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Tissue Doppler Imaging Findings and Lipid Profile Changes in Diabetes Mellitus Type I Children

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Abstract

Background

Diabetes mellitus type I (DMTI) is one of the most common endocrine and metabolic conditions in childhood. We aimed to assess the tissue Doppler imagining changes in children with DMTI compared to healthy children.

Materials and Methods

This case-control study was performed on 96 DMTI and 96 healthy children. The diabetes mellitus type I was confirmed by the clinical manifestation and laboratory measures. Both groups underwent echocardiography by tissue Doppler imaging by a pediatric cardiologist and their height and weight were measured using standard equipment and then BMI was calculated. Patients' HbA1c, diabetic duration and lipid profiles of cholesterol, HDL, LDL, and triglyceride were measured.

Results

Left ET', left IRT', left E', right ET', right ICT', right IRT', right S', right E', left MPI', and right MPI', left E/E' were significantly different in diabetes patients compared to healthy children (P>0.05). In patients based on HbA1c, left ICT' (P=0.010), right S' (P=0.050) were higher in abnormal status of HbA1c and in the case of diabetes duration categorization the results revealed that all the TDI findings were similar. The patients with higher TG had lower value of left A/A'. Right S', right E', right A', right E/E', and LDL were different in patients that were grouped based on CHO (P<0.05). Right S' and right E'E' were different in patients with normal LDL (P<0.05). Right S' had higher values in abnormal status of LDL.

Conclusion

It was concluded that DMTI had more tissue Doppler imaging involvement. No changes were observed in TDI except right S', left MPI' and left ICT' in HbA1c and right IRT', left ET' and right MPI' in diabetic duration.

Key Words: Children, Diabetes mellitus, Hemoglobin A1c, Tissue Doppler Imaging.

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1- INTRODUCTION

Diabetes mellitus type I (DMTI) is one of the most common endocrine and metabolic conditions in childhood (1). It is the predominant form of diabetes mellitus (DM) during childhood and adolescence but can present in adulthood, with the typical symptoms of polyuria, polydipsia, and weight reduction (1, 2). Diabetes mellitus advances myocardial damage even without hypertension, valvular or ischemic coronary illness and the condition is portrayed as diabetic cardiomyopathy (3). The frequency of diabetes mellitus (DM) is estimated as 387 million people worldwide (4), of which DMTI accounts for between 5% and 10% in different areas (3, 4). In Iran, the prevalence of DMT1 is 40 in 100,000 and is expected to increase in future (5).

The mean annual age- and sex-specific incidence rates of the DMTI are 3.14/100,000 for males and 4.37/100,000 for females at the age of 0–14 years and the peak are between 10 and 14 years of age in both sexes with earlier onset in girls (6). Impact of DMTI on development of left ventricular (LV) and right ventricular (RV) systolic dysfunction is controversial. Studies on tissue deformation revealed some evidence of LV and RV contractile impairment, while other studies did not show any difference (3). A close link exists between diabetes mellitus (DM) and cardiovascular disease (CVD). CVD is the most prevalent cause of mortality and morbidity in diabetic populations even in general population (7). As a result, CVD mortality rate in diabetic patients tends to be about twice as much as that of non-diabetic ones (7). The risk of death due to CVD is increased between 6 and 12 times compared with the general population (8). Kids and young people with DMTI have subclinical CVD variations from the norm even within the first decade of DM diagnosis according to a number of different methodologies (8). DM is a developed hazard factor for heart events and the enhancement of heart disappointment. Different free examiners have demonstrated that in diabetic patients there is broad impedance in left ventricular capacities. Diastolic dysfunction has been characterized as the most punctual indication of diabetic myocardial disease to occur before systolic impairment (9). Children with type 1 diabetes are at risk of cardiovascular disease and a healthy lifestyle and pharmacological treatment for those who had high low-density lipoproteins (LDL) cholesterol levels is recommended (8-9). Thus, it seems important to pay attention to lipid abnormalities in order to reduce cardiovascular disease in this population at an early age (10). There is a decrease in High-density lipoprotein (HDL), cholesterol and increase in Cholesterol to HDL ratio in type 1 diabetic patients as compared to the control group (11, 12).

Vergès (10) reported that lipid abnormalities are observed in patients with poorly controlled diabetes. Patients with optimally controlled type 1 diabetes show normal or slightly decreased triglycerides and LDL-cholesterol levels and sometimes increased HDL cholesterol levels. Qualitative abnormalities of lipoproteins are observed in patients with type 1 diabetes, even in good glycemic control and these abnormalities are not fully explained by hyperglycemia and may partly be due to peripheral hyperinsulinemia associated with the subcutaneous route of insulin administration. The exact consequences of these qualitative lipid changes on the development of cardiovascular disease in diabetes are still unknown. Echocardiography is a critical diagnostic tool to show heart utilitarian anomalies in interminable illnesses such as thalassemia, diabetes and celiac disease. The most well-known procedure is conventional echocardiography, however lately, another

system called Tissue Doppler Imagining (TDI) has offered enhanced picture quality and expanded the affectability of echocardiography for discovery of subclinical ventricular dysfunction (6-9). Considering above reports and on the grounds that diabetic autonomic dysfunction is one of the basic complexities of DM that can cause mortality and morbidity, and in light of the fact that cardiac autonomic function disorder (CAFD) is one of the most severe complications of diabetes, the present study aimed to assess the rate of changes in Tissue Doppler Imagining findings in children and adolescents with DMTI compared to healthy ones.

2- MATERIALS AND METHODS

2-1. Method

This case-control study performed on 192 participants, consisted of 96 healthy children (children who referred to hospital for checkup), and 96 patients with DMTI. The study conducted in Ali Asghar Pediatric Hospital, Zahedan, the capital city of Sistan & Baluchestan province, Iran. The study was run in two centers in collaboration with endocrinology and cardiology departments between March 2017 and April 2018. Sample size was calculated from the following formula where, Zβ=0.84, Zα=1.96 and r =1. Statistics of σ=0.07, Multidimensional Pain Inventory (MPI) mean in patients and controls were 0.29 and 0.27, respectively (13). Using the mentioned parameters in the below formula gave us 96 subjects for each group.

$$n = \left(\frac{r+1}{r}\right)\frac{\sigma^2 (Z_\beta + Z_{\alpha/2})^2}{(d\text{ifference})^2}$$

2-2. Criteria

Inclusion criteria were DMTI children either symptomatic or asymptomatic. Diabetes was confirmed by clinical manifestation of polyuria, polydipsia, weight loss and laboratory measures such as fasting blood glucose > 125, random blood glucose>200 mg/dl. Exclusion criteria were patients with age higher than 18 years, documented evidence of other cardiac disease like ischemic, hypertensive disease, cardiomyopathy, valvular heart disease, congenital heart disease, myocarditis, features of hypothyroidism, uremia, and random blood sugar > 140 mg/dL for the healthy children.

