

# A Study of ECG and 2D Echo Findings in Type-II Diabetes Mellitus Patients

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**Abstract:** Diabetes mellitus (DM) is one of the most common disorder in the world. Diabetic mellitus is a chronic progressive metabolic disease which involves myocardium at relatively early stage even before clinical manifestations become obvious. It is associated with a multitude of cardiovascular complications with increased incidence of atherosclerotic coronary artery disease, myocardial infarction, congestive heart failure, coronary microangiopathy and systemic arterial hypertension. The study intends to assess echocardiographic detection of left ventricular diastolic dysfunction and other echo findings and electrocardiographic findings in diabetes mellitus patients excluding other comorbidities

**Keywords:** DM, ECG, 2D ECHO

## 1. Introduction

Diabetes mellitus (DM) is one of the most common disorder in the world reaching epidemic proportions with 415 million people having diabetes and 12% of global health expenditure been spent on diabetes and 5 million deaths been recorded in 2015 according to International Diabetes Federation<sup>1</sup>. The theme of World Diabetes Day 2017 is **Women and diabetes - our right to a healthy future**<sup>2</sup>. Diabetes is a chronic disease that occurs when the pancreas is no longer able to make insulin, or when the body cannot make good use of the insulin it produces<sup>1</sup>. India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the “Diabetes capital of the world”.

There are two broad categories of DM<sup>3</sup> designated type 1 and type 2:

| Type of Diabetes     | Normal glucose tolerance | Hyperglycemia   |  |
|----------------------|--------------------------|---|--|
|                      |                          | Pre-diabetes*<br>Impaired fasting glucose or impaired glucose tolerance | Diabetes Mellitus<br>Not insulin required for survival |
| Type 1               | ←                        | →   | →  |
| Type 2               | ←                        | →   | →  |
| Other specific types | ←                        | →   | →  |
| Gestational Diabetes | ←                        | →   | →  |
| Time (years)         | →                        | →   | →  |
| FPG                  | <5.6 mmol/L (100 mg/dL)  | 5.6–6.9 mmol/L (100–125 mg/dL)  | ≥7.0 mmol/L (126 mg/dL)                                |
| 2-h PG               | <7.8 mmol/L (140 mg/dL)  | 7.8–11.0 mmol/L (140–199 mg/dL)   | ≥11.1 mmol/L (200 mg/dL)                               |
| A1C                  | <5.6%                    | 5.7–6.4%  | ≥6.5%  |

### Classification of diabetes mellitus<sup>4</sup>

Diabetes can be classified into the following general categories:

- 1) Type 1 diabetes (due to autoimmune b-cell destruction, usually leading to absolute insulin deficiency)
- 2) Type 2 diabetes (due to a progressive loss of b-cell insulin secretion frequently on the background of insulin resistance)

- 3) Gestational diabetes mellitus (GDM) (diabetes diagnosed in the second or third trimester of pregnancy that was not clearly overt diabetes prior to gestation)
- 4) Specific types of diabetes due to other causes, e.g., monogenic diabetes syndromes (such as neonatal diabetes and maturity-onset diabetes of the young [MODY]), diseases of the exocrine pancreas (such as cystic fibrosis), and drug or chemical induced diabetes (such as with glucocorticoid use, in the treatment of HIV/AIDS, or after organ transplantation)

Left ventricular diastolic dysfunction (LVDD) may represent the reversible first stage of diabetic cardiomyopathy preceding changes in systolic function reinforcing the importance of early examination of diastolic ventricular dysfunction in individuals with DM. Diastolic heart failure is a distinct clinical entity that in most cases has a silent course and may be totally asymptomatic especially in early stages and almost constitute one third of all cases of heart failure<sup>5</sup>. The mortality rates among the patients with diastolic heart failure ranges from 5-8 % annually which is comparable to systolic heart failure (10- 15 % ). Hence, assessment of diastolic dysfunction should be an integral part of an evaluation of cardiac function because about 30 % of patients with heart failure have a preserved LVEF. Assessment of diastolic dysfunction requires an understanding of diastole and various means to evaluate diastolic function. Currently echocardiography is the best non-invasive way to evaluate diastolic function and to estimate filling pressure.

The study intends to assess echocardiographic detection of left ventricular diastolic dysfunction and other echo findings and electrocardiographic findings in diabetes mellitus patients excluding other comorbidities

ECG abnormalities are found to be predictors of silent ischemia in asymptomatic persons. An abnormal ECG response is associated with statistically significant high risk for cardiac mortality and morbidity<sup>6</sup>. The importance of

diabetes mellitus, both type 1 and type 2, in the epidemiology of cardiovascular diseases cannot be overemphasized. About one third of acute myocardial infarction patients have diabetes mellitus, the prevalence of which is steadily increasing: In the 1960s, there were 2 million Americans with diabetes mellitus; in the year 2000, their number was 15 million. Statistics have shown that the decrease in cardiac mortality in persons with diabetes mellitus is lagging behind that of the general population. Early diagnosis of diabetes mellitus is crucial<sup>7</sup>.

