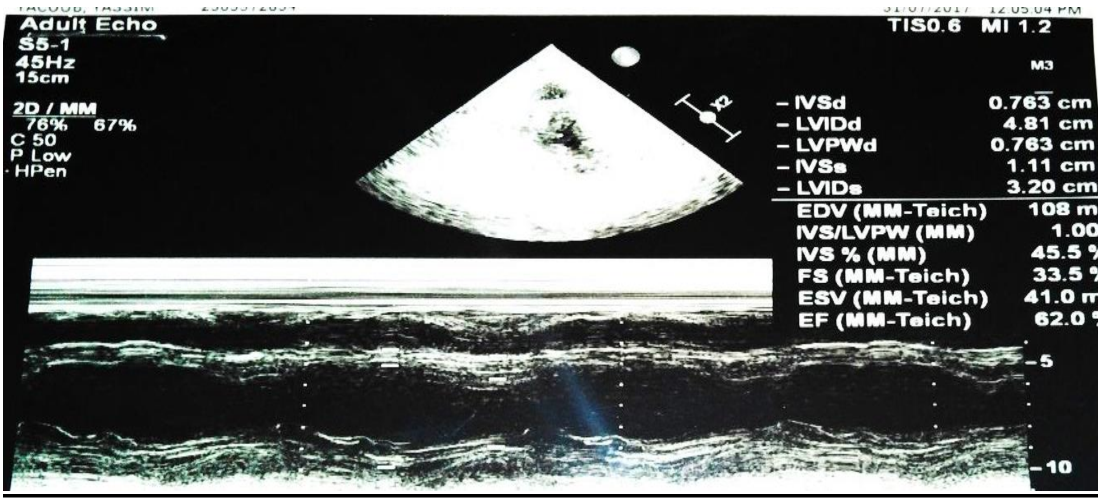


Image 1: showed PSAX view of 2D echocardiography with normal echo parameters measurments mainly EF measured 62 % in M-Mode 2D transthoracic echocardiogram with age 32 years old .

<u>Image 2</u>

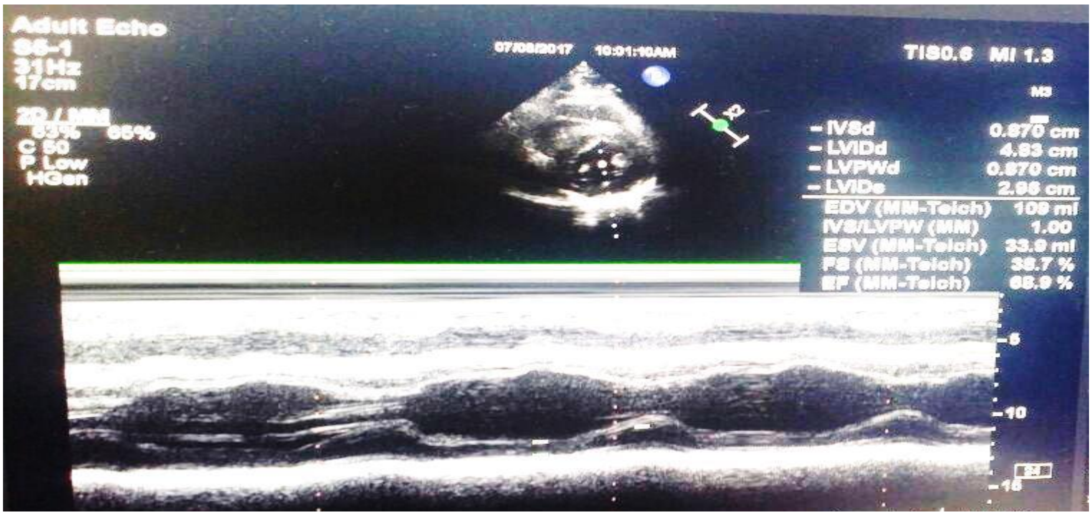


Image 2: showed PSAX view of 2D echocardiography with normal echo parameters measurments mainly EF measured 68.9 % in M-Mode 2D transthoracic echocardiogram with age 40 years old .

