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Original Research Article

An Observational study on Echocardiographic assessment of Left Ventricular function in patients with and without metabolic syndrome

Article History:

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Abstract: ***Background:*** Metabolic Syndrome is a group of risk factors that leads to deterioration of target organs. According to the NCEP ATP III definition, Metabolic Syndrome is defined as the presence of three or more of the following: obesity, high TGL, low HDL, hyperglycemia, and hypertension. Obesity is an increased accumulation of fat in the body that threatens life. Metabolic Syndrome is mostly associated with LV function. The anomalous stiffening of the ventricles, which develops improper filling of the ventricles during diastole, is known as Diastolic Dysfunction. Heart failure is most commonly and largely influenced by the development of Diastolic dysfunction. (1)(2) ***OBJECTIVE:*** To analyze the LV function through echocardiography in patients with and without metabolic syndrome in outpatients and inpatients of the cardiology department. ***MATERIALS AND METHODS*** The prospective study was conducted in the department of cardiology at Chettinad Hospital and Research Institute, Kelambakkam. Fifty consecutive patients presenting to the hospital with Metabolic Syndrome and fifty patients without non- metabolic syndrome during a period of six months were studied according to the protocol given in the Proforma. Between the months of February 2022 to May 2022, a total of 50 patients were a known case of Metabolic syndrome and 50 patients were non-Metabolic. ***RESULTS*** The study included 100 patients were taken in which 64 patients were male (64%), and 36 patients were female (36%) who underwent Trans Thoracic Echocardiogram in Chettinad Super speciality Hospital were included. In 100 patients, with mean age group of 30 to 70 years, 30% patients were within the age group of 30 to 50, 56% patients were within the age group of 50 to 60 and 14% patients were within the age group of 60 to 70 years. Among 100 patients, by including both Metabolic and Non-Metabolic syndrome, 34 patients had a known comorbidity of Type II Diabetes mellitus, 28 patients with Systemic Hypertension, 18 patients with Dyslipidemia, 16 patients with Hypothyroidism, and 4 patients had Coronary Artery Disease. The average changes in echocardiographic parameters after performing Trans thoracic Echocardiogram in Metabolic syndrome patients revealed LA diameter ranges between 2.9 + 0.8, Deceleration time ranges from 225 + 11.75, E/A value ranges between 0.81 + 0.10, E/E' ranges between 11.78 + 0.93, Iso volumetric relaxation time ranges from 95.99 + 16.04 and Ejection fraction ranges from 48.5 + 6.2. The changes in echocardiographic parameters in Non-Metabolic syndrome patients revealed LA diameter ranges between 2.8 + 0.8, Deceleration time ranges from 185 + 13.32, E/A value ranges between 1.10 + 0.14, E/E' ranges between 7.94 + 0.88, Iso volumetric relaxation time ranges from 85.19 + 13.71 and Ejection fraction ranges from 60.5+4 .***CONCLUSION:*** According to the current study, individuals with metabolic syndrome exhibit impaired LV diastolic function. The degree of LVDD is linked to several metabolic syndrome features, including waist circumference, FBS,

E/A, IVRT, and DT. A statistically significant correlation between E/E' and the degree of diastolic dysfunction was found. Therefore, aggressive therapy should be given to individuals with metabolic syndrome to prevent the risk of heart failure in the future.

Keywords: Metabollic syndrome, diastolic dysfunction, systolic function, non-metabollic.

INTRODUCTION

Metabolic syndrome is a group of diseases that consists of central obesity, decreased HDL cholesterol, an increase in TGL, elevated blood sugars, and a rise in BP. Presence of three or more of the above criteria is known as Metabolic syndrome. It is associated with a common metabolic disorder called Insulin resistance, which prevents your body from consuming insulin efficiently. That's why it is also known as insulin resistance syndrome(1).

Serum TGL > 150mg/dl
Serum HDL <40mg/dl
Blood pressure >130/80mmHg
FBS > 100mg/dl or T2DM
Waist Circumference >90cm

INTRODUCTION

Obesity or Overweight, which is the excessive amount of fat that is deposited in the body which increases the risk to your health. A BMI range over 25 is taken as obese or overweight. An increase in triglycerides, which is a certain type of fat that makes the arteries hard and can lead to a heart attack. High-density Lipoprotein, also called good cholesterol. A decrease in HDL may cause an increase in risk of heart disease. In Insulin resistance syndrome, excess adipose tissue releases fatty acids in excess. Excess fatty acids cause impairment of endothelial function and also cause visceral and vascular insulin resistance.(1)

Hyperglycemia and fatty acids in diabetes increase the cell concentration of the metabolite diacylglycerol. Diacylglycerol activates protein kinase C, which is important in metabolic activity. An insulin defect leads to glucose release, which leads to fasting hyperglycemia. It also leads to VLDL release and causes hypertriglyceridemia. This causes low HDL in circulation and cholesterol ester and TGL exchange takes place between LDL. And leads to dense lipoprotein particles. In diabetic patients, lipid profile is described by an increase in TGL levels, low high-density lipoprotein, or normal to high levels. This is also called diabetic dyslipidemia (1).

