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Assessment of Ventricular Function in Children with Bronchial Asthma

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Abstract

Background:Bronchial asthma is a chronic inflammatory disease of airways in which many cells and cellular elements play a role particularly mast cells, eosinophils, T lymphocytes, macrophages, neutrophils and epithelial cells.Chronic bronchial asthma may cause pulmonary arterial hypertension which causes RV hypertrophy and dilatation as well as systolic and diastolic RV dysfunction. The level of right ventricular diastolic dysfunction depends on the degree of right ventricular hypertrophy and pulmonary vascular resistance.

Aim of the study: The aim of this study wasto evaluatethe ventricular functions in patients with bronchial asthma using Traditional Echocardiography and tissue Doppler imaging.

Patients and methods:This was a cross sectional study that included thirty-eight patients with bronchial asthma. All patients were subjected to full history taking, clinical examination and they underwent Echocardiography.

Results:Tricuspid and mitral E wave velocities were significantly lower among cases. Tricuspid and mitral A wave Velocities were significantly higher among cases. No significant differencewas found regarding any of the measured cardiac dimensions. No significant statistical difference regarding fractional shortening was found.Right ventricular myocardial performance (MPI) was higher in case group when compared to control group with no significant statistical difference.

Conclusion:Early and late biventricular diastolic dysfunction was detectable in children with bronchial asthma using conventionalDoppler echocardiography. The absolute value of right ventricular tissue Doppler-derived MPI was increased in cases of bronchial asthma compared with control subjects although the difference did not reach statistical significance.

Keywords:Bronchial asthma, Ventricular function, myocardial performance index, Echocardiography.

1. Introduction:

Bronchial asthma is a chronic inflammatory disease of airways in which many cells and cellular elements play a role in particular, mast cells, eosinophils, T lymphocytes, macrophages, neutrophils and epithelial cells. Inflammation causes recurrent series of wheezing, breathlessness, chest tightness and coughing, particularly at night or in the early morning. These episodes are usually associated with widespread and variable airflow obstruction that is often reversible either spontaneously or with treatment **(1).**

The inflammatory process can lead to an associated increase in bronchial hyper-responsiveness

(BHR) to a variety of stimuli (e.g., allergens, respiratory viruses and some occupational exposures). Reversibility of airflow limitation may be incomplete in some asthmatic patients **(1)**.

Right ventricular (RV) dysfunction, pulmonary hypertension, atrial enlargement, and atrial stretch may be seen more frequently in patients with bronchial asthma than in individuals without bronchial asthma. These conditions may likely result in the disruption of the electrophysiological properties of the atrium and subsequently on ventricular filling and functions**(2).**

2. Patients and Methods:

2.1. The current study was conducted asCross-sectional study.A total number of thirty-eight patients with bronchial asthma. Those patients were either admitted at chest unit or outpatients followed up at chest clinic of pediatric children's hospital.Echocardiography was performed at Pediatric Cardiology Unit of Pediatric Department, Zagazig University Hospital.The study was conducted from December 2018 to March 2021.

Control group:

Thirty-eight Healthy individuals of comparable age and gender to patients. They were selected from patients that were examined at echocardiography laboratory of Zagazig University Children's hospital who were found to have structurally normal heart. They had no clinical complaints and no evidence of chest disease on physical examination.

2.2.A consent form approved by the committee of patients'rights in research at Zagazig University was obtained from each patient parents before the study initiation.

2.3. Patients who were included in this study of more than 2 years of age who were clinically diagnosed with bronchial asthma, as suggested by episodic symptoms of airflow obstruction or airway hyper-responsiveness (e.g. episodic breathlessness, wheezing, cough, and chest tightness that respond to long term bronchial asthma treatment).

2.4. All patients who hadsystemic hypertension, structural heart disease as left ventricular wall motion abnormality, primary cardiomyopathy or mitral stenosis,Bundle branch block, known to be diabetic, aged below 2 years were excluded from the study.

2.5. The patients who met the inclusion criteria and were suitable candidates for the study have been subjected to:

-Detailed medical history.
-Full general examination.
-Local examination of chest and heart.
-Echocardiographic examination.
-Pulse oximetry for (oxygen saturation).
-CBC.

2.6. Echocardiography:

Two-dimensional, M-mode, pulsed wave, continuous wave and color flow Doppler echocardiographic examination were performed to patients and control groups.

Echocardiographic examinations were performed by the same operator with a My Lab Six

(Esáote) machine using a 3-11 MHz transducer.
All patients were examined in the supine and occasionally left lateral position.
Echocardiographic measurement was carried out according to the recommendations of the American Society of Echocardiography. Conventional pulsed wave Doppler examination was done by placing the sample volume at the level of tricuspid and mitral valve annuli**(3).**

Tissue Doppler echocardiography was performed in apical four-chamber view with the pulsed-wave Doppler sample volume placed at the lateral tricuspid annulus **(4)** to assessTissue Doppler-derived RV myocardial performance index (MPI) which was calculated as the sum of isovolumic contraction time (IVCT) and isovolumic relaxation time (IVRT) divided by ejection time(ET)**(5).**

2.7. Statistical analysis

Data were collected throughout history, clinical examination, laboratory investigations. Outcome measures were coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. Qualitative data were represented as number and percentage, quantitative data were represented by mean ± SD, and the following tests were used to test differences for significance; difference and association of qualitative variable by Chi square test (X^2). Differences between quantitative independent groups by unpaired t test. P value was set at <0.05 for significant results &<0.001 for highly significant results.

