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A Study of Left Ventricular Diastolic Function Assessed by Echo in Metabolic Syndrome

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Abstract

Introduction: Metabolic syndrome is commonly associated with left ventricular diastolic dysfunction and Metabolic syndrome, previously known as "Syndrome X" or "insulin resistance," comprises a cluster of interconnected risk factors that tend to coexist and collectively elevate the risk of developing atherosclerotic cardiovascular diseases such as coronary artery disease, stroke, diabetes, chronic kidney disease, and certain cancers.

Methods: In this study to find out the prevalence of left ventricular diastolic dysfunction in metabolic syndrome and to highlight the importance of primary prevention in metabolic syndrome. This study was Prospective open label observational study carried out at Department of General Medicine, Patna Medical College and Hospital, Patna. With Department of Cardiology, Department of Medical Biochemistry. This study based on 100 patients, male 59 female 41 having metabolic syndrome.

Result: The left ventricular diastolic dysfunction grade is associated with the number of characteristics of metabolic syndrome.

Conclusion: Diastolic dysfunction is more common in newly diagnosed type 2 diabetes patients compared to healthy individuals. Women with new type 2 diabetes are twice as likely to experience this condition as men. Diastolic dysfunction in these patients is closely linked to factors such as age, high body mass index (BMI), use

of multiple medications, elevated fasting plasma glucose (PPBS), high hemoglobin A1c, and increased levels of total cholesterol and triglycerides.

Keywords: Metabolic Syndrome, Diastolic Dysfunction, Hypertension, Blood Pressure, Myocardial Ischemia.

Introduction

Subclinical left ventricular diastolic dysfunction (LVDD) is prevalent in the general population and serves as a significant predictor of heart failure and long-term mortality. Epidemiological research has consistently linked impaired diastolic function with advancing age, hypertension, and myocardial ischemia. Moreover, recent studies have revealed an independent correlation between diastolic dysfunction and obesity, particularly with excess abdominal fat and visceral adiposity. The presence of insulin resistance emerges as a crucial physiological mechanism underlying this association. Insulin resistance, characterized by reduced responsiveness of body cells to insulin, appears to play a pivotal role in the pathogenesis of LVDD in obese individuals, contributing to adverse cardiac structural and functional changes that ultimately impair diastolic function 5.

Metabolic syndrome (MetS), previously known as "Syndrome X" or "insulin resistance," comprises a cluster of interconnected risk factors that tend to coexist and collectively elevate the risk of developing atherosclerotic cardiovascular diseases such as coronary artery disease, stroke, diabetes, chronic kidney disease, and certain cancers. The definition of MetS varies across different organizations, but typically includes specific diagnostic criteria such as abdominal obesity, hypertension, hyperglycemia, elevated triglyceride levels (hypertriglyceridemia), and low levels of high-density lipoprotein cholesterol (HDL-C). These factors together contribute to an increased likelihood of developing serious cardio metabolic conditions, emphasizing the importance of identifying and managing MetS to mitigate its associated health risks.

This condition represents a group of factors affecting approximately 20-25% of adults in developed nations. In India, the prevalence ranges from 21% to 25% among adults. Elevated blood pressure, hyperglycemia, and central obesity have detrimental effects on the heart both physiologically and pathologically. These components, including hyperglycemia, hypertension, abnormal lipid profiles, and central obesity, are becoming increasingly prevalent due to sedentary lifestyles. Individuals affected by this syndrome often present with heart failure with preserved ejection fraction (HFpEF).

Individuals diagnosed with metabolic syndrome face a heightened risk of heart failure (HF), with a notable proportion developing heart failure with preserved ejection fraction (HFpEF). Patients with metabolic syndrome are at a significantly increased risk of cardiac events compared to those without this condition. This risk is exacerbated by sedentary lifestyles and the rising prevalence of metabolic risk factors, underscoring the urgent need for lifestyle interventions and targeted management strategies to reduce cardiovascular risks associated with metabolic syndrome.