2-3. Doppler and Tissue Doppler imaging measurements

2-3-1. Tissue Doppler imaging (TDI): was another method performed from the apical four-chamber view and a 3 mm pulsed Doppler sample volume was placed at the level of the lateral mitral annulus. Myocardial velocity profiles of the lateral tricuspid annulus and lateral mitral annulus were obtained by placing the sample volume at the junction of the tricuspid annulus and the right ventricle (RV) free wall and at the junction of the mitral annulus and LV posterior wall, respectively. With this modality, the recorded values were the early (E), and late (A) diastolic mitral and tricuspid annular velocities, and the ratio of E/A. Right ventricle and left ventricle myocardial performance index (MPI) was obtained by dividing the sum of isovolumic relaxation time (IRT) and isovolumetric contraction time (ICT) by the ejection time (ET) (MPI = (ICT + IRT)/ET)(13).

2-3-2. Left and right S: systolic myocardial velocity above the baseline in mitral and tricuspid.

2-3-3. Left and right E: early diastolic myocardial relaxation velocity below the baseline in mitral and tricuspid.

2-3-4. Left and right A: myocardial velocity associated with atrial contraction in mitral and tricuspid. Particular attention was paid to placing the sample volume on

the myocardium and not the endocardium or epicardium. In each case, the subsequent measurements were obtained in three heartbeats in all positions and the average value was recorded.

2-4. Patients measures and lipid profiles

To evaluate the cardiac functions in our patients, they were categorized based on Hemoglobin A1c (HbA1c), and Duration of diabetic state. To measure blood lipids, including cholesterol, triglyceride, HDL, and LDL, blood samples were derived from the cubital vein of the left hand after 12 h fasting. The blood sample was taken in 3 ml vacuum tubes containing separator gel and clot activator manufactured by Bacton Dickinson (UK). The obtained samples were immediately centrifuged and their respective lipid levels were determined by applying enzymatic procedure using German Rosh kits, with Biochemical Autoanalyser Prestige 24i (Japan).

2-4-1. HbA1c

The level of HbA1c reflects glycemic control. HbA1c is the mean blood glucose concentration during the 3 months preceding measurement. Higher values indicate higher blood glucose levels, and therefore, more poorly controlled diabetes. Laboratory results for blood samples for HbA1c assays are conducted as part of the patients' regular outpatient visit. The normal range on this assay is 4.0-6.1%. For the purposes of this study, we considered good control to be an HbA1c < 7%, and poor control to be an HbA1c ≥ 7%. (14). With regard to specific complications for elevated HbA1c, acceptable responses included: having high blood sugar, feeling symptoms of high blood sugar, ketoacidosis, kidney disease, eye disease, amputation/loss of a limb, and sexual dysfunction. In terms of acceptable responses for an HbA1c of 7%, the following were considered: feeling symptoms of low blood sugar, going to the hospital for low blood sugar, and having low blood sugar leading to loss of consciousness. Answers were scored based on the above mentioned guidelines.

2-4-2. Duration of diabetic state

The diabetic duration was considered the time between diabetes detection time and by pediatric endocrinology till the time that patient refereed to the pediatric cardiologist for performing Doppler and tissue Doppler imaging echocardiography. The patients were grouped according to HbA1c states in two groups and diabetic duration in three groups.

2-4-3. Lipid profiles

Patients were tested for their lipid profiles of cholesterol (CHO) mg/dl, high density lipoprotein (HDL) mg/dl, low density lipoprotein (LDL) mg/dl, and triglyceride (TG) mg/dl. Abnormal lipid profile was defined as CHO >200 mg/dl, HDL < 40 mg/dl, LDL >130 mg/dl, and TG >150 mg/dl (16).

2-5. Anthropometric measurements

All the present study participants were older than 2 years of age, the height and weight of children were measured by an experienced expert using standard equipment and then BMI was calculated [Weight (Kg) / Height (m^2)]. The participants' height was measured to the nearest 0.1 centimeter (cm) in bare feet in position of standing upright against a mounted stadiometer. Participants' weight was measured to the nearest 0.1 kilogram (kg) with participants lightly dressed using a portable digital scale (Tanita HD 309, Creative Health Products, MI USA).

2-6. Ethical Approval

Informed consent was obtained from all individual participants included in the study after the study approval. The study was approved as a project proposed (ID-code: 7230) to the Children and

Adolescent Health Research Center by the Ethics Committee.

2-7. Statistical Analysis

Data was analyzed via SPSS software version 18.0 (SPSS Inc, Chicago, IL, USA). Descriptive statistics were presented in mean ± standard deviation (SD). Comparisons between DMTI subjects and healthy children were performed using t-test and Mann-Whitney U test and in more than two groups the One-way Analysis of Variance and Kruskal –Wallis tests were used based on normality of the variable data distribution. The correlations between the variables were calculated using Pearson's correlation. $P < 0.05$ was considered significant.

3- RESULTS

To analyze changes in Tissue Doppler Imaging parameters in diabetes, first we used the Kolmogorov-Smirnov test normality in all participants and the patients separately. In participants all the findings were in free distribution because of the p-value was higher than 0.05. Moreover, this trend was observed for the patients only (**Table.1**). Sex distribution in diabetes patients and healthy children showed a non-significant correlation (Chi-square=1.692, P=0.193). The frequency of females in the patient and healthy children groups was 52.1% and 42.7%, respectively. This distribution in participants was 47.4% in total. The Doppler Tissue Imaging findings were compared in diabetes patients and healthy children. The analysis showed left ET' (MWU=487.5, P<0.001), left IRT' (MWU=1496.5, P<0.001), left E' (MWU=993, P<0.001), right ET' (MWU=993, P<0.001), right ICT' (MWU=1284.00, P<0.001), right IRT' (MWU=1284.00, P<0.001), right S' (MWU=906, P<0.001), right E' (MWU=1721.5, P=0.002), left MPI' (MWU=30.00, P<0.001), and right MPI' (T=5.87, P<0.001), left E/E' (MWU=1559.5, P<0.001), were significantly different in diabetes patients compared to healthy children. This differences showed higher levels in left IRT', left E', right ICT', left MPI' and right MPI' in favor of diabetes patients. While the other significant finding was higher in healthy children (**Table.2**).

Table-1: Test of normality for Tissue Doppler Echocardiography findings in the patients and all participants consisted of patients and controls.

Variables	Only patients				Both patients and healthy ones			
	Mean	SD	K.S	P-value	Mean	SD	K.S	P-value
Age (year)	10.87	3.46	0.13	<0.001	10.82	3.15	0.07	0.030
Height(cm)	137.45	19.00	0.07	0.200	145.50	18.02	0.09	0.001
Weight(Kg)	33.24	11.78	0.08	0.200	38.78	13.24	0.08	0.003
BMI (Kg / m²)	17.00	2.68	0.17	<0.001	17.73	2.97	0.15	<0.001
Left ET'	234.63	37.80	0.15	<0.001	287.84	83.81	0.19	<0.001
Left ICT'	91.60	21.62	0.09	0.061	90.70	20.17	0.08	0.003
Left IRT'	88.42	16.45	0.09	0.070	82.87	17.72	0.09	0.001
Left S'	8.76	1.40	0.11	0.007	8.78	1.61	0.11	<0.001
Left E'	17.54	15.76	0.41	<0.001	16.26	11.36	0.36	<0.001
Left A'	6.98	1.69	0.13	<0.001	6.84	1.74	0.09	<0.001
Right ET'	232.89	23.69	.09	0.071	254.17	44.46	0.15	<0.001
Right ICT'	94.04	21.13	0.10	0.032	84.01	20.02	0.13	<0.001
Right IRT'	81.38	14.57	0.12	0.001	89.07	18.16	0.10	<0.001

