International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

# Evaluation of left ventricular function in normotensive type-2 dm patients by echocardiography

Dhirendra Kumar Gautam [1], Abhijeet Kumar [1,*] and Jyoti Prabha [2]

[1] *Department of Medicine, NDMC Medical College and Hindu Rao Hospital, Delhi, India.*
[2] *Department of Obstetrics & Gynecology, NDMC Medical College & Hindu Rao Hospital, Delhi, India.*

International Journal of Science and Research Archive, 2024, 11(02), 2023–2033

Publication history: Received on 14 March 2024; revised on 23 April 2024; accepted on 26 April 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.11.2.0696

## Abstract

The prevalence of diabetes mellitus (DM) is increasing globally. Indians are also believed to have a greater degree of insulin resistance and a stronger genetic predisposition to diabetes. Type II DM is a risk factor for cardiovascular disease and cardiovascular complications and these are a major cause of mortality and morbidity in diabetic patients. Left ventricular dysfunction, increased left ventricular wall thickness, increased left ventricular mass, and specific diabetic cardiomyopathy are some of the cardiovascular complications associated with diabetes. So the present study was performed to assess normotensive diabetic patients by echocardiography to evaluate their left ventricular function.

A case control cross sectional study was conducted on 40 normotensive type 2 diabetes mellitus patients. 40 patients who were non-diabetic, non-hypertensive were taken as a control. A standard 2D echocardiography with M mode and Doppler was performed on case and control. In our study among 40 cases, 55% were male and 45% were female with mean age of case population being 47.5±7.24 year and among 40 controls, 50% were male and 50% were female with mean age 48.03±7.14 year. Mean BMI in case group was 29.49±2.37 kg/m$^2$ and in control group 29.36±2.46 kg/m$^2$. In our study we found that LVDD was present in 57.5% cases, 47.5% of cases had grade 1 LVDD whereas 10% had grade 2 LVDD. In comparison, only 10% of controls had LVDD with all of them having grade 1 LVDD. Also LV Systolic dysfunction, LVM and LVMI were higher in cases as compared to controls. Thus we concluded that the prevalence of left ventricular diastolic dysfunction in asymptomatic, normotensive patients with type 2 DM without significant coronary artery disease is much higher than previously suspected as evidenced by the results of this study and also of similar other studies and it increases with the duration of Diabetes. Left ventricular systolic dysfunction, LVM and LVMH prevalence were also higher in cases as compared to controls and they also correlate with duration of Diabetes.

**Keywords:** LVDD (Left ventricular diastolic dysfunction); LVSD (LV Systolic dysfunction); LVM (Left Ventricle Mass); LVMI (Left Ventricle Mass Index)

## 1. Introduction

The prevalence of diabetes mellitus (DM) is increasing globally [1,2]. It is projected that 366 million people will be diabetic in 2030, 290 million of whom will be living in developing countries. [3,4]. India is home to 69.1 million people with DM and is estimated to have the second highest number of cases of DM in the world after China in 2015. The prevalence of DM in India ranges from 5–17%, with higher levels found in the southern part of the country and in urban areas. Indians are also believed to have a higher degree of insulin resistance and a stronger genetic predisposition to diabetes.

The latest estimates by the international diabetes federation project that 592 million (1 in 10 persons) worldwide will have DM by 2035[5]. While the rates of both type 1 DM (T1DM) and T2DM are growing, T2DM has a disproportionately greater contribution to the rising prevalence of DM globally compared to T1 DM. Type II DM is a risk factor for

* Corresponding author: Dhirendera Kumar Gautam

cardiovascular disease and cardiovascular complications and these are a major cause of mortality and morbidity in diabetic patients.

The results of the Framingham Heart Study showed that the frequency of HF was twice as high in diabetic men and five times higher in diabetic women compared with control subjects; however, not much is known about the cause of this disparity [6]. This association was independent of age, hypertension, obesity, coronary artery disease (CAD) and hyperlipidemia. Other studies showed similar results after correction for confounding variables[7,8].Left ventricular dysfunction, increased left ventricular wall thickness, increased left ventricular mass, and specific diabetic cardiomyopathy are some of the cardiovascular complications associated with diabetes. Myocardial involvement in diabetics may occur relatively early in the course of disease, initially impairing early diastolic relaxation and when more extensive, it causes decreased myocardial contraction. Prior to the development of symptomatic congestive heart failure, sub-clinical left ventricular dysfunction (systolic or diastolic) exists for sometimes. Increased mortality among type II diabetic patients with heart failure with normal ejection fraction also suggests a role for diastolic heart failure.

Till date, limited studies have demonstrated left ventricular diastolic dysfunction in diabetic patients who are normotensive and have no symptoms of cardiac disease. The data regarding systolic dysfunction in asymptomatic normotensive diabetics is even more scarce. Also, frequency of progression from pre-clinical to clinically evident myocardial dysfunction is not well established. With the availability of echocardiography and Doppler studies, the natural history of cardiac involvement from pre-clinical to clinical stage in patients with diabetes can be elucidated.

