Original Research Article

Role of Resting Electrocardiography and Transthoracic Echocardiography in the Diagnosis of Cardiac Impairments in Type 2 Diabetics

Abstract

Background: The cardiac changes associated with diabetes are thought to comprise thickening of the myocardium and is characterized by predominantly diastolic dysfunction (DD), the diabetic cardiomyopathy. So, this study aimed to evaluate cardiac impairments in patients in delta region with type 2 diabetes mellitus using resting electrocardiogram (ECG) and resting transthoracic echocardiography.

Methods: This was a cross-sectional study carried out on 50 diabetic patients to evaluate of cardiac impairments in patients in delta region with type 2 diabetes mellitus using resting ECG and resting transthoracic echocardiography at the Department of Cardiology, Tanta University Hospitals in a period of six months starting from January 2020 till June 2020.

Results: There were significant negative correlations between abnormal echocardiography with (body mass index) BMI, duration of diabetes and systolic blood pressure (SBP) ($P<0.05$). The sensitivity of ejection fraction (EF), early trans-mitral flow velocity (E), atrial trans-mitral flow velocity (A) and E/A in detecting cardiac changes in type 2 diabetes mellitus (DM) was 68%, 52%, 76%, 72% and specificity was 52%, 68%, 36%, 30% at cutoff value 65, 75, 65, 77.5 and AUC 0.619, 0.606, 0.538, 0.534, respectively ($P> 0.05$).

Conclusions: The effect of DM on the left ventricular (LV) diastolic function is still controversial. Therefore, they need to be further substantiated, preferably with evidence from extensive longitudinal studies in people with type 2 diabetes representative of type 2 diabetes healthcare populations. Echocardiographic and ECG abnormalities are very common in outpatients with type 2 diabetes. DD is the main cardiac impairment caused by DM.

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Keywords: electrocardiography, transthoracic echocardiography, cardiac impairments and type 2 diabetes mellitus.

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Introduction:

Diabetes is a risk factor independent of atherosclerosis [1]. People with type 1 and type 2 diabetes are at an elevated risk for atherosclerotic cardiovascular disease. Diabetes is connected with micro- and macro-vascular problems and is a significant and independent risk factor for cardiovascular diseases (CVD). About 67% of men and 55% of women at age 50 years have a high lifetime risk for cardiovascular disease (CVD) [2].

The great majority (90%) of persons with diabetes have type 2 diabetes (T2D), which is generally avoidable and is associated with increasing sedentary behaviour and obesity. Previously uncommon in young individuals, T2D is now being diagnosed in children, adolescents, and adults under 30 years of age [3, 4].

Diabetes is believed to cause a continuum of cardiac dysfunction, from asymptomatic DD to subclinical systolic dysfunction to overt heart failure (HF) with decreased ejection fraction (EF) [5].

Diabetes mellitus is widespread among patients with heart failure, particularly those with heart failure and preserved ejection fraction (HFpEF), and individuals with both illnesses have a greater risk of death compared to those without diabetes or heart failure [6-8].

Diabetes provides a significant risk for the development of cardiovascular disease (CVD) since it is associated with an accelerated atherosclerotic process and an increased risk for atherothrombotic complications [9].

Ischemic heart disease is the most prevalent cardiovascular illness and is associated with the highest morbidity and death in persons with type 2 diabetes [10, 11].

The leading cause of death in diabetics is due to cardiovascular damage. This heavy mortality attributable to heart disease is often insidious and sometimes asymptomatic, such as coronary heart disease and heart failure. Their diagnosis involves additional tests, the simplest of which are electrocardiography and echocardiography [12, 13].

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The aim of this work was to evaluate cardiac impairments in patients in delta region with type 2 diabetes mellitus using resting electrocardiogram (ECG) and resting transthoracic echocardiography.

Patients and Methods:

This was a cross-sectional study carried out on 50 diabetic patients to evaluate of cardiac impairments in patients in delta region with type 2 diabetes mellitus using resting ECG and resting transthoracic echocardiography at the Department of Cardiology, Tanta University Hospitals in a period of six months starting from January 2020 till June 2020. Written or informed consent from patients was taken after explaining the aim of study. All procedures were carried out in accordance with the ethical standards of the institutional and/or national research committee, Tanta University.

