ECHOCARDIOGRAPHIC FINDINGS IN EGYPTIAN CHILDREN WITH TYPE 1 DIABETES MELLITUS

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ABSTRACT

Background: Type 1 diabetic children have echocardiographic evidence of subtle RV and LV dysfunction with delayed myocardial relaxation. Thus, it is important to evaluate the cardiac function in children with T1D by conventional echocardiography and tissue Doppler imaging (TDI), for early detection of this dysfunction.

Aim and objectives: this work aims to assess cardiac function in children with type 1 Diabetes Mellites using different modalities of echocardiography.

Patients and methods: This case control study was conducted on 70 children attending the Outpatient pediatric clinic, and Clinics of Pediatric cardiology and endocrinology, Al-Hussein University Hospital in Cairo; in the period from the beginning of July 2021 to the end of November 2021.The recruited children were randomly assigned into two groups:

Patient Group: included 50 children with type 1 diabetes mellitus. They were defined according to the American Diabetes Association criteria for diagnosis and classification of diabetes. Patients were selected randomly from outpatient pediatric clinics in Al Hussein University hospital. 26 were males and 24 were female's patient ages ranged from 2-18 years old.

Control Group: included 20 healthy (10 boys and 10 girls) children (2-18 years old).

The study was approved by the ethical committee of the faculty of medicine, Al-Azhar University. Informed parental consent from one of the parents was obtained before enrollment in this study.

Results: Patients had significantly lower mitral and tricuspid E and A waves velocity (p value 0.000, 0.001, 0.000, and 0.000, respectively). Patients had significantly lower A' and E' velocities of the RV and S' velocity of the LV (p value 0.016, 0.022 and 0.006 respectively). They also had significantly longer IRT (p value 0.000), and higher MPI of the RV (p value 0.007), larger LVIDd and LVIDs diameters and increased IVS and

LVPW thickness in comparison to the controls (p value 0.00, 0.00, 0.004 and 0.001, respectively).

Conclusion: *Type 1 diabetic children have echocardiographic evidence of subtle RV and LV dysfunction with delayed myocardial relaxation. TDI has an additional value in evaluating ventricular filling. This highlights the importance of periodic cardiac evaluation with both conventional and tissue Doppler echocardiography for early detection of this dysfunction.*

Keywords: *Tissue Doppler echocardiography, Type 1 diabetes, Children, Diastolic dysfunction.*

INTRODUCTION

Diabetes mellitus significantly increases the risk of heart disease. Diabetic heart disease is a conglomeration of coronary artery disease (CAD), cardiac autonomic neuropathy (CAN), and diabetic cardiomyopathy (DCM) **(Rajbhandari et al., 2021)**.

Diabetic cardiomyopathy has been defined as ventricular systolic or diastolic dysfunction in a patient with DM without other recognized cause (such as CAD or hypertension) **(Dunlay et al., 2021)**.

The high incidence of such diastolic dysfunction and its association with HF and with mortality underscore the existence of diabetic cardiomyopathy as a very serious clinical condition **(From et al., 2010)**.

Even if these complications affect predominantly the adult diabetic patient, the process of vascular changes starts much earlier. Autopsies have shown that the atherosclerotic processes at the endothelial level begin in childhood and progress rapidly in the presence of risk factors **(Dalla Pozza et al., 2011)**.

Thus, children with diabetes mellitus are considered as high-risk patients and special attention to vascular health has been recommended **(Nesto et al., 2020)**.

Echocardiography has become the most important non-invasive technique for the diagnosis and follow-up of heart disease in children. It will add important information about the effect of chronic hyperglycemia in type 1 diabetic children on the cardiac functions. Highly informative subcostal windows often yield a structural diagnosis within the first few minutes of imaging. Echocardiography also permits detailed assessment of ventricular size and function **(McLeod et al., 2018)**.

In this study we aim to assess myocardial affection in Children with Type 1 Diabetes Mellitus using different modalities of Echocardiography.

Aims of the Work

The aim of the work is to assess cardiac function in children with type 1 Diabetes Mellitus using different modalities of Echocardiography.

Ethical considerations:

1. An informed consent was obtained from parents or legal guardians before getting involved in the study.

2. The study was done after approval of ethical committees of Pediatrics department & faculty of medicine for Al-Azhar University.

