Zagazig University Medical Journal
www.zumj.journals.ekb.eg

Volume 29, Issue 2, March 2023, page (300-309) Supplement Issue

Manuscript ID ZUMJ-2003-1767 (R1)
DOI **10.21608/ZUMJ.2021.25268.1767**

ORIGINAL ARTICLE

Ventricular Assessment by Echocardiography in Children with Bronchial Asthma

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Submit Date 2020-04-13
Revise Date 2020-06-23
Accept Date 2021-02-23

ABSTRACT

Background: Bronchial asthma is a chronic inflammatory condition of the airways characterized by hyper-responsiveness of the airways arising from a combination of genetic and environmental factors. The aim of this work is to evaluate the effect of bronchial asthma with different grades of severity and medical control on the ventricular function of the heart using echocardiography.

Methods: This case-control study was carried out at pulmonology and cardiology units, Pediatric Department, Zagazig University Hospitals during the period from December 2016 to January 2018. Included 120 age and sex matched children; 60 of them were asthmatic and 60 of them were healthy children. All children were assessed clinically, radiologically, and investigated by Electrocardiography (ECG), pulmonary function tests and by conventional and tissue echocardiography.

Results: Echocardiographic data of the left ventricle Demonstrated statistically important variations between cases and controls as regard LV systolic function as Ejection Fraction (EF) showed significant decrease in cases when compared to controls. Right ventricle wall thickness by conventional echocardiography was significantly thicker in asthmatics than control with highly significant difference between cases and controls as regard IVRT, IVCT, ET of right ventricle, lateral tricuspid É and É/Á ratio. Also, significant correlations between findings on TDE and pulmonary function tests in asthmatic patients were found

Conclusions: TDE can be used for early detection of impairment of cardiac function in asthmatic children at a stage when conventional echocardiographic indices are still normal**,** diastolic function of right ventricle is more affected by asthma than systolic function detected by TDE. TDE findings has strong correlations with pulmonary function tests in these patients.

Key words: Ventricular Assessment; Bronchial asthma; Echocardiography; Children

INTRODUCTION

Asthma is a heterogeneous disease, generally characterized by chronic inflammation of the airways. It is characterized by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that differ in length and severity, along with variable airflow obstruction [1].Asthma diagnosis should be suspected if there is a history of frequent wheezing, coughing or trouble breathing and these symptoms arise or intensify due to exercise, respiratory infections, allergens or air pollution. Spirometry is then used to validate the diagnosis. Asthma patients experience pulmonary hypertension due to persistent hypoxia and chronic inflammation, leading to right heart enlargement with ventricular hypertrophy. Patients with serious asthma may experience cor-pulmonale later in life, but little is known about ventricular function during the early stages of the disease [2].Conventional Echocardiography is a bedside, readily available procedure for routine RV function assessment in asthma patients. In several of the previous research, RV and LV dysfunction were seen in children with extreme asthma using traditional echocardiography [3].However irregular shape of RV, its retrosternal rotation, and the frequent coexistence of lung hyperinflation make standard "gray- scale" imaging suboptimal for routine assessment of the right ventricle. Tissue Doppler Echocardiography (TDE) is a new technique providing quantitative measurement of regional myocardial velocities even when a gray-scale image is suboptimal. Echocardiography is the most widely used method for evaluation of heart function as it has many advantages. [4].Tissue Doppler Imaging (TDI) is an evolving ultrasound technology that tests cardiac function without the invasive and painful elements of cardiac catheterization and biopsy. This measures the velocity of the cardiac muscle itself, rather than the velocity of the blood, which is a direct measure of the activity of the heart. It's easy to do and available on most of the latest echocardiography equipment, and its measurements are not affected by factors such as anemia, excess fluid, and valve leakage which may cause inaccurate measurements with traditional blood flow Doppler [4].

The aim of this work is to evaluate the effect of bronchial asthma with different grades of severity and medical control on the ventricular function of the heart using echocardiography.

METHODS

This case-control study was carried out at pulmonology unit and cardiology unit, pediatric department, in Zagazig University hospitals during the period from December 2016 to January 2018. It included 120 age and sex matched children; 60 of them were asthmatic and 60 of them were healthy children. Asthmatic children were divided into 3 groups according to disease severity based on Global Initiative for Asthma (GINA) guidelines (2019) [5]; 22 asthmatic children with mild bronchial asthma, 28 asthmatic children with moderate bronchial asthma and 10 asthmatic children with severe bronchial asthma. All children were assessed clinically, radiologically, and investigated by Electrocardiography (ECG), pulmonary function tests and by conventional echocardiography

Inclusion criteria: Children aged 5 to18 years. Children with bronchial asthma on the basis of patient symptoms and medical history according to GINA guidelines.

Exclusion criteria: Patient outside this age group. Co-morbid diseases as upper respiratory tract infection, allergic rhinitis, chronic cardiovascular or pulmonary diseases with possible cardiovascular complications.