All patients were selected according to the Inclusion criteria: Type 2 diabetic patients of both sexes, followed on an outpatient basis at the Department of Cardiology, Tanta University Hospitals. Exclusion criteria: **v**alvular heart disease. **c**ongenital heart diseases and **p**atient refusal.

All participants included in the study were subjected to the followings:

Full history taking, complete clinical examination and routine laboratory tests including (Fasting blood glucose., Glycated Haemoglobin and Complete lipid profile: Total cholesterol TC, triglyceride level (TGL), low-density lipoprotein (LDL), high-density lipoprotein (HDL), very-low-density lipoprotein (VLDL)) were done.

Resting twelve-leads ECG: Standard 12-lead ECG was obtained for all patients and limb leads I, II, III, aVR, aVL, aVF, and chest leads from V1to V6 for all patients.

Resting transthoracic echocardiography.

All studies were performed using (a GE vivid five cardiac ultrasound phased array system without tissue Doppler imaging using M3S transducer 2.5MHz)

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Different modalities were used: Doppler echocardiography: calculation of valve gradient (stenosis) and functional area, colour Doppler lesion detection: convergence zone (stenosis, regurgitation) or regurgitant jet and estimation of LV filling pressure/diastolic function.

Modalities:

- Continuous-wave Doppler (CW):

o Assessment of valve stenosis

Assessment of aortic (AS) and pulmonary (PS) valve stenosis

Transvalvular velocity (m/s)/gradient (mmHg): the highest velocity (best aligned) was recorded (multiple windows were used).

Mitral (MS) and tricuspid (TS) stenosis assessment

Transvalvular velocity (m /s)/gradient (mmHg)

- Pressure half-time (PHT/T1/2)
- TTE planimetry:

o Assessment of valve regurgitation

Aortic (AR)/Pulmonary (PR) regurgitation assessment

- (PHT/T1/2)
- Deceleration time
- Diastolic flow reversal in descending aorta

Mitral (MR) and tricuspid (TR) regurgitation assessment

- CW Doppler envelope

- Pulsed-wave Doppler (PW)

Diastolic function was assessed through PW Doppler echocardiography.

Measurements: Peak of early filling (E velocity), peak of late atrial filling (A velocity) and the E/A ratio (normal range: (0.8 – 1.5).

- Colour-flow Doppler: used to detect time flow /abnormal flow.

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Left ventricle (LV)

- Measurement of LV size and systolic function through M mode. M-Mode (Teichholz method)

Right ventricle (RV): RV enlargement is measured by LV diameters (2D diameters, apical 4CV) and RV dysfunction is evaluated by fractional area change (a value < 32% indicates RV dysfunction) and by Tricuspid annular plane systolic excursion (TAPSE) method (TAPSE < 14 mm indicates RV dysfunction).

Statistical analysis

Data was collected, tabulated and statistically analysed using an IBM compatible personal computer with Statistical Package for the Social Sciences (SPSS) version 23 (Armnok, NY: IBM Corp.) statistics were divided into two parts: A-Descriptive statistics: in which quantitative data was presented in the form of median and range (In descriptive statistics, the inter quartile range (IQR) is the first quartile subtracted from the third quartile; these quartiles can be clearly seen on a box plot on the data. It is a trimmed estimator, defined as the 25% trimmed range, and is a commonly used robust measure of scale. The IQR is a measure of variability, based on dividing a data set into quartiles). and qualitative data was presented in the form numbers (N) and percentages (%). P value <0.05 was considered statistically significant.

Results:

There was no significant relation between abnormal echocardiography with age and sex of the studied patients (p>0.05) **(Table 1).**

Table 1: Abnormal echocardiography in relation to demographic data of the studied patients (N=50).