An increase in blood glucose level in the blood is known as hyperglycemia. Elevated blood glucose may affect the vessels that supply blood to the heart. These patients have a higher chance of developing HF. The Framingham Heart study says that diabetes increases the rate of HF 2-fold in men and 5-fold in women. Study shows that about 12% of diabetics have CHF, and 3% of the population are without CHF.

An elevated blood pressure where the blood force against the wall of the arteries is too high. Hypertension may cause hypertensive and ischemic heart disease. Chronic high blood pressure may give over strain to the heart and make very hard to pump the blood from the heart. It also makes the blood vessels thicken and simultaneously makes heart muscles to weak and may cause heart failure. HTN increases the risk of HF 2 fold in men and 3 fold in women.(3)(6)

Metabolic syndrome and Coronary disease are closely related. Atherosclerosis is the major threat to patient with or without metabolic syndrome. Hyperglycemia affects muscles of the heart thus causes systolic and diastolic dysfunction and failure. About 97% hyperglycemic patients are dyslipidemic. As a result, there is increased TGL and decrease in HDL found in plasma of diabetics. Dyslipidemia is the process which promotes atherosclerosis in diabetics. Even in those who are not diabetics like prediabetes are also associated with increase rate of CAD. Both diastolic and systolic abnormalities are seen in these patients.Metabolic syndrome is more relatable to the function of the Left Ventricle. Left Ventricular function is divided into two which is systolic and diastolic function. Most of the heart failure are occurred by dysfunction of the Left ventricles. Abnormalities of myocardium are clinically manifested as impairment of the Left Ventricle

LV is the essential part of CVS. Due to LV contraction, oxygen rich blood is transported to entire body through aortic valve. The primary function of LV is to provide cardiac output to keep blood flow to other organs. Systolic contraction of LV results cardiac output which influences preload, afterload and contractility.

CO = HR X SV

CO is defined by amount of blood volume which is pumped out from heart in given time. HR is number of heartbeats in given time recorded in beats per minute (BPM). SV is volume of blood ejection in

single ventricular contraction.

SV is calculated by difference between EDV and ESV, EDV is the blood volume in LV at the end of diastole. ESV is residual blood volume remaining in LV after ejection.

SV = EDV – ESV

EF is the commonly used index to estimate CO, LVEF is blood volume pumped out during systole relative to blood volume in LV at the end of diastole.

LVEF = SV / EDV

The simplest and widely used parameter is EF. Over last decades strain imaging has become available. 2D Echocardiography, 2D guided M-mode and Doppler echo are used to measure LV dimension and volume.(4)

Global LV Systolic function can be assessed by the following:

Ejection Fraction:

EF is defined by percentage of blood leaving the LV while each contraction.

The qualitative assessment of EF by PLAX and PSAX view. In PLAX view, observe the wall motion of LV whether hyper contractility or hypo contractility and MV leaflet function. In PSAX view at mid papillary level, observe the muscle in similar fraction and ensure that all sides of wall are moving inward equally. LV diastole start immediately next to systole. The entire middle layer of myocardium must relax itself rapidly during diastole, so that ventricle can relax and refill with blood during systole. Diastole allows sufficient filling of both ventricles during at rest and work without any increase of ventricular pressures.(4)

PHASES OF DIASTOLE:

Isovolumetric Relaxation Time:

The time period that extends from closure of the Aortic Valve to the opening of the Mitral Valve without any change in LV volume. It ends when the Left ventricular pressure decreases below the Left atrial pressure, resulting Mitral Valve Opening and the beginning of the rapid filling phase.

Rapid Filling phase:

This phase starts with the Mitral Valve Opening, in which blood rapidly moves from Left Atrium to the Left Ventricle with 70% of the stroke volume which is obtained by first third of diastole. The Rapid filling ends at the moment that atrial and ventricular pressure equilibrate.