3. The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

4. All the data of the patients and results of the study are confidential and the patients have the right to keep it.

5. The parents have the right to withdraw from the study at any time without giving any reasons.

PATIENTS AND METHODS

Sample size calculation:

The sample size was calculated using Power and Sample size

$$n = 2\left[\frac{(Z_{\alpha/2} + Z_{\beta}) * \sigma}{\mu_1 - \mu_2}\right]^2$$

software version 3 (epi info). The sample size was calculated using the following formula:

Where:

n = sample size

$Z_{\alpha/2}$ = The critical value that divides the central 95% of the Z distribution from the 5% in the tail.

Z_{β} = The critical value that separates the lower 20% of the Z distribution from the upper 80%.

σ = The estimate of the standard deviation of the children with diastolic dysfunction in the lowest quartile.

μ_1 = mean children with diastolic dysfunction in the lowest quartile.

μ_2 = mean children with diastolic dysfunction in the other quartiles follow up.

By calculation, the sample size will be equal to 70 in total.

This case control study was conducted on 70 children attending the Outpatient pediatric clinic, and Clinics of Pediatric cardiology and endocrinology, Al-Hussein University Hospital in Cairo, in the period from the beginning of July 2021 to the end of November 2021. The recruited children were randomly assigned into two groups:

Patient Group: included 50 children with type 1 diabetes mellitus. They were defined according to the American Diabetes Association criteria for diagnosis and classification of diabetes.

Patients were selected randomly from outpatient pediatric clinics in Al Hussein University hospital. Children who fulfilled the inclusion criteria were only considered for the study.

Inclusion Criteria:

- Age 2–18 years.
- Both sexes will be included.
- Diagnosed as Type1 Diabetes.

Exclusion criteria:

- Cardiac disease whether congenital or acquired.
- Arrhythmias.
- Hypertension.

- Thyroid disorder.
- Type 2 DM.

Control Group: included 20 healthy (10 boys and 10 girls) children (2-18 years old).

All the study population were subjected to:

1. **Complete detailed history taking:** with emphasis on age, sex, age of onset of diabetes and its duration, insulin therapy dose, symptoms suggesting how well the diabetes is controlled, cardiac symptoms (including history of palpitation, chest pain, hypertension, dyspnea on exercise, and manifestations of heart failure), and history of illness regarding respiratory, neurological and gastrointestinal systems.

2- **Complete general and systemic examination. With emphasis on vital signs, anthropometric measurement:** Weight, Height, Body mass index (BMI), cardiac examination, and systemic examination regarding respiratory, neurological and abdominal systems.

3- **Laboratory investigations including:** Random blood sugar, Complete blood count (CBC), (HbA1c), measured

using quantitative colorimetric ion exchange resin chromatography kits. Calibrators referenced to National Glycohemoglobin Standardization Program (NGSP) and HbA1c values were reported using the unit of a percentage (%), Blood or urine ketone levels (in the presence of prolonged/severe hyperglycemia or acute illness), lipid profile including serum triglycerides (TG), Total cholesterol, Low density lipoproteins (LDL) and High-density lipoproteins (HDL), albumin/ creatinine ratio in the first morning sample, Urinary albumin was measured by rate nephelometry, and urinary creatinine was measured by modified Jaffe's method, Fundus examination, and ECG.

4- Echocardiography:

Echocardiography was performed for all cases and controls in the supine, left lateral position, using a (PHLIPS EPIC) cardiovascular ultrasound machine, with 8 MHz electronic sector transducer (multi- frequency transducer) according to the age of patient, having tissue velocity imaging capabilities. The electrocardiography cable was connected to the ultra-sound machine to define and to time the cardiac cycle events. The examination was performed by a pediatric cardiologist expert in echocardiography and tissue Doppler imaging (TDI) in accordance with the recommendations of the American Society of Echocardiography. The examination consisted of M-mode, two dimensional, pulsed-wave, and color Doppler blood flow velocity measurements of the heart valves.