Considering the paucity of data in regard to development of left ventricular dysfunction in diabetic patients, the present study was performed to assess normotensive diabetic patients by echocardiography and to make further inroads into this aspect of diabetes that would have far reaching implications in management of diabetes as a whole.

## 2. Material and Methods

### 2.1. Source of data

After taking approval from the ethical committee of institution, this case control cross sectional study was conducted on 40 type 2 normotensive diabetes mellitus patients attending the OPD of department of internal medicine at Hindu Rao Hospital Delhi and compared to the control group who were non-diabetic, non-hypertensive [who were accompanying patient in hospital]. This study was conducted from May 2015 to May 2017.

### 2.2. Method of collection of data

*2.2.1. Case population*

Inclusion criteria

- Cases of Type 2 DM diagnosed by WHO criteria
- BP: <130/86 mm Hg (at least 3 recordings with the highest recording taken into consideration)
- Willing to participate in the study

Exclusion criteria

Patients with

- Systemic Hypertension (BP≥140/90 or taking antihypertensive medications) [as per JNC 8 guideline]
- Ischemic heart disease (anginal chest pain, abnormal E.C.G. showing ST segment, and T wave changes, pathological Q wave and /or RWMA on Echo)
- Congestive heart failure (exertional dyspnea, Palpitations, raised JVP, pedal oedema, basal crepitations on chest auscultation)
- Congenital or Acquired Valvular Heart Disease
- CKD [known case of CKD or GFR <90 ml /min/1.73m2 or GFR >90 ml/min/1.73m2 with albuminuria >30mg/24 hour during present visit]

*2.2.2. Control population*

Age and sex matched subjects with no history of DM and systemic hypertension and who were apparently healthy and willing to participate in the study were selected from people accompanying patients to hospital. Exclusion criteria for the cases were also applied to controls.

### 2.3. Methodology

Informed written consent of cases and controls were taken. All patients were subjected to a detailed history, physical examination and investigations through a pre-set proforma.

#### *2.3.1. Clinical examination*

- Blood Pressure
- Standing height
- Weight
- Body Mass Index (BMI) was calculated based on the following formula

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (meter)}^2}$$

  BMI of 23 – 24.9 categorized as overweight and BMI ≥25 categorized as obesity in Asians.
- Body Surface Area : was calculated based on Du Bois formula
  $\text{BSA} = 0.007184 \times W^{0.425} \times H^{0.725}$
- ECG:
- Blood glucose
- Kidney function test

### 2.4. Lipid profile

The test includes three basic parameters: HDL cholesterol, LDL cholesterol and triglycerides. It is usually done in fasting blood specimen.

Dyslipidemia according to NCEP guideline defined as LDL ≥130mg/dl, TG ≥150mg/dl, Cholesterol ≥200mg/dl, HDL <40 mg/dl in male and <50 mg /dl in female

### 2.5. Urine albumin by dipstick

Measures albumin concentration via a colorimetric reaction between albumin and tetra-bromophenol blue producing different shades of green according to the concentration of albumin in the sample.

- Negative
- Trace — between 15 and 30 mg/dL
- 1+ — between 30 and 100 mg/dL
- 2+ — between 100 and 300 mg/dL
- 3+ — between 300 and 1000 mg/dL
- 4+ — >1000 mg/dL

### 2.6. Echocardiography

A standard 2D echocardiography with M mode and Doppler was performed on case and control on a Philips Envisor C machine with a 3-5 MHz transducer probe. Echocardiographer was not aware of this study to avoid bias in the interpretation. The following were registered on assessment –

- LVEF - EF calculated by modified Simpson method by using this formula –
  EF = (EDV -ESV)/EDV
  Cut-off for left ventricular systolic dysfunction for male and female was taken as LVEF <55%
- LV Mass- LVM calculated by linear method using cube formula
  LV Mass=0.8×1.04× [(IVS + LVID + PWT)$^3$-LVID$^3$] + 0.6 gm [Where IVS is interventricular septum; LVID is LV internal diameter, and PWT is inferolateral wall thickness.]
- LVMI – LVMI was calculated by dividing LVM by BSA to decrease the influence of obesity on LV Mass. BSA [Body Surface Area] calculated by Dubois and Dubois formula.
- BSA = 0.20247 x height (m)$^{0.725}$ x weight (kg)$^{0.425}$

LV mass for female 67-162 gm is considered as normal LV mass and >162gm is considered as high LV mass, for male 88-224 gm is considered as normal and >224 gm is considered as high LV Mass.

LVMI for female is 43-95 considered as normal and >95 is considered as high LVMI, or male 46-115 is considered as normal and >115 =high LVMI.

