

## A Cross Sectional Observational Study to Examine the Echocardiographic Features of Patients with T2DM

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Conflict of interest: Nil

### Abstract

**Aim:** To examine the echocardiographic features of patients with T2DM.

**Materials and Methods:** The present cross-sectional study was carried out in the General Medicine ward and Outpatients Department, and Diabetic Clinic of the Patna Medical College & Hospital. A total of 80 patients were studied. 40 male and 40 female diabetic patients were selected. 48 of the patients were on oral hypoglycemic agents and 32 were on insulin. Patients were diagnosed as having diabetes mellitus based on the criteria laid down by the American Diabetes Association, 2017. Each patient underwent a thorough Echocardiographic and Doppler study to assess the cardiac structure and function at PMCH. The system has a full sector movable dipper facility with a movable cursor and inbuilt computer software. Two dimensional and M- mode echocardiography was performed with a 3.5 HZ transducer. The echo cardiographer was kept uninformed about the clinical details of the subject in order to eliminate the possibility of biased observation. Echocardiography and Doppler studies were performed in the resting state and during valsalva manoeuvre.

**Results:** All of the 80 cases selected had altered waist hip ratio. However, 74 out of the 80 patients had high BMI. Increased Interventricular septal thickness was found in 60% of cases as compared to 10 % of controls. Increased LV posterior wall thickness was found in 63.75 % of cases whereas none of the controls had increased LVPWT. Early diastolic dysfunction was found in 62.5% of cases as against 7.5 % of controls. 52% of male cases had early diastolic dysfunction as against 48 % of females. Pseudonormalization pattern was found in 32 % of cases whereas none of the controls showed pseudonormalization pattern.

**Conclusion:** Type 2 diabetics with obesity, particularly central type, have an increased predisposition to the development of left ventricular structural or geometrical abnormality. They have significantly higher left ventricular Mass. Obese type 2 diabetics also have higher incidence of diastolic dysfunction. All these abnormalities occur with greater frequency in females.

**Keywords:** Echocardiography, T2DM, Left ventricular mass, Diastolic dysfunction

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### Background

Cardiovascular disease (CVD) is the main cause of mortality among diabetic patients

[1]. Epidemiological studies showed that more than 70% of patients with T2DM die

of CVD, with 2–3 times higher CVD mortality than among non-diabetic individuals [1–3]. In China, T2DM is associated with increased mortality, especially in rural areas [4].

Early detection of potential CVD in diabetic patients can significantly reduce mortality from diabetic cardiovascular complications. Echocardiography allows determination of the morphological and functional characteristics of the heart and may indicate pathological changes that increase the risk of CVD [5]. Among the indicators, left ventricle hypertrophy (LVH) is a common finding in patients with hypertension, atherosclerosis, obesity, and/or dyslipidemia, but it remains controversial whether T2DM is independently associated with LVH since all the above conditions often coexist with T2DM [5,6]. The 3 main risk factors for increased left ventricle mass (LVM) are hypertension, insulin resistance (IR), and visceral adiposity [7]. LVH is dependent on body surface area and has been shown to predict short- and long-term CVD in patients with T2DM [8]. According to the ACCF/AHA guidelines, T2DM is considered to be a risk factor for heart failure that is independent of the other cardiovascular risk factors [9]. Hypertension in diabetic patients further increases the risks of CVD and death [10].

Therefore, the present study aimed to examine the echocardiographic features of patients with T2DM. The results could help understand the development of CVD in patients with T2DM and provide some clues and further research directions for the prevention of CVD in patients with T2DM.

### Materials and Methods

The present cross-sectional study was carried out in the General Medicine ward and Out patients Department, and Diabetic Clinic of the Patna Medical College & Hospital. A total of 80 patients were studied. 40 male and 40 female diabetic patients were selected. 48 of the patients

were on oral hypoglycemic agents and 32 were on insulin.

### Inclusion criteria

1. Patients were diagnosed as having diabetes mellitus based on the criteria laid down by the American Diabetes Association, 2017. [11]
  - a) Fasting plasma glucose > 7.0 mmol/l (or 126 mg/dl) (Fasting defined as no caloric intake for at least 8hours). Or b) 2-hour plasma glucose > 11.1 mmol/l (200mg/dl) during an oral glucose tolerance test using glucose load containing the equivalent of 75 g anhydrous glucose in water. Or c) Symptoms of diabetes plus random plasma glucose concentration > 11.1 mmol/l (200 mg/dl). Or d) HBA1C  $\geq$  6.5%. These were confirmed on a second occasion.
2. Age more than 50years.
3. An objective response to oral hypoglycemic drugs at some time during the period of study and the absence of a history of diabetic ketoacidosis were the parameters used to rule out type 1 diabetes mellitus (187) [12].
4. All the patients meeting above criteria and having a BMI > 30 and/or Waist Hip Ratio > 0.85 for females and > 0.95 formales.