## 2. Study

The present study was conducted in a tertiary care hospital. This is a two year cross-sectional study of ECG AND 2D ECHO findings in type 2 dm patients. Patients admitted in medicine ward of tertiary care hospital who satisfy the inclusion criteria were enrolled in the study. Total 100 patients were included in the study

### Inclusion Criteria

- 1) A case of Type 2 diabetes mellitus.\*
- 2) Age : 30-70 years
- 3) Blood pressure:  $\leq 140/90$  (at least 3 recordings with the highest recording taken into consideration)

### A case of diabetes mellitus type 2 included

- 1) Patients were already known diabetic on oral hypoglycemic agents or insulin.
- 2) Symptoms of diabetes mellitus with random blood sugar  $\geq 200$  mg/dl.
- 3) Fasting plasma glucose  $\geq 126$  mg/dl.
- 4) 2 hour plasma glucose  $\geq 200$  mg/dl
- 5) HbA1c  $\geq 6.5$

### Exclusion Criteria

- 1) Myocardial infarction by history.
- 2) Patients with angina pectoris.
- 3) Patients with known ischemic heart diseases on treatment.
- 4) Patients with hypertension. (BP  $> 140/90$ ) or history of hypertension on antihypertensives.
- 5) Age less than 30 and more than 70 years
- 6) Who do not give consent for study.

This cross sectional study comprised a total of 100 cases of type 2 DM between the age of 30 and 70 years including both males and females who clinically had no symptoms of cardiovascular involvement and blood pressure  $< 140/90$  mmHg. The diagnosis of diabetes was made on the basis of clinical evaluation, biochemical and ancillary investigation like fasting plasma glucose (FPG)/postprandial plasma glucose (PPPG) and HbA1C according to recent American Diabetic Association (ADA) recommendations.

A detailed clinical history with specific reference to cardiovascular symptoms, drug intake and smoking and alcohol was taken. A complete general and systemic examination particularly for stigmata of cardiovascular status was carried out. Patients with cardiac diseases like valvular heart disease, ischemic and hypertensive heart disease, congestive heart failure, cardiomyopathy, renal failure, chronic pulmonary disease, severe anemia and

haemoglobinopathies were excluded from the study. Patients underwent thorough clinical examination supported by relevant investigations .

All patients underwent the baseline 2d echo and ecg

### Echocardiographic Examination:

All the subjects underwent resting transthoracic 2-dimensional echocardiography and Doppler imaging, to assess left ventricular diastolic function. Echocardiographic study was done by the same operator using an echocardiographic machine (Philips) equipped with 2.4 MHz phased array probe. The examinations were done with the patient in left lateral decubitus, utilizing left parasternal long axis, short axis apical 4 and 5 apical chamber views according to the recommendations of American Society of Echocardiography<sup>8</sup>. The measurements included: LV systolic function (EF and Fractional Shortening) and LV diastolic function was obtained from Doppler examination of mitral valve flow pattern. The transducer was positioned in the apical 4 chamber views; the sample volume marker was positioned at the level of mitral valve annulus.

Left ventricular overall ejection fraction (systolic function) was calculated by modified Simpson's method ; and, LVEF  $\geq 50\%$  was considered as normal. All patients were in sinus rhythm, the following parameters were measured:

Maximal early filling velocity (E wave), maximal late atrial filling velocity (A wave), from which the E/A ratio was derived. The deceleration time of E wave (DT-E) was obtained by measuring the interval from the peak of E wave to the end of E flow. Isovolumic relaxation time (IVRT) was measured as the interval from the end of aortic flow to the onset of mitral inflow with the transducer in apical 5-chamber view with the sample volume marker midway between mitral valve annulus and LV outflow tract. LV diastolic dysfunction was considered to be present if any of the following findings were seen, as previously described:

- E/A ratio  $< 1$  or  $> 2$ .
- DT  $< 150$  or  $> 220$  ms.
- IVRT  $< 60$  or  $> 100$  ms.

### Electrocardiographic Examination

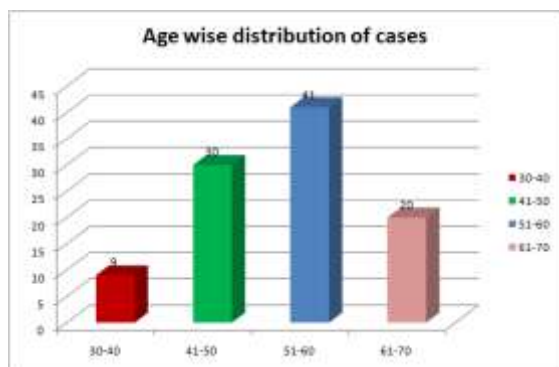
All the subjects underwent resting electrocardiography and assessed ECG findings. Electrocardiographic study was done by the same operator using an electrocardiographic machine. The examinations were done with the patient in supine position. All patients were in sinus rhythm, the following parameters were measured.

- 1) Rate
- 2) Rhythm
- 3) ST-segment elevation or depression.
- 4) T- wave aberrations (inversion or tall T-wave)
- 5) Bundle branch block (RBBB LBBB)
- 6) LVH
- 7) Arrhythmias
- 8) Prolonged QT and other changes to detect signs of myocardial ischaemia in asymptomatic patients<sup>9</sup>.