Right S’	11.25	11.94	0.39	<0.001	33.28	30.98	0.34	<0.001
Right E’	13.76	2.91	0.05	0.200	14.39	2.82	0.05	0.200
Right A’	6.86	2.12	0.10	0.024	7.05	2.15	0.09	<0.001
Left MPI’	0.78	0.11	0.06	0.200	0.65	0.18	0.10	<0.001
Right MPI’	0.76	0.12	0.10	0.016	0.69	0.13	0.05	0.200
Left E’/E	4.97	1.47	0.11	0.003	4.86	1.45	0.13	<0.001
Left E/E’	5.80	1.49	0.11	0.004	6.39	2.04	0.12	<0.001
Left E’/A’	7.87	2.05	0.13	0.001	8.27	3.84	0.18	<0.001
Right E’/E	7.46	2.22	0.08	0.177	7.51	4.29	0.17	<0.001
TG (mg/dl)	124.52	76.17	0.17	<0.001	SD: Standard deviation, K.S: Kolmogorov-Smirnov, ET: Ejection time, S: Systolic myocardial velocity above the baseline in mitral and tricuspid, IRT: Isovolumic relaxation time, ICT: Isovolumic contraction time.			
CHO (mg/dl)	155.54	37.52	0.12	0.004				
LDL (mg/dl)	90.61	23.93	0.21	<0.001				
HDL (mg/dl)	54.23	11.91	0.17	<0.001				
Duration (year)	31.67	23.60	0.17	<0.001				
HbA1c (%)	8.57	1.94	0.11	0.008				

A: Peak A velocity, E: Peak E velocity, MPI: Myocardial performance index, TG: Triglycerides, CHO: Cholesterol, LDL: Low-Density Lipoproteins, HDL: High-Density Lipoproteins, HbA1c: Hemoglobin A1c.

Table-2: Comparison of Tissue Doppler Imaging findings between Diabetes type I children and healthy ones.

Variables	Groups	Mean Rank	Sum of Ranks	M W U	P- value	Variables	Groups	Mean Rank	Sum of Ranks	M WU	P-value
Age (year)	Diabetes	98.72	9477.00	4395	0.5785	Right ET’	Diabetes	123.61	11866.50	2005.50	<0.001
	Healthy	94.28	9051.00				Healthy	69.39	6661.50		
Height (cm)	Diabetes	73.10	7018.00	2362.00	<0.001	Right ICT’	Diabetes	72.30	6941.00	2285.00	<0.001
	Healthy	119.90	11510.00				Healthy	120.70	11587.00		
Weight (Kg)	Diabetes	73.67	7072.50	2416.50	<0.001	Right IRT’	Diabetes	53.21	5108.00	452.00	<0.001
	Healthy	119.33	11455.50				Healthy	139.79	13420.00		
BMI (Kg / m^2)	Diabetes	81.42	7816.50	3160.50	<0.001	Right S’	Diabetes	84.00	8064.00	3408.00	0.002
	Healthy	111.58	10711.50				Healthy	109.00	10464.00		
Left ET’	Diabetes	59.95	5755.00	1099.00	<0.001	Right E’	Diabetes	90.82	8718.50	4062.50	0.156
	Healthy	133.05	12773.00				Healthy	102.18	9809.50		
Left ICT’	Diabetes	98.86	9491.00	4381.00	0.554	Left MPI’	Diabetes	136.77	13130.00	742.00	<0.001
	Healthy	94.14	9037.00				Healthy	56.23	5398.00		
Left IRT’	Diabetes	115.65	11102.50	2769.50	<0.001	Right MPI’	Diabetes	123.14	11821.00	2051.00	<0.001
	Healthy	77.35	7425.50				Healthy	69.86	6707.00		
Left S’	Diabetes	95.17	9136.50	4480.50	0.740	Right E/E’	Diabetes	101.24	9719.00	4153.00	0.237
	Healthy	97.83	9391.50				Healthy	91.76	8809.00		
Left E’	Diabetes	105.47	10125.50	3746.50	0.025	Left E/E’	Diabetes	77.77	7466.00	2810.00	<0.001
	Healthy	87.53	8402.50				Healthy	115.23	11062.00		
Left A’	Diabetes	99.48	9550.00	4322.00	0.457	Left A/A’	Diabetes	94.60	9082.00	4426.00	0.636
	Healthy	93.52	8978.00				Healthy	98.40	9446.00		
Right ET’	Diabetes	65.24	6263.00	1607.00	<0.001	Right A/A’	Diabetes	102.97	9885.50	3986.50	0.11
	Healthy	127.76	12265.00				Healthy	90.03	8642.50		

MWU: Mann–Whitney U test, ET: Ejection time, S: Systolic myocardial velocity above the baseline in mitral and tricuspid, IRT: Isovolumic relaxation time, ICT: Isovolumic contraction time, A: Peak A velocity, E: Peak E velocity, MPI: Myocardial performance index.

The TDI findings were compared based on reference value of HbA1c in patients and diabetes duration. In the case of HbA1c, left ICT' (MWU=769.00, P=0.010) ion level was higher in abnormal status, right S' (MWU=861.00, P=0.050) was higher in abnormal status of HbA1c and in the case of diabetes duration categorization the results revealed that all the TDI findings were similar in patients' groups of short and long duration except HbA1c that was higher in patients with controlled diabetes (MWU=123.50, P<0.001) (**Table.3**). **Table.4** shows the body measures, lipid and diabetes parameters comparison in patients' groups based on HbA1c and diabetes duration. In the major parameters no significant difference was observed.

Table-3: Comparison of Tissue Doppler Imaging findings in patients' groups based on HbA1c and Diabetes duration.