<u>mage 3</u>

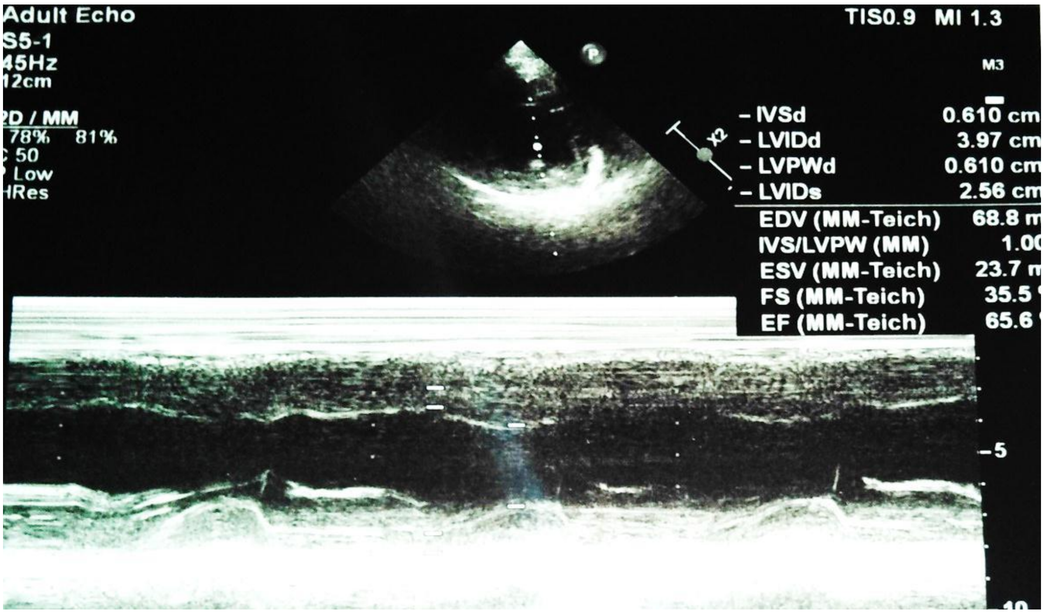
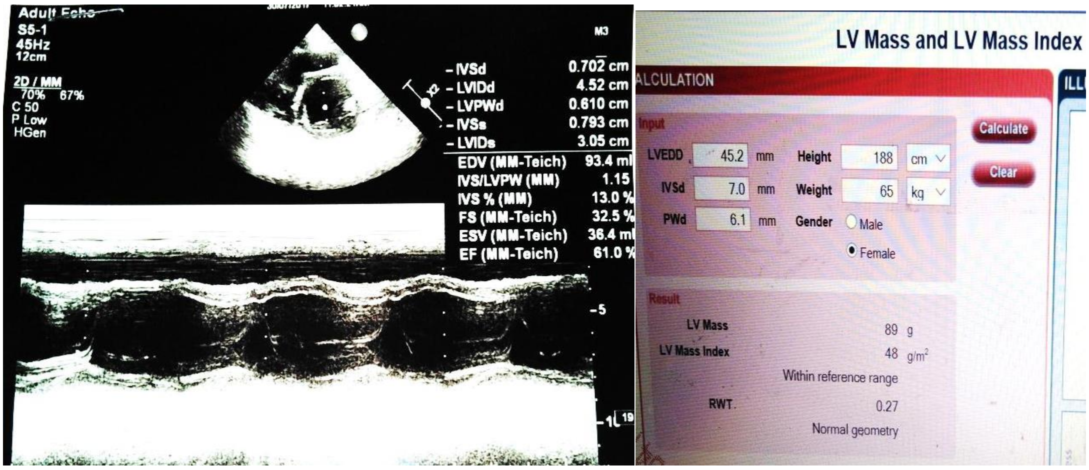


Image 3: showed PSAX view of 2D echocardiography with normal echo parameters measurments mainly EF measured 65.6 % in M-Mode 2D transthoracic echocardiogram with age 48 years old .