For M-mode the following measurements were done:

At the level of the tips of the mitral valve leaflets: inter ventricular septum (IVS), left ventricular posterior wall (LVPW), left ventricular internal diameter in diastole (LVIDd), and left ventricular internal diameter in systole (LVIDs), fractional shortening (FS), and ejection fraction (EF) were measured.

At the level of the aorta and left atrium, left atrium (LA) & aortic diameter (AO) were measured.

Trans mitral and trans tricuspid flows were obtained with pulsed wave Doppler at the leaflet tips; early diastolic inflow velocity (E), velocity during active atrial contraction (A), E to A wave

(E/A) ratio, and deceleration time (DT) were measured.

TDI was obtained from the four chambers apical view, and tissue velocities were calculated. Using pulsed tissue velocity indices, the sample volumes were placed in the lateral sides of the mitral and tricuspid annuluses and the base of the interventricular septum (IVS). The peak systolic (S') and early and late diastolic velocities (E' and A', respectively) at these points were measured, and the E/E' ratio was calculated. The isovolumic relaxation time (IVRT) and isovolumic contraction time (IVCT) were both measured for both left ventricle (LV) and right ventricle (RV) lateral walls.

Calculation of global myocardial performance index (MPI) was performed by pulsed tissue velocity imaging. For tissue Doppler, all interval measurements were performed within one cardiac cycle. The MPI was calculated a'–b'/b' where a' is the time interval from the end of A' wave to the onset of E' wave and b' the time from the onset to the end of the S' wave.

To reduce the effect of respiration on tissue velocities and as breath holding was not applicable in young children, three cardiac cycles were, recorded, and the average velocity was calculated. To reduce intra observer variability three different measurements for each tissue Doppler index was done and the average was taken.

Statistical Analysis of the data:

Data were statistically described in terms of mean ± standard deviation (SD), median and range, or frequencies (number of cases) and percentages when appropriate.

Data were tested for normal distribution using the Kolmogorov-Smirnov test. Comparison of numerical variables between the study groups was done using independent t test for independent samples when data were normally distributed and Mann Whitney U test for independent samples when not normally distributed.

For comparing categorical data, chi square (χ2) test was performed. p values less than 0.05 was considered statistically significant. All statistical calculations were done using computer program Statistical Package for the Social Science (SPSS Inc., Chicago, IL, USA) release 25 for Microsoft Windows (2016).

RESULTS

Table (1): Demographic characteristics of the subjects in the patient and control groups

Variables		Patient Group (N=50)	Control Group (N=20)	Test	P-value	Sig.
Age (yrs.)	Mean± SD	12.15±1.41	11.92 ± 1.86	Mann Whitney U-test (MWU)	0.55	NS
Gender	Male	26 (52.0%)	10 (50.0%)	chi square (χ^2)	0.81	NS
	Female	24 (48.0%)	10 (50.0%)			
Residence	Urban	30 (60.0%)	14 (70.0%)	-	-	-
	Rural	20 (40.0%)	6 (30.0%)			
Family history	DM +ve	22 (44.0%)	-	NA	NA	NA
	DM No	28 (56.0%)	-			
	Cardiac disease +ve	0	0	NA	NA	NA
	Cardiac disease No	50 (100%)	20 (100%)			

NA: not applicable, NS: not significant, S: significant.

Table (2): Clinical data of the subjects in the patient and control groups

Variables		Patient Group (N=50)	Control Group (N=20)
Cyanosis	+ve	0 (0%)	0 (0%)
	No	50 (100%)	20 (100%)
Palpitation	+ve	0 (0%)	0 (0%)
	No	50 (100%)	20 (100%)
Dyspnea at rest	+ve	0 (0%)	0 (0%)
	No	50 (100%)	20 (100%)
Exercise intolerance	+ve	9 (18%)	0 (0%)
	No	41 (82%)	20 (100%)
Diabetes duration (yrs.)	Mean ± SD	6.47 ± 1.03	NA
Weight (kg)	Mean ± SD	42.06 ± 4.77	40.50 ± 8.59
Height (cm)	Mean ± SD	144.88 ± 8.30	150 ± 11.58
BMI (kg/m^2)	Mean ± SD	19.99 ± 2.66	18.87 ± 0.31
Insulin dose per weight	Mean ± SD	1.29±0.147	NA
Cardiac examination	Normal	50 (100%)	20 (100%)
	Abnormal	0 (0%)	0 (0%)

NA: not applicable

There was no significant difference between both groups regarding age and gender distribution (P > 0.05). This table shows that controls were selected properly and matched for age and sex compared to patients. None of our patients had cyanosis, palpitation or dyspnea at rest but there was 18 % with exercise intolerance. All patients had normal cardiac examination. There was positive family history of diabetes in 44 % of the patients. All the patients were receiving insulin.