**3. Result**

**Table 1:** Age wise Distribution

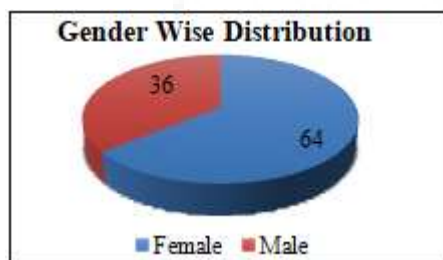
| Sr. No. | Age in yrs | Frequency | Percentage |
|---------|------------|-----------|------------|
| 1       | 30- 40     | 9         | 09.0       |
| 2       | 41-50      | 30        | 30.0       |
| 3       | 51-60      | 41        | 41.0       |
| 4       | 61-70      | 20        | 20.0       |
|         | Total      | 100       | 100.0      |



**Chart 1:** Age wise Distribution

**Table 2:** Gender wise Distribution

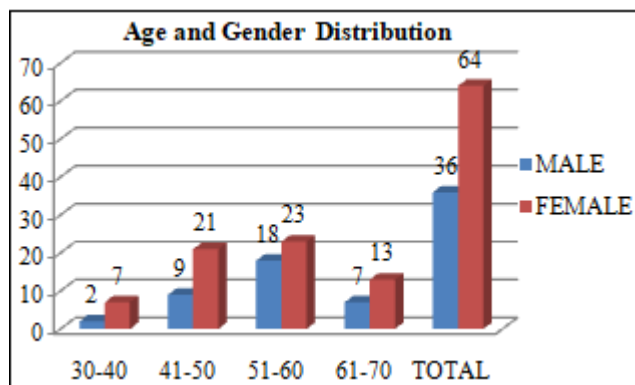
| Sr. No. | Gender | Frequency | Percent |
|---------|--------|-----------|---------|
| 1       | Female | 64        | 64.0    |
| 2       | Male   | 36        | 36.0    |
| 3       | Total  | 100       | 100.0   |



**Chart 2:** Gender wise Distribution

**Table 3:** Age and Gender Distribution

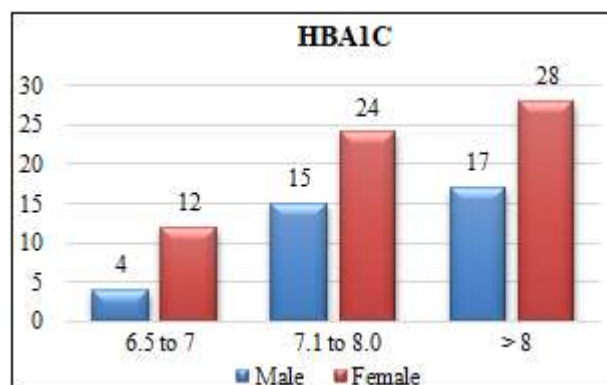
| Sr. No. | Age in yrs | Male (%)    | Female (%)  | Total (%) |
|---------|------------|-------------|-------------|-----------|
| 1       | 30- 40     | 02 (5.55%)  | 07 (10.93%) | 9 (9)     |
| 2       | 41-50      | 09 (25%)    | 21 (32.81%) | 30 (30)   |
| 3       | 51-60      | 18 (50%)    | 23 (35.93%) | 41 (41)   |
| 4       | 61-70      | 07 (19.44%) | 13 (20.31%) | 20(20)    |
|         | Total      | 36 (100%)   | 64 (100%)   | 100 (100) |



**Chart 3:** Age and Gender Distribution

**Table 4:** Distribution According to HbA1C Value

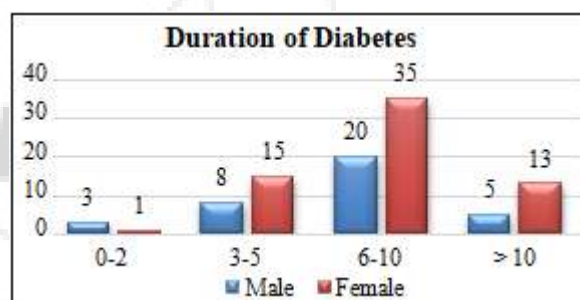
| Sr. No | HbA1c      | Male (%)   | Female (%) | Total (%) |
|--------|------------|------------|------------|-----------|
| 1      | 6.5 to 7   | 04 (11.11) | 12 (18.75) | 16 (16)   |
| 2      | 7.1 to 8.0 | 15 (41.66) | 24 (37.5)  | 39 (39)   |
| 3      | > 8        | 17 (47.22) | 28 (43.75) | 45 (45)   |
|        | Total      | 36 (100)   | 64 (100)   | 100 (100) |