The NCEP: ATP III 2001 criteria define metabolic syndrome as the presence of three or more of the following components:

- Central obesity, indicated by a waist circumference exceeding 102 cm in males or 88 cm in females.
- Hypertriglyceridemia, defined as a triglyceride level of 150 mg/dL or higher, or the use of specific medications.

- Low HDL cholesterol levels, characterized by levels below 40 mg/dL for men and below 50 mg/dL for women, or the use of specific medications.
- Hypertension, identified by a blood pressure measurement of 130 mmHg systolic or 85 mmHg diastolic or higher, or the use of specific medications.
- Elevated fasting plasma glucose levels, with a measurement of 100 mg/dL or higher, or the use of specific medications, or a previous diagnosis of type 2 diabetes.

This study aimed to evaluate the association between Left ventricular diastolic dysfunction and Metabolic syndrome. So far there is minimal literature in our institute regarding the study of diastolic dysfunction in subjects with metabolic syndrome.

Aims and Objectives

- To assess left ventricular function in metabolic syndrome.
- To grade the diastolic dysfunction of the left ventricle in metabolic syndrome.

Materials and Methods

Study Site: The study was done in the Department of General Medicine, Patna Medical College and Hospital, Patna.

Collaborating Departments: Department of Cardiology, Department of Medical Biochemistry.

Study Design: Prospective open label observational study.

Study Period: The study conducted from 1st January 2023 to 30th June 2024.

Selection of Study Population

Inclusion Criteria

- Patients meeting criteria for metabolic syndrome without any acute illness in the past 3 months.

Exclusion Criteria

- Cushing syndrome
- Hypothyroidism
- Anasarca, Known heart disease patients (Ischemic heart disease, congenital heart disease, etc.), Gout.

Sample Size: Using the above mentioned criteria 100 subjects were recruited.

Sampling Method: Convenience sampling methods was adopted.

Study Protocol

Subjects were recruited as per inclusion and exclusion criteria. This included physical and systemic examination. Results of investigation were noted. Left ventricular diastolic function was assessed by measuring E (early filling wave) and A (wave due to atrial contraction) velocity and myocardial relaxation. LV diastolic dysfunction grading I to IV was done.

Statistical Analysis

Data was entered into Microsoft excel and analyses were done using the Statistical Package for Social Sciences (SPSS) version 26. Statistical analysis was done using – Percentages, Mean values, Standard deviation, Standard error, Chi square test, T-test unpaired and 95% confidence interval. Level of significance used is 0.05 for the corresponding degree of freedom to draw the inference. A p value of <0.05 is considered statistically significant.

Result

Table 1: Gender Distribution

Gender	Number	Percentage
Male	59	59%
Female 41	41	41%

Graph 1: Gender Distribution

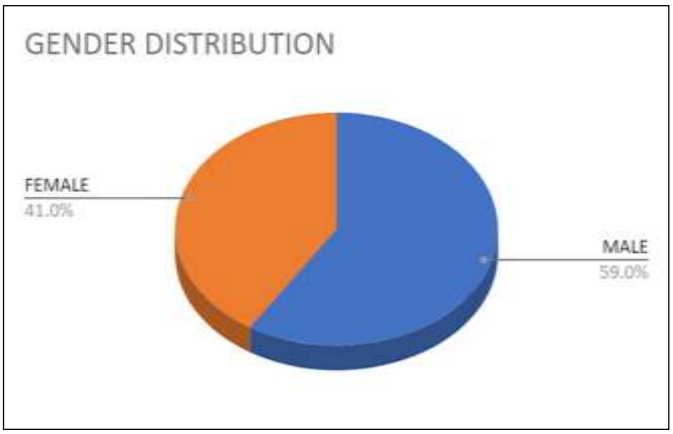


Table 2: Age Distribution

Age	Male	%	Female	%	Mean± Sd
30-40	15	25.42%	7	17.07%	49.9 ± 9.14
41-50	23	38.98%	15	36.58%	
51-60	11	18.64%	12	29.26%	
above 60	10	16.94%	7	17.07%	

