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

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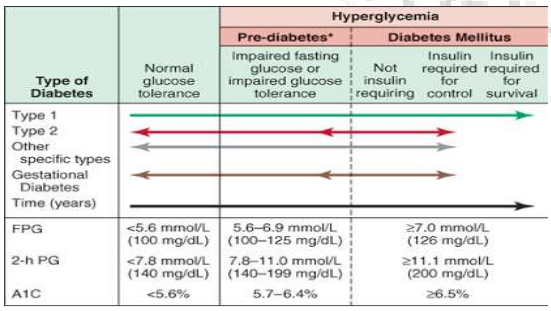
Abstract: ***Diabetes mellitus (DM) is one of the most common disorder in the world Diabetic mellitus is a chronic progressive metabolic disease which involves myocardium at relatively early stage even before clinical manifestations become obvious. It is associated with a multitude of cardiovascular 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[1]. The theme of World Diabetes Day 2017 is **Women and diabetes - our right to a healthy future**[2].**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[1].India leads the world with largest number of diabetic subjects earning the dubious distension of being termed the "Diabetes capital of the world".

There are two broad categories of DM[3] designated type 1 and type 2:



Classification of diabetes mellitus[4]
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[5].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 inasymptomatic persons. An abnormal ECG response is associated withstatistically significant high risk for cardiac mortality and morbidity[6].The importance of

diabetes mellitus, both type 1 and type 2, in theepidemiology of cardiovascular diseases cannot be overemphasized. About one third of acute myocardial infarction patients have diabetes mellitus, theprevalence of which is steadily increasing: In the 1960s, there were 2 millionAmericans with diabetes mellitus; in the year 2000, their number was 15million. Statistics have shownthat the decrease in cardiac mortality in persons with diabetes mellitus islagging behind that of the generalpopulation. Early diagnosis of diabete mellitus is crucia[7].

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: <= 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>= 200mg/dl.
3) Fasting plasma glucose >=126mg/dl.
4) 2 hour plasma glucose >= 200 mg/dl
5) Hba1c>=6.5

Exclusion Criteria

1) Myocardial infarction by history.
2) Patients with angina pectoris.
3) Patients with known ischiemic 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 cardio vascular 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[8]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 ≥ 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 assese 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[9].

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

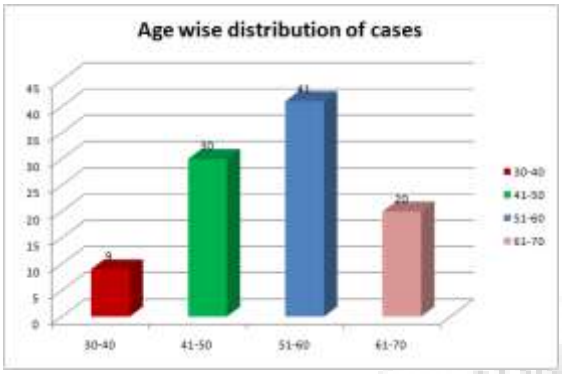


Chart 1: Age wise Distribution

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

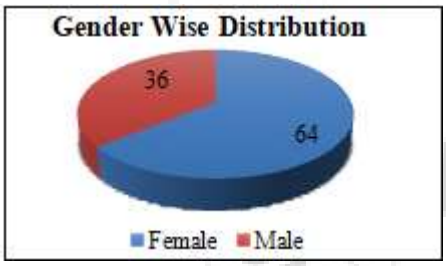


Chart 2: Gender wise Distribution

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)

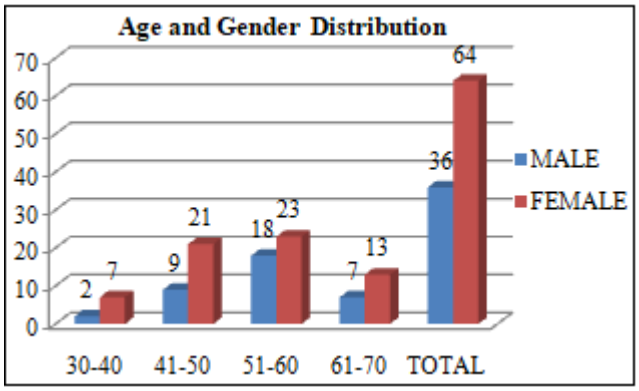


Chart 3: Age and Gender Distribution

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)