**Chart 4:** Distribution According to HbA1C Value

**Table 5:** Distribution According to Duration of Diabetes and gender

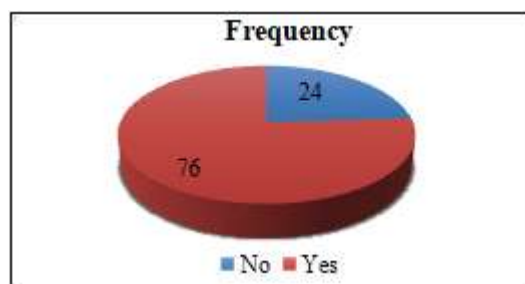
| Sr. No. | Duration in Yrs | Male (%)    | Female (%)  | Total (%) |
|---------|-----------------|-------------|-------------|-----------|
| 1       | 0-2             | 03 (8.33%)  | 01 (1.56%)  | 04 (4)    |
| 2       | 3-5             | 08 (22.22%) | 15 (23.43%) | 23 (23)   |
| 3       | 6-10            | 20 (55.55%) | 35 (54.68%) | 55 (55)   |
| 4       | > 10            | 05 (13.88%) | 13 (20.31%) | 18 (18)   |
|         | Total           | 36 (100%)   | 64 (100%)   | 100 (100) |



**Chart 5:** Distribution According to Duration of Diabetes

**Table 6:** Distribution According Oral Hypoglycemic Agents (OHA)

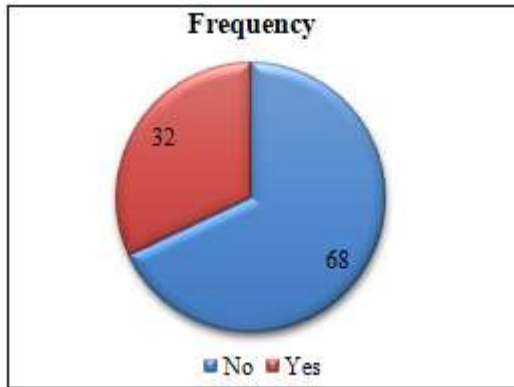
| Sr. No. | OHA   | Frequency | Percent | P Value |
|---------|-------|-----------|---------|---------|
| 1       | No    | 24        | 24.0    | 0.05    |
| 2       | Yes   | 76        | 76.0    |         |
|         | Total | 100       | 100.0   |         |



**Chart 6:** Distribution According Oral Hypoglycaemic Agents

**Table 7:** Distribution According Insulin

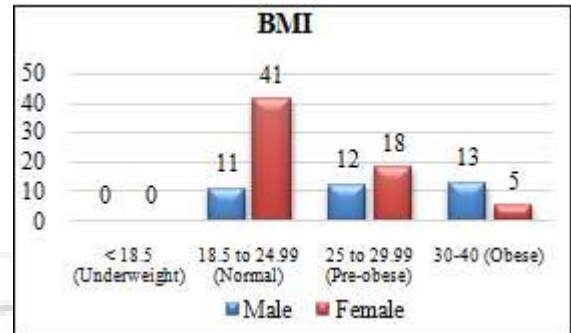
| Sr. No. | Insulin | Frequency | Percent |
|---------|---------|-----------|---------|
| 1       | No      | 68        | 68.0    |
| 2       | Yes     | 32        | 32.0    |
|         | Total   | 100       | 100.0   |



**Chart 7:** Distribution According Insulin

**Table 10:** Distribution According to BMI

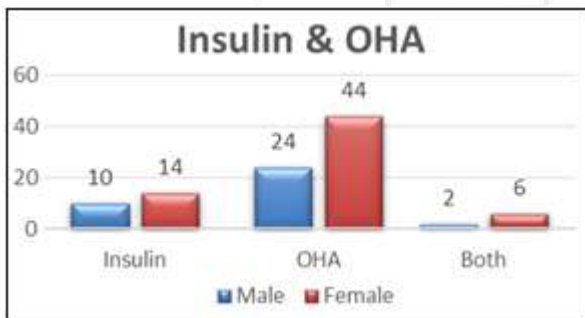
| Sr. No | BMI (Kg/m <sup>2</sup> ) | Male (%)    | Female (%)  | Total (%) |
|--------|--------------------------|-------------|-------------|-----------|
| 1      | < 18.5 (Underweight)     | 00 (00%)    | 00 (00%)    | 00 (00)   |
| 2      | 18.5 to 24.99 (Normal)   | 11 (30.55%) | 41 (64.06%) | 52 (52)   |
| 3      | 25 to 29.99 (Pre-obese)  | 12 (33.33%) | 18 (28.12%) | 30 (30)   |
| 4      | 30-40 (Obese)            | 13 (36.11%) | 05 (7.81%)  | 18 (18)   |
|        | Total                    | 36 (100%)   | 64 (100%)   | 100 (100) |



