Original Research Article

Assessment of Body Composition and Heart Rate Variability in Bronchial Asthma

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Abstract

Background: Previous studies were focused mainly either on autonomic modulation using heart rate variability (HRV) or body composition in the bronchial asthma patients, but our study has correlated both HRV and body composition indices in asthmatic patients. **Aim & Objective**:To evaluate the possible association of HRV and body composition parameters with main spirometric indices in newly diagnosed asthmatic patients & to compare these findings with healthy subjects. **Methods:** Thirty asthmatic patients (study group) and 30 apparently healthy subjects (controls) in age group of 20-55 years of both genders were included. BMI, waist- hip ratio (WHR) and body fat % were measured. Time and frequency domain parameters of HRV were recorded to determine sympathetic and parasympathetic autonomic modulations. Forced vital Capacity (FVC), Forced expiratory volume at 1st second (FEV_1) & FEV_1/FVC ratio parameters were recorded.**Results:** HF ms^2 & HF n.u were significantly ($P<0.001$) higher and LF n.u & LF-HF ratio were significantly ($P<0.001$) lower in asthmatics as compared to control. WHR was found to be significantly higher in study group as compared to control ($P<0.001$). We found a negative correlation of LF n.u & LF- HF ratio & positive correlation of HF n.u with FEV1(L), FEV1/FVC % & WHR which was not found statistically significant. **Conclusion:** In our study we observed altered autonomic activity with parasympathetic dominance as HF component was higher in asthmatic patients. We also found a significant association between WHR and asthma.

Key words : Bronchial asthma, body composition, heart rate variability.

Introduction

Bronchial asthma has become more common in both children and adults around the world in recent decades, particularly because of its early onset. The increase in the prevalence of asthma has been associated with an increase in atopic sensitization, and is paralleled by similar increases in other allergic disorders such as eczema and rhinitis. [1] [2] A report estimated that 300 million people worldwide had asthma, and projected that this number would increase to 400 million by 2025, as countries became more urbanized. [3]

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The exact pathogenesis of bronchial asthma is multi-factorial. The exaggerated broncho-constriction along with hyper-reactivity in bronchial asthma is associated with abnormal autonomic nervous system (ANS) control. [4] The parasympathetic nerves provide the dominant autonomic control of airway smooth muscle. They release acetylcholine onto muscarinic receptors, causing bronchoconstriction. [5] Studies have indicated that altered autonomic control of airway caliber in asthma is reflected by parallel changes in heart rate. Previous heart rate variability (HRV) studies in asthmatic subjects demonstrate predominance of parasympathetic drive concomitant with low HRV.[6, 7] which is against the general belief that enhanced parasympathetic modulation improves HRV. Other studies reported lack of association between bronchial asthma & ANS .[8, 9]

There are also studies suggesting that obesity represents a risk factor for the development of asthma, as both conditions are associated with underlying inflammatory pathway & thus seems to be associated. Increase in body mass index (BMI) values predisposes to new asthma development even in young adults .[10] A gender dependent influence has been observed with a significant association between body fat & asthma in women .[11] Overweight has been associated with an increase in inflammatory markers & with an imbalance in ANS. [12]

In the view of above data and lack of studies, the present study was designed to investigate HRV and the body composition parameters in newly diagnosed asthmatic patients and to compare these finding with healthy subjects. Study was also planned to see the possible association of cardiovascular autonomic changes using HRV and body composition parameters with patho-physiology of asthma by more elaborate and reliable pulmonary function tests.

Material and methods

After approval from institutional ethical committee on human experimentation, this observational study was conducted in the research lab of department of Physiology, in collaboration with department of pulmonary medicine Subharti medical college and associated Chhatrapati Shivaji Subharti hospital, Meerut. Informed consent from all the subjects was obtained before the start of the study.

Study Subjects

The study group comprised of 30 patients of bronchial asthma in the age group of 20 to 55 years of both genders who were newly diagnosed (not taking any medication) with clinical symptoms along with positive PFT findings as defined by the American Thoracic Society recommendation. [13] Age & sex matched 30 apparently healthy volunteers were taken as control.

Exclusion criteria: having history of any other cardio-respiratory disease**,** hypertension, neuro-endocrine diseases**,** any psychiatric illness, allergy, atopy, urticaria**,** alcohol or any recreational drug and smoking in both groups.

After evaluating the past medical history including the bronchial-asthma treatment offered to the patient, all volunteers underwent clinical examination and investigations during the same hours of the day preferably between 11 AM-1PM to avoid confounding, effects of circadian rhythm on asthma severity & HRV. All the participants were asked to report to the research laboratory of the department with following instructions:

a) No eating or drinking 3 to 4 hours prior to the test

b) No exercise 12 hours prior to the test.

c) No caffeine consumption 24 hours prior to the test.

d) To remove all metal objects.