Graph 2: Age Distribution

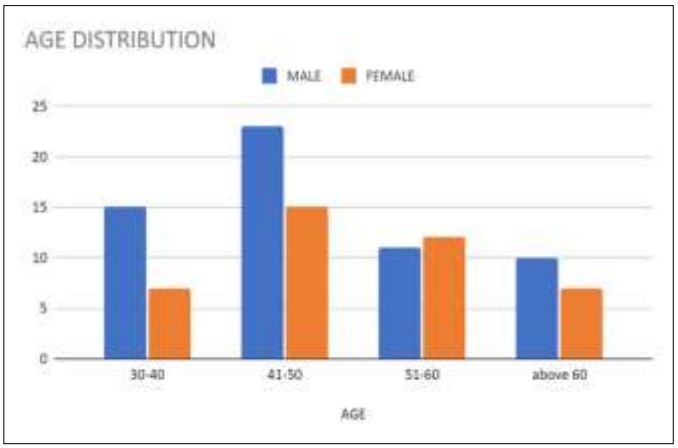


Table 3: BMI

BMI	Male	%	Female	%	Total
23-24.9	5	62.5%	3	37.5%	8
25-29.9	54	58.69%	38	41.30%	92

Graph 3: Body Mass Index

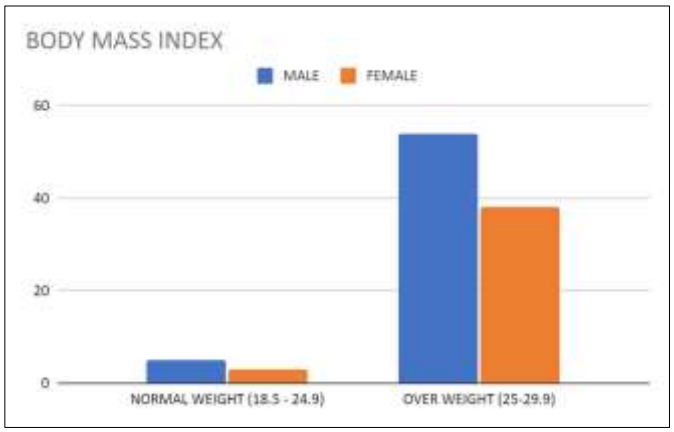


Table 4: Waist Hip Ratio

Waist Hip Ratio	Mean
Male	0.9479
Female	0.9602

Graph 4: Waist Hip Ratio

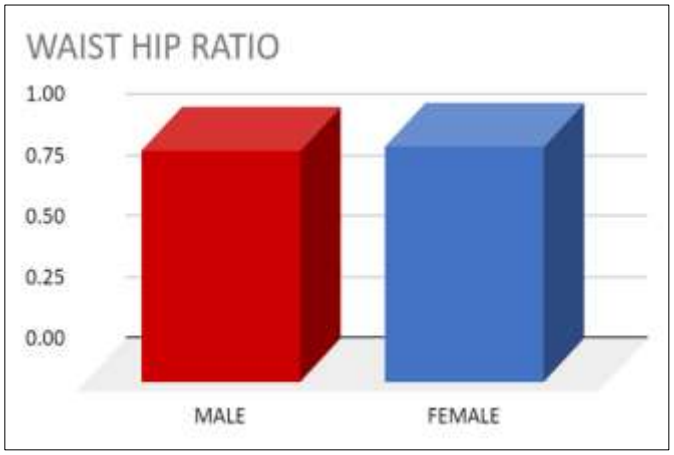


Table 5: Blood Pressure

Blood Pressure	Number	Mean ± Sd
Systolic Blood Pressure	100	127.7 ± 7.506
Diastolic Blood Pressure	100	84.78 ± 6.939