- E [Mitral Early filling velocity] and A [ Mitral late atrial filling velocity] was measured and then E/A ratio was calculated.
- IVRT [ Isovolumetric relaxation time]
- DT [ Deceleration time]

Then grading of diastolic dysfunction was done by using E/A, IVRT and DT as given below:

- Normal diastolic function: E/A=0.8-1.5, IVRT=60-100 millisecond, and DT=160-200 millisecond
- Grade 1 LVDD: E/A <0.8, DT >200 milliseconds, IVRT ≥100 millisecond
- Grade 2 LVDD: E/A= 0.8-1.5 but decreases by ≥50% during Valsalva maneuver (Pseudo-normal pattern)
- Grade 3 LVDD: E/A ≥2, DT <160 millisecond, IVRT ≤60 millisecond.

Our present study is comparative case control cross sectional study involving 40 cases and 40 controls. The obtained data was analyzed to look for left ventricular functional and structural abnormality in type 2 DM patients who are normotensive and without any cardiac symptom and also to assess the relationship between the duration of DM and development of LV functional and structural abnormalities.

*2.6.1. Demographic characteristic of study group –*

A total of 40 cases and 40 control were included in this cross- sectional observational study who met the inclusion and exclusion criteria, after taking informed consent.

40 cases and 40 control were taken, study groups demographics are shown in the table below.

**Table 1** Demographic characteristics of study group

| | **Group** | **N** | **Mean** | **Std. Deviation** | **t-value** | **p-value** |
|---|---|---|---|---|---|---|
| Age(year) | Case | 40 | 47.50 | 7.24 | 0.33 | 0.745 |
| | Control | 40 | 48.03 | 7.14 | | |
| Weight(kg) | Case | 40 | 76.98 | 4.80 | 0.82 | 0.418 |
| | Control | 40 | 78.00 | 6.34 | | |
| Height(cm) | Case | 40 | 161.82 | 6.00 | 0.94 | 0.348 |
| | Control | 40 | 163.15 | 6.54 | | |
| BMI (kg/m2) | Case | 40 | 29.49 | 2.37 | 0.24 | 0.814 |
| | Control | 40 | 29.36 | 2.46 | | |
| SBP (mmHg) | Case | 40 | 123.15 | 4.64 | 1.61 | 0.112 |
| | Control | 40 | 121.60 | 3.95 | | |
| DBP (mmHg) | Case | 40 | 81.85 | 2.58 | 0.62 | 0.54 |
| | Control | 40 | 81.50 | 2.51 | | |
| FBS (mg/dL) | Case | 40 | 186.30 | 29.43 | 18.85 | <0.001 |
| | Control | 40 | 93.40 | 10.27 | | |

Mean age in case group was 47.50 ±7.24 years and in control group 48.03 ±7.14 years; Mean weight in case group was 76.98 ±4.80 kg and in control group 78 ±6.34 kg; Mean height in case group was 161.82 ±6 cm and in control group 163.15 ±6.54 cm; Mean BMI in case group was 29.49 ±2.37 $kg/m^2$ and in control group 29.36 ±2.46 $kg/m^2$; Mean SBP in case group was 123.15 ±4.64 mmHg and in control group 121.60 ±3.95mmHg. Mean DBP in case group was 81.85 ±2.58 mmHg and in control group 81.50 ±2.51mmHg; Mean FBS in case group 186.30±29.43mg/dl and in control group 93.40±10.27 mg/dl [p value <0.001]

**Table 2** BMI distribution in study group

| | | Group | | Total | Pearson Chi-Square | p-value |
|---|---|---|---|---|---|---|
| | | Case | Control | | | |
| BMI (kg/m2) | Overweight | 2 | 4 | 6 | 0.721 | 0.396 |
| | Obese | 38 | 36 | 74 | | |
| Total | | 40 | 40 | 80 | | |

In case group 5% patients were overweight and 95% patient obese. And in control group 10% overweight and 90% were obese. There were no statistically significant difference in BMI of case and control group. [p value- 0.369]

**Table 3** Lipid profile in study group

| | | Group | | Total | Pearson Chi-Square | p-value | |
|---|---|---|---|---|---|---|---|
| | | Patient | Control | | | | |
| Lipid Profile | Dyslipidaemia | 36 | 28 | 64 | 5.0 | 0.025 | |
| | Normal | 4 | 12 | 16 | | | |
| Total | | 40 | 40 | 80 | | | |

In case group 36 (90%) patients had dyslipidemia present out of 40 cases and in control group 28 (70%) control had dyslipidemia out of 40 control. This difference was statistically significant [p value 0.025]