Written Informed consent was taken from the patient parents to participate in the study. The permission for the study was received from the Pediatrics Departments of Zagazig University Hospitals after the permission of the Institutional Review Board (IRB). The research was carried out in compliance with the Code of Ethics of the World Medical Association (Decleration of Helsinki) for studies involving humans.

Methods: Each Patient is subjected to complete history taking including Family history of asthma. Severity of attacks. Duration of asthma. Controller medications used. Number of admissions to hospital due to asthma. Possible predisposing factors and associated manifestations. Complete physical examination. Chest X-ray (PA view).

Pulmonary function tests: (a) Spirometry: Measures airflow and lung volumes during a forced expiratory maneuver using Spirometer Flowscreen Pro 1990´S manufactured by Jaeger,2010. Normative values of FEV1 % (forced expiratory volume in 1st sec) have been standardized for children based on height, gender, and ethnicity. The reduction in FEV1 % as a percentage of predicated is one of four criteria used to determine asthma severity. (b) Measurement of the peak expiratory flow rate: using a mini-wright peak flow meter manufactured by CLEMENT CLARKE Ltd, November 2016. The best reading of the three forced expirations was reported [6].

Routine echocardiography:

Echocardiographic and Doppler examination were performed by the same operator using a Vivid7 dimension (General Electric) machine equipped with a multi-frequency M3S and a 7s transducers. Conventional Echocardiography was evaluated. Cardiac Dimensions: Aortic (AO) and left atrial (LA) dimensions were measured from the parasternal short axis view. Interventricular septum (IVS), left ventricular posterior wall (LVPW) thickness, left ventricular end diastolic (LVED) and left ventricular end systolic (LVES) dimensions were measured from the parasternal short axis view with orientation of the plane of sound just below the tips of the mitral valve. Right ventricular wall thickness and Right ventricle diameter were also measured.

Conventional LV systolic and diastolic functions:

The left ventricular end diastolic (LVED) and left ventricular end systolic (LVES) dimensions parameters were measured from M- mode (MM) images. The EF and %FS were calculated through MM . FS (%) = (LVEDd – LVESd) / LVEDd x 100 Where LVEDd is left ventricular end diastolic dimension, LVESd is the left ventricular end systolic dimension. EF (%) = (LVEDv – LVESv) / LVEDv x 100

Where LVEDv is left ventricular end diastolic volume, LVESv is the left ventricular end systolic volume.

Diastolic function of the right ventricle was measured by assessment of tricuspid E and A velocity and tricuspid deceleration time.

Tissue Doppler echocardiography

RV and LV functions were also evaluated using TDE. Peak systolic (Ś) and early and late diastolic velocities (É, Á) were measured from the apical four-chamber view with the pulsed-wave Doppler sample volume placed at the lateral tricuspid annulus and the posterior mitral annulus. The ratio of early to late diastolic annular velocities (É/Á) was calculated. Systolic and early diastolic velocities and isovolumetric relaxation time (IVRT). Doppler-derived myocardial performance index (MPI) combining systolic and diastolic time intervals was calculated as the sum of Isovolumetric contraction time **(**IVCT) and IVRT divided by ejection time (ET).

STATISTICAL ANALYSIS

Data were analyzed using the Statistical Package for Social Sciences (SPSS) release 16. Data showing normal distribution were presented as the means and standard deviation. For comparison between the means of two groups, the t-test was used. The non-parametric values were tested using the Mann–Whitney-U test. Qualitative data are represented by frequency and relative percentage and chi-square test was used for testing the association of the qualitative data. In all analyses, *P* values <0.05 were considered statistically significant.

RESULTS

There was no statistically significant difference according to the age and sex among asthmatic group in comparison to the control group. There was a statistically highly significant decrease in measurements of FEV1 %and FEV1 %/FVC% in cases as compared to controls with no statistically significant difference between cases and control as regard PEF and FVC%. Table (1)There was a statistically highly significant difference between cases and controls as regard the right ventricle wall thickness as the RV wall was statistically thicker among asthmatic patients than healthy children and Tricuspid deceleration time (DT) which is more prolonged in case group. There was no statistically significant difference between cases and control as regard ejection fraction (EF), fraction shortening (FS), right ventricle diameter, tricuspid peak velocity during early diastole (E), and tricuspid peak velocity during late diastole (A). and tricuspid peak E/A ratio. Table (2)There was a statistically highly significant difference between cases and controls as regard IVRT, IVCT, ET of right ventricle, lateral tricuspid É and É/Á ratio. It also shows statistically significant difference between cases and controls as regard MPI and lateral tricuspid Á. There is no statistically significant difference between cases and control as regard as septal Ś, septal É, septal Á and lateral Ś velocities of tricuspid. Table (3)Our results showed significant strong direct correlation between PEF and tricuspid E/A ratio, also significant direct correlation between PEF and Tricuspid DT and inverse correlation between PEF and tricuspid A. There was significant inverse correlation between FEV1 % and EF, significant direct correlation between FEV1 % and tricuspid DT. Also significant direct correlation between FVC% and RV wall thickness. No significant correlation between pulmonary function tests and other conventional echocardiography parameters. Table (4)The results also showed that significant direct correlation between pulmonary functions in the form of (PEF, FEV1 % and FEV1 %/FVC%) and tricuspid lateral É/Á, inverse correlation between pulmonary functions in the form of (PEF, FEV1 %/FVC%) and Tricuspid lateral Á. inverse correlation between PEF and MPI. Also significant direct correlation between FEV1 %/FVC% and IVRT. No significant correlation between pulmonary function tests and other findings on TDE. Table (5)