Image 4



A B

Image 4: showed PSAX view of 2D echocardiography with normal echo parameters measurments mainly EF measured 61% in M-Mode 2D transthoracic echocardiogram in image A and normal LVM measured 89 g for woman in figure B with age 42 years old & BMI measured 28.34kg/m^2.

B.2 Samples of some Echocardiographic images for hypertensive & diabetic patients

Image 4

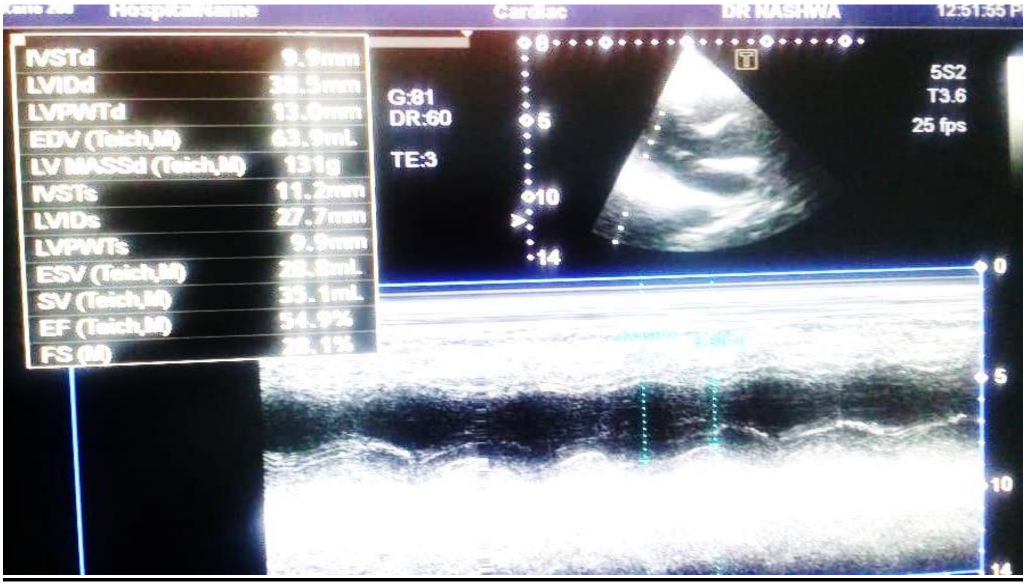


Image 4: showed PLAX view of 2D echocardiography with normal echo parameters measurments mainly with in border line of EF measured 54.9 % in M-Mode 2D transthoracic echocardiogram for woman with age 65 years old