### Exclusion criteria

Patients with pancreatic calcification, recent history of severe malnutrition were excluded from the study. Also excluded were patients with history of Diabetic ketoacidosis, gestational diabetes, uncontrolled hypertension, other endocrinological disorders, chronic renal disease, liver disease and chronic obstructive pulmonary diseases. Patients with uncontrolled hyperglycemia were also excluded from the study. Patients with history of symptomatic heart disease, angina stable or unstable. Patients with structural heart disease, alcoholic patients, dyslipidemia of genetic origin, hereditary

cardiac disease; rheumatic heart disease, tuberculosis, collagen vascular diseases, drug induced diabetes were also excluded.

### Selection of controls

Controls were selected from the patients attending the Outpatients Department of Medicine and admitted in the Medicine Ward of Patna Medical College and Hospital. They were non-diabetics and non-obese but matching with age, sex and other characteristics of the cases.

### Methods

Detailed history of chief complaints, history of duration of diabetes and medication, history of respiratory, cardiac symptoms, hypertension, smoking, alcohol abuse and personal medical history were taken. History suggestive of peripheral neuropathy and autonomic neuropathy was also taken. History of any past myocardial

infarction, angina or any other significant illness in the past and family history of diabetes were also taken. a) Fasting and postprandial venous plasma glucose level was estimated by enzymatic oxidase method [13]. Glycosylated hemoglobin was estimated by ion exchange chromatography [14]. Each patient underwent a thorough Echocardiographic and Doppler study to assess the cardiac structure and function at PMCH. The system has a full sector movable dipper facility with a movable cursor and inbuilt computer software. Two dimensional and M- mode echocardiography was performed with a 3.5 HZ transducer. The echo cardiographer was kept uninformed about the clinical details of the subject in order to eliminate the possibility of biased observation. Echocardiography and Doppler studies were performed in the resting state and during valsalva manoeuvre.

### Results

**Table 1: Demographic profile of the study Population**

	Cases (n =80)	Controls (n = 80)
Age	62±8	60±8
Heart Rate (b/m)	74±10	73±11
Systolic BP	135±17	130±17
Diabetic BP	82±10	80±10
FBG	128±68	107±12
PPBG	200±50	140±35
HbA1C	6.6±0.9	5.3±0.3
Total cholesterol	177.5±45.3	162±25.9
HDL cholesterol	40.5±81	50.2±11
Triglyceride	164.6±71.9	124.3±26.9
LDL	100±25	94±20
No of patients on		
OHA	24	
Insulin	16	
Height (cm)	158+ 12	158 + 14
Weight kg	78+13	56+ 8
BMI	31+ 3	22.18+ 1.62
Waist circumference	98.4 +11.6	78.6 +9
Hip circumference	98.8+10	89+6.9
WH Ratio	1.00+0.06	0.87+0.011

The blood pressures of the cases and controls were comparable and matched. All of the 80 cases selected had altered waist hip ratio. However, 74 out of the 80 patients had high BMI. Thus 6 out of 80 patients with type2 DM had normal BMI with increased WHR.

**Table 2: Number (%) of cases and control with Abnormality of LV geometry detected by echocardiography**

	Cases		Controls	
	No of cases	%	No	%
<b>Abnormality</b>				
IVST > 1.1 cm	48	60	8	10
Female	25	52	-	-
Male	23	48	-	-
LVPWT > 1.1 cm	51	63.75	0	0
Female	29	56	-	-
Male	22	44	-	-
<b>LV Mass</b>				
Males > 135g	28	70	7	17.5
Females > 111.9 g	30	75	9	22.5

Increased Interventricular septal thickness was found in 60% of cases as compared to 10 % of controls. Increased LV posterior wall thickness was found in 63.75 % of cases where as none of the controls had increased LVPWT. Increased LV mass was found in 70 % of male cases as compared to 17.5 % of male controls and in 75% of female cases as compared to 22.5% of female controls.

**Table 3: Number (%) of cases and controls with LV Diastolic function abnormality detected by Echo Doppler**

	No. of subjects	%	Controls	
			No	%
<b>Abnormality</b>				
E/A < 1	50	62.5	6	7.5
Males	26	52	3	7.5
Females	24	48	3	7.5
E/A >1	30	37.5	74	92.5
<b>Pattern of Diastolic Dysfunction</b>				
Delayed Relaxation	54	67.5	8	10
IVRT > 90 m sec	50	62.5	5	6.25
Male	26	52	-	-
Female	24	48	-	-
Pseudonormalization	26	32	-	-
Males	12	30	-	-
Females	14	35	-	-
Restrictive filling	-	-	-	-

Early diastolic dysfunction was found in 62.5% of cases as against 7.5 % of controls. 52% of male cases had early diastolic dysfunction as against 48 % of females. Pseudonormalization pattern was

found in 32 % of cases whereas none of the controls showed pseudonormalization pattern. This more advanced form of diastolic dysfunction was found in 35 % of females as against 30 % of males. Thus

95.0 % of the cases had diastolic dysfunction and a significantly higher number (35%) of females had more advanced form of diastolic dysfunction. The P value for this being  $< 0.01$ , obtained by chi square test.

## Discussion

All the cases and controls in the present study were subjected to echocardiography and 2D Doppler study. The results were analyzed using the statistical methods mentioned in the materials and methods. Significant abnormalities in left ventricular geometry and function were detected.