Variables	HbA_{1C} (mg/dl)	Mean	SD	MW U	P-value	Duration (year)	Mean	SD	MW U	P-value
Left ET'	Normal	232.84	40.56	1048.5	0.580	<4	238.9	70.58	358	0.390
	Abnormal	232.37	23.34			≥4	234.13	32.67		
Left ICT'	Normal	85.66	22.65	769	0.010	<4	100	22.43	289.5	0.090
	Abnormal	96.45	19.69			≥4	90.63	21.45		
Left IRT'	Normal	90.18	16.65	984	0.300	<4	79.5	18.14	277	0.070
	Abnormal	87.22	16.3			≥4	89.45	16.03		
Left S'	Normal	8.87	1.47	1031	0.500	<4	9.27	2.04	371.5	0.480
	Abnormal	8.68	1.35			≥4	8.7	1.31		
Left E'	Normal	15.53	2.38	952.5	0.210	<4	16.5	2.37	367.5	0.450
	Abnormal	19.25	21.46			≥4	17.66	16.64		
Left A'	Normal	7.07	1.66	1042	0.550	<4	7.53	2.6	396.5	0.690
	Abnormal	6.93	1.73			≥4	6.91	1.56		
Right ET'	Normal	235.52	25.69	1005.5	0.380	<4	218.3	31.48	313	0.160
	Abnormal	230.16	21.77			≥4	234.58	22.23		
Right ET'	Normal	90.32	22.99	861	0.050	<4	94	24.36	430	1.000
	Abnormal	97.69	18.92			≥4	94.05	20.88		
Right ICT'	Normal	83.02	15.4	1038	0.530	<4	72.9	17.75	272.5	0.060
	Abnormal	79.71	13.83			≥4	82.36	13.95		
Right IRT'	Normal	11.01	12.2	1030.5	0.490	<4	21.12	25.56	370	0.470
	Abnormal	10.27	8.26			≥4	10.1	8.8		
Right S'	Normal	13.26	2.98	948	0.190	<4	14.53	3.77	392.5	0.650
	Abnormal	14.11	2.76			≥4	13.67	2.81		
Right E'	Normal	6.96	1.72	946	0.190	<4	8.13	4.06	350	0.340
	Abnormal	6.79	2.44			≥4	6.71	1.75		
Left MPI'	Normal	0.76	0.11	922.5	0.140	<4	0.79	0.16	344.5	0.310
	Abnormal	0.8	0.1			≥4	0.78	0.11		
Right MPI'	Normal	0.74	0.13	918.5	0.130	<4	0.77	0.13	411.5	0.820
	Abnormal	0.77	0.1			≥4	0.75	0.12		
Right E/E'	Normal	5.19	1.69	998.5	0.360	<4	4.84	1.25	427.5	0.980
	Abnormal	4.79	1.26			≥4	4.98	1.5		
Left E/E'	Normal	5.83	1.56	1119.5	0.990	<4	5.44	0.79	379	0.540
	Abnormal	5.77	1.45			≥4	5.85	1.55		
Left A/A'	Normal	7.84	2.32	1067	0.680	<4	7.54	2.55	410	0.810
	Abnormal	7.88	1.83			≥4	7.91	2		
Right A/A'	Normal	7.43	2.36	1098.5	0.860	<4	6.53	2.92	303.5	0.130
	Abnormal	7.38	1.99			≥4	7.57	2.12		

SD: Standard deviation, MWU: Mann–Whitney U test, ET: Ejection time, S: Systolic myocardial velocity above the baseline in mitral and tricuspid, IRT: Isovolumic relaxation time, ICT: Isovolumic contraction time, A: peak A velocity, E: Peak E velocity, MPI: Myocardial performance index.

Table-4: Comparison of Body measures, Lipid and Diabetes parameters comparison in patients' groups based on HbA1c and diabetes duration.

Variables	HbA_{1C}	Mean	SD	MW U	P-value	Duration	Mean	SD	M-W U	P-value
Age (year)	Normal	10.11	3.48	824	0.030	<4	10.8	4.29	425	0.950
	Abnormal	11.61	3.29			≥4	10.87	3.38		
Height (cm)	Normal	134.3	18.39	928	0.150	<4	143.5	20.42	335.5	0.260
	Abnormal	139.73	19.26			≥4	136.74	18.83		
Weight (Kg)	Normal	31.3	11.09	938	0.170	<4	37.7	13.03	324.5	0.210
	Abnormal	34.63	12.18			≥4	32.72	11.6		
BMI (Kg / m^2)	Normal	16.77	2.69	1003.5	0.380	<4	17.75	3.09	373	0.490
	Abnormal	17.16	2.69			≥4	16.91	2.63		
TG (mg/dl)	Normal	136.86	88.01	978	0.450	<4	104.38	53.01	314	0.720
	Abnormal	113.9	63.27			≥4	126.41	77.96		
CHO (mg/dl)	Normal	159.26	42.2	954.5	0.350	<4	138.5	33.03	222	0.110
	Abnormal	152.34	33.09			≥4	157.14	37.7		
LDL (mg/dl)	Normal	93.56	26.62	903.5	0.180	<4	95.13	24.35	326	0.850
	Abnormal	88.08	21.3			≥4	90.19	23.99		
HDL (mg/dl)	Normal	54.53	11.07	968	0.500	<4	51.14	9.49	268	0.660
	Abnormal	53.96	12.71			≥4	54.48	12.1		
Duration (year)	Normal	35.43	22.51	896.5	0.090					
	Abnormal	28.43	24.25							
Hb A1c (%)						<4	10.93	2.35	123.5	<0.001
						≥4	8.33	1.72		

MWU: Mann–Whitney U test, TG: Triglycerides, CHO: Cholesterol, LDL: Low-Density Lipoproteins, HDL: High-Density Lipoproteins, HbA1c: Hemoglobin A1c.

Analysis was performed on the patients based on reference points of TG and CHO. **Table.5** showed that the patients with higher TG had lower value of left A/A' and right S' (MWU=139.5, P<0.001), right E'(MWU=267.00, P=0.05)', right A'(MWU=235.50, P=0.020), right E/E'(MWU=250.00, P=0.031), and LDL (MWU=10.50, P<0.001). Those patients who were abnormal regarding CHO, had higher levels in right S', right E', right A' and LDL when right E/E' had higher level in normal status of CHO (5.07 compared to 4.09). **Table.6** shows body measures, lipid and diabetes parameters comparison in patients' groups based on lipid profiles' reference points of TG and CHO and resulted in similarity in all variables except LDL by CHO that changed significantly (MWU=10.50, P<0.001).

Table-5: Comparison of Tissue Doppler Imaging findings in patients' groups based on Lipid profiles of TG and CHO normality.

Variables	TG	Mean	SD	MW U	P-value	CHO	Mean	SD	M-W U	P-value
Left ET'	Normal	229.4308	24.62022	869	0.277	Normal	230.7093	25.63815	377	0.524
	Abnormal	245.5161	55.23638			Abnormal	268.3000	86.42665		
Left ICT'	Normal	94.7538	21.28455	774	0.066	Normal	91.7907	22.31018	399.5	0.713
	Abnormal	85.0000	21.15183			Abnormal	90.0000	15.18771		
Left IRT'	Normal	86.7385	15.88068	827.5	0.156	Normal	88.9535	16.75843	340.5	0.28
	Abnormal	91.9355	17.31076			Abnormal	83.8000	13.28157		
Left S'	Normal	8.5954	1.32245	794.5	0.095	Normal	8.7523	1.42529	389.5	0.627
	Abnormal	9.1129	1.50704			Abnormal	8.8500	1.19838		
Left E'	Normal	15.8323	2.59971	929	0.538	Normal	17.8244	16.61753	330.5	0.233
	Abnormal	21.1194	27.43610			Abnormal	15.0900	2.63247		
Left A'	Normal	6.8246	1.67407	812.5	0.126	Normal	6.9884	1.74122	412	0.829
	Abnormal	7.3000	1.70529			Abnormal	6.8900	1.22697		
Right ET'	Normal	232.4154	23.37660	995	0.922	Normal	232.0349	24.16631	340.5	0.281
	Abnormal	233.8710	24.68568			Abnormal	240.2000	18.44391		
Right ET'	Normal	96.5692	21.79160	812.5	0.125	Normal	95.7209	20.53900	252	0.032
	Abnormal	88.7419	18.90849			Abnormal	79.6000	21.64974		
Right ICT'	Normal	79.3385	14.51107	795.5	0.093	Normal	81.4186	14.60658	417	0.875
	Abnormal	85.6452	13.98225			Abnormal	81.0000	15.05545		
Right IRT'	Normal	9.2354	1.87803	919.5	0.490	Normal	9.0384	1.74195	139.5	<0.001
	Abnormal	15.4742	20.41640			Abnormal	30.2700	32.06140		
Right S'	Normal	13.9046	2.68307	903	0.413	Normal	13.5640	2.92063	267	0.050
	Abnormal	13.4645	3.36021			Abnormal	15.4700	2.25883		
Right E'	Normal	6.9408	2.37659	973	0.787	Normal	6.7541	2.19288	235.5	0.020
	Abnormal	6.6774	1.46440			Abnormal	7.7300	1.05415		
Left MPI'	Normal	.7942	.09737	772.5	0.066	Normal	.7870	.10026	272.5	0.059
	Abnormal	.7405	.13147			Abnormal	.6894	.16543		
Right MPI'	Normal	.7608	.12363	913.5	0.461	Normal	.7662	.11035	238	0.021
	Abnormal	.7473	.10096			Abnormal	.6726	.13923		
Right E/E'	Normal	4.8501	1.29992	929	0.538	Normal	5.0710	1.51212	250	0.031
	Abnormal	5.2171	1.77836			Abnormal	4.0882	.56233		
Left E/E'	Normal	5.9995	1.47486	822	0.146	Normal	5.7575	1.52419	352	0.349
	Abnormal	5.3941	1.46375			Abnormal	6.2042	1.15111		
Left A/A'	Normal	8.2260	2.12424	701.5	0.016	Normal	7.8727	2.13071	403.5	0.751
	Abnormal	7.1303	1.68329			Abnormal	7.8679	1.20656		
Right A/A'	Normal	7.3531	2.07034	975.5	0.802	Normal	7.5037	2.16405	347	0.319
	Abnormal	7.6891	2.52828			Abnormal	7.0997	2.76751		