Variable	Abnormal echocardiography N=50		Total	U	P value	95% CI	
	No (N=25)	Yes (N=25)				Lower	Upper

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Age (year)	51.72±5.06		51.56±5.58		51.64±5.27		0.106	0.916	-2.87	3.19
Sex	**No.**	**%**	**No**	**%**	**No**	**%**	X^2			
Male	12	48.00	16	64.00	28	56.00	1.299	0.254	---	---
Female	13	52.00	9	36.00	22	44.00				
Smoking							X^2			
No	18	72.00	16	64.00	34	68.00	0.368	0.544	---	---
Yes	7	28.00	9	36.00	16	32.00				

t: independent T test

BMI, duration of diabetes and SBP were significant relations with abnormal echocardiography (P<0.05). While diastolic blood pressure (DBP) didn't show statistically significant relation with abnormal echocardiography of the studied patients, (p=0.717) **(Table 2).**

Table 2: Abnormal echocardiography in relation to clinical data of the studied patients (N=50).

Variable	**Abnormal echocardiography N=50**		**Total**	**U**	**P value**	**95% CI**	
	No (N=25)	**Yes (N=25)**				**Lower**	**Upper**
BMI (Kg/m^2)	28.02±4.02	24.44±4.46	26.23±4.57	2.987	**0.004***	1.17	6.00
Duration of diabetes	9.08±2.43	7.40±1.85	8.24±2.30	2.751	**0.008***	0.45	2.91
SBP (mmHg)	117.84±6.83	113.52±6.72	115.68±7.05	2.255	**0.029***	0.47	8.17
DBP (mmHg)	78.40±11.06	79.52±10.68	78.96±10.78	-0.364	0.717	-7.30	5.06

BMI: Body Mass Index, **SBP:** Systolic blood pressure, **DBP:** Diastolic blood pressure, **T**: independent test, ***:** significant

HbA1C, total cholesterol, TGL, VLDL, HDL and LDL didn't show statistically significant relation with abnormal echocardiography (p>0.05) **(Table 3).**

Table 3: Abnormal echocardiography in relation to laboratory investigation of the studied patients (N=50).

Variable	**Abnormal echocardiography N=50**		**Total**	**U**	**P value**	**95% CI**	
	No (N=25)	**Yes (N=25)**				**Lower**	**Upper**
HbA1C (mmol/mol)	7.28±0.69	7.33±0.81	7.31±0.75	-0.225	0.823	-0.48	0.38
TC (mg/dL)	224.80±34.09	222.68±53.02	223.74±44.13	0.168	0.867	-23.23	27.47
TGL (mg/dL)	171.76±30.23	180.92v35.70	176.34±33.06	-0.979	0.332	-27.97	9.65

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VLDL (mg/dL)	34.82±6.60	36.21±7.11	35.52±6.83	-0.713	0.479	-5.29	2.52
HDL (mg/dL)	46.47±8.45	47.20±8.88	46.84±8.58	-0.297	0.768	-5.66	4.20
LDL (mg/dL)	138.97±30.63	137.02±43.84	137.99±37.44	0.183	0.856	-19.55	23.46

HbA1C: Hemoglobin A1c, **TC**: Total cholesterol, **TGL**: Triglyceride level, **VLDL**: Very-low-density lipoprotein, **HDL**: High-density lipoprotein, **LDL**: Low-density lipoprotein, T: independent t test

Distribution of the studied cases according to transthoracic echocardiography, left ventricle abnormalities., LA diameter, RV function and ECG changes **(Table 4).**

Table 4: Distribution of the studied cases according to transthoracic echocardiography, left ventricle abnormalities., left atrium diameter, right ventricle function and ECG changes.

Transthoracic echocardiography	EF	66.70 ± 4.73
	E	0.75 ± 0.18
	A	0.78 ± 0.23
	E/A	0.98 ± 0.34
	DD	31 (62.0%)
Left ventricle abnormalities.	Hypertrophy (%)	10 (20.0%)
	Systolic anterior motion of mitral leaflet	1 (2.0%)
	Reduced left ventricular ejection fraction (%)	6 (12.0%)
Left atrium diameter	Left atrial enlargement (%)	10 (20.0%)
Right ventricle function	Reduced right ventricular function (%)	7 (14.0%)
	Ascending aorta dilatation and total abnormal echo studies.	
	Dilated ascending aorta (%)	1(2.0%)
	Abnormal echocardiography (%)	25 (50.0%)
ECG changes	LAE	3 (6.0%)
	LVH	2 (4.0%)
	BBB	2 (4.0%)
	ST elevation	0 (0.0%)
	ST depression and T wave inversion	6 (12.0%)

The results of multiple logistic regression analysis indicated that EF, early trans-mitral flow velocity (E), atrial trans-mitral flow velocity (A), EA, DD, blood–brain barrier (BBB), reduced left ventricular EF and reduced right ventricular function didn't show any association detection of cardiac changes in type 2 DM (P>0.05) **(Table 5).**

Table 5: Multinomial logistic regression analysis using as the studied variable as detection of cardiac changes in type 2 DM.