The table above shows significant inverse correlation between PEF & MPI, and between FVC%1/FVC% and (É) of tricuspid lateral annulus. there is no significant correlation between pulmonary function tests and findings of TDE in healthy children.

There was a significant correlation between different medications and TDI parameters as regard: IVRT, septal early diastolic (É) peak, Lateral Late diastolic (Á) peak and Lateral É/Á ratio Table (6)

Table 1: Comparison between studied groups as regard (demographic data and spirometry findings).

Demographic data	Group I Asthmatic patients (N= 60)	Group II Healthy children (N= 60)	Test	p
Age (years)			**T**	
Mean ± SD	7.5 ± 2.7	7.5 ± 2.6	-0.01	0.92 (NS)
Median (Range)	6 (5 – 13)	6 (5 – 12)		
Sex			**χ^2**	
Male	32 (53.3 %)	34 (56.7 %)	0.00	1 (NS)
Female	28 (46.7 %)	26 (43.3 %)		
Spirometry findings	**Group I Asthmatic patients (n=60)**	**Group II Healthy children (n=60)**	**Test**	**p**
PEF(%)			**T**	
Mean ± SD	86.7 ± 5.	87.3 ± 6.8	-0.39	0.7

Demographic data	Group I Asthmatic patients (N= 60)	Group II Healthy children (N= 60)	Test	p
Median (Range)	85 (80 – 96)	85 (80 – 100)		(NS)
FEV1(%)			**MW**	
Mean ± SD	91 ± 6.3	98.3 ± 6.8	188	**<0.001**
Median (Range)	90 (84 – 106)	100 (87 – 109)		**(HS)**
FVC(%)			**T**	
Mean ± SD	87.5 ± 4.6	87.4 ± 5.4	0.08	0.94
Median (Range)	90 (80 – 95)	90 (78 – 95)		(NS)
FEV1/FVC			**T**	
Mean ± SD	103.7 ± 4.3	113.1 ± 3	-9.83	**<0.001**
Median (Range)	103 (100 – 115)	115 (107 – 120)		**(HS)**

t: independent Student t-test. χ^2: Chi-square test.
P value <0.05 was considered statistically significant. P value < 0. 005 highly significant.
** P value >0. 05 not significant (NS). ****HS (highly significant)

Table 2: Comparison between studied groups as regard conventional echocardiography findings

	Group I Asthmatic patients (n=60)	Group II Healthy children (n=60)	Test	p
Ejection Fraction (EF) (%)			**T**	
Mean ± SD	71.4 ± 5.6	72.5 ± 4.4	-1.19	0.2
Median (Range)	70 (63 – 82)	75 (66 – 82)		(NS)
Fraction Shortening (FS) (%)			**T**	
Mean ± SD	38.5 ± 3.6	40.1 ± 2.3	-0.87	0.39
Median (Range)	40 (33 – 43)	40 (36 – 44)		(NS)
RV diameter (mm)			**MW**	
Mean ± SD	25 ± 1.3	25.1 ± 1.4	435	0.82
Median (Range)	25 (21 – 27)	25 (22 – 27)		(NS)
RV wall thickness (mm)			**MW**	
Mean ± SD	5 ± 0.7	3.8 ± 0.4	70	**<0.001**
Median (Range)	5 (4 – 6)	4 (3 – 4.2)		**(HS)**
Tricuspid Peak (E) velocity (cm/sec)			**MW**	
Mean ± SD	81.4 ± 10.3	79.1 ± 10.6	369	0.2
Median (Range)	80 (63 – 100)	80 (64 – 107)		(NS)
Tricuspid Peak (A) velocity (cm/sec)			**T**	
Mean ± SD	55.1 ± 13.6	49.7 ± 9.2	1.8	0.08
Median (Range)	58 (35 – 85)	50 (39 – 70)		(NS)
Tricuspid Peak E/A ratio			**T**	
Mean ± SD	1.5 ± 0.3	1.6 ± 0.2	-1.09	0.28
Median (Range)	2 (1.12 – 2)	2 (1.3 – 2)		(NS)
Tricuspid Deceleration time (m.sec)			**T**	
Mean ± SD	164.8 ± 28.1	149.7 ± 26.1	2.15	**0.04**
Median (Range)	160 (107 – 206)	145 (113 – 197)		**(S)**

Table 3: Comparison between studied groups as regard Tissue Doppler echocardiography (TDE) findings.