MWU: Mann–Whitney U test, TG: Triglycerides, CHO: Cholesterol, ET: Ejection time, S: Systolic myocardial velocity above the baseline in mitral and tricuspid, IRT: Isovolumic relaxation time, ICT: Isovolumic contraction time, A: peak A velocity, E: Peak E velocity, MPI: Myocardial performance index.

Table-6: Comparison of Body measures, Lipid profiles and Diabetes parameters in patients' groups based on TG and CHO reference points.

Variables	TG	Mean	SD	MW U	P-value	CHO	Mean	SD	M-W U	P-value
Age (year)	Normal	10.79	3.38	953.00	0.668	Normal	10.95	3.36	386.00	0.596
	Abnormal	11.03	3.68			Abnormal	10.15	4.38		
Height (cm)	Normal	136.97	18.88	943.00	0.613	Normal	137.56	18.69	430.00	1.000
	Abnormal	138.45	19.52			Abnormal	136.50	22.56		
Weight (Kg)	Normal	33.03	11.92	946.00	0.630	Normal	33.15	11.58	412.00	0.829
	Abnormal	33.68	11.67			Abnormal	34.00	14.11		
BMI (Kg / m²)	Normal	17.00	2.62	978.50	0.820	Normal	16.95	2.65	402.00	0.737
	Abnormal	16.99	2.84			Abnormal	17.37	2.99		
TG (mg/dl)						Normal	124.51	72.12	253.00	0.484
						Abnormal	124.57	123.54		
CHO (mg/dl)	Normal	157.32	29.47	843.50	0.577					
	Abnormal	151.39	52.09							
LDL (mg/dl)	Normal	89.78	24.14	702.00	0.080	Normal	85.91	16.97	10.50	<0.001
	Abnormal	92.54	23.75			Abnormal	148.43	21.99		
HDL (mg/dl)	Normal	53.16	11.92	714.00	0.120	Normal	53.73	11.50	210.50	0.197
	Abnormal	56.68	11.75			Abnormal	60.29	15.92		
Duration (year)	Normal	31.46	24.91	926.50	0.696	Normal	31.53	23.46	382.50	0.954
	Abnormal	32.13	20.88			Abnormal	33.00	26.34		
HbA1c (%)	Normal	8.84	2.00	770.00	0.100	Normal	8.53	1.90	351.50	0.651
	Abnormal	8.00	1.69			Abnormal	9.00	2.31		

MWU: Mann–Whitney U test, TG: Triglycerides, CHO: Cholesterol, LDL: Low-Density Lipoproteins, HDL: High-Density Lipoproteins, HbA1c: Hemoglobin A1c.

From the **Table.7** it was revealed that right S'(MWU=188.50, P=004), right E'E' (MWU=254.00, P=0.035), and CHO (MWU=71.00, P=0.001) were significantly different in patients with normal LDL compared with those who had abnormal LDL status. Right S' and CHO had higher values in abnormal status of LDL when right E'E' had lower value.

Table.8 showed body measures, lipid and diabetes parameters comparison in patients' groups based on lipid profiles reference points of LDL and HDL and resulted in similarity in all variables except age and body measures that were changed by CHO significantly (MWU=10.50, P<0.001).

Table-7: Comparison of Tissue Doppler imaging findings in patients' groups based on Lipid profile of LDL and HDL.

Variables	LDL (mg/dl)	Mean	SD	M-W U	P-value	HDL (mg/dl)	Mean	SD	MW U	P-value
Left ET'	Normal	231.1628	25.12410	407.5	0.787	Abnormal	226.7000	26.89093	362.5	0.417
	Abnormal	264.4000	89.57083			Normal	235.5465	38.88858		
Left ICT'	Normal	91.3372	22.31149	396	0.682	Abnormal	91.1000	20.81906	417	0.876
	Abnormal	93.9000	15.05877			Normal	91.6628	21.83069		
Left IRT'	Normal	89.4767	16.57690	265.5	0.047	Abnormal	92.7000	12.35628	351.5	0.344
	Abnormal	79.3000	12.52597			Normal	87.9186	16.84477		
Left S'	Normal	8.7384	1.43167	357	0.381	Abnormal	8.4100	1.01811	382.5	0.568
	Abnormal	8.9700	1.10459			Normal	8.8035	1.43473		
Left E'	Normal	17.7919	16.62567	360.5	0.404	Abnormal	16.4700	2.66293	382	0.565
	Abnormal	15.3700	2.44497			Normal	17.6640	16.63620		
Left A'	Normal	6.9907	1.73975	415	0.857	Abnormal	6.4500	1.24744	355	0.368
	Abnormal	6.8700	1.24459			Normal	7.0395	1.72942		
Right ET'	Normal	232.6860	23.88219	407.5	0.786	Abnormal	228.1000	18.79391	363	0.42
	Abnormal	234.6000	23.06127			Normal	233.4419	24.22085		
Right ET'	Normal	95.2093	20.97456	304.5	0.131	Abnormal	96.1000	24.25993	407	0.782
	Abnormal	84.0000	20.77392			Normal	93.8023	20.88051		
Right ET'	Abnormal	81.9302	14.25960	365.5	0.434	Normal	73.8000	13.39818	291.5	0.093
	Normal	76.6000	17.12179			Abnormal	82.2558	14.51991		
Right ICT'	Normal	9.0663	1.74272	188.5	0.004	Abnormal	9.3500	1.33104	394	0.666
	Abnormal	30.0300	32.23601			Normal	11.4709	12.59848		
Right IRT'	Normal	13.6221	2.90462	325.5	0.21	Abnormal	13.8900	2.71557	424	0.943
	Abnormal	14.9700	2.79128			Normal	13.7477	2.94454		
Right S'	Normal	6.7948	2.17166	293.5	0.101	Abnormal	7.1900	2.37601	365	0.435
	Abnormal	7.3800	1.61024			Normal	6.8169	2.10103		
Right E'	Normal	.7854	.09888	307.5	0.142	Abnormal	.8140	.07833	346.5	0.317
	Abnormal	.7032	.18089			Normal	.7725	.11455		
Left MPI'	Normal	.7641	.11179	275	0.063	Abnormal	.7465	.13162	409.5	0.806
	Abnormal	.6899	.13996			Normal	.7576	.11534		
Right MPI'	Normal	5.0700	1.51235	254	0.035	Abnormal	4.8551	1.31325	420	0.905
	Abnormal	4.0966	.57258			Normal	4.9818	1.49582		
Right E/E'	Normal	5.7791	1.54115	379	0.541	Abnormal	5.5817	.91696	377.5	0.529
	Abnormal	6.0183	.98783			Normal	5.8299	1.54563		
Left E/E'	Normal	7.8689	2.12783	401.5	0.732	Abnormal	8.0454	2.00560	426	0.962
	Abnormal	7.9001	1.25338			Normal	7.8520	2.06500		
Left A/A'	Normal	7.5183	2.17304	327	0.217	Abnormal	6.5608	1.83104	321	0.191
	Abnormal	6.9743	2.67558			Normal	7.5663	2.24716		