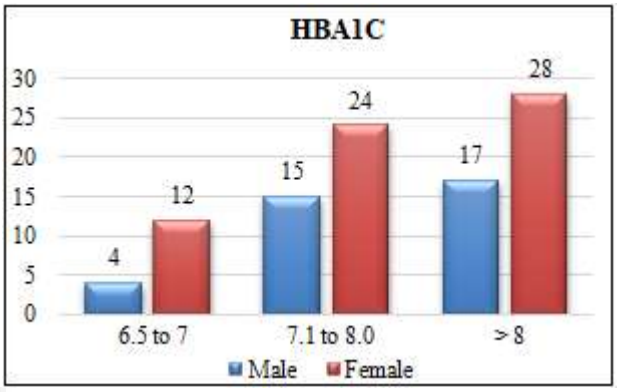


Chart 4: Distribution According to HBA1C Value

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)

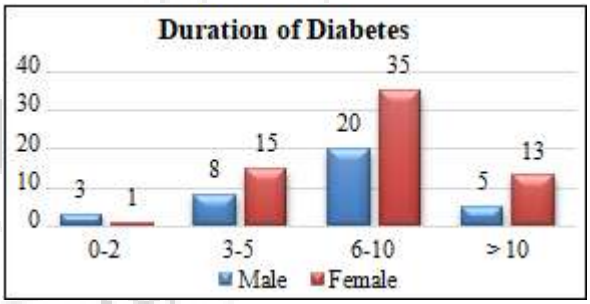


Chart 5: Distribution According to Duration of Diabetes

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	

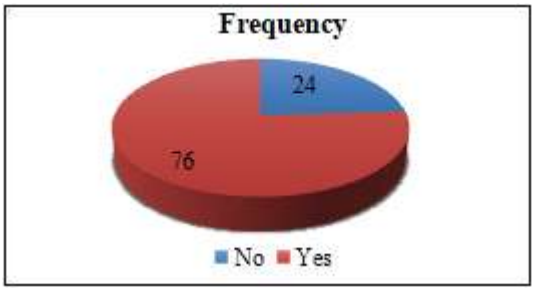


Chart 6: Distribution According Oral Hypoglycaemic Agents

Table 7: Distribution According Insulin

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

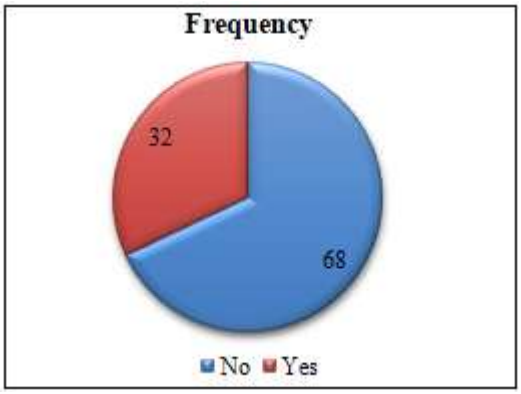


Chart 7: Distribution According Insulin

Table 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)

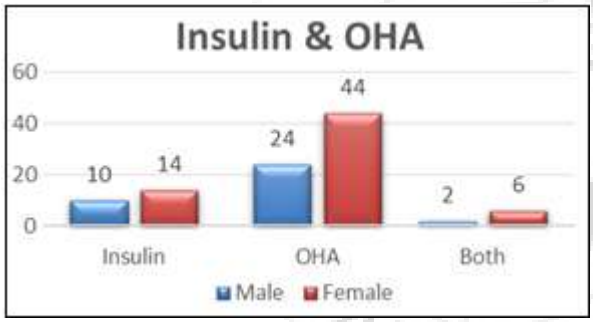


Chart 8: Distribution According Treatment (Insulin & OHA)

Table 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 10: Distribution According to BMI

Sr. No	BMI (Kg/m^2)	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)