Graph 5: Blood Pressure

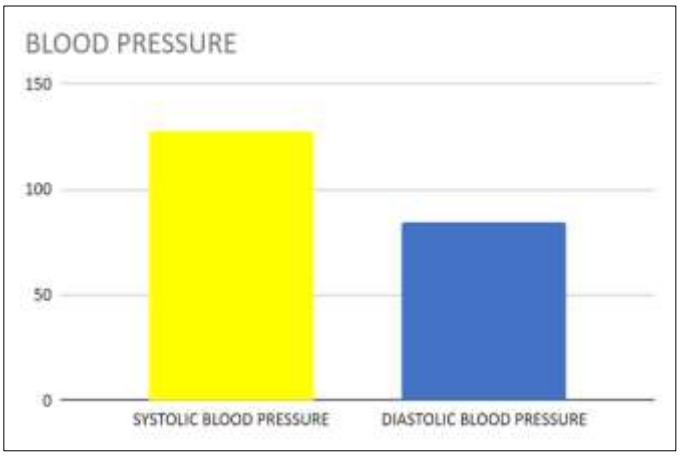


Table 6: Blood Glucose Level

Blood Glucose Level	Number	Mean ± Sd
FBS	100	115.48 ± 14.4
PPBS	100	157.9 ± 19.56

Graph 6: Blood Glucose Level

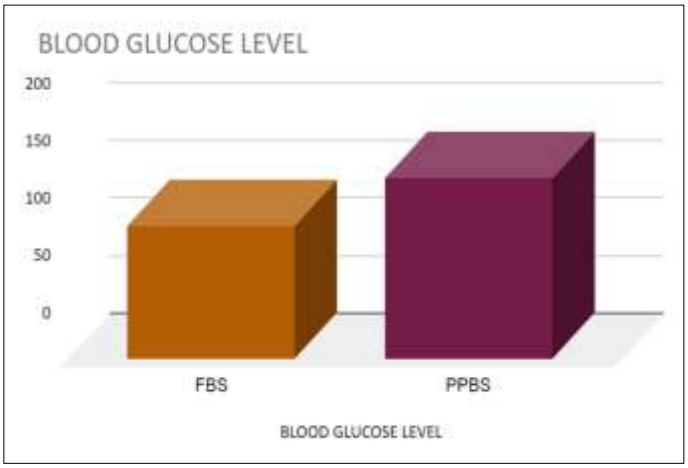


Table 7: Hba1c

HbA1c	Number	Mean ± Sd
4.5 - 5.5	32	6.068 ±0.7319380666
5.6-6.5	38	
6.6 and above	30	

Graph 7: Hba1c

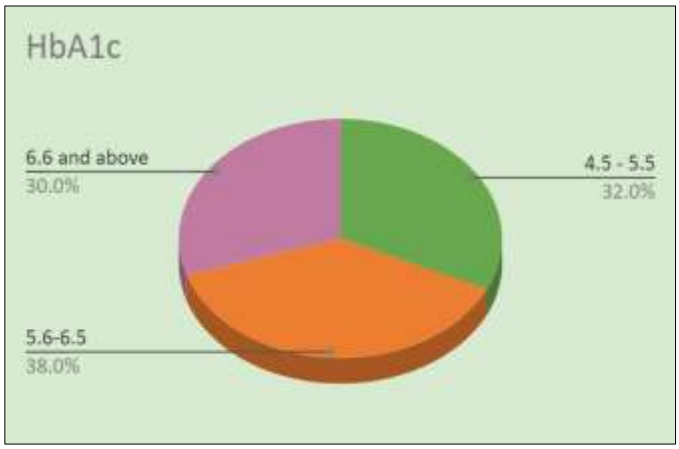


Table 8: Lipid Profile

Lipid Profile	Mean ± SD
Total Cholesterol	195.89 ± 19.46916495
Serum Triglycerides	163.5 ± 30.79534925
Hdl Cholesterol	48.18 ± 9.647713918
Ldl Cholesterol	127.45 ± 31.05953065