Atrial Systole:

This phase occurs when Left Atrium pressure is more than Left Ventricle pressure, the rapid filling phase allows Mitral Valve Opens and increase diastolic volume by 25%. Diastole end and ventricular systole starts.

LV DIASTOLIC FUNCTION:

2D Echocardiography helps in diagnosing diastolic dysfunction. It is measured using pulse wave Doppler and Tissue Doppler Imaging Technology. Using pulse wave Doppler velocity Mitral inflow velocity, Medial annulus, Pulmonary vein flow and hepatic vein flow velocity is measured.

Blood flow across MV :

E/A ratio is the Flow velocity across MV in A4C using PWD, Sample volume is placed between leaflet tips and sweep speed is 50-100 mm/s. Gain and filter should reduced to obtain optimal imaging. PWD positioned using color Doppler to see direction of flow and CWD to locate maximum flow velocity. Mitral inflow yield three phase on spectral curve: E wave, Diastasis and A wave

E wave velocity:

E wave represents passive flow of blood from LA to LV. Pressure Gradient develops immediately after AV closes and LV starts relaxation. This results in drop in pressure of ventricles. Pressure of Ventricle drops below pressure of atria, result in opening of MV and passive flow of blood from atrial to ventricle. The factor determining E wave velocity are PG and LV compliance. The velocity of peak E wave is 0.6-0.8ms.

Diastasis:

E wave is followed by diastasis, where there is no flow across Diastasis duration is inversely related to Heart Rate. Diastasis may disappear at very high HR.

A wave velocity:

It reflects flow of blood created by active atrial systole. Velocity is estimated by atrial systole and LV complaince. A wave velocity is 0.2- 0.35ms.

Mitral E/A ratio:

E wave is normally greater than A wave, ratio need to be >1. E/A is dependent of age. E wave become smaller and A wave become greater with age.

Mitral Annular Velocity:

The measurement of motion of mitral annulus while systole and diastole using TDI. While Mitral annulus systole move toward apex and while diastole so the velocities are negative. Two negative waves are seen while diastole e' and a'. Mitral annular velocity can be measured either medially or laterally.

Normal medial velocity <8 cm/s Normal lateral velocity <10 cm/s

E/e' ratio:

The ratio dividing the peak E wave and peak e' velocity, LVEDP can be obtained. Normal E/e' ratio is <15, >15 suggest elevated LVEDP.

Deceleration Time:

Deceleration Time indicates duration of pressure

difference between LA and LV. DT represents rapid acceleration and deceleration. DT normal range 150 – 241ms.

Isovolumetric Relaxation Time:

The time interval from Aortic Valve Closure to Mitral Valve Opening. If Mitral Valve Open delays relaxation gets prolonged and IVRT increases. If Mitral valve opens earlier IVRT gets shortened.

Diastolic dysfunction has been classified into four grades:

Grade I- Mitral Inflow E/A ratio is measured. In Apical 4 chamber view E/A ratio is measured using PWD, where E is smaller than A wave. E wave- Early filling in diastole

A wave- Atrial systole

Grade II- Pseudo normal pattern. It is associated with normal pattern. E wave is higher than A wave.

Grade III- It is Restrictive filling pattern. In this very high E wave and very small A wave is noted. E wave become two time taller than A wave.

Grade IV – It is also called as Irreversible restrictive filling pattern. It is similar to grade III diastolic dysfunction. In this condition diastolic dysfunction can't be reversed(5)(8)(9).

METHOD

The prospective study was conducted in the department of cardiology at Chettinad Hospital and Research Institute, Kelambakkam. Fifty consecutive patients presenting to the hospital with Metabolic Syndrome and fifty patients without non- metabolic syndrome during a period of six months were studied according to the protocol given in the Proforma.

Between the months of February 2022 to May 2022, a total of 50 patients were a known case of Metabolic syndrome and 50 patients were non-Metabolic. All these patients underwent 2D transthoracic echocardiogram during their regular checkup and follow up to Cardiology Department were prospectively reviewed in Chettinad Super Speciality Hospital, Kelambakkam.

INCLUSION CRITERIA:

- Age limit 20 to 70 years
- Patient fulfilling Metabolic syndrome criteria

EXCLUSION CRITERIA:

- COPD
- Valvular heart disease
- Pericardial Effusion
- Pregnancy
- Psychiatric patients

TWO DIMENSIONAL ECHOCARDIOGRAPHIC METHODS

THE VIVID GE S5 SERIES machine was used for measurements in the study. With patients in the left lateral decubitus position, transthoracic echocardiography was performed. Using Conventional Echocardiography 2- Dimensional Echo, pulse wave Doppler, Continuous wave Doppler will be performed using Vivid S5 GE machine in Department of Cardiology. The Standard Parasternal Long axis, Parasternal short axis(PLAX), Apical 4 Chamber(A4C), Apical five chamber (A5C) and Apical 2 Chambers (A2C), Subcostal views will be recorded to assess the LV function.