	Group I Asthmatic patients (n=60)	Group II Healthy children (n=60)	Test	p
Isovolumetric relaxation time (IVRT) (m.sec)			**T**	
Mean ± SD	60.5 ± 5.4	45.4 ± 6.1	10.09	**<0.001**
Median (Range)	65 (52 – 70)	45 (36 – 55)		**(HS)**
Isovolumetric contraction time (IVCT) (m.sec)			**T**	
Mean ± SD	60 ± 8.2	51.1 ± 7.1	4.49	**<0.001**
Median (Range)	60 (44 – 78)	50 (40 – 68)		**(HS)**

	Group I Asthmatic patients (n=60)	Group II Healthy children (n=60)	Test	p
Isovolumetric relaxation time (IVRT) (m.sec)			**T**	
Ejection time (ET) (m.sec)			**T**	
Mean ± SD	250.3 ± 26.7	210.5 ± 12.9	7.36	**<0.001**
Median (Range)	246 (220 – 306)	205 (199 – 250)		**(HS)**
MPI (%)			**T**	
Mean ± SD	48. ± 5.5	45 ± 3.2	2.61	**0.01**
Median (Range)	50 (40 – 60)	45 (38 – 50)		**(S)**
Tricuspid annulus velocities				
Septal Systolic (Ś) peak (cm/sec)			**T**	
Mean ± SD	10.7 ± 2.7	10.6 ± 2.	0.16	0.87
Median (Range)	10 (7 – 16)	10 (7 – 14)		(NS)
Septal Early diastolic (É) peak (cm/sec)			**T**	
Mean ± SD	15.2 ± 2.6	15.1 ± 2.6	0.1	0.92
Median (Range)	15 (11 – 20)	15 (11 – 20)		(NS)
Septal Late diastolic (Á) peak (cm/sec)			**MW**	
Mean ± SD	6.9 ± 2.7	6.9 ± 2.7	450	1
Median (Range)	5 (4 – 13)	5 (4 – 13)		(NS)
Lateral Systolic (Ś) peak (cm/sec)			**T**	
Mean ± SD	11.5 ± 2.4	11.4 ± 1.9	0.18	0.86
Median (Range)	10 (7 – 15)	10 (8 – 15)		(NS)
Lateral Early diastolic (É) peak (cm/sec)			**T**	
Mean ± SD	17.4 ± 2.8	13.8 ± 1.3	6.28	**<0.001**
Median (Range)	18 (12 – 23)	15 (11 – 16)		**(HS)**
Lateral Late diastolic (Á) peak (cm/sec)			**T**	
Mean ± SD	8.9 ± 2.5	10.4 ± 1.3	-2.94	**< 0.05**
Median (Range)	9 (5 – 13)	10 (8 – 13)		**(S)**
Lateral É/Á ratio			**T**	
Mean ± SD	2.1 ± 0.6	1.4 ± 0.2	6.01	**<0.001**
Median (Range)	2 (1.3 – 3)	1.5 (1.1 – 2)		**(HS)**

Table 4: Correlations between findings on conventional echocardiography and pulmonary function tests in asthmatic patients.

	PEF		FEV1		FVC		FEV1/FVC	
	R	**P**	**R**	**p**	**r**	**P**	**r**	**P**
EF (%)	-0.19	0.33 (NS)	**-0.4**	**0.03 (S)**	-0.31	0.09 (NS)	-0.26	0.16 (NS)
FS (%)	-0.22	0.25 (NS)	+0.1	0.6 (NS)	+0.2	0.29 (NS)	-0.22	0.25 (NS)
RV diameter (mm) §	+0.19	0.31 (NS)	-0.06	0.75 (NS)	-0.01	0.96 (NS)	-0.04	0.86 (NS)
RV wall thickness (mm) §	-0.13	0.49 (NS)	+0.34	0.06 (NS)	**+0.44**	**0.02 (S)**	+0.17	0.38 (NS)
Tricuspid (E) (cm/sec)	+0.04	0.82 (NS)	+0.06	0.763 (NS)	+0.07	0.71 (NS)	-0.02	0.93 (NS)
Tricuspid (A) (cm/sec)	**-0.6**	**0.001 (HS)**	+0.01	0.95 (NS)	+0.11	0.55 (NS)	-0.13	0.5 (NS)
Tricuspid E/A ratio	**+0.80**	**<0.001 (HS)**	+0.08	0.69 (NS)	-0.1	0.61 (NS)	+0.29	0.12 (NS)
Tricuspid DT (m.sec)	**+0.37**	**0.05 (S)**	**+0.39**	**0.03 (S)**	+0.24	0.2 (NS)	+0.34	0.07 (NS)

Table 5: Correlations between findings on TDE and pulmonary function tests in asthmatic patients