<u>Image 5</u>

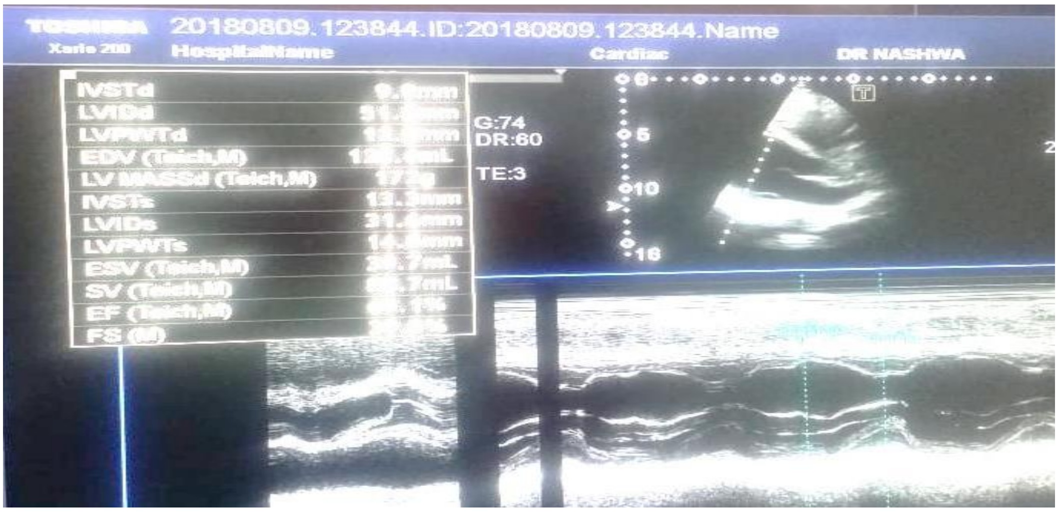


Image 5: showed PLAX view of 2D echocardiography with normal echo parameters measurments mainly EF measured 54.9 % in M-Mode 2D transthoracic echocardiogram and normal LVM measured 46 g for woman with age 65 years old

Image 6

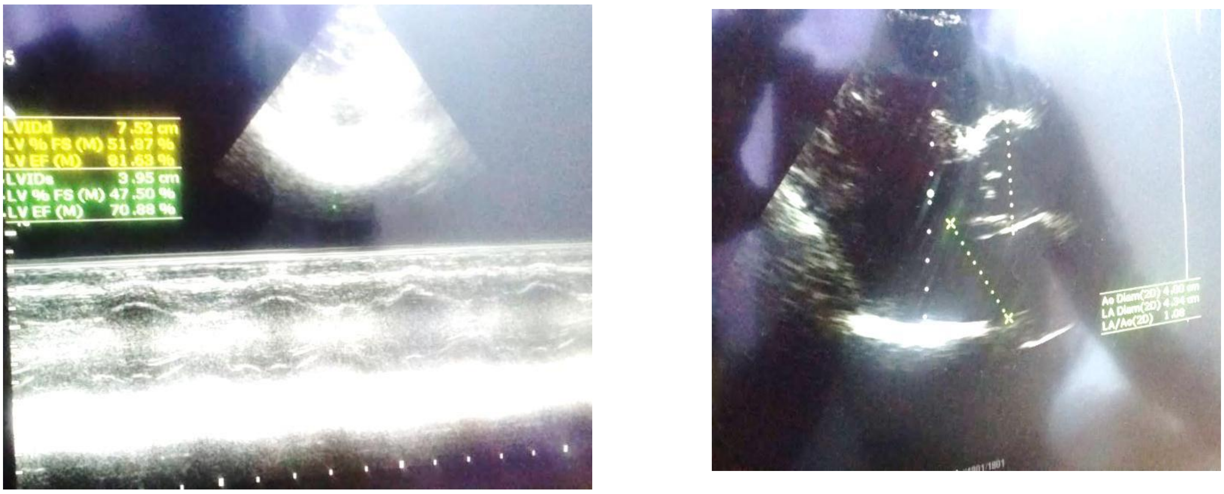


Image 6: showed PLAX view of 2D echocardiography with normal echo parameters measurments mainly EF measured 70.88 % in M-Mode 2D transthoracic echocardiogram for woman with age 53 years old