Assessment of LV systolic function with echocardiography by Ejection Fraction is determined by Simpsons Method

SIMPSONS METHOD

By tracing endocardial border at both systole and diastole, LV is segmented into several discs in A4c and A2C view. Systolic and diastolic volumes are used to calculate(7)(9).

LVEF = LVEDV – LVESV x 100 LVEDV

TABLE 3: SEVERITY OF EF

SEVERITY	EJECTION FRACTION
Normal	55-60%
Mild	45-50%
Moderate	31-40%
Severe	<30%

GRADING LEFT VENTRICULAR DIASTOLIC DYSFUNCTION

The parameters are

- E/A ratio
- E/E'
- Deceleration Time

➢ Isovolumetric Relaxation Time

E/A RATIO

E- Early rapid filling during diastole A-Atrial systole

E/A ratio is measured from Apical 4 chamber view using pulse wave Doppler imaging at the tip of mitral valve leaflets.

TABLE 4: GRADING OF E/A

GRADING	ms
NORMAL	0.9-1.5
GRADE I	<0.9
GRADE II	0.9-1.5
GRADE III	>1.8
GRADE IV	>2.0

E/E’ RATIO

E’- Early diastolic filling velocity

E/E’- Ratio of transmitral blood flow velocity to tissue Doppler velocity at medial annulus

TABLE 5: GRADING OF E/E'

GRADING	Ms
NORMAL	5-10
GRADE I	<8
GRADE II	9-12
GRADE III	>15
GRADE IV	>15

DECELERATION TIME

DT is the time Period between the peak of E wave and its baseline. It is measured in A5C using PWD. Sample volume is placed between LVOT and MV.

TABLE 6: GRADING OF DT

Deceleration Time	Ms
NORMAL	140-240
GRADE I	>240
GRADE II	140-200
GRADE III	<140
GRADE IV	<130

IVRT

IVRT is measured in A5C using PWD. Sample volume is placed between LVOT and MV, which allows to record both Aortic Valve Closure and Mitral Valve Opening.

TABLE 7: GRADING OF IVRT

IVRT	ms
NORMAL	70-90
GRADE I	>90
GRADE II	60-90
GRADE III	<70
GRADE IV	<70

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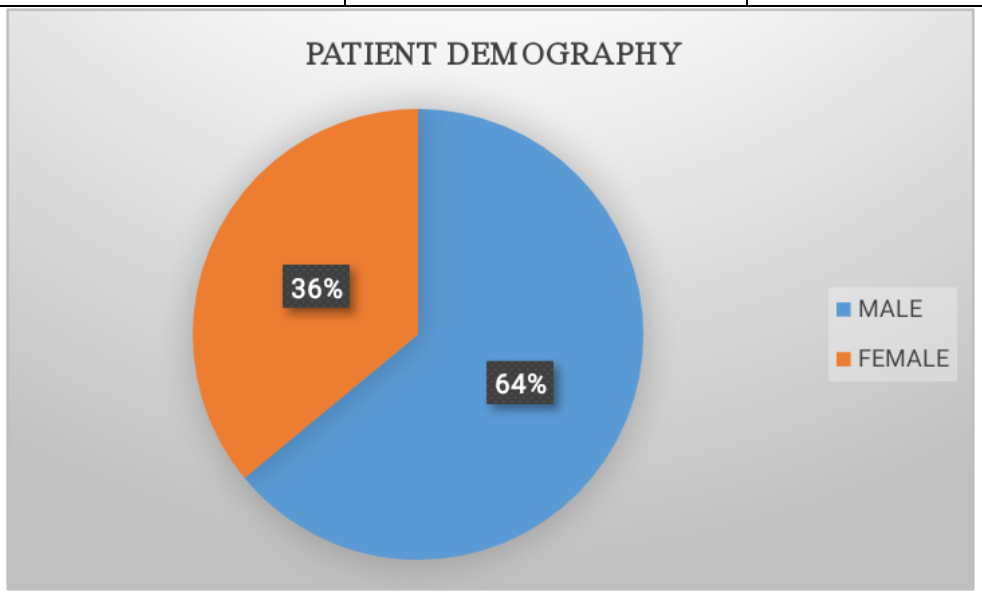
RESULTS