**Chart 10:** Distribution According to BMI

**Table 8:** Distribution According Treatment (Insulin & OHA)

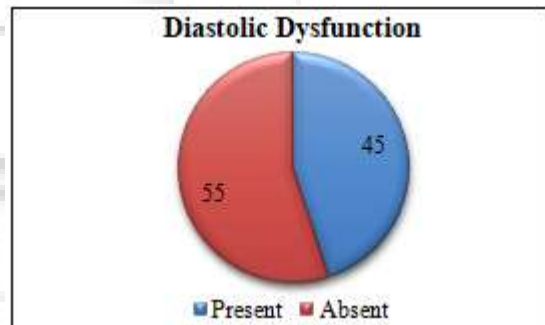
| Treatment | Male (%)    | Female (%)  | Total     |
|-----------|-------------|-------------|-----------|
| Insulin   | 10 (27.77%) | 14 (21.87%) | 24 (24)   |
| OHA       | 24 (66.67%) | 44 (68.75%) | 68 (68)   |
| Both      | 02 (5.55%)  | 06 (9.37%)  | 08 (08)   |
| Total     | 36 (100%)   | 64 (100%)   | 100 (100) |



**Chart 8:** Distribution According Treatment (Insulin & OHA)

**Table 11:** Distribution According to Diastolic Dysfunction on Echocardiography

| Diastolic Dysfunction | Present | Absent | Total |
|-----------------------|---------|--------|-------|
| Diastolic Dysfunction | 45      | 55     | 100   |



**Chart 11:** Distribution According to Diastolic Dysfunction on Echocardiography

**Table 9:** Distribution According to Addiction (Smoking & Alcohol)

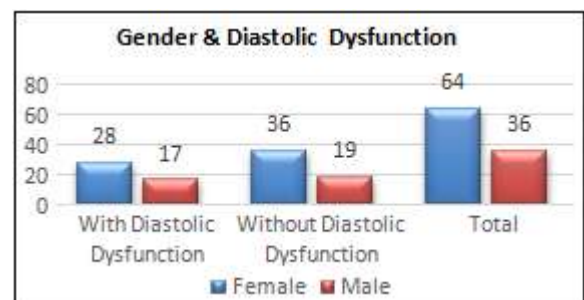
| Sr. No | Addiction | Frequency | Percentage |
|--------|-----------|-----------|------------|
| 1      | Smoking   | 08        | 8.00       |
| 2      | Alcohol   | 04        | 4.00       |
| 3      | Both      | 04        | 4.00       |
|        | Total     | 16        | 16.00      |



**Chart 9:** Distribution According to Addiction (Smoking & Alcohol)

**Table 12:** Gender wise Distribution According to Diastolic Dysfunction

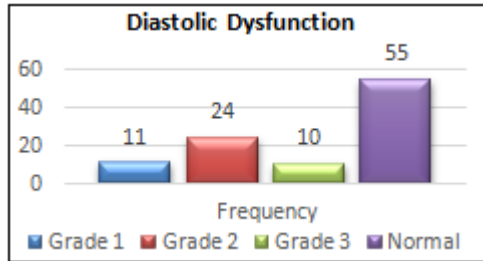
| Sr. No. | Gender | With Diastolic Dysfunction | Without Diastolic Dysfunction | Total |
|---------|--------|----------------------------|-------------------------------|-------|
| 1       | Female | 28 (62.2)                  | 36 (65.5)                     | 64    |
| 2       | Male   | 17 (37.8)                  | 19 (34.5)                     | 36    |
|         | Total  | 45(100%)                   | 55(100%)                      | 100   |



**Graph 12:** Gender wise Distribution According to Diastolic Dysfunction

**Table 13:** Distribution According to Diastolic Dysfunction on Echocardiography (Grade)

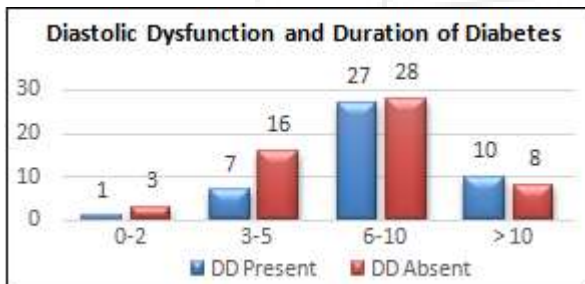
| Sr. No. | Grade   | Frequency | Percent |
|---------|---------|-----------|---------|
| 1       | Grade 1 | 11        | 11.0    |
| 2       | Grade 2 | 24        | 24.0    |
| 3       | Grade 3 | 10        | 10.0    |
| 4       | Normal  | 55        | 55.0    |
|         | Total   | 100       | 100.0   |



**Chart 13:** Distribution According to Diastolic Dysfunction

**Table 14:** Correlation between Diastolic Dysfunction and Duration of Diabetes

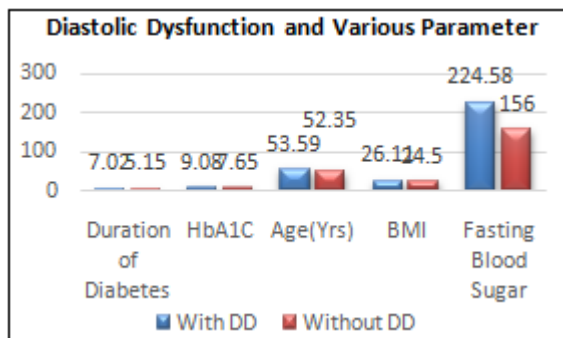
| Duration of Diabetes | DD Present (%) | DD Absent (%) | Total (%) |
|----------------------|----------------|---------------|-----------|
| 0-2                  | 01 (2.22%)     | 03 (5.45%)    | 04 (4)    |
| 3-5                  | 07 (15.55%)    | 16 (29.09%)   | 23 (23)   |
| 6-10                 | 27 (60%)       | 28 (50.90%)   | 55 (55)   |
| >10                  | 10 (22.22%)    | 08 (14.54%)   | 18 (18)   |
| Total                | 45 (100%)      | 55 (100%)     | 100 (100) |