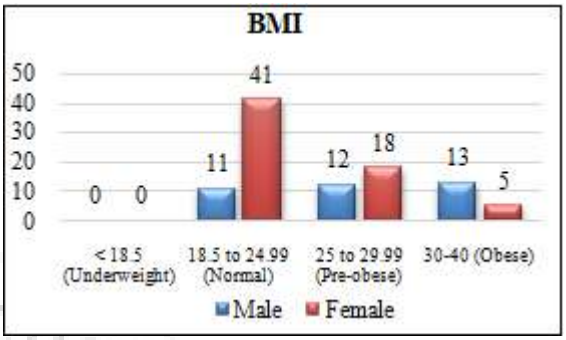


Chart 10: Distribution According to BMI

Table 11: Distribution According to Diastolic Dysfunction on Echocardiography

	Present	Absent	Total
Diastolic Dysfunction	45	55	100

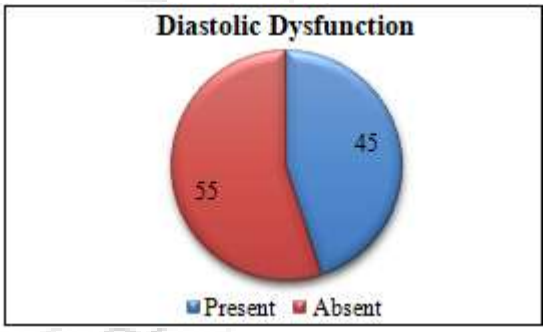
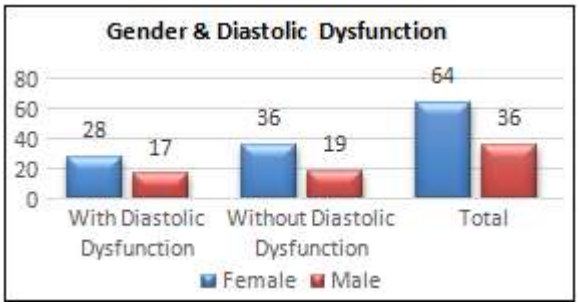


Chart 11: Distribution According to Diastolic Dysfunction on Echocardiography

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

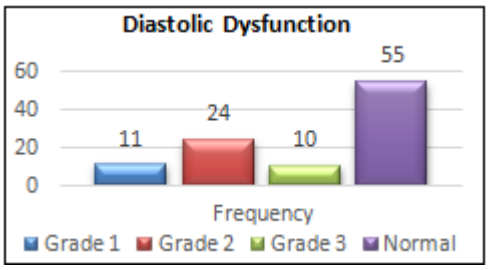


Chart 13: Distribution According to Diastolic Dysfunction

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)

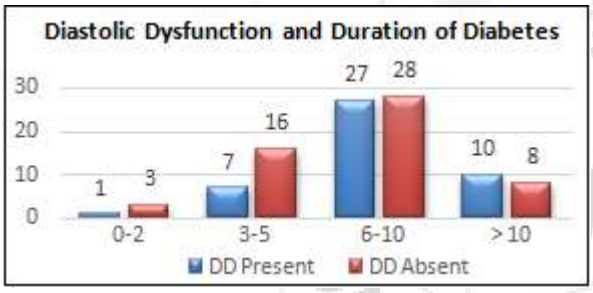


Chart 14: Correlation between Diastolic Dysfunction and Duration of Diabetes

Table 15: Diastolic Dysfunction and Various Parameters

Sr. No.	Parameters	With DD (N=45)	Without DD (N=55)	P valve
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