Image 7

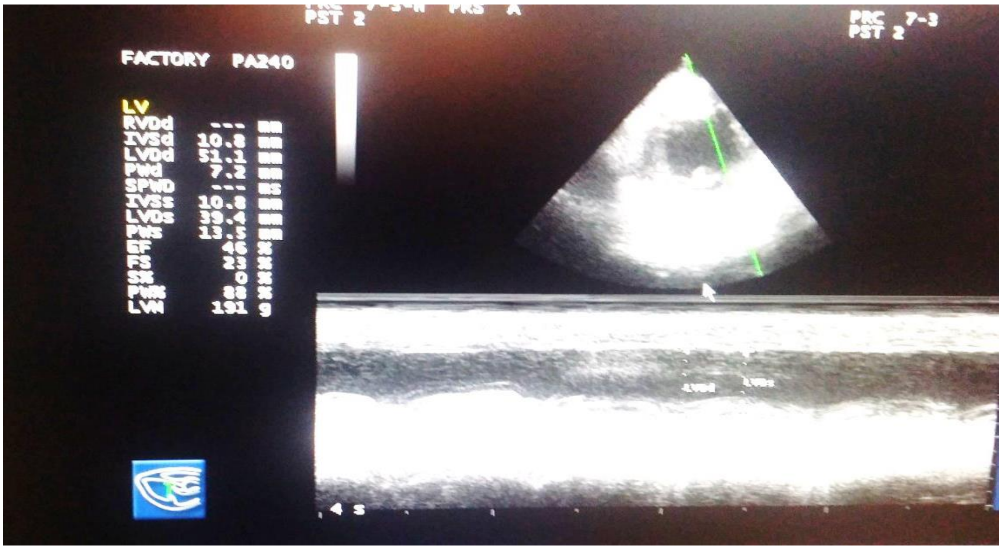


Image 7: showed PSAX view of 2D echocardiography using M-Mode technique with low EF measured 46% for woman with age 46 years old

mage 8

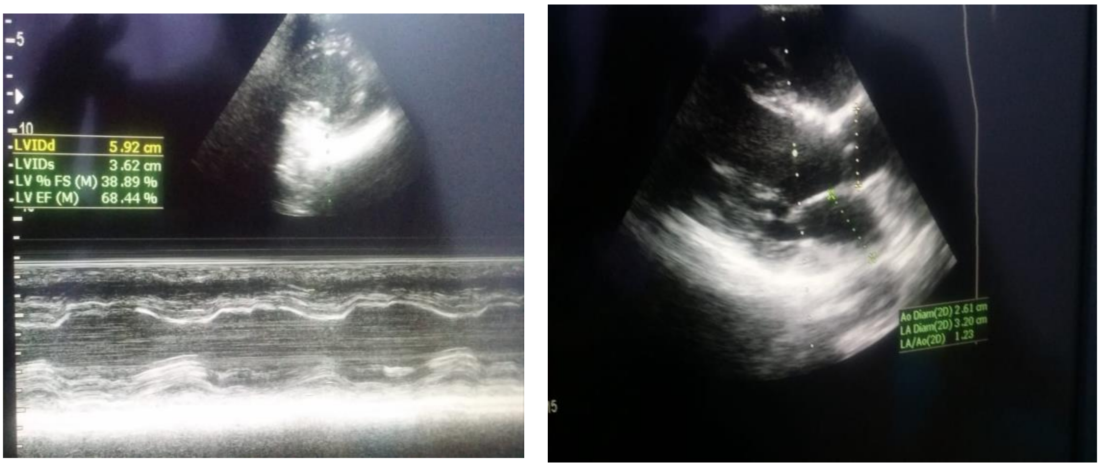


Image 8: showed PSAX view of 2D echocardiography using M-Mode technique with normal EF measured 68.44% for woman with age 32 years old