**Chart 14:** Correlation between Diastolic Dysfunction and Duration of Diabetes

**Table 15:** Diastolic Dysfunction and Various Parameters

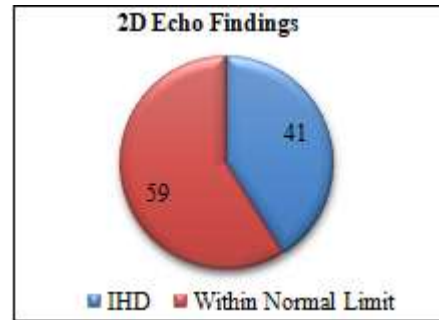
| Sr. No. | Parameters           | With DD (N=45) | Without DD (N=55) | P value |
|---------|----------------------|----------------|-------------------|---------|
| 1       | Duration of Diabetes | 7.02±3.05      | 5.15±2.66         | 0.01    |
| 2       | HbA1C                | 9.08±1.70      | 7.65±0.88         | 0.001   |
| 3       | Age(Yrs)             | 53.59±8.32     | 52.35±8.36        | 0.05    |
| 4       | BMI                  | 26.11±3.64     | 24.50±3.16        | 0.01    |
| 5       | Fasting Blood Sugar  | 224.58±94.26   | 156±29.25         | 0.001   |



**Chart 15:** Diastolic Dysfunction and Various Parameter

**Table 16:** Distribution According to 2D Echo Findings

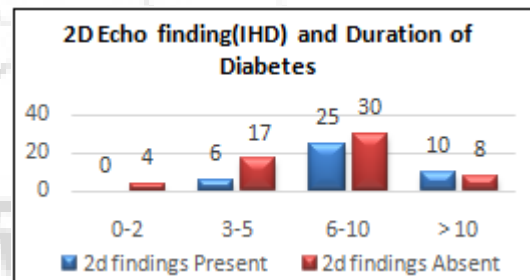
| 2D Echo Findings    | Frequency | Percent |
|---------------------|-----------|---------|
| IHD                 | 41        | 41.0    |
| Within Normal Limit | 59        | 59.0    |
| Total               | 100       | 100.0   |



**Chart 16:** Distribution According to 2D Echo Findings

**Table 17:** Correlation between 2D Echo finding (IHD) and Duration of Diabetes

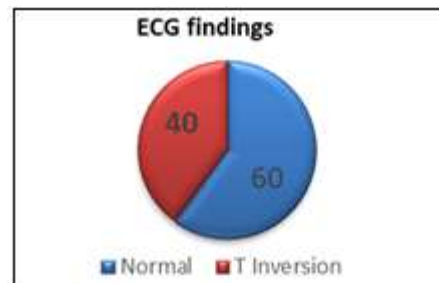
| Duration | 2d findings (IHD) Present (%) | 2d findings (IHD) Absent (%) | Total (%) |
|----------|-------------------------------|------------------------------|-----------|
| 0-2      | 0 (0)                         | 04 (6.77%)                   | 04        |
| 3-5      | 06 (14.63%)                   | 17 (28.81%)                  | 23        |
| 6-10     | 25 (60.97%)                   | 30 (50.84%)                  | 55        |
| > 10     | 10 (24.39%)                   | 08 (13.55%)                  | 18        |
| Total    | 41(100%)                      | 59(100%)                     | 100       |



**Chart 17:** Correlation between 2D Echo finding (IHD) and Duration of Diabetes

**Table 18:** Distribution According to ECG findings

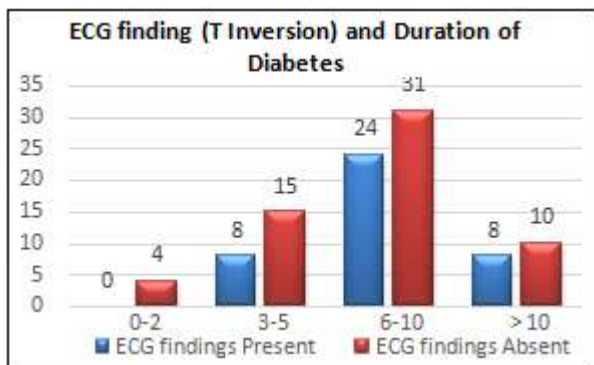
| ECG Findings | Frequency | Percent |
|--------------|-----------|---------|
| Normal       | 60        | 60.0    |
| T Inversion  | 40        | 40.0    |
| Total        | 100       | 100.0   |