Table (3): Laboratory characteristics of the subjects in the patient and control groups

Variables		Patient Group (N=50)	Control Group (N=20)	Test	P-value	Sig.
HbA1c (%)	Mean ±SD	9.52 ± 1.66	5.58 ± 0.34	Mann Whitney U test (MWU)	0.00	S
TG (mg/dL)	Mean ±SD	81.10 ± 25.38	55.0 ± 6.07		0.00	S
LDL (mg/dL)	Mean ±SD	99.36 ± 20.85	76.30 ± 8.34		0.00	S
HDL (mg/dL)	Mean ±SD	54.64 ± 7.871	51.10 ± 4.42		.217	NS
Cholesterol (mg/dL)	Mean ±SD	168.48 ± 21.56	141.25 ± 14.03		0.00	S
Microalbumin in urine	Mean ±SD	31.024±0.787	28.65 ± 0.81		0.00	S

NS: not significant, S: significant.

The HbA1c (%), TG (mg/dL), LDL (mg/dL), HDL (mg/dL), and Microalbumin in urine were significantly higher in diabetic patients compared to controls (p value 0.000, 0.000, 0.000, 0.000, and 0.000, respectively). There was no significant difference between both groups regarding Cholesterol (mg/dL) (P value 0.217).

Table (4): Comparison between patient group and control group regarding systolic functions

Variables		Patient Group (N=50)	Control Group (N=20)	Test	p-value	Sig.
AO (mm)	Mean ± SD	22.89 ± 1.59	20.84 ± 2.13	Mann Whitney U test (MWU)	0.001	S
LA (mm)	Mean ± SD	24.69±1.57	24.92 ± 2.141	Independent T test	0.618	NS
RV (mm)	Mean ± SD	14.15 ± 1.49	14.36 ± 1.64	Mann Whitney U test (MWU)	0.63	NS
LVIDd (mm)	Mean ± SD	40.62 ± 2.59	36.96 ± 3.36	Independent T test	0.000	S
LVIDs (mm)	Mean ± SD	26.40 ± 2.07	21.80 ± 2.52	Independent T test	0.000	S
IVS (mm)	Mean ± SD	7.10 ± 0.72	6.45 ± 0.83	Mann Whitney U test (MWU)	0.004	S
PW (mm)	Mean ± SD	6.78 ± 0.76	6.05 ± 0.89	Independent T test	0.001	S
FS (%)	Mean ± SD	40.04 ± 2.38	41.73 ± 5.35	Mann Whitney U test (MWU)	0.107	NS
EF (%)	Mean ± SD	67.56 ± 3.27	70.42 ± 5.81	Mann Whitney U test (MWU)	0.073	NS

NS: not significant, S: significant.

The dimensions of aorta (AO), left ventricular internal diameter in diastole (LVIDd), left ventricular internal diameter in diastole (LVIDs), IVS, and left ventricular posterior wall (LVPW) were significantly higher in diabetic patients compared to controls (p value 0.001, 0.000, 0.000, 0.004, and 0.001, respectively).There was no statistically significant difference between the two groups regarding LA (p= 0.618), RV (p= 0.63), FS (%) (p= 0.107) or EF (%) (p= 0.073).

Table (5): Comparison between Pulsed Wave echocardiography data of Tricuspid inflow of patients and controls

Variables		Patient Group (N=50)	Control Group (N=20)	Test	P-value	Sig.
E tricuspid (m/sec)	Mean ±SD	0.61 ± 0.07	0.71 ± 0.08	Independent T test	0.000	S
A tricuspid (m/sec)	Mean ±SD	0.43 ± 0.03	0.54 ± 0.09	Mann Whitney U test (MWU)	0.000	S
E/A ratio tricuspid	Mean ±SD	1.51 ± 0.17	1.38 ± 0.17	Independent T test	0.005	S
DT tricuspid (ms)	Mean ±SD	174.73 ± 34.04	166.57 ± 23.92	Mann Whitney U test (MWU)	0.091	NS

NS: not significant, S: significant.