	PEF		FEV1		FVC		FEV1/FVC	
	R	P	R	P	R	P	R	P
IVRT (m.sec)	-0.05	0.78 (NS)	+0.10	0.58 (NS)	-0.09	0.63 (NS)	**+0.48**	**0.01 (S)**
MPI (%)	**-0.48**	**0.01 (S)**	-0.05	0.8 (NS)	+0.06	0.74 (NS)	+0.05	0.8 (NS)
Tricuspid Septal (Ś) (cm/sec)	+0.05	0.78 (NS)	-0.09	0.65 (NS)	-0.01	0.96 (NS)	+0.11	0.56 (NS)
Tricuspid Septal (É) (cm/sec)	+0.06	0.77 (NS)	+0.14	0.48 (NS)	+0.32	0.09 (NS)	-0.17	0.38 (NS)
Tricuspid Septal (Á) (cm/sec)	-0.04	0.86 (NS)	-0.02	0.93 (NS)	+0.13	0.5 (NS)	-0.04	0.82 (NS)
Tricuspid Lateral (Ś) (cm/sec)	-0.13	0.48 (NS)	-0.11	0.58 (NS)	+0.18	0.35 (NS)	-0.03	0.87 (NS)
Tricuspid Lateral (É) (cm/sec)	-0.25	0.18 (NS)	+0.17	0.38 (NS)	+0.33	0.07 (NS)	-0.26	0.17 (NS)
Tricuspid Lateral (Á) (cm/sec)	-0.54	0.02 **(S)**	-0.35	0.06 (NS)	+0.07	0.7 (NS)	-0.49	0.01 (S)
Tricuspid Lateral (É/Á) ratio	+0.42	0.02 (S)	+0.42	0.02 (S)	+0.17	0.36 (NS)	+0.4	0.03 (S)

Table 6: Relation between medications used for control of asthmatic patients & Doppler echocardiography (TDE) findings.

	Mean ± SD	Median (Range)	Test	p
Isovolumetric relaxation time (IVRT) (m.sec)			**KW**	
Theohylline & ICS	50	65 (59 – 67)	12.81	**< 0.05 (S)**
Metrovent & ICS	60.8 ± 6.7	60 (55 – 70)		
LABA	63.1 ± 2.5	50		
Theohylline, ICS & LABA	60 ± 4.6	60 (55 – 63)		
MPI (%)			**F**	
Theohylline & ICS	49 ± 6.5	50 (40 – 60)	1.25	0.31 (NS)
Metrovent & ICS	48.8 ± 5.1	50 (43 – 56)		
LABA	48 ± 2.9	48 (45 – 50)		
Theohylline, ICS & LABA	44 ± 0.6	44 (43 – 44)		
Tricuspid annulus velocities				
Septal Systolic (Ś) peak (cm/sec)			**F**	
Theohylline & ICS	11.4 ± 2.4	10 (8 – 15)	0.61	0.61 (NS)
Metrovent & ICS	10.3 ± 3.7	10 (7 – 16)		
LABA	11 ± 1.7	11 (9 – 12)		
Theohylline, ICS & LABA	10 ± 1.7	10 (8 – 11)		
Septal Early diastolic (É) peak (cm/sec)			**KW**	
Theohylline & ICS	15.7 ± 1.9	15 (13 – 19)	10.32	**0.02 (S)**
Metrovent & ICS	12.8 ± 1.9	13 (11 – 15)		
LABA	15 ± 1.2	17 (16 – 18)		
Theohylline, ICS & LABA	17 ± 4.	17 (13 – 20)		
Septal Late diastolic (Á) peak (cm/sec)			**KW**	
Theohylline & ICS	7.9 ± 3	5 (5 – 13)	4.72	0.19 (NS)
Metrovent & ICS	5.3 ± 0.9	6 (4 – 6)		
LABA	8 ± 3.5	10 (5 – 11)		
Theohylline, ICS & LABA	6 ± 1.7	6 (4 – 7)		
Lateral Systolic (Ś) peak (cm/sec)			**KW**	
Theohylline & ICS	12 ± 2.8	10 (7 – 15)	4.15	0.25 (NS)
Metrovent & ICS	12 ± 2.44	10 (8 – 14)		

	Mean ± SD	Median (Range)	Test	p
LABA	10	10		
Theohylline, ICS & LABA	15 ± 1.15	13 (12 – 14)		
Lateral Early diastolic (É) peak (cm/sec)			**F**	
Theohylline & ICS	17.1 ± 2.5	18 (14 – 20)	1.4	0.26 (NS)
Metrovent & ICS	15 ± 3.3	20 (12 – 20)		
LABA	20 ± 3.5	20 (17 – 23)		
Theohylline, ICS & LABA	17 ± 1.7	17 (15 – 18)		
Lateral Late diastolic (Á) peak (cm/sec)			**F**	
Theohylline & ICS	9.2 ± 2.9	10 (5 – 13)	3.12	**0.04 (S)**
Metrovent & ICS	8 ± 1.2	8 (6 – 9)		
LABA	10	10		
Theohylline, ICS & LABA	12 ± 1.7	12 (10 – 13)		
Lateral É/Á ratio			**KW**	
Theohylline & ICS	2 ± 0.7	1.8 (1.3 – 3)	10.3	**0.02 (S)**
Metrovent & ICS	2 ± 0.5	2 (1.8 – 2.8)		
LABA	3 ± 0.5	3 (2.2 – 3)		
Theohylline, ICS & LABA	1.5 ± 0.1	1.5 (1.4 – 1.5)		