**Chart 18:** Distribution According to ECG findings

**Table 19:** Correlation between ECG finding (T Inversion) and Duration of Diabetes

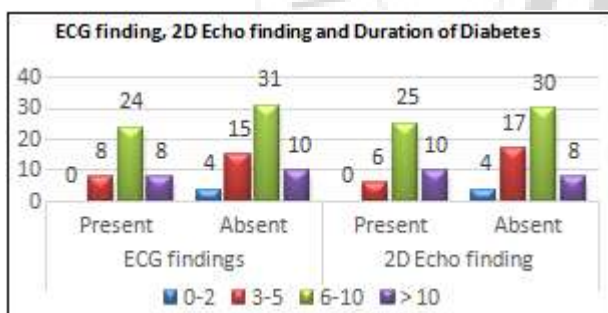
| Duration | ECG findings Present (%) | ECG findings Absent (%) | Total (%) |
|----------|--------------------------|-------------------------|-----------|
| 0-2      | 0 (0)                    | 04 (6.66%)              | 04 (4)    |
| 3-5      | 08 (20%)                 | 15 (25%)                | 23 (23)   |
| 6-10     | 24 (60%)                 | 31 (51.66%)             | 55 (55)   |
| >10      | 08 (20%)                 | 10 (16.66%)             | 18 (18)   |
| Total    | 40 (100%)                | 60 (100%)               | 100 (100) |



**Chart 19:** Correlation between ECG finding (T Inversion) and Duration of Diabetes

**Table 20:** Correlation between ECG finding, 2D Echo finding and Duration of Diabetes

| Duration | ECG findings |             | 2D Echo finding |             | Total (%) |
|----------|--------------|-------------|-----------------|-------------|-----------|
|          | Present (%)  | Absent (%)  | Present (%)     | Absent (%)  |           |
| 0-2      | 0 (0)        | 04 (6.66%)  | 0 (0)           | 04 (6.77%)  | 04        |
| 3-5      | 08 (20%)     | 15 (25%)    | 06 (14.63%)     | 17 (28.81%) | 23        |
| 6-10     | 24 (60%)     | 31 (51.66%) | 25 (60.97%)     | 30 (50.84%) | 55        |
| >10      | 08 (20%)     | 10 (16.66%) | 10 (24.39%)     | 08 (13.55%) | 18        |
| Total    | 40 (100%)    | 60 (100%)   | 41(100%)        | 59(100%)    | 100       |



**Graph 20:** Correlation between ECG finding (T Inversion), 2D Echo finding (IHD) and Duration of Diabetes

#### 4. Discussion

In this study, Out of the 100 participants, maximum number of participants were from age group between 51-60 yrs i.e. 41 in number (41.00%) followed by 41-50yrs i.e.30 in number (30.00%),(Table 1). The mean age of our study participants was  $53.76 \pm 9.22$ . Out of 100 total subjects 36 (36%) were male and 64 (64%) were females,(Table 2). In study by Madhumathiet al<sup>10</sup> on type 2 DM 30(60%) were females and 20 (40%) males. Most of the subjects were in 40-70 years age group. In study by Markuszewsk et al<sup>11</sup> the study comprised 57 subjects (35 men and 22 women) with DM type 2. In study by Sahil Gupta et al<sup>12</sup> mean age of asymptomatic diabetic patients was  $50.3 \pm 11.90$  years (age

range 25-75 years). In our study maximum number of participants had history of diabetes in between 6-10 yrs followed by 3-5 yrs followed by more than 10 yrs (Table 5) This shows that 82 patients had duration of diabetes less than 10 years.

In our study it was observed that as duration of diabetes has significant effect on development of diastolic dysfunction,It was statistically significant. ( $< 0.05$ ) (Table 14).In study by Matthew B. et al observed same as ours comparing with duration of diabetes, this study shows 21(42%) patients with less than 5 year duration of diabetes and 20(40%) patients with 5-10 years duration of diabetes. Statistically it was significant as study had higher percentage of patients with diastolic dysfunction as duration of diabetes increased.In study by Patil MB et al<sup>13</sup> concluded that prevalence of diastolic dysfunction increased with longer duration of diabetes. In our study, out of 100 participants 68 were on Oral Hypoglycaemic agents and 24 were using insulin and 8 were on both OHA and insulin (Table 6 ,7 and 8)Patil MB et al<sup>13</sup> also observed same as Diastolic dysfunction was more common in patients who were on treatment with both oral hypoglycaemic agents and insulin.

Left ventricular diastolic dysfunction was found in 45% cases in our study (Table 11) which was comparable to most other studies. Means prevalence of the diastolic dysfunction was 45 % (Table 11). In similar study by Poirier et al<sup>15</sup> observed the LVDD is much more prevalent than previously suggested in subjects with type 2 diabetes who are free of clinically detectable heart disease. Peter Godsk Jorgensen et al<sup>14</sup> observed the same result as more prevalence of diastolic dysfunction in diabetes mellitus patients.