3. Results:

Age was distributed as 4.47±1.42 and 4.78±1.51 years respectively between cases and control without significant difference between groups. There was no significant difference regarding sex distribution but family history of asthma was presentin cases**.**

Pulse and respiratory rate were significantly higher among cases but weight and hemoglobin were significantly lower among cases.

No significant difference regarding systolic, diastolic blood pressure, temperature and oxygen saturation.

Tricuspid and mitral E wave velocities were significantly lower among cases. Tricuspid and mitral A Wave Velocities were significantly higher among cases **(Table 1).**

No significant statistical differences regarding fractional shortening (Table 2).

There was no significant relation regarding RV MPI between the cases and control group **(Table 2).**

Cases with bronchial asthma were divided into two groups based on medication used for disease ControlGroup 1 patients were maintained on Inhaled corticosteroid fluticasone, Inhaled short acting beta2agonist PRN and anti-histamine medication.
Group 2 patients were kept on Inhaled corticosteroid fluticasone long acting beta 2 agonist, montelukast and Inhaled short acting beta2 agonist PRN (**Table 3).**

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Table (1): Traditional Doppler parameters in studied groups.

	Case N=38	Control N=38	t	P
Tricuspid Early E wave Diastolic velocity(m/sec)	0.54±0.12	0.79±0.06	3.186	0.002*
Tricuspid Peak Late Diastolic A wave Velocity(m/sec)	0.41±0.13	0.36±0.04	2.002	0.049*
Mitral Early E wave Diastolic velocity(m/sec)	0.86±0.15	1.12±0.06	3.246	0.001**
Mitral Late Diastolic A wave Velocity(m/sec)	0.52±0.12	0.36±0.11	5.110	0.00**

Table (2): Tissue Doppler-derived Right ventricular myocardial performance indexand FS measurements in studied groups.

	Case N=38	Control N=38	T	P
RV MPI	0.51±0.18	0.48±0.11	0.847	0.400
FS %	38.07±5.45	37.97±3.6	0.099	0.921

Table 3: Conventional Echocardiography Derived Parameters and tissue Doppler-derived MPI in Patients with Bronchial Asthma

	Group I	Group II	t	P
Tricuspid early E diastolic (m/sec)	0.52±0.13	0.56±0.11	0.636	0.529
Peak late diastolic A velocity (m/sec)	0.42±0.12	0.38±0.07	0.907	0.371
Mitral early E diastolic (m/sec)	0.85±0.16	0.84±0.15	0.210	0.835
Mitral late diastolic A velocity (m/sec)	0.51±0.12	0.44±0.10	1.458	0.154
RV MPI	0.53±0.26	0.43±0.11	1.082	0.287

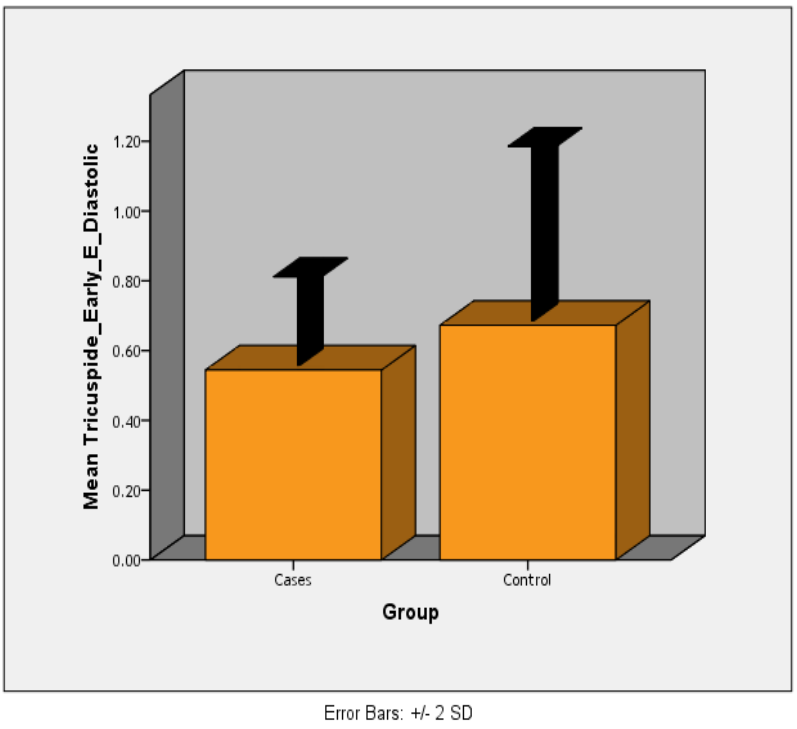

Figure (1): Mean tricuspid E wave velocity in cases compared with control subjects

4. Discussion:

Right ventricular (RV) dysfunction, pulmonary hypertension, atrial enlargement, and atrial stretch may be seen more frequently in patients with asthma than in individuals without asthma. These conditions may likely result in the disruption of the electrophysiological properties of the atrium **(6).**

This study aimed to evaluate the ventricular functions in patients with bronchial asthma using traditional Echocardiography.