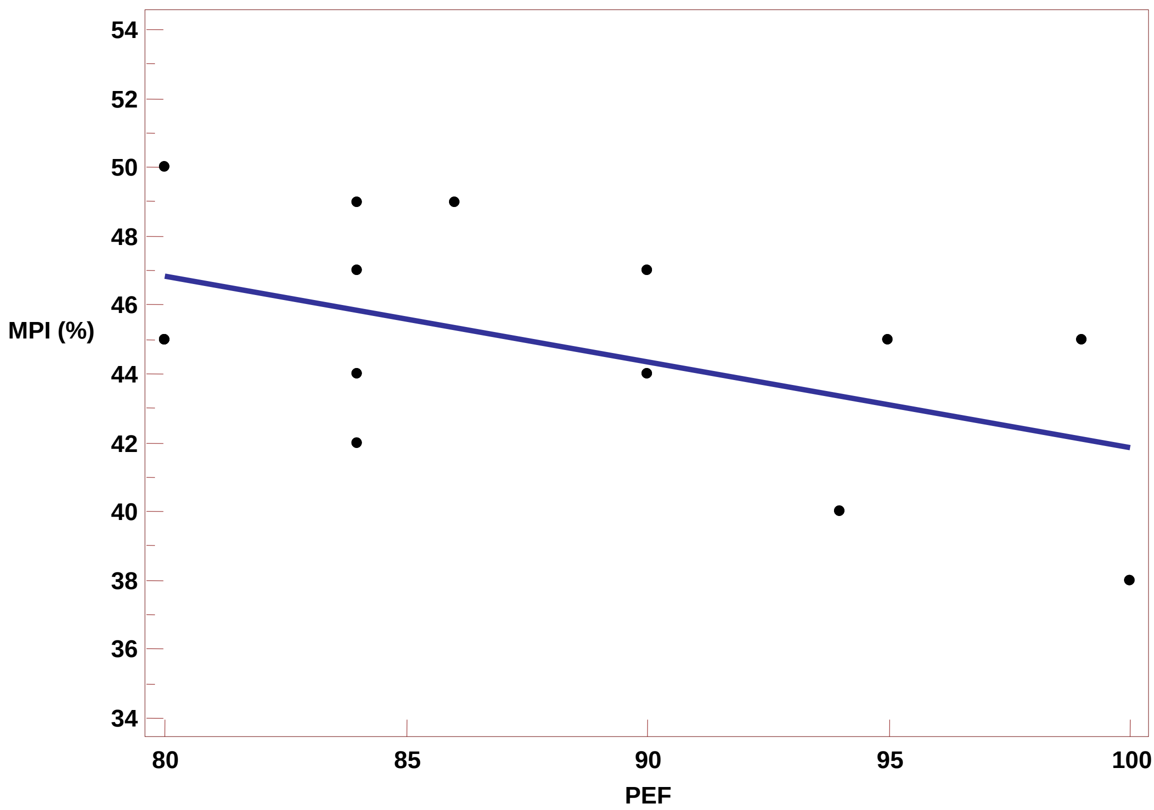

Figure 1: The correlation between PEF and MPI (%) in healthy children (r = -0.258, p=0.003).

DISCUSSION

In our study, range of the patient age constitutes the highest point of prevelance rate of asthma across all age groups worldwide. Abdalla and Abd El Azeem [7] studied TDE in young adults with asthma. There was no statistically significant difference in age between bronchial asthma patients and controls.Males were higher than females in our study (53.3%). This was consistent with Bateman [1] who reported that bronchial asthma is more common in males compared to females. The reason for this sex related difference is not clear. However, lung size in males is smaller than in females at birth but larger in adulthood.

In our study, the peak expiratory flow rate (PEF) was assessed in both asthmatic and control groups in cooperative children using mini-wright peak flow meter, the best reading from three forced expirations was recorded, there was no statistical significant difference between cases and controls regarding PEF (p=0.7). This result is in agreement with Ozdemir et al. [8] who reported that no significant difference between both groups (asthmatics and controls) regarding PEF, but contrary to the results found by Shedeed [9] who aimed to investigate the RV function in children with BA by both conventional and TDE and found that PEF of asthmatic children was significantly lower than control ones. This difference between our study and Shedeed [9] may be referred to type of patient selected. Shedeed [9] investigated 31 mild, 4 moderate and 15 severe cases, or may be due to degree of control (her study included chronic persistent asthmatics) or type of treatment (she selected cases receiving low dose Inhaled corticosteroids only), but the majority of our included subjects were mild to moderate cases and well controlled asthmatics.

Although FEV1 % and FEV1 %/FVC% parameters were all within normal limits. The asthmatic group had statistically lower values than control group (p < 0.001). This was like results of Ozdemir et al. [8]. This means that FEV1 % and FEV1 %/FVC% are best predictors of clinically undetected airway narrowing in asthma than PEF.