Image 9

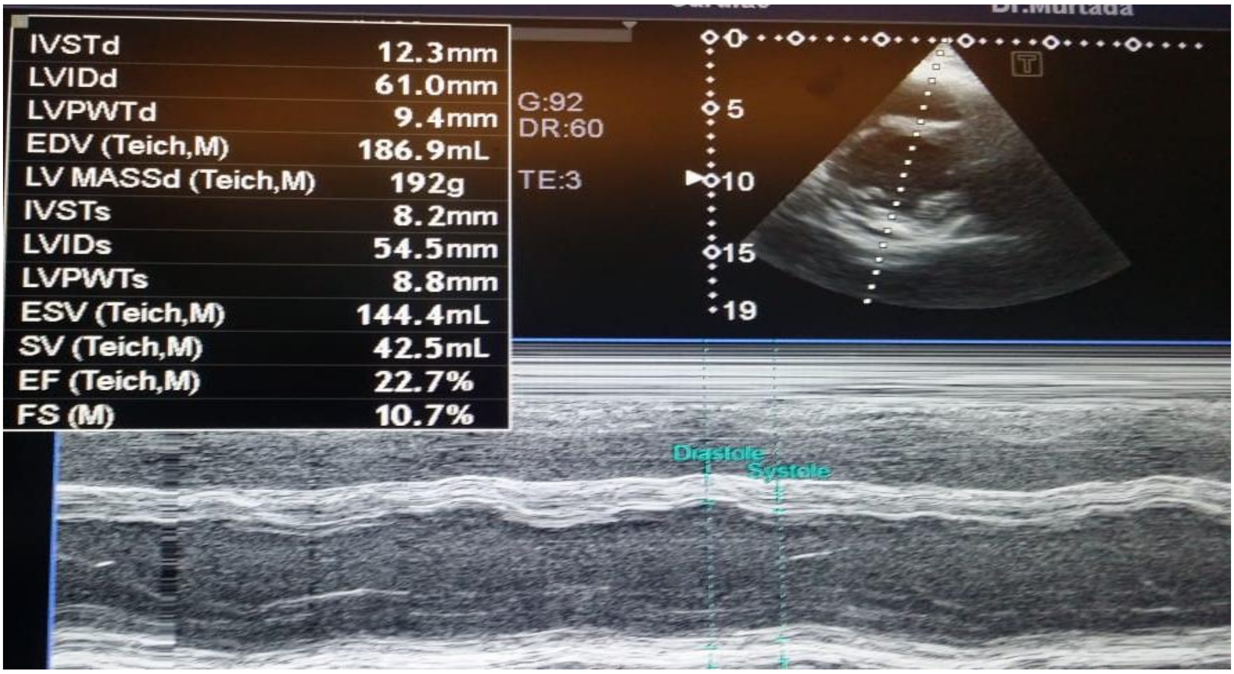


Image 9: showed PLAX view of 2D echocardiography using M-Mode technique with low 22.7 EF measured 68.44% for men with age 54 years old