Anthropometric and body composition measurements

Height was measured by stadiometer to nearest 1 cm and weight , by weighing machine (Krups) to the nearest 1 kg with subjects standing without shoes and wearing light clothes. Circumferences at waist (at the level of umbilicus) and hip (at the level of maximum extension of hips) were measured with a tape measure nearest to 0.1 cm. Participants were asked to lie in the supine position for 5 minutes breathing normally in a relaxed position. Body mass index, waist-hip ratio (WHR), body fat percentage (BF%) were measured by Multi-frequency impedance technique using Body stat QUADSCAN 4000 version 4/10(Isle of Man, UK) which employs multi-frequency (5, 50, 100 & 200 kHz) currents through a tetra polar hand-to-foot impedance model. Care was taken to place the arm well apart from the torso and the legs not touching one another.

Assessment of HRV

Analysis of HRV from ECG recording is an important method for assessing cardio-vascular autonomic regulations. After 5 min of supine rest Lead II ECG recordings were done (25mm/sec & at voltage at 10 mm/mV) for 5 min. ECG was taken to record all three leads at a sampling frequency of 256Hz to PC and were analyzed offline after visual checking of abnormal ECG. The data recorded was subjected to time domain and frequency domain analysis using the HRV analysis software (RMS Polyrite D version 4.0.2). Recommendation of Task Force on HRV was followed. [14]The time domain parameters included was SDNN (standard deviation of the averages of NN intervals).Frequency domain analysis was performed using non–parametric method of Fast –Fourier Transformation. The power frequency spectrum was subsequently quantified into standard frequency domain measurements as Total power (TP) in ms^2, Low frequency (LF) component (0.04-0.15 Hz) &High frequency (HF) component (0.15-0.4Hz) in normalized units (n.u) and power ms^2& LF-HF ratio (LF/HF).

Pulmonary function tests

Standardized protocol of performing spirometry was followed. Each subject performed 3 trials (with at least two reproducible and acceptable maneuvers) of all parameters according to the American Thoracic Society recommendation. Pulmonary function tests were recorded by Spirodoc (Spiro Pro 6.6 Spirometry standard mode, version no.A23-ow-06145). The parameters included were Forced vital Capacity (FVC) in L, Forced expiratory volume at 1st second (FEV_1) in L and FEV_1/FVC % ratio. When the subject coughs or did not performed the technique correctly, the turn was ignored and repeated.

Statistical Analysis

Software graph pad Instat 6.07 version and Microsoft excel were used for statistical analysis. All values were expressed as Mean± SD. Unpaired Student's t test was used to find out the level of significance between the two groups. Pearson correlation coefficient (r) was used to assess any possible association between the variables. A value of P< 0.05 was considered statistically significant.

Results

In present study, BMI was within normal range (25.14 ±2.25 & (23.26 ±5.57) in study and control groups respectively. There was no significant difference (P>0.05) in BMI & body fat% between 2 groups. However, WHR was found to be significantly higher (P<0.001) in asthmatics as compared to control group. FVC (L) and FEV_1 (L) were significantly (P<0.001) lower in asthmatics as compared to control. We did not find any significant difference in FEV1/FVC % between 2 groups.

In our study we observed altered autonomic activity with parasympathetic dominance in asthmatic patients. HF component of HRV was significantly higher (P <0.001) in asthmatics as compared to controls whether measured in absolute or normalized units. TP (ms^2) & LF (ms^2) were lower in asthmatics but the difference was not significant (P >0.05). However, the LF n.u. and LF-HF ratio were significantly (P<0.001) lower in asthmatics as compared to control. SDNN was lower in study group but this was statistically insignificant.

LF n.u. & LF-HF ratio were negatively correlated while HF n.u. was positively correlated with FEV1 (L), FEV1/FVC % & WHR which were not found statistically significant.

Table-1: Body Composition & Spirometry Parameters in Study group & Control (n=30) in each group

Parameters	Study group	Control	P-value
	Mean±SD	**Mean±SD**	
BMI (Kg/m^2)	25.14±2.25	23.26±5.57	0.092
WHR	1.01±0.03	0.96±0.04	<0.001
BODY FAT%	26.62±8.48	24.16±5.24	0.182
FVC(L)	2.23±0.69	4.46±0.48	<0.001
FEV1(L)	1.84±0.71	3.66±0.39	<0.001
FEV1/FVC (%)	80.43±14.34	82.18±2.09	0.512

BMI-Body mass index, WHR–waist-hip ratio, FVC- Forced vital capacity, FEV_1- Forced expiratory volume at 1st second , P<0.05 significant