**Table 4** Echocardiographic characteristic of study group

| | Group | N | Mean | Std. Deviation | t-value | p-value |
|---|---|---|---|---|---|---|
| LVEF (%) | Case | 40 | 61.28 | 5.39 | 6.14 | <0.001 |
| | Control | 40 | 67.13 | 2.70 | | |
| LV Mass(gm) | Case | 40 | 192.90 | 40.72 | 3.27 | 0.002 |
| | Control | 40 | 164.95 | 35.60 | | |
| LVMI (gm/m2) | Case | 40 | 107.48 | 20.84 | 4.08 | <0.001 |
| | Control | 40 | 89.66 | 18.13 | | |
| E/A | Case | 40 | 0.89 | 0.23 | 2.31 | 0.024 |
| | Control | 40 | 1.00 | 0.17 | | |
| IVRT (millisecond) | Case | 40 | 218.90 | 43.39 | 4.00 | <0.001 |
| | Control | 40 | 188.38 | 21.12 | | |
| DT (millisecond) | Case | 40 | 112.52 | 35.76 | 4.28 | <0.001 |
| | Control | 40 | 85.33 | 18.33 | | |

Mean LVEF in case group 61.28 ±5.39 % and in control group 67.13±2.70 % [p value -<0.001]; Mean LV Mass in case group 192 ±40.72 gm and in control group 164.95±35.60 gm [p value -0.002]; Mean LVMI in case group 107.48±20.84 gm /$m^2$and in control group 89.66±18.13 gm/$m^2$ [p value-<0.001]; Mean E/A in case group 0.89±0.23 and in control group 1.0 ±0.17[p value- 0.024]; Mean IVRT in case group 218.90 ±43.39 millisecond and in control group 188.38±21.12 millisecond. [p value <0.001]; Mean DT in case group 112.52±35.76 millisecond and in control group 85.33±18.33 millisecond [p value- <0.001

**Table 5** LV systolic dysfunction in study group

| | | Group | | Total | Pearson Chi-Square | p-value |
|---|---|---|---|---|---|---|
| | | Case | Control | | | |
| LVEF (%) | Normal | 36 | 40 | 76 | 4.211 | 0.04 |
| | SYSTOLIC DYSFUNCTION PRESENT | 4 | 0 | 4 | | |
| Total | | 40 | 40 | 80 | | |

In case group 10 % patients had left ventricular systolic dysfunction and in control group none had systolic dysfunction. And this difference was statistically significant in between groups [p value- 0.04]

**Table 6** LV Mass in study group

| | | Group | | Total | Pearson Chi-Square | p-value |
|---|---|---|---|---|---|---|
| | | Case | Control | | | |
| LV Mass (gm) | Normal | 21 | 31 | 52 | 5.495 | 0.019 |
| | High | 19 | 9 | 28 | | |
| Total | | 40 | 40 | 80 | | |

In case group high LV Mass present in 47.50% patients and in control group 22.5% control and this difference was statistically significant [p value-0.019]

**Table 7** LVMI in study group

| | | Group | | Total | Pearson Chi-Square | p-value |
|---|---|---|---|---|---|---|
| | | Case | Control | | | |
| LVMI (gm/m$^2$) | Normal | 19 | 30 | 49 | 6.373 | 0.012 |
| | High | 21 | 10 | 31 | | |
| Total | | 40 | 40 | 80 | | |

In case group high LVMI present in 52.5% case and in control group 25% control had high LVMI and this difference was statistically significant [p value -0.012]

## 3. Results and Discussion

Our present study was a case control cross sectional study. We enrolled 40 patients fulfilling inclusion and exclusion criteria and 40 age and sex matched controls after taking informed consent. Detailed history was obtained and examination was done. All requisite investigations and echocardiography were performed at Hindu Rao Hospital, Delhi.

Among 40 cases, 55% were male and 45% were female with mean age of case population being 47.5±7.24 year and among 40 controls, 50% were male and 50% were female with mean age 48.03±7.14 year. Both the groups were comparable.

Mean BMI in case group was 29.49±2.37 kg/m$^2$ and in control group 29.36±2.46 kg/m$^2$.There was no statistically significant difference in age, weight, height, BMI, BP between case and control group.

Our study group was demographically similar to the ones selected by Dodiyi- manual et al [9]and Patil et al [10] in their case control studies.

### 3.1. Comparison of LVDD between case and control population and correlation of LVDD with duration of DM

In our study we found that LVDD was present in 57.5% cases, 47.5% of cases had grade 1 LVDD whereas 10% had grade 2 LVDD. In comparison, only 10% of controls had LVDD with all of them having grade 1 LVDD. None of the controls had grade 2 LVDD. There was no effect of sex on occurrence of LVDD in either group [59.09% of male vs 55.55% of females, P value- 0.698].

Hence the prevalence of left ventricular diastolic dysfunction in the normotensive and asymptomatic diabetics without previous history of cardiac disease was quite high compared to controls (57.5% versus 10%, P value- 0).