Abnormal echocardiography (%)	B	Std. Error	OR	Sig.	Exp(B)	95% CI	
						Lower	Upper
EF	0.061	0.073	0.705	0.401	1.063	0.922	1.226
E	1.130	1.923	0.345	0.557	3.094	0.071	134.112
A	0.619	1.382	0.201	0.654	1.858	0.124	27.875
EA	-0.640	2.011	0.101	0.750	0.527	0.010	27.180
DD (mL/m2)	-1.236	1.437	0.740	0.390	0.290	0.017	4.859
BBB	0.047	1.447	0.001	0.974	1.048	0.061	17.852
Reduced left ventricular ejection fraction	-0.636	0.930	0.468	0.494	0.529	0.086	3.275
Reduced right ventricular function	0.057	0.884	0.004	0.948	1.059	.187	5.985

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EF: Ejection fraction, **E**: early trans-mitral flow velocity, **A:** atrial trans-mitral flow velocity, **DD:** Diastolic Dysfunction, **BBB**: Blood–brain barrier

There was significant negative correlation between abnormal echocardiography with BMI, duration of diabetes and SBP (P<0.05). On the other hand, there were no significant correlations between abnormal echocardiography with other parameters (P>0.05) **(Table 6).**

Table 6: Correlation between abnormal echocardiography and transthoracic echocardiography with all variables.

Variables	Abnormal echocardiography	
	r	P value
Age (year)	-0.015	0.916
Sex	-0.161	0.264
BMI (Kg/m2)	-0.396	**0.004***
Smoking	0.086	0.554
Duration of diabetes	-0.369	**0.008***
SBP (mmHg)	-0.310	**0.029**
DBP (mmHg)	0.052	0.717
LDL (mg/dL)	-0.026	0.856
HbA1C (mmol/molvariables..823		
TC (mg/dL)	-0.024	0.867
TGL (mg/dL)	0.140	0.332
VLDL (mg/dL)	0.102	0.479
HDL (mg/dL)	0.043	0.768
EF	0.201	0.163
E	0.181	0.209
A	0.107	0.461
E/A	0.109	0.451
DD (mL/m^2)	0-.124	0.392
LAE	0.253	0.077
LVH ($g.m^{-2}$)	-0.204	0.155
BBB	0.000	1.000
ST depression and T wave inversion	0.000	1.000
Hypertrophy (%)	0.000	1.000
Systolic anterior motion of mitral leaflet	0.143	0.322
Left ventricular ejection fraction (%)	0.253	0.077
Reduced left ventricular ejection fraction (%)	-0.123	0.394
Diastolic dysfunction (%)	0.000	1.000
Left atrial enlargement (%)	-0.100	0.490
Reduced right ventricular function (%)	0.058	0.691
Aortic stenosis (%)	0.000	1.000
Aortic regurgitation (%)	0.143	0.322
Mitral regurgitation (%)	0.000	1.000
Dilated aorta ascendence (%)	0.143	0.322
Abnormal echocardiography (%)	NA	---

BMI: Body Mass Index, **SBP:** Systolic blood pressure, **DBP:** Diastolic blood pressure, **HbA1C**: Hemoglobin A1c, **TC**: Total cholesterol, **TGL**: Triglyceride level, **VLDL**: Very-low-density lipoprotein, **HDL**: High-density lipoprotein, **LDL**: Low-density lipoprotein, **EF:** Ejection fraction, **E**: early trans-mitral flow velocity, **A:** atrial trans-mitral flow velocity, **DD:** Diastolic Dysfunction, **BBB**: Blood–brain barrier, **ST elevation**: segment elevated myocardial infarction, *: Significant

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The sensitivity of EF, E, A and E/A in detecting cardiac changes in type 2 DM were 68%, 52%, 76%, 72% and specificity were 52%, 68%, 36%, 30% at cut off value 65, 75, 65, 77.5 and AUC 0.619, 0.606, 0.538, 0.534, respectively (P> 0.05) **(Table 7).**

Table 7: ROC curve analysis of transthoracic echocardiography among studied groups in detection of cardiac changes in type 2 DM.