MWU: Mann–Whitney U test, SD: Standard deviation, ET: Ejection time, S: Systolic myocardial velocity above the baseline in mitral and tricuspid, IRT: Isovolumic relaxation time, ICT: Isovolumic contraction time, A: peak A velocity, E: Peak E velocity, MPI: Myocardial performance index.

Table-8: Comparison of Body measures, Lipid profiles and Diabetes parameters in patients' groups based on LDL and HDL reference points.

Variables	LDL (mg/dl)	Mean	SD	MW U	P-value	HDL (mg/dl)	Mean	SD	MW U	P-value
Age(year)	Normal	10.98	3.31	367.00	0.448	Abnormal	8.15	4.07	242.00	0.024
	Abnormal	10.68	3.02			Normal	10.96	3.04		
Height(cm)	Normal	137.55	18.71	429.00	0.990	Abnormal	123.20	24.12	251.00	0.032
	Abnormal	151.95	14.61			Normal	146.73	16.87		
Weight(Kg)	Normal	33.15	11.58	412.00	0.829	Abnormal	26.00	11.47	255.00	0.036
	Abnormal	43.34	12.78			Normal	39.48	12.99		
BMI (Kg / m^2)	Normal	16.96	2.65	405.00	0.764	Abnormal	16.36	0.98	417.50	0.881
	Abnormal	18.36	3.07			Normal	17.81	3.02		
TG (mg/dl)	Normal	124.45	72.15	258.00	0.531	Abnormal	105.80	103.28	307.50	0.182
	Abnormal	125.29	123.29			Normal	126.77	72.73		
CHO (mg/dl)	Normal	150.38	31.39	71.00	0.001	Abnormal	157.70	53.09	343.00	0.371
	Abnormal	218.86	50.74			Normal	155.28	35.63		
LDL (mg/dl)						Abnormal	105.00	33.62	324.00	0.257
						Normal	88.88	22.14		
HDL (mg/dl)	Normal	53.93	11.50	263.50	0.614					
	Abnormal	57.86	16.89							
Duration(year)	Normal	31.80	23.24	349.50	0.632	Abnormal	28.90	20.20	410.50	0.860
	Abnormal	30.44	28.36			Normal	32.00	24.05		
Hb A1c (%)	Normal	8.52	1.88	348.00	0.619	Abnormal	8.80	2.37	407.50	0.831
	Abnormal	1.04	3.02			Normal	4.69	4.49		

MWU: Mann–Whitney U test, SD: Standard deviation, TG: Triglycerides, CHO: Cholesterol, LDL: Low-Density Lipoproteins, HDL: High-Density Lipoproteins, HbA1c: Hemoglobin A1c.

4- DISCUSSION

Previous echocardiography studies in diabetes children focused on LV diastolic functions and resulted in a reduction in early diastolic filling based on transmitral flow analysis (11-19). The present study was conducted to assess the tissue Doppler imaging changes in children with diabetes mellitus type I (DMTI) compared to healthy ones and changes in lipid profiles based on HbA1c and diabetes duration. Results showed that ET', IRT', E', MPI' and E/E' in left heart and ET', ICT', IRT', S', E', MPI' in right heart were different in DMTI children compared to healthy ones, so that left IRT', left E', right ICT', left MPI' and right MPI' were higher in patients. Left ICT' and right S' were higher in abnormal status of HBA1c. All TDI findings were similar in patients' groups of short and long duration. Patients with higher TG had lower value of left A/A'. Those patients who had abnormal cholesterol, had higher right S', right E' and right A' but had lower right E/E'. Right S' was higher in DMTI children with Abnormal LDL when right E/E' was lower. All the DTI findings did not change by HDL changes. The present study showed ET', IRT', E', MPI' and E/E' in left heart and ET', ICT', IRT', S', E', MPI' in right heart were different in DMTI children compared to healthy children, so that left IRT', left E', right ICT', left MPI' and right MPI' were higher in patients. Left ICT' and right S' were higher in abnormal status of HBA1c. All TDI

findings were similar in patients' groups of short and long duration. Patients with higher TG had lower value of left A/A'. Those patients who had abnormal cholesterol, had higher right S', right E' and right A' but had lower right E/E'. Right S' was higher in DMTI children with Abnormal LDL when right E/E' was lower. All the DTI findings did not change by HDL changes. Di Cori et al. (17) concluded IRT was longer in DMTI children than healthy children but peak A' velocity, Peak E' velocity and peak S' velocity were lower. The reason for dissimilarity with the present findings is probably due to age of the patients when our patients were aged younger than 18 years old. Suran et al. (1) concluded that septal mitral isovolumetric contraction had better diagnostic accuracy than lateral tricuspid annulus to predict early contractile impairments in DMTI children. Compared with the results from the present study, left heart TDI parameters were similar with our findings so that E' were decreased in diabetic group in left and right heart when E/E' increased.

The results of this study indicate worsening diastolic function of both ventricles. In the present study right E' and left E/E' were higher in healthy children when left E' and right E/E' were similar in better diagnostic accuracy than lateral tricuspid annulus to predict early contractile impairments in DMTI children and healthy children. Regarding the design and methodology, the difference with Suranet al. (1) was in the right heart findings. Konduracka et al. (18) concluded there were no differences in LV diastolic function between DMTI children and healthy children, neither by conventional echocardiography nor by TDI except E/E'. Comparing with the present study a similarity regarding E/E' was found. The present study resulted that E' was significant in right heart and A' was not significant in both sides of heart. This suggests that subclinical LV systolic and diastolic alterations might develop concurrently in DMTI children, which has not been observed till now. A recent study by Fagan et al. (19) concluded only a slight reduction in E/A and an increase in E/E' DMTI children when the present study found a decrease and Gusso et al. (20) found systolic dysfunction in DMTI adolescents during short exercise, implying a loss of systolic reserve. Medalists did exhibit diastolic dysfunction, evidenced by lower E/A, and higher E/E', but in Konduracka et al.'s study (18), this was demonstrated in patients with a much shorter duration of diabetes. Khattab et al. (21) showed that in left heart, E', E'/A', E/E', IRT' and MPI' were significant between diabetic and healthy children as well as E', E'/A' and E/E' in right heart.