Graph 8: Lipid Profile

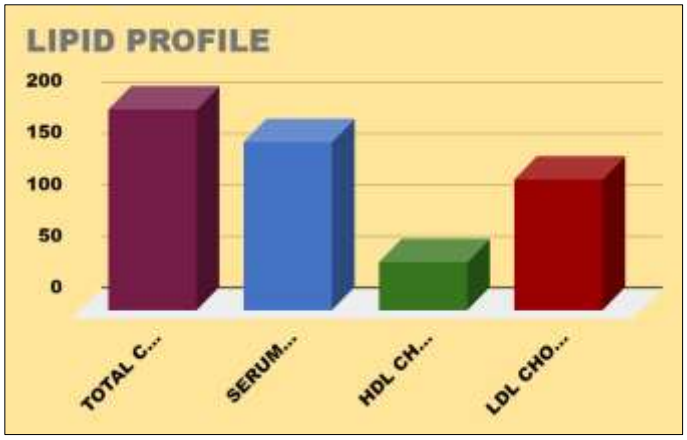


Table 9: E/A Ratio

E/A Ratio	Number	Mean ± Sd
<1	59	0.9936 ±0.177
>1	41	

Graph 9: E/A Ratio

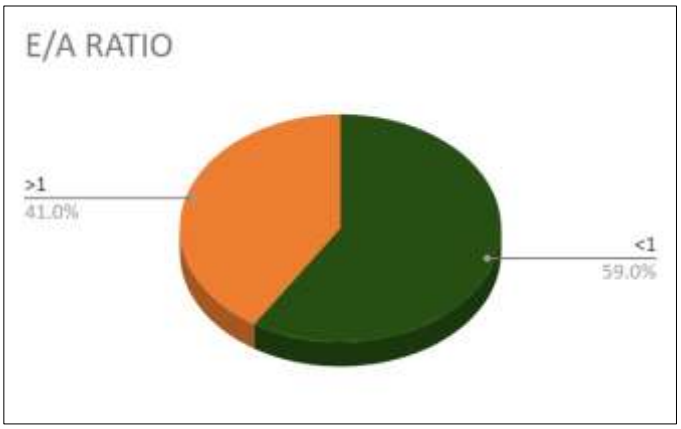
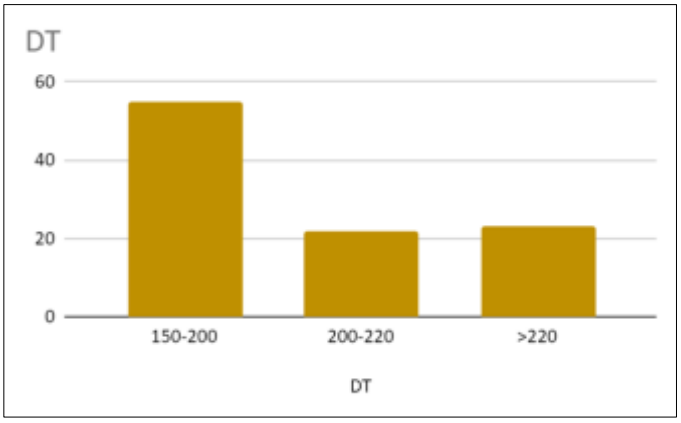


Table 10: Deceleration Time

Deceleration Time	Number	Mean ± Sd
150-200	55	202.19 ±25.562
200-220	22	
>220	23	

Graph 10: Deceleration Time



Discussion

Epidemiological studies indicate that individuals with diabetes face a heightened risk of cardiovascular disease and increased overall mortality, particularly from heart-related issues. Approximately 30% of those with diabetes also experience diastolic dysfunction. Diastolic dysfunction, specifically left ventricular diastolic failure, might be an early sign of diabetic cardiomyopathy, emphasizing the importance of early diagnosis and monitoring in diabetes patients.