The early diastolic inflow velocity (E), velocity during active atrial contraction (A), across the tricuspid valve, were significantly lower in diabetic patients compared to controls (p value 0.000, and 0.000, respectively). E to A wave (E/A) ratio, across the tricuspid valve was significantly higher in diabetic patients compared to controls (p value 0.006). There was no statistically significant difference between the two groups regarding DT (p value 0.091).

Table (6): Comparison between Pulsed Wave echocardiography data of Mitral inflow of patients and controls

Variables		Patient Group (N=50)	Control Group (N=20)	Test	P-value	Sig.
E mitral (m/sec)	Mean ±SD	0.94 ± 0.1	1.05 ± 0.09	Mann Whitney U test (MWU)	0.000	S
A mitral (m/sec)	Mean ±SD	0.51 ± 0.07	0.6 ± 0.105		0.001	S
E/A ratio mitral	Mean ±SD	1.77 ± 0.25	1.86 ± 0.29		0.316	NS
DT mitral (ms)	Mean ±SD	150.90 ± 20.42	143.20 ± 20.59	Independent T test	0.160	NS

NS: not significant, S: significant.

The early diastolic inflow velocities (E), velocity during active atrial contraction (A), across the mitral valve, were significantly lower in diabetic patients compared to controls (p value 0.000, and 0.001, respectively). There was no

statistically significant difference between the two groups regarding E to A wave (E/A)

ratio and DT (p value 0.316 and 0.160 respectively).

Table (7):   Comparison between patient group and control group regarding right ventricle diastolic functions

Variables		Patient Group (N=50)	Control Group (N=20)	Test	P-value	Sig.
RV-S' (cm/sec)	Mean ±SD	12.00 ± 1.007	13.38 ± 2.49	Mann Whitney U test (MWU)	0.071	NS
RV-A' (cm/sec)	Mean ±SD	9.11 ± 1.539	10.17 ± 1.92		0.016	S
RV-E' (cm/sec)	Mean ±SD	16.27 ± 1.33	17.50 ± 2.105		0.022	S
RV-ICT (ms)	Mean ±SD	41.56 ± 3.777	45.95 ± 6.392		0.007	S
RV-IRT (ms)	Mean ±SD	43.899 ± 4.504	35.885 ± 5.620		0.000	S
RV-MPI	Mean ±SD	0.313 ± 0.048	0.272 ± 0.040		0.007	S
RV-E/E'	Mean ±SD	3.901 ± 0.530	4.159 ± 0.759		0.111	NS

NS: not significant, S: significant.

The A' and E' velocities of the RV were significantly lower in diabetic patients compared to controls (p value0.016 and 0.022, respectively). The ICT of the RV was significantly shorter in diabetic patients compared to controls (p value 0.007). The IRT of the RV was significantly longer in diabetic patients compared to controls (p value 0.000). The MPI of the RV of the patients was significantly higher than controls (p value 0.007). There was no statistically significant difference between the two groups regarding RV-S' (cm/sec) and RV-E/E' (p value 0.071 and 0.111 respectively).

Table (8): Comparison between patient group and control group regarding Left Ventricle diastolic functions

Variables		Patient Group (N=50)	Control Group (N=20)	Test	P-value	Sig
LV-S' (cm/sec)	Mean ± SD	7.64 ± 0.495	9.14 ± 1.915		0.006	S
LV-A' (cm/sec)	Mean ± SD	6.85± 0.967	6.92 ± 1.533		0.907	NS
LV-E' (cm/sec)	Mean ± SD	17.489 ± 1.73	18.742 ± 2.638		0.097	NS
LV-ICT (ms)	Mean ± SD	40.38 ± 4.862	42.820 ± 5.415	Mann Whitney U test (MWU)	0.110	NS
LV-IRT (ms)	Mean ± SD	44.283 ± 3.68	44.351 ± 8.345		0.995	NS
LV-MPI	Mean ± SD	0.290± 0.018	0.270 ± 0.0486		0.226	NS
LV-E/E'	Mean ± SD	5.572 ± 0.828	5.870 ± 0.880		0.252	NS

NS: not significant, S: significant.