TABLE 5.1: PATIENT DEMOGRAPHY

SEX	NO OF PATIENTS	%
MALE	64	64%
FEMALE	36	36%

FIGURE 5.1:

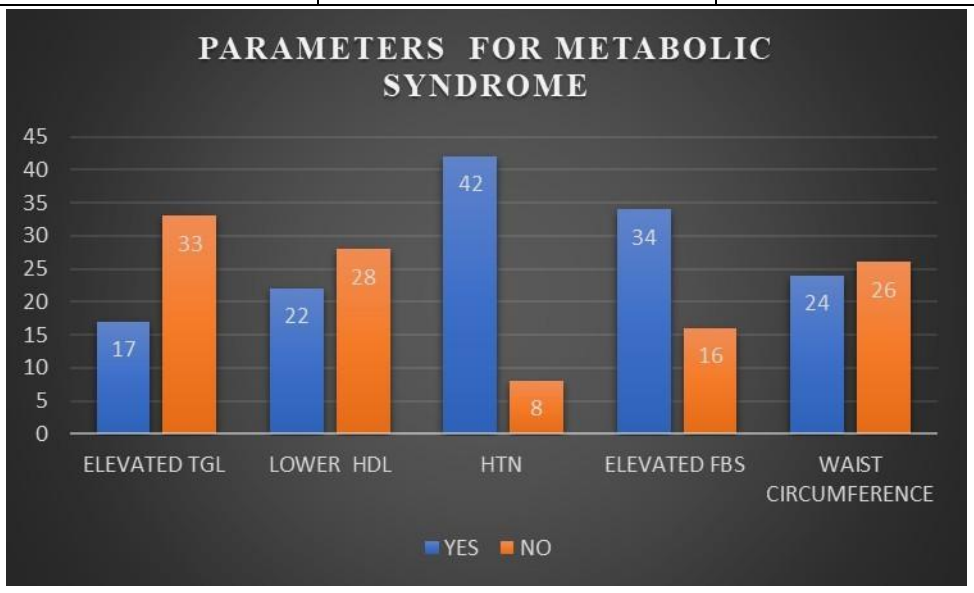


REPRESENT THE PATIENT DEMOGRAPHY

TABLE 5.4: PARAMETERS FOR METABOLIC SYNDROME

VARIABLES	YES	NO
ELEVATED TGL	17	33
LOWER HDL	22	28
HTN	42	8
ELEVATED FBS	34	16
WAIST CIRCUMFERENCE	24	26

FIGURE



5.4: REPRESENTS THE PARAMETERS FOR METABOLIC SYNDROME

TABLE 5.5: ECHOCARDIOGRAPHIC PARAMETERS

VARIABLES	GROUP I (METABOLIC)	GROUP II (NON - METABOLIC)
LA DIAMETER	2.9 ± 0.8	2.8 ± 0.8
DT	225 ± 11.75	185.00 ± 13.2
E/A	0.81 ± 0.10	1.10 ± 0.14
E/E’	11.78 ± 0.93	7.94 ± 0.88
IVRT	95.99 ± 16.04	85.9 ± 13.71
EF	48.5 ± 6.2	60.5± 4.0