**Table:** comparison of diastolic dysfunction in present study with other studies

| Studies                            | Percentage |
|------------------------------------|------------|
| Poirier et al Study <sup>15</sup>  | 60         |
| Faden et al <sup>16</sup>          | 64         |
| Markuszewsk et al <sup>11</sup>    | 43         |
| Virendra Patil et al <sup>17</sup> | 54.33      |
| Present Study                      | 45         |

The glycemic control of the study population was measured by correlating with the HbA1c level. In our study 100 patients was having HbA1c more than 6.5 means patient have diabetes mellitus (Table 4). In the present study, out of the 100 cases,45% patients have HbA1c value of more than 8. 39 % patients have HbA1c value between 7.1 to 8 and 16 % patients have HbA1c value between 6.5 to 7. Number of patients having Diastolic dysfunction is increasing as rise in HbA1c (Table 15).The difference was statistically significant ( $p < 0.05$ ). In study by Madhumathi R et al<sup>10</sup> Prevalence of diastolic dysfunction increased gradually with the rise in HbA1c levels and it was statistically significant. In study by Markuszewsk et al<sup>11</sup> observed the same as Diastolic dysfunction of the left ventricle was observed in 43% of patients with HbA1c  $> 6.1\%$  comparing to 4.5% of patients in the group with HbA1  $< \text{or} = 6.1\%$ . Thus it concluded that HbA1c is a strong contributing factor in diabetes mellitus causing diastolic dysfunction. In study by Abhay kumar et al<sup>18</sup> also observed that mean HbA1c level of LVDD group was found higher as compared

to those without LVDD. HbA1c and age were found to be strong indicators of LVDD in newly diagnosed cases of Type 2 DM. Patil MB et al<sup>13</sup> also observed as Diastolic dysfunction was significantly associated with uncontrolled diabetes as assessed by HbA1c levels.

There was a linear progression of diastolic dysfunction with the increase age group. In present study out of 100 patients, the incidence of diastolic dysfunction increases as age increases. In present study out of 100 patients 45 have diastolic dysfunction and out of 45 patients 28 patients are above 50 yrs of age. Thus older the age group, more the diastolic dysfunction. Similar results were found in, Virendrapatil et al<sup>17</sup> who concluded that diastolic dysfunction was significantly higher in age >45 years compared to age <45 years (p value < .05)

In this study out of 100 patients of diabetes mellitus, 60 patients does not have any ECG abnormalities like ST-T wave changes, LVH, arrhythmia and 40 patients have T wave changes on ECG like inversion (Table 18). In study conducted by Sahil Gupta et al<sup>12</sup> most common abnormality observed was ST-T changes, followed by Left Atrial Enlargement (LAE), Left Ventricular Hypertrophy (LVH), Left Bundle Branch Block (LBBB) and Right Bundle Branch Block (RBBB). O. Kittnar et al<sup>19</sup> observed that repeatedly reported results showed in DM patients without cardiovascular complications are the tachycardia, shortening of the QRS and QT intervals, increase of the dispersion of QT interval.

Sharol Ashma<sup>20</sup> et al observed that electrocardiographic changes were poor progression of R waves (18%), Q waves (10%), bundle branch blocks (8%), QT prolongation (8%), ectopics (6%), axis changes (6%), heart blocks (6%), rate abnormalities (8%) and chamber enlargement (6%) in type 2 DM patients.

In our study it was observed that higher the BMI more was the diastolic dysfunction (Table 15). The difference was statistically significant. In similar study by W AlJaroudiet al<sup>21</sup> concluded that patients with normal LVEF, with higher BMI was independently associated with worsening DD. (p value 0.001)

In our study, conducted on 100 type 2 DM patients, correlation between duration of Diabetes and 2D echo findings (IHD), duration of Diabetes and ECG findings (T inversion) and duration of Diabetes with 2D echo finding (IHD) and ECG finding (T inversion) is done and is statistically significant. (Table 17, 18, 19, 20).

## 5. Conclusion

- Present study was Descriptive cross-sectional study, conducted on 100 type 2 diabetes mellitus patients.
- Mean age of the study was 53.76±9.22 yrs and maximum patients were from age group 51-60 yrs.
- Females were more than males.
- Maximum number of patients were having duration of diabetes between 6-10 yrs.
- Maximum number of patients were taking treatment in the form of oral hypoglycemic agent (68%).

- There were 16 participants having history of addiction (8 Smoking, 4 alcoholic and 4 of both smoking and alcohol)
- Maximum number of participants was within normal range of BMI followed by Pre-obese and obese.
- Maximum number of patients were having HbA1c value more than 8 (45%),
- There were 40 patients having T inversion on ECG.
- Maximum number of diastolic dysfunction were of Grade 2 i.e. 24 in number followed by Grade 1 i.e. 11 in number followed by Grade 3 i.e. 10 in number.
- There were 45 patients having diastolic dysfunction.
- There were 41 patients were having IHD on 2D Echo finding.
- Duration of Diabetes, HbA1C, Age (Yrs), BMI, Fasting Blood sugar were significantly associated with diastolic dysfunction.
- Correlation between 2D Echo finding (IHD), the ECG finding (T inversion) and Duration of Diabetes were statistically significant.

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