In this regards, the present study demonstrated that E', A', E'/A' and ICT' were non-significant in left heart but in right heart most of the parameters were significant except A' and E'/A'. Acar et al. (22) resulted that in left heart, E' and E'/A' were lower and in right, A', IRT' and MPI' were higher in DMTI children. ICT', S' and ET' did not show any significant difference between groups. The left E/E' was significantly higher in DMTI children similar to the present study; and in right heart it was resulted that E', A', E'/A' S', IRT', ICT', and MPI' values were not significant. The present study resulted that diastolic functions of both ventricles were impaired in comparison to matched healthy children and there was a possible systolic impairment of both ventricles in the DMTI children. From the study it was revealed that left ET', left IRT', right ET', right ICT', right IRT', right S', right E', left MPI', right MPI', left E'/E, and left E/E' were different in patients and healthy children. Diastolic dysfunction has been defined as the earliest sign of diabetic myocardial disease to occur before systolic impairment. S'

shows abnormal systolic function in early stages of the disease. Thus, S' appears to be a more sensitive measure than the other systolic measures such as EF and FS. Acar et al. (22) also concluded that the baseline S' value less than 4.4 cm/s was considered to have accurately predicted abnormal systolic functions. Based on this result, Khattab et al. (20) mentioned that none of the patients in the diabetic group and the subjects in the control group had systolic dysfunction. But in the present study it was shown that diabetic group had S' value less than healthy children with no significant difference in left heart. Ozdemir et al. (23) reported that E', S', E/E', left ET', and MPI' varied in patients and healthy children, but the other parameters of left ventricle were similar. In right heart they also resulted that there was significant difference in parameters observed with TDI such as E', E/E', right ventricular ET', and right ventricular MPI' and other parameters of right ventricle were not significantly different.

In comparison with the present study that concluded left ET', left IRT', right ET', right ICT', right IRT', right S', right E', left MPI', right MPI', left E'/E, and left E/E' were different in patients and healthy children, in both studies, approximately right heart parameters were similar. Ahmad et al. (24) observed an increase of E/E', A' and E' and a decrease in S' in patients. The changes were significant except in E'. The present study revealed similarity with S' and dissimilarity with the other parameters. Short diabetes duration of patients in this study may explain this finding. Kim and Kim (25) revealed that an increase in diabetes duration will likely increase the clinical or subclinical micro and macro vascular complications. They also concluded that a fluctuation in blood glucose levels increased exposure to oxidative stress due to glycolysis end products. From the results of the study a correlation between diastolic functions and HbA1C levels in patients was also determined. Acar et al. (22) classified patients based on the levels of HbA1c < 9% (well-controlled), and > 9% (poorly controlled). They showed that in left heart, E' and E'/A' were significantly lower in the patients with HbA1c < 9 compared to healthy children and also were significantly lower in the HbA1c > 9 group compared to HbA1c < 9 group. A', IRT' and MPI' were found to be significantly higher in the poorly-controlled group compared with the well-controlled, and healthy children. CT', S' and ET' did not significantly differ between the three groups. The E / E' ratio of the mitral valve was significantly higher in the well-controlled and poorly-controlled groups compared to that of the healthy; and in right heart it was shown that E', A', E'/A' S', IRT', ICT', and MPI' values did not significantly differ between the three groups. There was no statistically significant difference between the three groups in terms of right E/E'.

In the present study TDI parameters were compared based on HbA1c based on the cut-off =7 and it was illustrated that, left ICT', right S', left MPI', were different in patients whose HbA1c was lower than 7 (well control). In some of the TDI parameters such as E', A', E'/A' and IRT' dissimilarity was observed in these two studies. This dissimilarity is probably due to the HbA1c cutoff point difference. Karamitsos et al. (26) showed a negative correlation of left and right E'/A' and left S' velocity with the diabetes duration. But, they did not find any correlations with right S' velocity. Inconsistent with the present study, left and right E'/A' and left S 'velocity did not change with the diabetic duration when right S' velocity had similar trends. Kim and Kim (25) grouped the patients based on diabetes duration in year, the participants were grouped as diabetes duration > 4 years and diabetes duration < 3 years. Their

study on TDI findings did not show any significant differences with diabetic duration. These findings and discussion lead readers to think that more time is needed for systolic dysfunction to occur, because most of the studies in this area have emphasized that in early stages of disease, subclinical diastolic dysfunction is more common than systolic dysfunction. Though diastolic dysfunction is seen due to deposit of glycolysis end products and abnormal collagen in very early stages of disease, impairment of systolic functions due to myocardial cell death, fibrosis, and remodeling requires a longer time interval.

From the present study it was revealed that amongst the patients' lipids, cholesterol had the higher effects on DTI findings in diabetes type I patients. In the diabetes mellitus abnormal increased levels of lipid may be due to the abnormal lipid metabolism (27). Elevated levels of lipid peroxide in diabetes mellitus may be due to the alteration of function of erythrocytes membrane. This inhibits the activity of superoxide dismutase enzyme leading to accumulation of superoxide radicals which cause the maximum lipid peroxidation and tissue damage in diabetes (12). Therefore, there is a clear association between lipid peroxide and glucose concentration, which may also play a role in increased lipid peroxidation in diabetes mellitus.

High level of cholesterol, triglyceride, LDL-cholesterol and low HDL-cholesterol may be due to obesity, increased calorie intake and lack of muscular exercise in the patients of diabetes mellitus. The estimation of lipid peroxide along with other lipid profile in the diabetes mellitus is very useful as it may serve as a practical way to monitor the prognosis of the patient. The detection of risk factor in the early stage of the disease will help the patient to improve and reduce the morbidity rate (28). Vinereanu et al. (29) conducted a study on left ventricular dysfunction in patients with diabetes to find the relation with serum lipids and glycated hemoglobin A1c.They established that, patients with Type II diabetes and no clinical heart disease, have impaired sub-endocardial function of the left ventricle at rest and peak stress, which is related to glycated hemoglobin and serum low-density lipoprotein–cholesterol. Abd El Dayem et al. (30) showed LDL was higher in diabetes patients compared to healthy children and HDL was lower while TG and CHO were similar. The difference with the present study was that the participants in the Abd El Dayem et al.'s study (30) considered overweight children with and without type I diabetes.

4-1. Study Limitations

The study had two major limitations, the first was lack of proper participation that resulted in low sample size and the second was the use of single HbA1c reading instead of using a mean of readings over several months. The limitation was due to the cost of the laboratory tests.

5- CONCLUSION

From the present study it was concluded that left IRT', left E', right ICT', left MPI' and right MPI' were higher in patients than healthy children. It was also concluded that the HbA1c and diabetic duration in diabetes mellitus type I patients did not change the parameters of TDI except right S', left MPI' and left ICT' changes in HbA1c and right IRT', left ET' and right MPI' in diabetic duration. Most of the right heart functions changed with TG, CHO, and LDL variation when HDL did not have any effect on heart functions. From left heart functions, only A/A' was impressive by TG. The present study results suggest that right and left heart systolic and diastolic functions were impaired in DMTI children.

6- CONFLICT OF INTEREST: None.