In this study we showed that positive family history of bronchial asthma was present in 63.2% of patients. There was no significant difference regarding age and sex distribution.

A study was conducted by **Hasnainet al. (7)** to analyze the risk conferred by family history of asthma, allergic rhinitis and eczema for the development of childhood asthma. The study revealed that the history of asthma in parents and siblings conferred a 4.2-fold increased risk for development of childhood asthma. The risk for the development of childhood asthma was increased ≥ 3 times with a history of rhinitis or eczema in parents and siblings.

Lowering of tricuspidE wavevelocity indicates early diastolic dysfunction of right ventricle (RV) Reduced mitral E wave velocity points out to leftventricular (LV) early diastolic dysfunction. Both were significantly lower in our patient's vs control. Higher Tricuspid A wave velocity indicates late diastolic dysfunction of right ventricle (RV). Higher mitral Awave velocity denotes late left ventricular (LV) diastolic dysfunction. Both were significantly higher among our patient'svs control**. (Table 1)**

In contrast with us **Ghaderian et al.(8)** showed that conventional findings in echocardiography such as Tricuspid E and A velocity, E/A ratio and RV diameter did not differ significantly between patients and controls (P>0.05).

Çiftel et al. (9) showed that the mitral E, mitral A, mitral E/A ratio, tricuspid E, tricuspid A, and tricuspid E/A ratio were similar between the asthma and control groups.

Ozdemir et al. (10) showed that the conventional pulsed Doppler indices of both ventricles, such as E, A, and ratio of E to A wave velocities, did not differ significantly between patients with asthma and healthy controls (p< 0.05).

Abdalla M E and Abd El Azeem H (11) showed that there were no statistically significant differences in Evelocity, A velocity, E/A velocity, ratio Iso volumetric relaxation time, Isovolumetric contraction time , Ejection time and Myocardial performance index (MPI) between the asthma and control groups.

Shedeed et al. (12) showed that the right ventricle conventional pulsed Doppler indices (peak E velocity, peak A velocity, and ratio of peak E to peak A) did not differ significantly between the asthmatic cases and the control subjects.

Yucel et al. (13) showed no significant differences between patients with bronchial asthma and control group regarding Tricuspid and mitral E and A wavesvelocities.

In agreement with our findings, **Elmasry et al (14)** showed that Peak E velocity was lower during the acute attack, but the difference was not statistically significant. Conversely, Peak A velocity was significantly higher during the acute exacerbation of bronchial asthma (p<0.05). Both resulted in a significant reduction in E/A ratio during the acute exacerbation compared to E/A ratio after resolution of the attack (p<0.05).
In this study showed that RVMPI was not significantly higher in patient's vs control. Denoting absence of right ventricle (RV) systolic or diastolic dysfunction as measured by RV- tissue Doppler-derived MPI however, the absolute value of RV-MPI was higher in our patients compared with control which might indicate the need for a longer term follow up of children with asthma (Table 2).

Abdelmohsenet al. (15) showed that the RV-MPI was significantly higher in patients when compared to controls (P = .001).
De-Paula et al. (16)showed that the MPI was higher in the group with asthma. Right isovolumetric relaxation time was higher (p = 0.0007) in asthmatic than the control group reflecting global systolic and diastolic myocardial dysfunction.
Ozde et al. (17) showed that RV myocardial performance index was significantly higher in the asthma group than in the control group.
Abdalla M E and Abd El Azeem H (15) showed that the mean RV MPI in the bronchial asthma group was not significantly different from that of the controls.
Ghaderian et al.(8) showed thatthe mean MPI for the right ventricle showed higher values in patients compares to controls (P< 0.01).

Çiftelet al. (9) showedthat MPI measured using tissue Doppler echocardiography were higher in patients than in controls, respectively.

Ozdemir Et al. (10) Showed that IVRT of the lateral tricuspid annulus was significantly longer and mean MPI for the right ventricle was significantly greater for patients with asthma compared with healthy children (p = 0.01).

Mahmoud et al (18) showed that the mean RV MPI in the bronchial asthma group was not significantly different from that of the controls.

5. Conclusion:

Early and late biventricular diastolic dysfunction was detectable in children with bronchial asthma using conventionalDoppler echocardiography. The absolute value of right ventricular tissue Doppler-derived MPI was increased in cases of bronchial asthma compared with control subjects although the difference did not reach statistical significance.

6. ConflictofInterest: Noconflictofinterest.

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