The S' velocity of the LV was significantly lower in diabetic patients compared to controls (p value 0.006). There was no statistically significant difference between the two groups regarding LV-A' (cm/sec), LV-E' (cm/sec), LV-ICT (ms), LV-IRT (ms), LV-MPI, and LV-E/E' (p value 0.907, 0.097, 0.110, 0.995, 0.226 and 0.252 respectively

DISCUSSION

Diabetes mellitus significantly increases the risk of heart disease. Diabetic heart disease is a conglomeration of coronary artery disease (CAD), cardiac autonomic neuropathy (CAN), and diabetic cardiomyopathy (DCM) (**Rajbhandari et al., 2021**).

Children with diabetes mellitus are considered as high-risk patients and special attention to vascular health has been recommended (**Nesto et al., 2020**).

Diastolic dysfunction refers to abnormalities in ventricular relaxation and filling (RV, LV, or both) with prolonged or incomplete return to presystolic length and force (**Zile et al., 2002**).

Echocardiography has become the most important non-invasive technique for the diagnosis and follow-up of heart disease in

children. It will add important information about the effect of chronic hyperglycemia in type 1 diabetic children on the cardiac functions. Highly informative subcostal windows often yield a structural diagnosis within the first few minutes of imaging. Echocardiography also permits detailed assessment of ventricular size and function (**McLeod et al., 2018**).

In this study we aimed to assess myocardial affection in Children with Type 1 Diabetes Mellitus using different modalities of Echocardiography.

This case control study, carried out on 50 children with type 1 diabetes mellitus, aged between 2 and 18 years, and 20 healthy control children, age and sex matched. The patients were subjected to clinical evaluation and laboratory investigations including glycosylated hemoglobin A1c (HbA1c), and serum lipids and lipoproteins. Conventional echocardiography and TDI were performed to patients and controls.

Regarding demographic characteristics among the two studied groups, there was no significant difference between both groups regarding age, body weight, height and BMI (P > 0.05). There was no significant

difference between both groups in gender distribution as the Chi-squared value was 0.81 (P > 0.05). None of our patients had cyanosis, palpitation or dyspnea at rest but there was 18 % with exercise intolerance. All patients had normal cardiac examination. There was positive family history of diabetes in 44 % of the patients. All the patients were receiving insulin.

Regarding laboratory characteristics among the two studied groups, the HbA1c (%), TG (mg/dL), LDL (mg/dL), HDL (mg/dL), and Microalbumin in urine, were significantly higher in diabetic patients compared to controls (p value 0.000, 0.000, 0.000, 0.000, and 0.000, respectively). This could be explained by the nature of the disease. There was no significant difference between both groups regarding Cholesterol (mg/dL) (P value 0.217).

Our study showed that regarding comparison between the studied groups.

Pulsed Wave echocardiography revealed that our patients had significantly lower mitral and tricuspid E and A waves velocity (p value 0.000, 0.001, 0.000, and 0.000, respectively).

Our results come in agreement with the study of (F et al. 2017),

who demonstrated that, the patients had significantly lower E and A waves velocity across both the mitral valve and the tricuspid valve than controls (p value 0.019, 0.054, 0.023, and 0.006, respectively).

Furthermore, Our results come in agreement with **(Salem et al., 2009)**, who found that, both mitral and tricuspid (E) wave velocities were lower in diabetics, but without statistical significance, however; the (A) wave velocities of both the mitral valve and the tricuspid valve were significantly higher in diabetics (P < 0.05, P < 0.05) respectively, with a consequently significant lower E/A ratio (P < 0.05, P < 0.05) respectively compared to controls.

Also, our results come in agreement with the study of **(Labombarda et al., 2014)**, who found that, the mitral A wave and E/A ratio were lower than the healthy group but without statistical significance (p value 0.76, and 0.08, respectively), whereas the (E) wave velocity of the mitral valve was significantly lower in diabetics (p value 0.025).