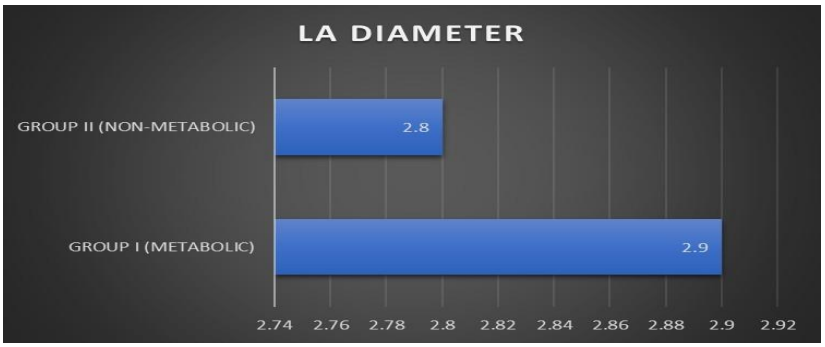


FIGURE 5.5: LA DIAMETER

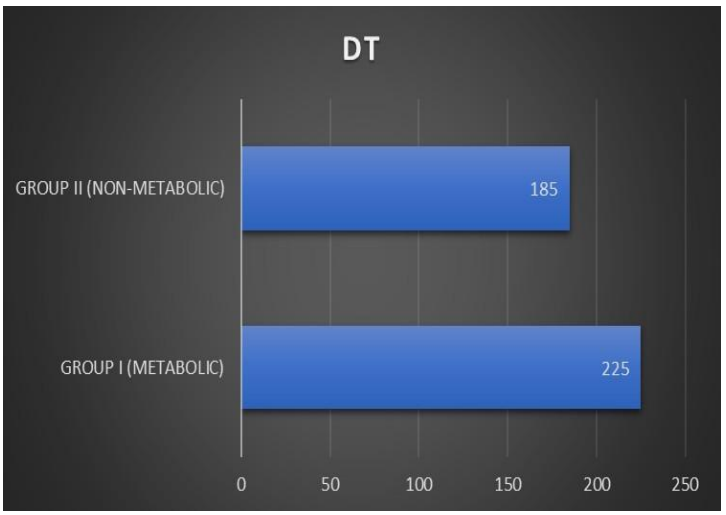


FIGURE 5.6: DECCELERATION TIME

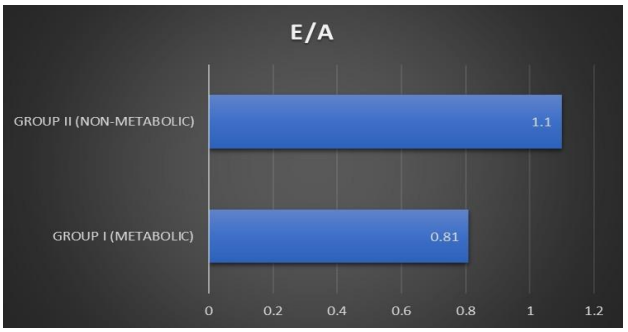
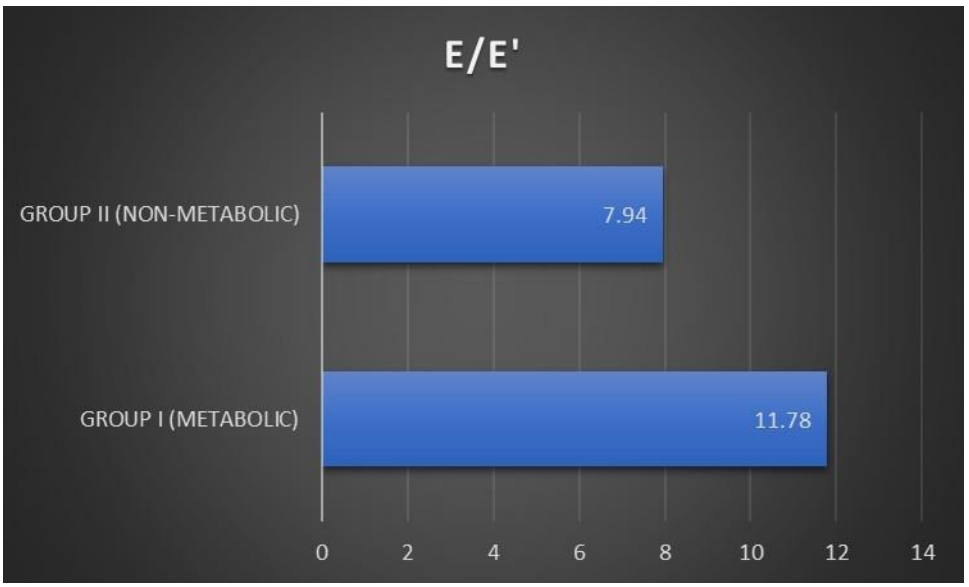


FIGURE 5.7: REPRESENTS MITRAL INFLOW VELOCITY E/A



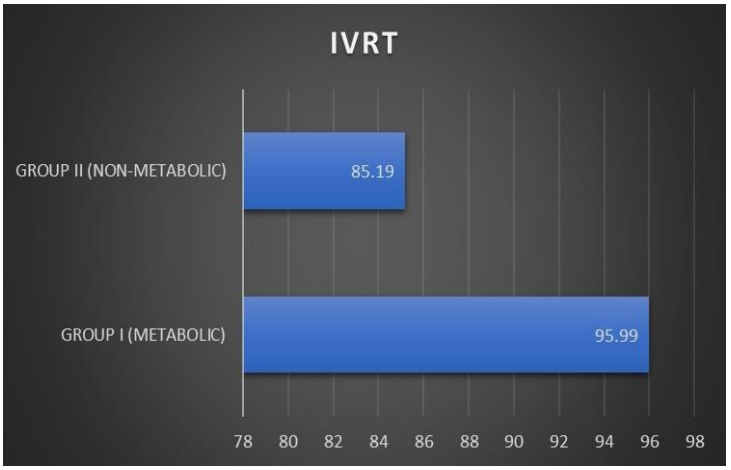


FIGURE 5.8: REPRESENTS MITRAL INFLOW VELOCITY USING TDI E/E’