Other workers using similar Doppler methods for assessing left ventricular function have previously reported similar findings [11-13].

### 3.2. Comparison of prevalence of diastolic dysfunction with other studies

Soldatos et al [14] in their case control study of 55 individuals with type -2 DM found that diastolic dysfunction was present in a significant proportion of population with Type 2 DM. In the Patil et al [10] study, 54.33% of subjects from the case group had diastolic dysfunction and 11 (11%) amongst control group had the diastolic dysfunction (P < 0.001). Like-wise in present study prevalence of LVDD in case group was 57.5% and 10% among control group [ p value-0].

The LV diastolic dysfunction is much more prevalent in patients with type-2 diabetes mellitus and LV diastolic dysfunction is an early marker of diabetic cardiomyopathy. Exiara et al [15] in their study of 114 subjects stated that the prevalence of LV diastolic dysfunction in normotensive, asymptomatic and well-controlled DM type 2 patients is high, and increases with age. A total of 63.2% patients had diastolic dysfunction in their study agreeing with our study. Diamant et al.[16] stated that early (E) acceleration peak, deceleration peak, peak filling rate, and E/A ratio, and all other indices of diastolic function, were significantly decreased in patients with recently diagnosed, well-controlled and uncomplicated type 2 diabetes compared with the controls ('P' < 0.02). These findings are similar to our results.

Bonito et al [17] stated that, an impairment of LV diastolic function occurs early in the natural history of type-2 DM, and is related to clinical evidence of microangiopathic complications.

Our study had lower prevalence of LVDD compared to study by Boyer et al [18] where the prevalence of LV diastolic dysfunction in asymptomatic, normotensive patients with type 2 diabetes disease was 75%. They also found that, TDI (Tissue Doppler imaging) detected diastolic dysfunction more often than any other echocardiographic parameter whereas in our study, prevalence of diastolic dysfunction was 57.5% as we did not use TDI.

In addition to detecting diastolic dysfunction, we also analyzed the severity of diastolic dysfunction. Among 57.5% diabetic patients with diastolic dysfunction, 47.5% had impaired relaxation [grade 1 LVDD], 10 % had pseudo normal filling [Grade 2 LVDD]. None of the patients had grade 3 diastolic dysfunction. In the control group, 10% had impaired relaxation [Grade 1 LVDD] while no subject had pseudo normal diastolic filling pattern. These results were similar to the findings of Dodiyi-manuel et al [9] where, of 65.5% diabetic patients with diastolic dysfunction, 57.8% had impaired relaxation [Grade 1 LVDD], 6.7% had pseudo normal filling [Grade 2 LVDD], and 1.1% had restrictive filling pattern [Grade 3 LVDD]. In the control group, three had impaired relaxation while only one subject had pseudo normal diastolic filling pattern. Poirer et al [19] studied 46 normotensive type II DM patients and reported diastolic dysfunction in 60% patients with 15 (32%) having impaired relaxation and 13 (28%) having pseudo normalized filling.

In our study, diastolic dysfunction was present in 59% of male cases and 55.5% of female cases [p value-0.698] and similar findings were reported by Kalyan Mansukhbhai Shekhda et al [20], Patil MB et al [21], and also by the strong heart study by Devereuex and colleagues in 2000 [22].

Hence, our findings are similar to the findings of previous studies.

We also observed a significant positive correlation of LVDD with duration of diabetes. In group with diabetes duration ≤ 5 years, 12 of 27 (44.4%) patients had LVDD, and all had grade 1 LVDD. Whereas in group with diabetes duration >5 years, 11 of 13 (84.6%) patients had LVDD and among them 7(53.8%) patients had grade 1 LVDD and 4(30.7%) had grade 2 LVDD [ 44.4% vs 84.6%, P value- 0.003].

In agreement with our study, a study by Patil, et al [10] showed that duration of diabetes mellitus of 11 to 15 years had more prevalence of diastolic dysfunction as compared to the 6 -10 years group (p value < 0.02).

Mishra et al [23] in their case control study of 71 subjects with type 2 DM found that asymptomatic diabetic patients had reduced LV systolic and diastolic function as compared with healthy subjects. LV systolic and diastolic abnormalities had correlation with the duration of diabetes and with diabetic microangiopathies, like retinopathy and neuropathy.

From et al [24] in their study of 484 subjects between 1996 to 2007 year found that a duration of diabetes ≥ 4 years was independently associated with LV diastolic dysfunction (E/e' >15) with odds ratio 1.91. Similar to our study, duration of diabetes >5 years had more prevalence of diastolic dysfunction as compared to the ≤5year group (p value 0.003).

From the above discussion and comparison of our study findings with various studies, we conclude that there was a high prevalence of diastolic dysfunction in subjects with normotensive type 2 DM, and it correlates with duration of diabetes.