In contrary, our results come in disagreement with the study of **(Gökşen et al., 2013)**, who found that, tricuspid A-wave velocity was significantly higher (p value 0.000), whereas E/A ratio was

significantly lower (p value 0.000) in patients compared with controls. Tricuspid E-wave velocity, mitral E and A velocities and mitral E/A ratio had no significant differences between patients and control.

Tissue Doppler echocardiography revealed that our patients had significantly lower A' and E' velocities of the RV (p value 0.016 and 0.022, respectively), whereas the A' and E' velocities of the LV were lower in diabetics, but without statistical significance (p value 0.907, and 0.097, respectively). The S' velocity of the LV was significantly lower in comparison to the controls (p value 0.006), whereas the S' velocity of the RV was lower in diabetics, but without statistical significance. (p-value 0.071).

Our results come in agreement with the study of **(F et al., 2017)**, who found that, the E' and A' velocities of both LV and RV, were lower in diabetics, but without statistical significance (p value 0.200, 0.963, 0.097 and 0.185, respectively). The S' velocity of LV was significantly lower in comparison to the controls (p value 0.041), whereas the S' velocity of the RV was lower in diabetics, but without

statistical significance. (p-value 0.172).

Also, our results come in agreement with the study of (**Hensel et al., 2016**), who found that, the E', A' and S' velocities of the LV were lower in diabetics, but without statistical significance.

In contrary, our results come in disagreement with the study of (**Salem et al., 2009**), who found that, the A' and S' velocities of both RV and LV were higher in diabetics, but without statistical significance. (p value > 0.05).

Also, our results come in disagreement with the study of (**Rakha et al., 2019**), who found that, the A' and S' velocities of the LV were higher in diabetics, but without statistical significance (p value 0.968 and 0.764, respectively).

The mitral annular or basal LV velocities reflect the long axis mitral motion of the ventricle, which is an important component of LV systolic and diastolic function. The peak systolic velocity is also a sensitive marker of mildly impaired LV systolic function, even in those with a normal LV ejection fraction or apparently preserved LV systolic function, such as diastolic heart failure or in diabetic subjects without overt heart disease (**Yu et al., 2007**).

Subclinical LV dysfunction may be identified by reduced longitudinal contraction. The radial contractility appears to compensate for reduced longitudinal contractility in subclinical LV dysfunction occurring in the absence of ischemia or LV hypertrophy (**Fang et al., 2004**).

Other findings which support the presence of subtle diastolic dysfunction were significantly longer IRT (p value 0.000), and significantly higher MPI of the RV (p value 0.007) in our patients. The IRT and MPI of the LV showed no significant differences between the two groups.

It is important to emphasize that the diastolic dysfunction was more prominent in the RV parameters. These changes reflect early changes in myocardial relaxation.

Our results come in agreement with the study of (**F et al., 2017**), who demonstrated that, there were significantly longer IRT (p value 0.001), and significantly higher MPI (p value 0.049) of the RV, whereas the IRT and MPI of the LV showed no significant differences between the two groups.

Also, our results come in agreement with the study of (**Çiftel et al., 2014**), who found

that, there were significantly longer IRT and higher MPI of both LV and RV (p value <0.001, <0.001, <0.001, and <0.001, respectively).

Also, our results come in agreement with the study of (**Khattab et al., 2015**), who found that, there were longer IRT and higher MPI of both LV and RV, but without statistical significance (p value 0.087, 0.382, 0.056, and 0.112, respectively).

M-mode echocardiography showed a tendency to ventricular hypertrophy in the absence of hypertension. Our patients had significantly larger LVIDd and LVIDs diameters and increased IVS and LVPW thickness in diabetics in comparison to the controls (p value 0.00, 0.00, 0.004 and 0.001, respectively).

Our results come in agreement with the study of (**F et al., 2017**), who demonstrated that, there were significantly larger LVIDd and LVIDs diameters and increased IVS and LVPW thickness in diabetics in comparison to the controls (p value 0.000, 0.000, 0.000 and 0.002, respectively).

Also, our results come in agreement with the study of (**Gul et al., 2009**), who demonstrated that, there was significantly increased LVPW thickness in diabetics in comparison to the controls (p value 0.019).