FIGURE 5.9: REPRESENTS ISOVOLUMETRIC RELAXATION TIME

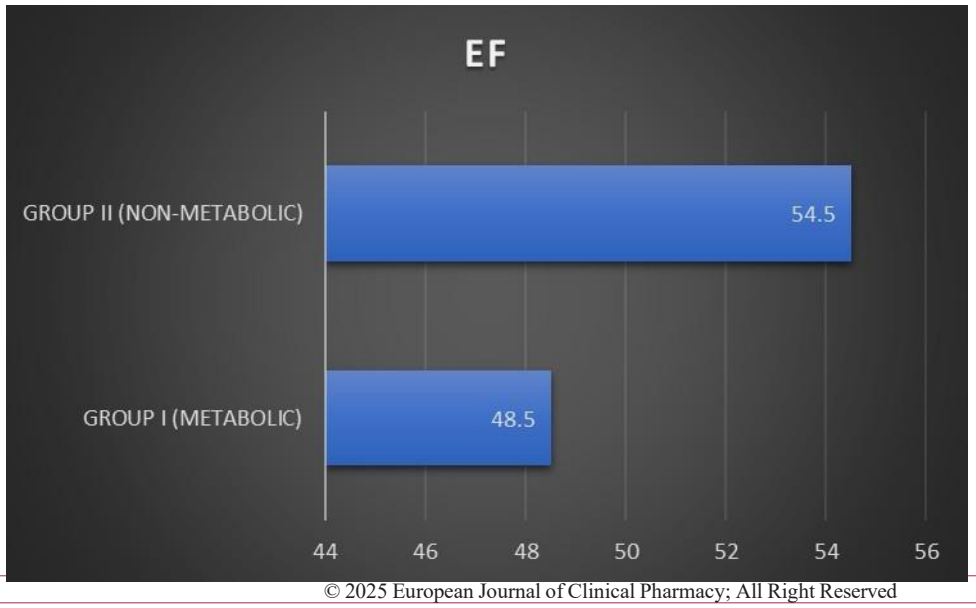


FIGURE 5.10: REPRESENTS EJECTION FRACTION

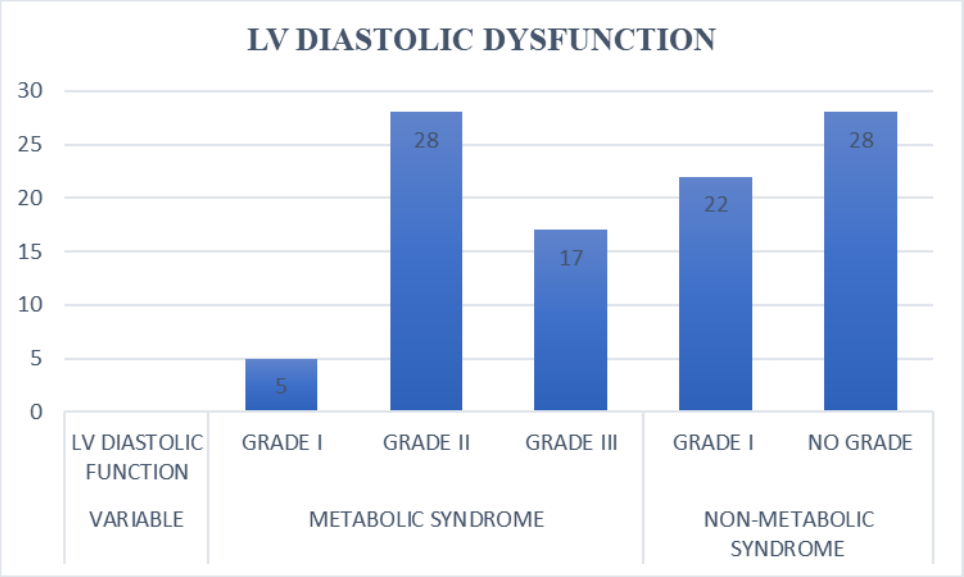


FIGURE 5.11: REPRESENTS LV DIASTOLIC DYSFUNCTION

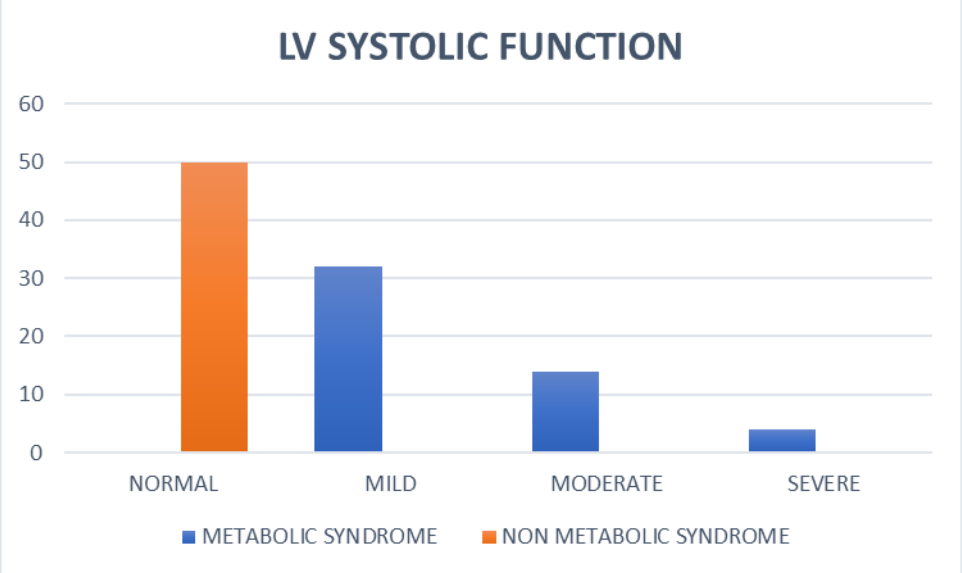


FIGURE 5.12 : REPRESENTS LV SYSTOLIC FUNCTION

DISCUSSION

In this study, 100 patients were taken in which 64 patients were male (64%), and 36 patients were female (36%) who underwent Trans Thoracic Echocardiogram in Chettinad Super Speciality Hospital were included.

In 100 patients, with mean age group of 30 to 70 years, 30% patients were within the age group of 30 to 50, 56% patients were within the age group of 50 to 60 and 14% patients were within the age group of 60 to 70 years.

Among 100 patients, by including both Metabolic and Non-Metabolic syndrome, 34 patients had a known comorbidity of Type II Diabetes mellitus, 28 patients with Systemic Hypertension, 18 patients with Dyslipidemia, 16 patients with Hypothyroidism, and 4 patients had Coronary Artery Disease.

By performing Trans thoracic echocardiogram in both Metabolic and Non- Metabolic syndrome patients, the parameters including LA diameter, Deceleration time, Iso volumetric relaxation time, E/A, E/E’, Ejection fraction were taken.

The average changes in echocardiographic parameters after performing Trans thoracic Echocardiogram in Metabolic syndrome patients