Variable	Area	cutoff	Std. Error	Sens	Spec	Asymptotic Sig.	Asymptotic 95% CI	
							Lower	Upper
EF	0.619	65	0.081	68.000	52.000	0.148	0.461	0.777
E	0.606	75	0.081	52.000	68.000	0.200	0.448	0.764
A	0.538	65	0.083	76.000	36.000	0.648	0.376	0.700
E/A	0.534	77.5	0.084	72.000	30.000	0.684	0.369	0.698

The sensitivity of EF, E, A and E/A in detecting cardiac changes in type 2 DM were 68%, 52%, 76%, 72% and specificity were 52%, 68%, 36%, 30% at cut off value 65, 75, 65, 77.5 and AUC 0.619, 0.606, 0.538, 0.534, respectively (P> 0.05) **(Figure 1).**

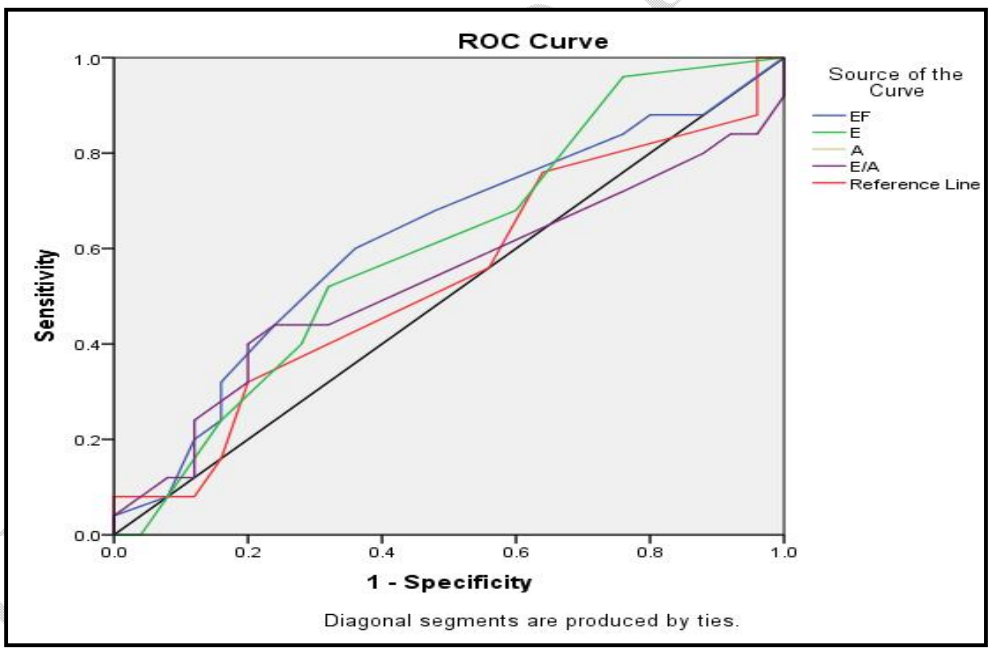

Figure 1:ROC curve analysis of Transthoracic echocardiography among studied groups in detection of cardiac changes in type 2 DM

Discussion

It is believed that the cardiac alterations associated with diabetes include thickening of the myocardium and are characterised by primarily DD, the diabetic cardiomyopathy. Boyer et

al., Poulsen et al., and Boonman et al. have all observed a significant incidence of DD in this patient population. [14-16]

In addition, due to increasing age and co-morbidities, such as hypertension and obesity, individuals with type 2 diabetes are susceptible to various cardiac diseases that influence prognosis, including but not limited to Kuperstein et al. Reduced left and right ventricular ejection fraction Kenchaiah et al. [18], dilated LA Poulsen et al. [19] or valve abnormalities Nkomo et al. [20]

73% of 100 patients studied by Venkateswari et al. [21] had poor glycaemic control, whereas only 27% had adequate glycaemic control, as defined by HbA1c and other trustworthy measures.