Also, our results come in agreement with the study of (**Jędrzejewska et al., 2016**), who demonstrated that, there was significantly increased LVPW thickness in diabetics in comparison to the controls (p value < 0.001).

On the contrary, our results come in disagreement with the study of (**Kim et al., 2010**) who found that, there was no change in the LVPW thickness in diabetics in comparison to the controls.

The FS of LV was lower in diabetics in comparison to the controls, but remained within normal values, (p value 0.107). This may imply an early affection of the systolic function.

Our results come in agreement with the study of (**Hensel et al., 2016**), who reported that, The FS of LV was lower in diabetics in comparison to the controls, but without statistical significance.

Also, Our results come in agreement with the study of (**F et al., 2017**), who reported that, The FS of LV was lower in diabetics in comparison to the controls, but without statistical significance (p value 0.270).

CONCLUSION

Type 1 diabetic children have echocardiographic evidence of subtle RV and LV dysfunction with delayed myocardial relaxation. TDI has an additional value in evaluating ventricular filling. This highlights the importance of periodic cardiac evaluation with both conventional and tissue Doppler echocardiography for early detection of this dysfunction.

RECOMMENDATIONS

1. Periodic cardiac evaluation with both conventional and tissue Doppler echocardiography, for early detection of diastolic and systolic dysfunctions.

2. Echocardiographic examination should be done for any diabetic child where biventricular systolic and diastolic function needs to be assessed.

Limitations of the study

1. Uncertainty of HbA1c measurements, as we depended on one single measurement.

2. Difficulty in recruitment of diabetic patients to our study.

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دراسة الموجات الصوتية على القلب للأطفال المصريين المصابين بالنوع الأول من مرض السكري

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إن الأطفال المصابون بداء السكري من النوع الأول لديهم أدلة على وجود وجود خلل وظيفي دقيق في وظائف البطين الأيمن والأيسر، مع تأخر استرخاء عضلة القلب. وبالتالي، فمن المهم تقييم وظيفة القلب لدى الأطفال الذين يعانون من داء السكري من النوع الأول عن طريق تخطيط صدى القلب التقليدي وتصوير الدوبلر النسيجي، للكشف المبكر عن هذا الخلل الوظيفي.

تهدف هذه الدراسة إلى تقييم مدى تأثر عضلة القلب لدى الأطفال المصابين بالنوع الأول من داء السكري باستخدام طرائق مختلفة لتخطيط صدى القلب.

وقد تم إجراء هذه الدراسة على 70 طفلاً يترددون على العيادة الخارجية للأطفال، وعيادات أمراض القلب للأطفال والغدد الصماء، مستشفى الحسين الجامعي بالقاهرة، في الفترة من بداية يوليو 2021 إلى نهاية فبراير 2022. تم تقسيم الأطفال بشكل عشوائي إلى مجموعتين:

مجموعـــة المرضـــى: تشـمل 50 طفــلاً يعـانون مـن مـرض السـكري من النوع الأول، تتراوح أعمارهم بين 2 و18 عامًا.

مجموعـــة المراقبـــة: تضـم 20 طفـلًا يتمتعـون بصـحة جيـدة، ويتطابق العمر والجنس معهما.

ولقد تم عمل الآتي لهم:

- اخذ تاريخ مرضى مفصل.

- فحص إكلينيكي شامل.

- فحـص معملـي شـامل بمـا فـي ذلـك الهيموجلـوبين السـكرى ودهون الدم والبروتينات الدهنية.

- عمـل موجـات صـوتية علـى القلـب باسـتخدام تخطـيط صـدى القلب التقليدي وتصوير الدوبلر النسيجي.

وقد خلصت الدراسة إلي:

وجـود خلـل وظيفـي دقيـق فـي وظـائف البطـين الأيمـن والأيسـر مـع تـأخر اسـترخاء عضـلة القلـب، وذلـك عنـد الاطفـال المصـابين بـداء السـكري مـن النـوع الاول عـن اولئـك الاطفـال الغير مصابين.

بنـاءً علـى نتائجنـا، نوصـى بـإجراء التقيـيم القلبـي الـدوري باسـتخدام تخطـيط صـدى القلـب التقليـدي وتصـوير الـدوبلر النسيجي للكشف المبكر عن هذا الخلل الوظيفي.