In the present study abnormalities in left ventricular geometry were detected in the form of increased interventricular septal wall thickness, increased left ventricular posterior wall thickness and increased left ventricular mass.

Increased interventricular septal wall thickness was found in 60% of the cases as compared to 10% of the controls. Among the cases in the present study incidence of increased IVST was higher in female (52%) as compared to males (48%).

Increased left ventricular posterior wall thickness was found in 63.75% of cases whereas none of the controls had an increase in left ventricular posterior wall thickness. Among the cases in the present study incidence of increased LVPWT was slightly higher in females (56%) as compared to males (44%).

The mean left ventricular mass of the cases in the present study was 186.24 grams, which was significantly higher than that of controls, 119 grams. 72.5% of the cases in the present study had a high left ventricular mass. Among the cases incidence of higher left ventricular mass in females was 75% as compared to 70% in males.

Thus, in the present study type 2 diabetic subjects with a high waist hip ratio and a high BMI had a higher interventricular septal wall thickness, left ventricular posterior wall thickness and LV mass than

those without diabetes and normal waist hip ratio and BMI. In the present study, females had higher incidence of abnormalities in left ventricular geometry as compared to males.

Ronald M *et al*, in the Hoorn study in 2004 [15], found a significantly higher left ventricular mass, interventricular septal wall thickness and left ventricular posterior wall thickness in female type 2 diabetes mellitus patients. The mean left ventricular mass in their study was 169 grams. The results of this study are similar to the present study. However, the mean left ventricular mass calculated in the present study was higher i.e. 186.24 grams. This difference could be due to the higher waist hip ratio and BMI of the type 2 diabetic subjects in the present study.

The Framingham Study Cohort [16] concluded that diabetic individuals, particularly women, had greater left ventricular wall thickness and greater cardiac mass. In a re-examination of 2623 participants in the Framingham Offspring study that had no history myocardial infarction or heart failure, worsening glucose intolerance was associated with increasing left ventricular mass, a finding that was more significant in women than in men. In the present study also, females had a higher incidence of greater left ventricular wall thickness and LV mass, which is in accord with the Framingham study.

Sukamal Santra *et al*. (2011) in the study found that left Ventricular Mass and left ventricular mass Index were Significantly high in Patient of T 2DM, compared with age – sex match healthy population. It was  $104.9 \pm 21\text{gm} / \text{m}^2$  VS  $78.5 \pm 22.7 \text{gm} / \text{m}^2$  [17].

Palmieri V *et al* [18] in a study of 1950 participants concluded that subjects with type 2 diabetes mellitus had higher LV mass and wall thickness than those without diabetes independent of age, systolic blood pressure and sex. The mean LV mass in their study was 178 gm. The higher LV

mass in the present study could be due to the difference in the profile of the type 2 diabetic cases who had a high waist hip ratio and BMI.

Ashmed SS, Jaferi GA *et al* [19], in a population-based sample of type 2 diabetes mellitus patients showed that type 2 diabetes mellitus was associated with higher left ventricular mass and lower myocardial function independent of age, sex and arterial blood pressure.

Z Sasson *et al* [20] in their study concluded that LV mass in the normotensive obese population was strongly associated with the degree of insulin resistance. In the present study of type 2 diabetes subjects with obesity as determined by high waist hip ratio and BMI, high left ventricular mass and left ventricular wall thickness (IVST and LVPWT) were found.

Numerous studies have attempted to determine the prevalence of left ventricular diastolic dysfunction in asymptomatic type 2 diabetic patients [21,22]. However, these studies which used Doppler assessment of trans mitral flow velocity could have underestimated the prevalence of left ventricular diastolic dysfunction between 20% - 40%, because they neglected to account for pseudonormal patterns of left ventricular filling which are often noted in the evaluation of left ventricular diastolic function. Thus, the present study, in which valsalva manoeuvre was used to unmask the pseudonormal pattern, demonstrated a much higher incidence of left ventricular diastolic dysfunction.

Thus, the present study found a significantly increased left ventricular thickness (IVST and LVPWT) and a significantly higher LV mass in type 2 diabetes mellitus patients with high waist hip ratio and high BMI. The incidence of these abnormalities was higher than the other studies.

The present study also demonstrated a very high incidence of diastolic dysfunction in the type 2 diabetes mellitus

patients with high waist hip ratio and BMI. The incidence of LV diastolic dysfunction was also much higher than the other studies.

This higher incidence of abnormalities in the left ventricular geometry and function could be due to the study group, which consisted of obese or centrally obese diabetics. This association between obesity, type 2 diabetes mellitus and left ventricular abnormalities could be responsible for higher incidence of cardiovascular events in such patients.

However, a much larger population-based study is required before a definite causal association can be established between obesity type 2 diabetes mellitus and abnormalities of left ventricular geometry and function.

### Conclusion

Form the data of the present study it can be concluded that type 2 diabetics with obesity, particularly central type, have an increased predisposition to the development of left ventricular structural or geometrical abnormality. They have significantly higher left ventricular Mass. Obese type 2 diabetics also have higher incidence of diastolic dysfunction. All these abnormalities occur with greater frequency in females.

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