From Jorgensen et al .[23] This measure is more conservative, as it only classifies individuals with obviously aberrant diastolic function and not those with borderline abnormal diastolic function. This, of course, makes our prevalence estimates more cautious, but it also reveals a subset with a confirmed elevated risk.

DD was present in 62% of our patients.

In line with guidelines, resting ECG abnormalities might be a useful tool for CVD screening in people with type 2 diabetes.

According to our study, ECG abnormalities were detected in 32% of patients, the most common ECG presentation was ST depression and T wave inversion which was present in 6 (12%) of our patients. Followed by LAE in 3 (6.0%) patients, then LVH & BBB; each of them was presented in 2 (4%) of patients. ST elevation was not reported in our study.

LVH is a well-established precursor both of systolic dysfunction and overall cardiovascular disease. Though typically associated with hypertension, its prevalence increases with increasing age, BMI and presence of hypertension and diabetes; all the characteristics of a population of outpatients with type 2 diabetes Drazner et al. [24]. Fang et al. [25] evaluated

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186 individuals with normal EF and no signs of CAD: 48 with just diabetes (DM group), 45 with only left ventricular hypertrophy (LVH group), 45 with both diabetes and LVH (DH group), and 48 normal controls. Peak strain and strain rate of six walls in apical four-chamber, long- axis, and two chamber views were evaluated and averaged for each patient. They discovered that all patient groups had reduced systolic function compared to controls, as evidenced by lower peak strain (p0.001) and strain rate (p=0.005), and they concluded that people with diabetes without overt cardiovascular disease have evidence of systolic dysfunction and increased myocardial reflectivity.Another study by Jørgensen et al. [22] mentioned that a total of 1030 patients with type 2 diabetes participated. LVH and LA enlargement, were present in 213 (21.0%) and 200 (19.6%), respectively. Tougouma et al. [26] who conducted study to describe the electrocardiographic and echocardiographic abnormalities observed in patients with type 2 diabetes and found that, echocardiographic examination showed (LVH) in 20,64% of cases. LA was dilated in 14.19% of cases, LV was dilated in 1.3% of cases. Abnormal LV EF was detected in 3.87% of cases.

LA enlargement is related with stroke and death in the general population, patients with myocardial infarction, and patients with ischemic cardiomyopathy, according to Sabharwal et al. [27]. Notably, Poulsen et al. [19] discovered that LA enlargement is linked with a composite endpoint of all-cause mortality and cardiovascular events in patients with type 2 diabetes. Ng et al. [28] found that LV strain and strain rate analyses were used to detect subtle myocardial dysfunction in 47 asymptomatic type 2 DM patients compared to 53 healthy controls. The diabetic patients had impaired longitudinal, but preserved circumferential and radial systolic, and DM was an independent predictor for longitudinal strain, and systolic strain rate (all p0.001).

In agreement with our findings, Harms et al. [29] found that ECG abnormalities are prevalent in all individuals with type 2 diabetes (29.1%), including those without a history of CVD

(24%) Traditional cardiovascular risk factors are associated with the prevalence of ECG abnormalities, concluding the study. In our study, reduced LV EF was present in 6 (12.0%) patients, an abnormal echocardiogram was found in 49.8% of Jørgensen et al. [22] Hypertrophy, DD, and LA enlargement accounted for the biggest proportion of patients, with a frequency of around 20% for each, whereas 12.5% of the population had systolic dysfunction.

According to Venkateswari et al[21] .'s study, there is a high correlation between age and DD with a P-value of 0.003. All of the cases included in this study were diabetes patients, thus it could not be determined if this link was exclusively attributable to age or whether it was due to an additive impact of a rise in diabetes duration with increasing age.

Previous investigations on echocardiographic anomalies in patients with type 2 diabetes have mostly focused on the prevalence of systolic and DD and HF to identify individuals with diabetic cardiomyopathy [14, 15, 30]; Zabalgoitia et al., Boyer et al., and Poulsen et al. This is not limited to type 2 diabetes, and Jensen et al. [31] previously reported a high prevalence of DD in patients with type 1 diabetes without known heart disease. Similar sex differences were observed in type 2 diabetes; however, small-sized studies have reported a wide variation in the prevalence of DD, ranging from 40% to 75%.