revealed LA diameter ranges between 2.9 + 0.8, Deceleration time ranges from 225 + 11.75, E/A value ranges between 0.81 + 0.10, E/E' ranges between 11.78 + 0.93, Iso volumetric relaxation time ranges from 95.99 + 16.04 and Ejection fraction ranges from 48.5 + 6.2.

The changes in echocardiographic parameters in Non-Metabolic syndrome patients revealed LA diameter ranges between 2.8 + 0.8, Deceleration time ranges from 185 + 13.32, E/A value ranges between 1.10 + 0.14, E/E' ranges between 7.94 + 0.88, Iso volumetric relaxation time ranges from 85.19 + 13.71 and Ejection fraction ranges from 60.5+4 .

By comparing LV systolic and diastolic function in both Metabolic and Non- Metabolic patients, LV Diastolic dysfunction were occur earlier.

In this study, while comparing Metabolic and Non-Metabolic, patients with Metabolic syndrome develops Grade II and Grade III Diastolic dysfunction where Non- metabolic syndrome patients develops Grade I Diastolic dysfunction or No grade.

By this study it came to know Metabolic syndrome primarily affects LV diastolic function which may followed by LV Systolic dysfunction too.

CONCLUSION

According to the current study, individuals with metabolic syndrome exhibit impaired LV diastolic function. The degree of LVDD is linked to several metabolic syndrome features, including waist circumference, FBS, E/A, IVRT, and DT. A statistically significant correlation between E/E' and the degree of diastolic dysfunction was found. Therefore, aggressive therapy should be given to individuals with metabolic syndrome to prevent the risk of heart failure in the future.(8)(9)

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