Echocardiographic data of the left ventricle showed statistically significant differences between cases and controls as regard LV systolic function as Ejection Fraction (EF) showed significant decrease in cases when compared to controls. In contrast to our results Alpaslan et al. [10] Revealed that the right ventricular echocardiographic measurements showed no major variations between asthmatic patients relative to control subjects. Also results of Mahmoud et al. [11] showed that there was no substantial difference in RV echocardiographic indices between the two classes. The findings indicated that there is diastolic LV dysfunction in bronchial asthma patients. Among the LV diastolic function echocardiographic indices, peak E velocity, E velocity / A velocity ratio, isovolumetric relaxation time and MPI in the BA category were significantly different from those of the controls.

Shafiek [12] reported that left ventricle EF using Modified Simpson showed significant decrease in cases when compared to control. But other LV systolic functions are not significantly different between cases and controls.

In favor of our results Hirono et al. [13] investigated diastolic LV dysfunction in bronchial asthma patients with long-term oral b2-adrenoceptor agonists and found that daily use of oral b2-adrenoceptor agonists caused left ventricular diastolic dysfunction. Researchers concluded that long-term use of oral B2 agonists impaired left ventricular diastolic function in patients with BA, and the cessation of B2 agonists had restored normal rates of diastolic pump output.

Goloskokova et al. [14] Studied right and left ventricular function in asthma patients and found that LV alterations in asthma patients were moderate and involved diastolic LV dysfunction in extreme asthma patients and the function decline with prolongation of phase of asthma.

Ozdemir et al. [8] Subclinical ventricular dysfunction was studied using traditional and TDE in asthmatic children with no cardiovascular symptoms. Fifty-one pediatric patients (mean age 10.4 ± 2.2 years) with asthma and 46 age-and sex-related healthy children (mean age 10.9 ± 2.4 years) were observed. All subjects were tested by traditional echocardiography and TDE, and spirometry tests were performed on pulmonary function. They found that both clinical and traditional echocardiography findings were apparently common in children with asthma and did not show a substantial difference in LV echocardiographic indices between astmatic and healthy classes, Nevertheless, TDE analysis of RV diastolic function showed that annular peak velocity during early diastole (E0), annular peak velocity during late diastole (A0), E0/A0 ratio and myocardial output index of lateral tricuspid annulus in asthmatic patients differed significantly from those of healthy children.

Abdalla and Abd El Azeem [7] reported that there were no statistically significant variations in the RV dimensions and functions of the echocardiographic indices between the two classes. Statistically important differences were found in peak E velocity, peak E velocity / peak A velocity ratio and isovolumetric relaxation time between the two classes (p<0,05). The mean LV MPI of the bronchial asthma category (0.40±0.13) was also significantly higher than that of the controls (0.36±0.11, p<0.05).

The right ventricle wall thickness of traditional echocardiography was substantially thicker in asthmatics than in controls. ElMasry et al. [15] results showed that the appropriate ventricular echocardiographic measurements had no major variations between asthmatic patients compared to control subjects, except that the right ventricular wall thickness was higher among patients than the controls. This can be explained by repeated exposure to hypoxia along with persistent and prolonged inflammation leading to pulmonary vasoconstriction in asthmatic patients, which may result in developing pulmonary hypertension, and subsequently enlargement of the heart with ventricular hypertrophy. Also, Shedeed [9] results confirmed that all left ventricular dimensions and functions among asthmatic children were not substantially different from control, except that the right ventricular wall was thicker among the cases. At the present study, after comparing cases and controls as regard right ventricle diastolic functions, only tricuspid deceleration time (DT) was statistically significant different between both groups it was higher in asthmatics than in controls but lateral tricuspid E, lateral tricuspid A and tricuspid E/A ratio were not statistically significant different between both groups. This agree with the results found by Ozdemir et al. [8] who found that there was no significant difference between mild asthmatics and controls as regard tricuspid E/A ratio. In the present study, TDE of RV diastolic function revealed that tricuspid lateral A' velocity among cases was significantly lower than control while tricuspid lateral E' velocity and E'\A' ratio were significantly higher among cases than control, IVRT of right ventricle was significantly longer among cases than control. This means that asthmatic children have impaired relaxation pattern of the RV and consequently impaired RV diastolic function. This is in agreement with Ozdemir et al. [8] who obtained the same results.

Also, Shedeed [9] and Correale et al. [2] Tricuspid lateral annular velocity and IVRT have been shown to be substantially different between mild cases and control subjects. It is emphasized that well-controlled asthmatic children have a sub-clinical impairment of ventricular function during the early stages of the disease, and TDE can detect this impairment at a stage when traditional echocardiographic indices are still normal.