### 3.3. Comparison of LV Systolic dysfunction between case and control population and relation of LV Systolic dysfunction with duration of DM

In our study, we found left ventricular systolic dysfunction among 10% of cases whereas none of the controls had systolic dysfunction [10% vs 0, P value- 0.04]. There was no effect of sex on occurrence of systolic dysfunction among diabetics [13.6% males vs 5.5% females, P value- 0.39]. A negative correlation was found between duration of diabetes and LVEF. In patients with diabetes duration ≤ 5year duration, all had normal systolic function. In comparison 30.7% of patients with diabetes duration >5 years had systolic dysfunction [ 0 vs 30.7%, P value- 0.002].

Mean LVEF was significantly lower in cases as compared to controls (61.28±5.39% versus 67.13± 2.70 %, P value <0.001) although the mean values were normal in both groups. This significant reduction in mean ejection fraction signifies early left ventricular systolic dysfunction in these diabetic patients despite absence of symptoms of cardiovascular disease. Dodoiyi manuel et al [9] also demonstrated a significant reduction in mean left ventricular ejection fraction in diabetics compared to healthy controls (62.2% versus 68.5%; P value 0.001). Although the mean values were normal in both groups, proportion of patients with reduced EF (<55%) differed amongst cases and controls. 15.65% of diabetics had reduced EF compared to only 4.4% of control subjects.

Dinesha and Kalabharathi [25] in their study of asymptomatic type 2 diabetes mellitus patients reported LV diastolic dysfunction in more than 50% of patients and systolic dysfunction in 6% of patients. They defined systolic dysfunction as LVEF <50% in their study whereas in our analysis cut-off for systolic dysfunction was taken as LVEF <55%. This difference in cut-off may account for the apparent disagreement in our findings.

In agreement with our study, Mishra et al [23] in their case control study found that patients with type 2 diabetes had a lower ejection fraction (54 +/- 10.8 vs. 67 +/- 6.1%, p < or = 0.001) compared with the control subjects, and An inverse correlation was found between duration of diabetes and both ejection fraction (r = -0.53, p = 0.05) and E/A ratio (r = 0.36, p = 0.003).

### 3.4. Comparison of LVM and LVMI between case and control population and correlation of LVM and LVMI with duration of DM

In our study we found high LV Mass in 47.50% patients and 22.5% of Controls [47.5% vs 22.5%, P value-0.019]. Among case group, high LVMI was present in 52.5% case and in control group 25% control had high LVMI [52.5% vs 25% p value-0.012]. LV Mass and LVMI were not influenced significantly by sex [ high LVM 40.9% male vs 55.5% female, p value 0.356 in case group and in control group 20% male vs 25% female, p value 0.705. High LVMI 55% male vs 44.4% female, p value 0.726 in case group, and in control group 20% male vs 30% female p value 0.465].

.Dodoiyi- manuel et al [9] in their study found abnormalities in cardiac structure of diabetic patients included a significant increase in LVMI and relative wall thickness compared to normal controls. They reported high LVMI in 45 (50%) patients compared to 23 (25.6%) controls (P value 0.001).

In our study we observed that the mean of LVM and LVMI was significantly higher in diabetic patients as compared to healthy control subjects. Similar result were reported by Santra et al [26] Hirayama et al [27] from Japan demonstrated in their study that LVM and LVMI were significantly greater in the normotensive type 2 DM patients than the normotensive control population.

In agreement to our study, a study by Santra et al [26] showed the prevalence of high LVM and high LVMI in all type 2 DM patients in their study was 44% and 53%, respectively. The prevalence of high LVM and high LVMI in male subjects with type 2 DM was 40% and 54%, respectively and the prevalence of high LVM and high LVMI in female subjects with type 2 DM was 50% and 53%, respectively.

In our study we found LV Mass and LVMI correlated positively with duration of DM.

In ≤5 years duration of DM group, 7(25.9%) patients had high LV Mass out of 27 patients, and in >5 years duration of DM group 12(92.3%) patients had high LV Mass out of 13 patients [ 25.9% vs 92.3%, p value-<0.001].

In ≤ 5 years duration of DM group 8(29.6%) patients had high LVMI out of 27 patients and in>5 years duration of DM group 13(100%) patients had high LVMI out of 13 patients [29.6% vs 100%, p value-<0.001]. Sato et al [28] and Santra et al [26] also reported a significant correlation between glycemic control, duration of DM, and LVMI.

In this study we found that there is a significant difference in LVM between normotensive, type 2 DM patients and the control group which must be noted because increased LVM is associated with increased cardiovascular morbidity and mortality and its early diagnosis and prevention is important; drug therapy can cause improvement in left ventricular function and can decrease cardiovascular morbidity. The high prevalence of LVM and LVMI in diabetic patients supports the idea that early echocardiographic screening may be beneficial to these patients.