Table-2: HRV parameters in Study group and Control (n=30) in each group

Parameters	Study group	Control	P-value
	Mean± SD	Mean± SD	
TP ms^2	852.98±702.37	1086.74±916.18	0.272
LF ms^2	165.31±175.60	195.97±175.04	0.501
HF ms^2	296.23±307.43	111.57±112.31	<0.001
LF n.u	37.34±8.12	63.67±7.33	<0.001
HF n.u	62.66±8.12	36.30±7.34	<0.001
LF-HF ratio	0.62±0.21	1.87±0.61	<0.001
SDNN(ms)	37.03±13.77	40.69±21.37	0.433

TP-Total power, LF-Low frequency, HF- High frequency, SDNN-standard deviation of the averages of NN intervals , P<0.05 significant

Table-3: Correlation of FEV1, FEV1/FVC & WHR with HRV Parameters in Study group

Parameters		FEV1	FEV1/FVC	WHR
LF n.u	r- value	-.225	-.193	-.181
	p-value	.231	.306	.338
HF n.u	r- value	.225	.193	.181
	p-value	.232	.307	.339
LF-HF RATIO	r- value	-.228	-.181	-.211
	p-value	.225	.337	.264

Discussion

The present study was conducted to assess autonomic modulations based on short term HRV indices and body composition parameters in newly diagnosed asthmatic patients . The objective of the study was to determine whether HRV and body composition correlate with the main spirometric indices. We observed parasympathetic dominance as the HF ms^2 & HF n.u, were significantly (P<0.001) higher in asthmatic patients as compared to control . Our study is in accordance with Gupta et al who reported an enhanced central vagal tone, as exemplified by as high HF index of HRV in asthmatics. Similar findings were also reported by other studies. [15, 16] Conversely, some studies were unable to prove parasympathetic dominance in patients with bronchial asthma .

We found that TP ms^2 & LF ms^2 were lower in asthmatics and showed no significant (P>0.05) difference. However LF n.u, which reflects the fluctuation in sympathetic tone of HRV and LF-HF ratio, a marker of sympatho-vagal balance, were significantly low (P<0.01) in the asthmatic patients when compared with control group.

The results of our present study are consistent with those observed by Garrard et al. [17] and Pichon et al.[18] who also reported low sympathetic activity represented by LF n.u. in asthmatics as compared to controls. On the contrary, a study reported that there was no significant difference in the low frequency band amplitude and LF-HF ratio between the controls and the asthmatic children. [19]

In our study SDNN, which reflects all cyclic components of the variability in RR intervals, was lower in case but this was statistically insignificant. Kazuma et al examined the circadian rhythm of parasympathetic nervous function in asthmatic children and found that SDNN was lowest in the severe asthma group. A study has also documented a circadian pattern in the components of HRV, the LF component having minimal power and the HF component having maximal power during the nocturnal period .[20] Vagal tone increases to the heart at night and and as changes in cardiac vagal activity reflect changes in bronchomotor tone this has led to the hypothesis that vagal activity may be important in the pathogenesis of nocturnal asthma .[21]

In the present study, BMI was within normal range in both groups. There was no significant difference (P>0.05) in BMI & body fat% between 2 groups. However, WHR, was found to be significantly higher (P<0.001) in asthmatics as compared to controls . A study suggested that obesity and overweight are linked with allergic diseases such as rhinitis and asthma, probably because of the immunological effects of adipose tissue.

Autonomic nervous system plays a central role in modifying energy expenditure and body fat content; however, the extent to which the ANS contributes to obesity remains uncertain. [22, 23] A disordered homeostatic mechanism may promote excessive storage of energy which may be promoted by decreasing sympathetic activity, while defending against weight gain by decreasing parasympathetic activity .[24].

In our study, LF n.u. & LF-HF ratio were negatively correlated while HF n.u. was positively correlated with FEV1, FEV1/FVC & WHR and this was not statistically significant. Behera et al also found positive correlations with the HF component and FEV_1, and negative correlations with the LF component and peak expiratory flow in smokers.[25] A study reported that HF norm correlates negatively and LF norm correlates positively with both weight and BMI. In addition LF/HF correlates positively with weight but not BMI in healthy subjects. [26]

Conclusion

Our study provides the evidence of a relationship between WHR and asthma. We observed altered autonomic activity with parasympathetic dominance which leads to an imbalance in sympatho-vagal interplay an essential feature of bronchial asthma. So, it can be stated without reservation from our study, that HRV is an absolutely safe and useful non-invasive method for assessing autonomic modulation in numerous disease states including bronchial asthma which will lead to better symptomatic control and reduction in number of asthmatic attacks. We have not evaluated gender difference as the sample size was small.

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