The mean right ventricular MPI of our patients (48 ± 5.5) was significantly higher than that of the control subjects (45 ± 3.2) and significantly higher than normal values, suggesting global decreased myocardial output among asthmatic children and deeper rates of ventricular dysfunction. This was agreed with Mahmoud et al. [11] who evaluated ventricular activity by measurement of (MPI) and transmittal flow propagation velocity (TFPV) in bronchial asthma patients and found that tricuspid lateral E, E / A ratio, IVRT and MPI in the BA community were significantly different from the controls ($p<0,05$). This means that the MPI is a valuable clinical measure of global ventricular activity for the measurement of both systolic and diastolic functions. A variety of factors can be responsible for diastolic dysfunction in bronchial asthma. The first and most important factor is a substantial rise in the heart rate in the bronchial asthma community. Tachycardia has reduced the diastolic filling period, and atrial contraction may have occurred before early filling; myocardial output is better than if the heart rate is slower. This tachycardia can be attributed to various factors, including hypoxemia or medications.

In this study, when evaluating the systolic velocity of the lateral tricuspid annulus (S) 'wave using TDE, it was found that there was no substantial difference between both asthma and control groups, unlike Shedeed [9] who reported that the systolic velocity of the lateral tricuspid annulus (S') wave using TDE was found to be lower in asthmatics compared to control, this indicates impaired systolic RV function at this sub-clinical level. This could be explained by the role of inflammatory mediators and their long-term impact on myocardial function, especially among severely asthmatic patients (who are excluded from our study), Numerous mediators and cytokines are released during the early and late stages of inflammation, including interleukins (IL) such as IL-1 β, IL-2, IL-6 and IL-8, as well as tumor necrosis factor alpha (TNF 5-007) inside the core. In the current study, we found that PEF was negatively correlated with MPI, Á value of the tricuspid lateral annulus and (É/Á) ratio of tricuspid lateral annulus meaning that when PEF increasing, MPI and Á and (É/Á) ratio decrease, but no correlation between PEF and IVRT. Shedeed [9] reported that PEF negatively correlated with the IVRT of the lateral tricuspid annulus. Ozdemir et al. [8] and Shedeed [9] reported that PEF negatively correlated with lateral tricuspid annulus (E'/A' ratio).Our study revealed that our cases differ in controller medications received as Theophylline and ICS is the most common used combination used in our cases and there are statistically significant effect of different combinations on TDE findings in the form of IVRT, tricuspid septal É and tricuspid lateral Á and tricuspid lateral É/Á as asthmatic children receiving ICS and LABA have the longest IVRT and highest septal diastolic Ś and (É/Á) ratio of tricuspid lateral annulus also Theo, ICS & LABA combination had highest lateral diastolic (Á) peak velocity of tricuspid. This mean that use of LABA in asthmatic children associated with more dysfunction of Right ventricle, lateral more than septal side and diastolic more than systolic functions .Abdalla and Abd El Azeem [7] assessed ventricular function in young adults with bronchial asthma. They concluded that LV diastolic function was compromised in patients with bronchial asthma, despite no effect on RV diastolic function. Ozdemir et al. [8] investigated Subclinical ventricular dysfunction using traditional and TDE in asthmatic children with no cardiovascular symptoms. They concluded that bronchial asthma affects RV diastolic function in children, as increased respiratory efforts can increase intrathoracic pressure. They found that while clinical and traditional echocardiography results were apparently common in children with asthma, TDE demonstrated a subclinical right ventricle dysfunction that is negatively associated with PEF. Such results suggested the diagnostic importance of TDE in early detection and monitoring of these deleterious effects in asthmatic patients.Sobhy et al. [16] Evaluated right ventricular diastolic dysfunction in various asthmatic stages. The sample population consisted of fifty individuals divided into 30 asthmatic adults and 20 safe control subjects. The incidence of right ventricular dilation among asthmatic adults was statistically higher (66 per cent) than controls (0 per cent). There was also a substantial increase in the mean value of ESPAP among asthmatic adults relative to control. In addition, the mean value of RVEDD among asthmatic adults was significantly higher compared to control subjects. They concluded that asthmatic adults have a right ventricular disorder in the form of diastolic dysfunction that begins early in the disease. Conventional and tissue Doppler echocardiography should be performed in asthmatic patients to determine the progress of the disease cycle.

CONCLUSION

TDE can be used for early detection of abnormal cardiac function in asthmatic patients at a point when traditional echocardiographic indices are still normal. Left ventricular diastolic function is compromised in patients with bronchial asthma. Detected by TDE, diastolic function of right ventricle is more affected by asthma than systolic function. Lateral annulus indices of tricuspid are more affected than septal indices of tricuspid in asthmatic children. LABA is associated with the most deleterious effect on TDI parameters versus other controller medications and asthmatic children who are using LABA need strict follow up with TDE.

Conflict of interest : no conflicts of interest.
Financial Disclosures: not supported by any source of funding

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To Cite:
Abdallah, B, ElSaid, H., Ibrahem, M. Ventricular Assessment by Echocardiography in Children with Bronchial Asthma. Zagazig University Medical Journal, 2023; (300-309): -.doi: 10.21608/ZUMJ.2021.25268.1767.