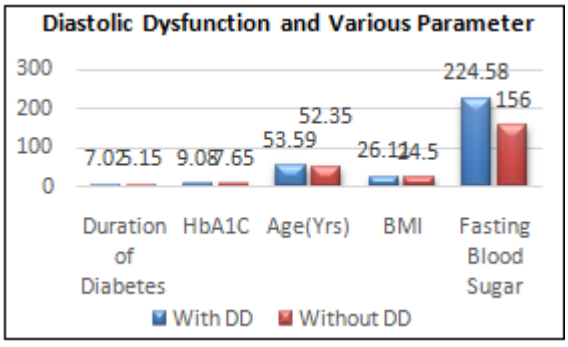


Chart 15: Diastolic Dysfunction and Various Parameter

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

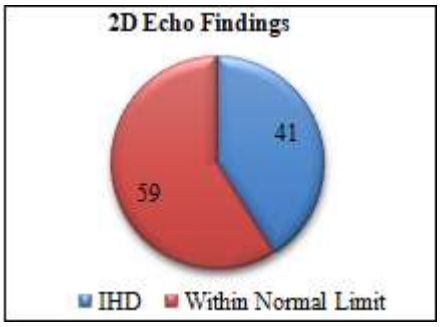


Chart 16: Distribution According to 2D Echo Findings

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

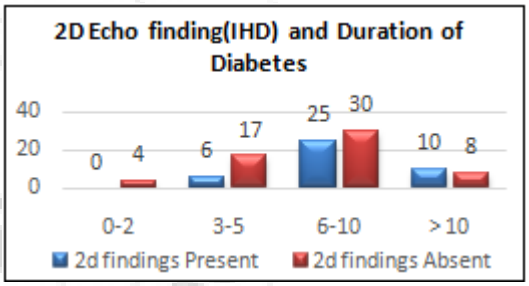


Chart 17: Correlation between 2D Echo finding (IHD) and Duration of Diabetes

Table 18: Distribution According to ECG findings

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

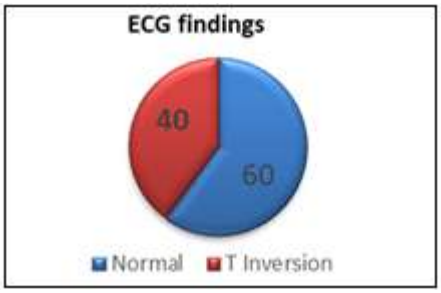


Chart 18: Distribution According to ECG findings

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)

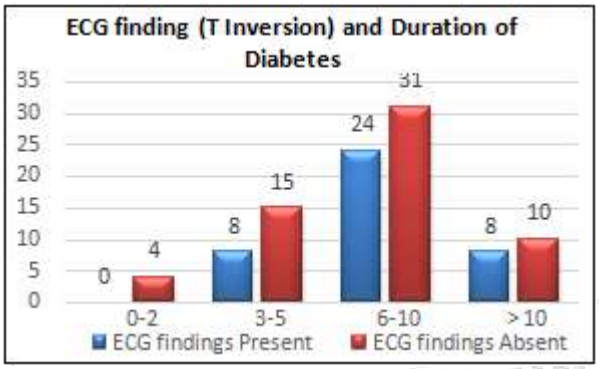
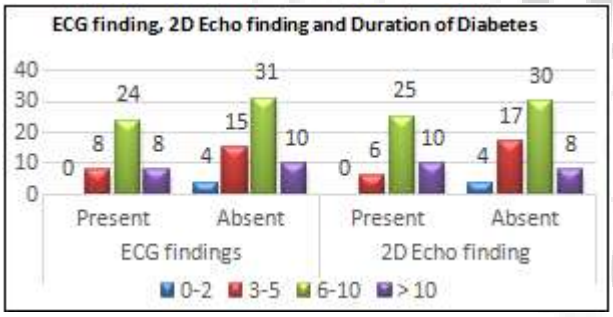


Chart 19: Correlation between ECG finding (T Inversion) and Duration of Diabetes

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 ± 9.22.Out of 100 total subjects 36 (36%) were male and 64 (64%) were females,(Table 2). In study by Madhumathiet al[10] 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[11]the study comprised 57 subjects (35 men and 22 women) with DM type 2. In study by Sahil Gupta et al[12]mean age of asymptomatic diabetic patients was 50.3±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 alobserved 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 byPatilMBet al[13]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 MBet al[13]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 al58observed 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[14]observed the same result as more prevalence of diastolic dysfunction in diabetes mellitus patients.

Table: comparison of diastolic dysfunction in present studywith other studies

Studies	Percentage
Poirier et al Study[15]	60
Faden et al[16]	64
Markuszewsk et al[11]	43
Virendra Patil et al[17]	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 etal[10]Prevalence of diastolic dysfunction increased gradually with the rise in HbA1c levels and it was statistically significant. In study by Markuszewsk et al[11]observed the same asDiastolic 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 < 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[18]also observed that mean HbA1c level of LVDD group was found higher as compared

to those without LVDD. HbA1cand agewere found to be strong indicators of LVDD in newly diagnosed cases of Type 2 DM. Patil MBet al[13]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 is increases as age is 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[17]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[12]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[19]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.
SharolAshma[20]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[21]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 statisticaly 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 numberof patients were having duration of diabetes between 6-10yrs.
- Maximum numberof 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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