Our research revealed that newly diagnosed type 2 diabetes patients were more likely to exhibit diastolic dysfunction (28%) compared to controls (4%). Among newly diagnosed type 2 diabetes patients, those without microvascular complications, hypertension, or coronary artery disease showed similar outcomes on Doppler echocardiography, particularly in the E/A ratio. In a study by Gough et al., pulsed wave Doppler mitral flow velocities were used to assess left ventricular diastolic function in 20 normotensive patients with newly diagnosed type 2 diabetes. Although glucose management improved significantly in the diabetic group over six months (HbA1c reduced from 9.9% to 7.4%, and maintained at 7.0% at six months), the E/A ratio remained unchanged.

Beljic et al. conducted a study measuring left ventricular diastolic function before and after 6 and 12 months of effective diabetes control. They found that the peak E/A ratio was significantly lower in diabetic individuals before therapy, but it did not change substantially after one year of good glycemic management. Conversely, Vanninen et al. demonstrated that diastolic function in newly diagnosed diabetics improved with reduced blood glucose levels, using advanced echocardiographic markers rather than the conventional mitral E/A ratio. In a case-control study by Di Bonito et al., similar results were found using Doppler echocardiography (E/A ratio). Diastolic dysfunction was identified in 16 normotensive patients with type 2 diabetes who had a disease duration of less than a year and no microvascular complications. These findings suggest that diastolic dysfunction can occur early in the course of type 2 diabetes and is not necessarily linked to microvascular complications.

Detecting left ventricular diastolic dysfunction (LVDD) early is essential because it can signify the onset of heart disease related to metabolic syndrome, which may eventually lead to cardiac failure if left untreated. LVDD is recognized as one of the earliest indicators of cardiovascular complications associated with metabolic syndrome, including obesity, hypertension, and insulin resistance. Identifying LVDD at an early stage allows for timely intervention with lifestyle modifications (such as diet and exercise) and appropriate medical management (such as medications to control blood pressure and glucose levels) to prevent the progression of heart disease.

It's important to acknowledge that LVDD can also occur due to other medical conditions unrelated to metabolic syndrome. In our study, individuals with these alternative conditions that could potentially influence LVDD were deliberately excluded to ensure a focused examination of the relationship between LVDD and metabolic syndrome-induced heart disease. This targeted approach helps to clarify the specific impact of metabolic syndrome on cardiac health and underscores the significance of early detection and intervention to mitigate cardiovascular risks in affected individuals.

Conclusion

Diastolic dysfunction is more common in newly diagnosed type 2 diabetes patients compared to healthy individuals. Women with new type 2 diabetes are twice as likely to experience this condition as men. Diastolic dysfunction in these patients is closely linked to factors such as age, high body mass index (BMI), use of multiple medications, elevated fasting plasma glucose (PPBS), high hemoglobin A1c, and increased levels of total cholesterol and triglycerides. Consequently, it is recommended that echocardiography be used to assess heart function in all newly diagnosed diabetic patients who present these risk factors. Additionally, all newly diagnosed diabetics may require an echocardiogram to detect LV diastolic dysfunction once appropriate treatment and prevention strategies are established.

The abnormalities in left ventricular diastolic function, such as changes in E/A ratios, prolonged deceleration times (DT), and isovolumetric relaxation times (IVRT), indicate a connection with metabolic syndrome. These cardiac function changes are likely driven by metabolic issues like insulin resistance, dyslipidemia, and obesity, commonly associated with metabolic syndrome. Identifying these patterns of diastolic dysfunction highlights the urgent need for early detection and proactive management of metabolic risk factors to prevent the progression of cardiovascular complications in those with metabolic syndrome.

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