### *Limitations of the study*

Stress electrocardiography, stress echocardiography, myocardial perfusion imaging, and coronary angiography were not used to exclude sub clinical coronary disease.

## 4. Conclusion

Based on our case control study of 40 normotensive Type 2 diabetes patients and 40 age- and sex- matched controls, we conclude that-

The prevalence of left ventricular diastolic dysfunction in asymptomatic, normotensive patients with type 2 DM without significant coronary artery disease is much higher than previously suspected as evidenced by the results of this study and also of similar other studies [57.5% cases vs 10% controls, P value- 0].

Prevalence of LV diastolic dysfunction rises with increase in duration of diabetes [ 44.4 % with diabetes duration <5 years vs 84.6% with diabetes duration >5 years, P value- 0.003].

LV systolic dysfunction is also more prevalent in normotensive type 2 DM patients compared to control subjects [10% cases vs 0 controls, P value- 0.04].

Systolic dysfunction correlates with duration of diabetes. Systolic dysfunction was found only in patients where the duration of diabetes duration more than 5 years. Though LVDD, high LV Mass and high LVMI, were present even in type 2 diabetics with diabetes duration less than 5 year.

- The prevalence of systolic dysfunction is almost similar in both male and female patient [13.6% vs 5.5%, P value- 0.39].
- LVM is significantly higher in type 2 diabetic patients without hypertension, and apparent ischemic heart disease as compared to healthy controls [47.50% case vs 22.5% control, p-value-0.019]
- The prevalence of high LV Mass and high LVMI is almost similar in both male and female patients. [LVM 55% vs 44.4% ,p value-0.726 and LVMI 20% vs 30% ,p value-0.465]
- LVM in diabetic patients increases with the duration of diabetes. So patients with a longer duration of diabetes have more chances of having high LV Mass [ 25.9 % with diabetes duration <5 years vs 92.3% with diabetes duration >5 years, p value- <0.001] and high LVMI [ 29.6 % with diabetes duration <5 years vs 100% with diabetes duration >5 years, P value-< 0.001].

Our small but significant study has thrown light on the prevalence of increased LVDD, systolic dysfunction and LV Mass in asymptomatic type 2 DM patients who are not otherwise suffering from hypertension, florid ischemic heart disease, and microvascular complications. As it is evidenced by previous studies, asymptomatic echocardiographic abnormalities are often preceded by development of clinical heart failure, echocardiographic evaluation may be an

important tool in workup of type 2 DM patients for earlier recognition of these findings so that strict management and supervision may be undertaken to delay, if not prevent development of heart failure.

### *Recommendation*

Our study suggests that a diabetic person should undergo 2D echocardiography at regular intervals so that the early changes of left ventricular dysfunction can be identified before a person has symptomatic diastolic or systolic heart failure.

Large, prospective studies may be undertaken to reveal the actual prevalence of LVDD, systolic dysfunction and LVM in such population and also elucidate further the natural history of these asymptomatic findings, utility and cost-benefit analysis of echocardiographic screening of asymptomatic diabetics.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of ethical approval*

The present research work does not contain any studies performed on animals/human subjects by any of the authors.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

## References

[1] Zimmet PZ, McCarty DJ, de Courten MP. The global epidemiology of non-insulin-dependent diabetes mellitus and the metabolic syndrome. Journal of Diabetes and its Complications. 1997 Mar 1; 11(2):60-8.

[2] Murray CJ, Lopez AD, World Health Organization. The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020: summary.

[3] Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030 Diabetes Care 27: 1047–1053.

[4] Sobngwi E, Mauvais-Jarvis F, Vexiau P, Mbanya JC, Gautier JF. Diabetes in Africans. Part 1: epidemiology and clinical specificities. Diabetes & metabolism. 2001 Dec; 27(6):628-34.

[5] Aguiree F, Brown A, Cho NH, Dahlquist G, Dodd S, Dunning T, Hirst M, Hwang C, Magliano D, Patterson C, Scott C. IDF diabetes atlas.

[6] Kannel WB, McGee DL. Diabetes and cardiovascular disease: the Framingham study. Jama. 1979 May 11; 241(19):2035-8.

[7] Nichols GA, Hillier TA, Erbey JR, Brown JB. Congestive heart failure in type 2 diabetes. Diabetes care. 2001 Sep 1; 24(9):1614-9.

[8] Bertoni AG, Tsai A, Kasper EK, Brancati FL. Diabetes and idiopathic cardiomyopathy. Diabetes care. 2003 Oct 1; 26(10):2791-5.

[9] Dodiyi-Manuel ST, Akpa MR, Odia OJ. Left ventricular dysfunction in normotensive type II diabetic patients in Port Harcourt, Nigeria. Vascular health and risk management. 2013; 9:529.