Cosson et al. [32] found no variations in diastolic performance between healthy participants and type 2 diabetic patients without hypertension, coronary artery disease, or microangiopathic sequelae. However, this was done with a significantly lower sample size (n = 78) and using older criteria for DD.

In their study, Boonman et al. [16] determined the prevalence of systolic and DD in a primary care context to be 0.7% and 25.1%, respectively, among 581 individuals with type 2 diabetes and no history of heart failure. In addition, they evaluated the incidence of cardiologist-confirmed HF in this cohort and discovered that 96.3% of newly diagnosed HF patients

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exhibited DD. Different criteria for confirming the existence of DD account for the disparity in prevalence between prior and current investigations.

Various studies have demonstrated varying degrees of correlation between gender and DD. 72% of the participants in the research by Venkateswari et al. [21] showed DD. There were 55.6% females and 44.4% men total. The estimated correlation coefficient between gender and DD is less than 0.254. The study by Venkateswari et al. did not reveal a substantial correlation between gender and DD.

According to our study, ten patients exhibited LA enlargement in relation to the left ventricle, ten patients had left ventricular hypertrophy, one patient had systolic anterior motion of the mitral leaflet, and three patients had lower LV ejection fraction.

LVH is a recognised risk factor for systolic dysfunction, according to Drazner et al. [24]. Although its prevalence rises with age, BMI, hypertension, and diabetes also have a role. Kuperstein et al. [17] provide all the features of a cohort of type 2 diabetes outpatients. Consequently, LVH is a significant issue in this community, and consistent with this, we discovered a prevalence of 24.6% in women and 19.1% in males. However, further study is required to assess the effect of diabetes on this group on its own.

As documented by Moller et al. and Sabharwal et al. [27, 33], LA enlargement reflects increased LV filling pressures in the failing heart and is related with stroke and death in the general population, patients with myocardial infarction, and those with ischemic cardiomyopathy.

Poulsen et al. [19] discovered that in individuals with type 2 diabetes, LA enlargement is related with a composite endpoint of all-cause death and cardiovascular events.

In this investigation, aorta ascendens dilation was recorded in 1 (2%), while abnormal echocardiogram was reported in 25 (50%) individuals.

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Jrgensen et al.[22] discovered that patients with abnormal echocardiography were older, had longer diabetes duration, larger BMI, higher SBP, and more frequently had atrial fibrillation, coronary heart disease, dyspnea, electrocardiographic abnormalities, albuminuria, higher serum creatinine levels, and lower high-density lipoprotein cholesterol levels. In addition, patients were administered insulin, beta-blockers, angiotensin II receptor blockers, calcium antagonists, and diuretics more frequently and metformin and glucagon-like peptide-1 receptor agonists less frequently.

This study has several limitations:

As this was a cross-sectional trial, the patients could not be followed for clinical outcomes such as AF and HF. Consequently, the outcomes of our investigation cannot be utilised to determine normal clinical care.

It was developed to examine echocardiography and ECG in a small group of type 2 diabetes outpatients. Determining the clinical prognostic significance of early LA functional impairment in this cohort necessitates long-term follow-up and large-scale prospective investigations.

Lack of noninvasive testing of coronary flow reserve to rule out microvascular dysfunction as a source of DD, such as cardiac magnetic resonance imaging (MRI), a highly costly treatment.

During the investigation, the Tissue Doppler modality, which is the first modality to detect DD, was unavailable.

All patients were recruited from outpatient specialty clinics. In light of this, the findings should not be applied to all individuals with type 2 diabetes, and especially not to those treated in a primary care context.

Conclusions:

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The effect of Diabetes Mellitus (DM) on the diastolic function of the left ventricle is still debatable. Therefore, they require more support, ideally from substantial longitudinal studies involving persons with type 2 diabetes who are typical of the type 2 diabetes healthcare community. Echocardiographic and ECG abnormalities are quite prevalent in type 2 diabetes outpatients. DD is the principal heart dysfunction produced by diabetes mellitus.

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