Appendix C

C1. Echocardiographic Machine

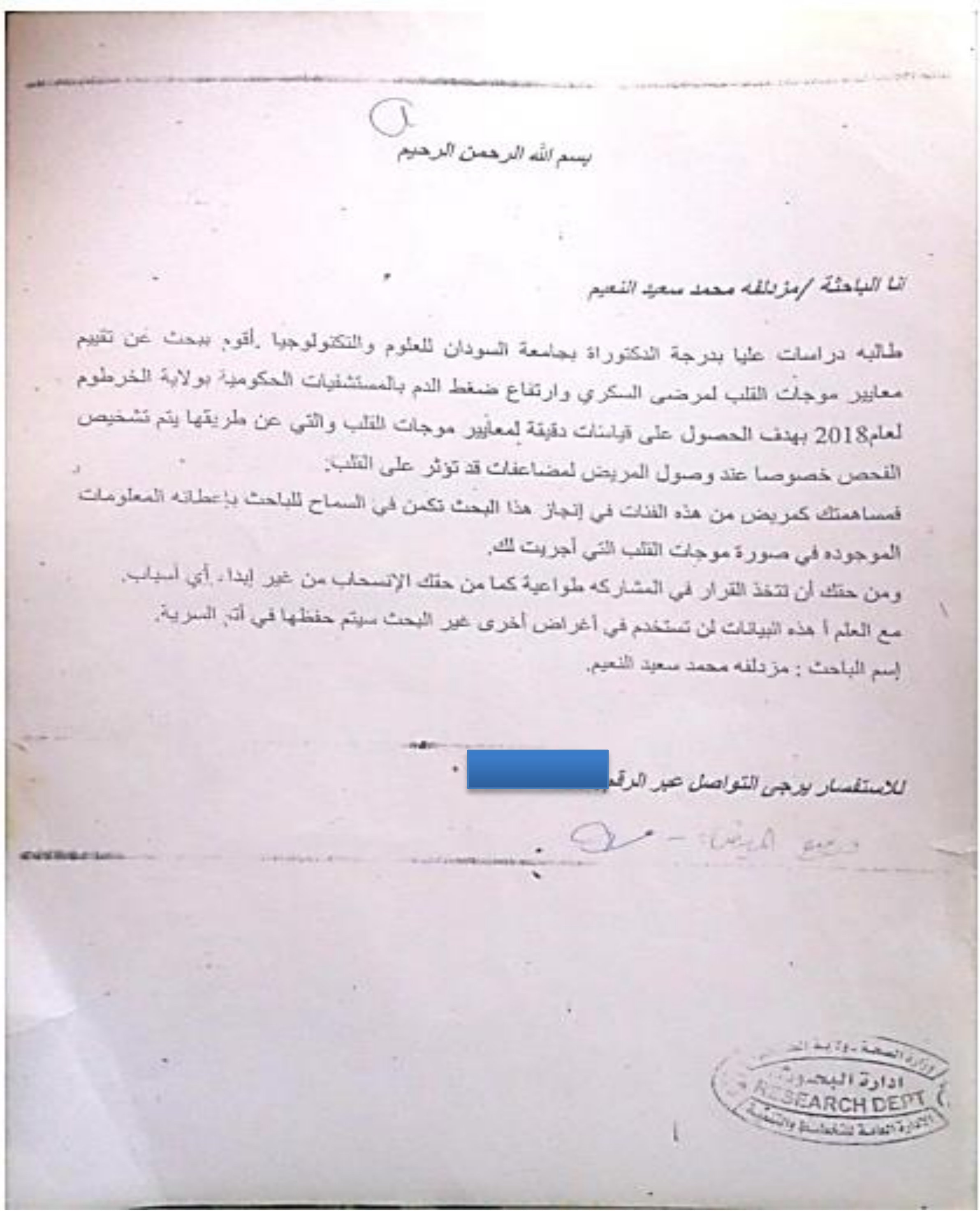

Xario 200
PROBE EXAM
PROBE
Preset
PIMS
Other
TSA Micro CV
Arteriel MCV
Veineux MCV
Abdo Vasc
TSA CV
Arteriel CV
Veines CV
TSA
Arteriel
Veineux
Sclerose
STANDBY
BATTERY
ACOUSTIC POWER
TWIN VIEW
WIDE VIEW
PW
POWER
CDI
ADF
2D
SET
NEXT
STILL STORE
CLIPS STORE
B/W PRINT
LAYOUT / QUAD
DUAL
SINGLE
UPDATE
Q.SCAN
CALIPER
ABC
FRZ
GAIN

C2 Echocardiographic Machine

C3. Echocardiographic Machine

Appendix D

Ethical paper



بسم الله الرحمن الرحيم

انا الباحثة /مزدلفه محمد سعيد النعيم

طالبه دراسات عليا بدرجة الدكتوراة بجامعة السودان للعلوم والتكنولوجيا .أقوم ببحث عن تقييم معايير موجات القلب لمرضى السكري وارتفاع ضغط الدم بالمستشفيات الحكومية بولاية الخرطوم لعام2018 بهدف الحصول على قياسات دقيقة لمعايير موجات القلب والتي عن طريقها يتم تشخيص الفحص خصوصا عند وصول المريض لمضاعفات قد تؤثر على القلب:

فمساهمتك كمريض من هذه الفئات في إنجاز هذا البحث تكمن في السماح للباحث بإعطائه المعلومات الموجوده في صورة موجات القلب التي أجريت لك.

ومن حقك أن تتخذ القرار في المشاركه طواعية كما من حقك الإنسحاب من غير إبداء أي أسباب.

مع العلم أ هذه البيانات لن تستخدم في أغراض أخرى غير البحث سيتم حفظها في أتم السرية.

إسم الباحث : مزدلفه محمد سعيد النعيم.

للاستفسار يرجى التواصل عبر الرقم [redacted]

توقيع المريض -

ادارة البحوث

RESEARCH DEPT

Appendix E

Published papers