[10] Patil VC, Shah KB, Vasani JD, Shetty P, Patil HV. Diastolic dysfunction in asymptomatic type 2 diabetes mellitus with normal systolic function. Journal of cardiovascular disease research. 2011 Oct 1; 2(4):213-22.

[11] Poirier P, Bogaty P, Garneau C. marois L, dumernoil JG, martin m. et al. Diastolic Dysfunction With Well–controlled Type 2 Diabetes. Diabetes Carer. 2004; 46:166-70.

[12] Brownlee, MD M. Advanced protein glycosylation in diabetes and aging. Annual review of medicine. 1995 Feb; 46(1):223-34.

[13] Schleicher ED, Wagner E, Nerlich AG. Increased accumulation of the glycoxidation product N (epsilon)-(carboxymethyl) lysine in human tissues in diabetes and aging. Journal of Clinical Investigation. 1997 Feb 1; 99(3):457.

[14] Soldatos G, Jandeleit-Dahm K, Thomson H, Formosa M, D'orsa K, Calkin AC, Cooper ME, Ahimastos AA, Kingwell BA. Large artery biomechanics and diastolic dysfunction in patients with Type 2 diabetes. Diabetic Medicine. 2011 Jan 1; 28(1):54-60.

[15] Exiara T, Konstantis A, Papazoglou L, Kouroupi M, Kalpaka A, Mporgi L, Risggits A, Filippidou E, Terzi S, Papanastasiou S. Left ventricular diastolic dysfunction in diabetes mellitus type 2: Pp. 17.147. Journal of Hypertension. 2010 Jun 1; 28:e294.

[16] Diamant M, Lamb HJ, Groeneveld Y, Endert EL, Smit JW, Bax JJ, Romijn JA, de Roos A, Radder JK. Diastolic dysfunction is associated with altered myocardial metabolism in asymptomatic normotensive patients with well-controlled type 2 diabetes mellitus. Journal of the American College of Cardiology. 2003 Jul 16; 42(2):328-35.

[17] Bonito PD, Cuomo S, Moio N, Sibilio G, Sabatini D, Quattrin S, Capaldo B. Diastolic dysfunction in patients with non-insulin-dependent diabetes mellitus of short duration. Diabetic medicine. 1996 Apr 1; 13(4):321-4. 43.

[18] Boyer JK, Thanigaraj S, Schechtman KB, Pérez JE. Prevalence of ventricular diastolic dysfunction in asymptomatic, normotensive patients with diabetes mellitus. The American journal of cardiology. 2004 Apr 1; 93(7):870-5.

[19] Poirier P, Bogaty P, Garneau C. marois L, dumernoil JG, martin m. et al. Diastolic Dysfunction With Well–controlled Type 2 Diabetes. Diabetes Carer. 2004; 46:166-70.

[20] Shekhda KM, Gohil AH, Gaur M. Evaluation of Left Ventricular Diastolic Dysfunction in Asymptomatic Normotensive Patients with Type-2 Diabetes Mellitus

[21] Patil MB, Burji NP. Echocardiographic evaluation of diastolic dysfunction in asymptomatic type 2 diabetes mellitus. J Assoc Physicians India. 2012 May; 60(60):23-6.

[22] Devereux RB, Roman MJ, Liu JE, Welty TK, Lee ET, Rodeheffer R, Fabsitz RR, Howard BV. Congestive heart failure despite normal left ventricular systolic function in a population-based sample: the Strong Heart Study. The American journal of cardiology. 2000 Nov 15; 86(10):1090-6.

[23] Mishra TK, Rath PK, Mohanty NK, Mishra SK. Left ventricular systolic and diastolic dysfunction and their relationship with microvascular complications in normotensive, asymptomatic patients with type 2 diabetes mellitus. Indian heart journal. 2007 Dec; 60(6):548-53.

[24] From AM, Scott CG, Chen HH. Changes in diastolic dysfunction in diabetes mellitus over time. The American journal of cardiology. 2009 May 15; 103(10):1463-6.

[25] Dinesha B, Kalabharathi H. World J Pharm Sci 2016; 4(2): 238-24656.

[26] Santra S, Basu AK, Roychowdhury P, Banerjee R, Singhania P, Singh S, Datta UK. Comparison of left ventricular mass in normotensive type 2 diabetes mellitus patients with that in the nondiabetic population. Journal of cardiovascular disease research. 2011 Jan 1; 2(1):50-6.

[27] Hirayama H, Sugano M, Abe N, Yonemochi H, Makino N. Determination of left ventricular mass by echocardiography in normotensive diabetic patients. Japanese circulation journal. 2001 Jan 1; 64(12):921-4.

[28] Sato A, Tarnow L, Parving HH. Prevalence of left ventricular hypertrophy in Type I diabetic patients with diabetic nephropathy. Diabetologia. 1999 Jan 1; 42(1):76-80.