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8- REFERENCES

1. Suran D, Sinkovic A, Naji F. Tissue Doppler imaging is a sensitive echocardiographic technique to detect subclinical systolic and diastolic dysfunction of both ventricles in type 1 diabetes mellitus. BMC cardiovascular disorders. 2016; 16(1):72.

2. Lind M, Bounias I, Olsson M, Gudbjörnsdottir S, Svensson AM, Rosengren A. Glycaemic control and incidence of heart failure in 20,985 patients with type 1 diabetes: an observational study. Lancet. 2011; 378:140–6.

3. Jedrzejewska I, Król W, Światowiec A, Wilczewska A, GrzywanowskaŁaniewska I, Dłużniewski M, et al. Left and right ventricular systolic function impairment in type 1 diabetic young adults assessed by 2D speckle tracking echocardiography. Eur Heart J Cardiovasc Imaging. 2015. doi:10.1093/ehjci/ jev164.

4. Maahs DM, West NA, Lawrence JM, et al. Epidemiology of type 1 diabetes. EndocrinolMetabClin North Am 2010; 39:481–97.

5. Zamanfar D, Yazdani P, Aarabi M, Pournorooz H. The Prevalence of Type 1 Diabetes in Children of Mazandaran Province. Iranian Journal of Health Sciences. 2018; 6(2):1.

6. Pishdad GR. Low incidence of type 1 diabetes in Iran. Diabetes care. 2005; 28(4):927-8.

7. Al-Naama LM, Kadhim M, al-Aboud MS. Lipid profile in children with insulin dependent diabetes mellitus. J Pak Med Assoc. 2002; 52(1):29-34.

8. Soedamah-Muthu SS, Fuller JH, Mulnier HE, et al. High risk of cardiovascular disease in patients with type 1 diabetes in the U.K.:a cohort study using the general practice research database. Diabetes Care 2006; 29:798–804.

9. Remuzzi A, Cornolti R, Bianchi R, Figliuzzi M, Porretta-Serapiglia C. Regression of diabetic complications by islet transplantation in the rat. Diabetologia.2009; 52: 2653–61.

10. Vergès B. Lipid disorders in type 1 diabetes. Diabetes Metab. 2009; 35(5):353-60.

11. Bina Dias, Subhashini Maharana. Lipid profile in children with insulin dependent diabetes mellitus. Int J Res Med Sci. 2016; 4(6):1970-1973.

12. Vasudevan DM, Sreekumari S, Vaidyanathan K. Textbook of biochemistry for medical students. JP Medical Ltd; 2013;336-8.

13. M Abd-El Aziz F, Abdelghaffar S, M Hussien E, M Fattouh A. Evaluation of cardiac functions in children and adolescents with type 1 diabetes. Journal of cardiovascular ultrasound. 2017; 25(1):12-9.

14. Noori N, NakhaeeMoghadam M, Razzaghian Pour M, Teimouri A, Bagheri H, Yazdanparast A. Tissue Doppler Imaging versus Conventional Echocardiography in Evaluation of Cardiac Functions in Diabetes Mellitus. International Journal of Pediatrics. 2019; 7(7):9677-91.

15. Noori N, Teimouri A, Nakhaee Moghadam AA, Kasravi M. Evaluation of Electrocardiographic Parameters in Diabetes Mellitus Type I. International Journal of Pediatrics. Articles in Press, Accepted Manuscript, Available Online from 29 May 2019. DOI: 10.22038/IJP.2019.40337.3417

16. Biadgo B, Abebe SM, Baynes HW, Yesuf M, Alemu A, Abebe M. Correlation between serum lipid profile with anthropometric and clinical variables in patients with type 2 diabetes mellitus. Ethiopian Journal of Health Sciences. 2017; 27(3):215-26.

17. Di Cori A, Di Bello V, Miccoli R, Talini E, Palagi C, Delle Donne MG, Penno G, Nardi C, Bianchi C, Mariani M, Del Prato S. Left ventricular function in normotensive young adults with well-controlled type 1 diabetes mellitus. The American journal of cardiology. 2007; 99(1):84-90.

18. Konduracka E, Gackowski A, Rostoff P, Galicka-Latala D, Frasik W, Piwowarska

19. W. Diabetes-specific cardiomyopathy in type 1 diabetes mellitus: no evidence for its occurrence in the era of intensive insulin therapy. Eur HeartJ. 2007; 28: 2465–71.

20. Fagan A, Asghar O, Pearce K, Stout M, Ray SG, Schmitt M, Malik RA. Medalists with extreme duration of type 1 diabetes exhibit only mild diastolic dysfunction and myocardial fibrosis. Diabetes Care. 2015; 38(1):e5-6.

21. Gusso S, Pinto TE, Baldi JC, Robinson E, Cutfield WS, Hofman PL. Diastolic function is reduced in adolescents with type 1 diabetes in response to exercise. Diabetes Care 2012;35: 2089–2094

22. Khattab AA, Soliman MA. Biventricular function and glycemic load in type 1 diabetic children: Doppler tissue-imaging study. PediatrCardiol. 2015; 36:423–31.

23. Acar OC, Epcacan S, Uner A, Ece I, Dogan M. Evaluation of left and right ventricular functions using conventional and tissue Doppler echocardiography in children with type 1 diabetes mellitus. Journal of Pediatric Endocrinology and Metabolism. 2016; 29(8):885-91.

24. Ozdemir O, Koksoy AY, Bulus AD, Andiran N, Yagli E. The effects of type 1 diabetes mellitus on cardiac functions in children: evaluation by conventional and tissue Doppler echocardiography. Journal of Pediatric Endocrinology and Metabolism. 2016; 29(12):1389-95.

25. Ahmed TA, Ahmed YA, Arafa AI, Salah RA. Detection of occult RV dysfunction in young Egyptians with type 1 diabetes mellitus by 2D speckle tracking echocardiography. Indian Heart Journal. 2018.

26. Kim EH, Kim YH. Left ventricular function in children and adolescents with type 1 diabetes mellitus. Korean Circ J 2010; 40: 125-30.

27. Karamitsos TD, Karvounis HI, Dalamanga EG, Papadopoulos CE, Didangellos TP, Karamitsos DT, Parharidis GE, et al. Early diastolic impairment of diabetic heart: the significance of right ventricle. International journal of cardiology. 2007; 114(2):218-23.

28. Yessoufou A, Moutairou K. Maternal diabetes in pregnancy: early and long-term outcomes on the offspring and the concept of "metabolic memory". Experimental diabetes research. 2011; 2011.

29. Suryawanshi NP, Bhutey AK, Nagdeote AN, Jadhav AA, Manoorkar GS. Study of lipid peroxide and lipid profile in diabetes mellitus. Indian Journal of Clinical Biochemistry. 2006; 21(1):126.

30. Vinereanu D, Nicolaides E, Tweddel AC, MÄDLER CK, Holst B, Boden LE, Cinteza M, FRASER AG. Subclinical left ventricular dysfunction in asymptomatic patients with Type II diabetes mellitus, related to serum lipids and glycated haemoglobin. Clinical Science. 2003; 105(5):591-9.

31. Abd El Dayem SM, Abd El Kader M, Ibrahim S, Mokhtar E, Abd El Megeed E. Leptin and Lipid Profile in Overweight Patient with Type 1 Diabetes. Open Access Maced J Med Sci. 2017; 5(2):131-36.