

Exercise Induced Changes in Autonomic Nerve Function in Patients with Irritable Bowel Syndrome by Power Spectral Analysis

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Abstract:

Background: Altered autonomic nerve function has been reported by various investigators in IBS and moderate to vigorous physical exercise causes autonomic nerve function improvement both in healthy and various clinical conditions. **Objective:** To observe the effect of brisk walking on the autonomic nerve function by analysis of heart rate in patients with Irritable bowel syndrome. **Methods:** This prospective interventional study was conducted in the Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU) between January to December 2013. For this purpose 77 male patients aged 20-50 years with IBS were included in this study, they were enrolled from OPD, Gastroenterology, BSMMU, Dhaka. For comparison, 28 apparently healthy male were also included as control. HRV measures were recorded once before exercise and also after 3 months of brisk walking. For assessing HRV, frequency domain measures such as total power, LF power, HF power, LF norm and HF norm were recorded by Polyrite D machine. ANOVA, Independent sample t-test and paired t-tests were performed for statistical analysis. **Results:** The pre-exercise values of HF power, HF norm and total power were significantly lower ($p < 0.05$) whereas values of LF power and LF norm were higher ($p < 0.05$) in all IBS patient compared to those of control. The post exercise data demonstrated significantly higher ($p < 0.05$) HF power, HF nu and total power in all IBS patients compared to their pre-exercise values. **Conclusion:** This study concluded that the frequency domain measures of HRV were decreased in IBS patients but all these parameters can be improved by regular moderate physical exercise.

Key words: Irritable bowel syndrome, Autonomic nerve dysfunction, Male, Physical exercise, Heart rate variability, power spectral analysis

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Introduction:

IBS is a chronic functional gastrointestinal disorder which is characterized by abdominal pain, bloating and bowel disturbance in the absence of organic cause¹. The diagnosis of IBS is made using Rome II criteria² and include abdominal discomfort or pain where at least 2 of the features are to be present that is relieved by defecation, onset associated with a change in frequency of stool, onset associated with a change in form of stool. The symptom must persist at least 12 weeks, in the preceding one year³.

According to the principal symptom present, IBS has been

classified as Diarrhoea predominant irritable bowel syndrome (IBS-D), Constipation predominant IBS (IBS-C) and Irritable bowel syndrome alternating type (IBS-A)⁴.

Though pathophysiology is unclear, however IBS is thought to be a disorder of the brain gut axis, altered visceral sensitivity and altered bowel motility⁵.

Many studies had reported of main characteristic of autonomic dysfunction in IBS included increased sympathetic activity and decreased parasympathetic activity⁶ and one study also showed vagal dysfunction in constipation predominant IBS and sympathetic dysfunction in diarrhea predominant IBS⁴.

Regular physical exercise improves autonomic nerve

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activities in both healthy individuals and in various clinical conditions such as myocardial infarction, rheumatoid arthritis, heart failure, coronary artery disease, type II diabetes mellitus, chronic renal failure, obesity and menopause.⁷⁻¹³

Though, many studies reported improvement of autonomic nervous activities; whereas others have failed to show that regular physical exercise improves autonomic nerve function¹⁴⁻¹⁵.

An increased HRV reflects good adaptability and well functioning autonomic nerve control. Whereas, reduced HRV acts as a strong predictor of risk for adverse events in patients with broad range of diseases¹⁶.

A number of frequency domain measures such as mean total power, HF power, LF power, LF norm and HF norm are used for analysis of HRV¹⁷.

In the power spectral analysis, the mean values of total power, HF power and HF norm were lower and on the other hand, mean values of LF power and LF norm were higher in IBS groups compared to those of the control^{4,18}

Various investigators reported significantly higher total power, HF power and HF norm, on the other hand lower mean LF power and LF norm were also reported in physically active subjects compared to those of healthy control⁷⁻⁸.

Though, few investigators showed that the regular physical exercise improves CANA in healthy subjects⁷⁻⁸, however, there is no reported data available to observe the effect of physical exercise on cardiac autonomic nerve function activity by analysis of power spectral analysis in patients with IBS.

Therefore, this study was conducted to evaluate the effect of moderate physical exercise on CANA and power spectral analysis of HRV in patients with IBS.

Methods:

This prospective study was conducted in the Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka from January to December 2013. The protocol of this study was approved by Institu-

tional Review Board, BSMMU. 77 male with Irritable bowel syndrome were enrolled for the study by random sampling from Gastroenterology OPD, BSMMU. 28 healthy controls were recruited through personal contact. According to the predominant symptom present², IBS patients were divided into 3 subgroups; these included 24 diarrhea predominant IBS (IBS-D), 26 constipation predominant IBS (IBS-C) and 27 altered bowel habit type IBS (IBS-A) patients. 28 apparently healthy sedentary male were enrolled as control. History of heart disease, diabetes mellitus, hypertension, chronic renal failure, thyroid disorders and smoking were excluded and also history of regular physical exercise were ruled out in all selected subjects.

Informed written consent was taken from all the participants. Subsequently, a detail family and medical histories were taken and also physical activity status were recorded. For HRV recording, the subjects were prepared from one day prior to the test. They were advised to take their meal by 9:00 p.m and to have sound sleep and not undergo any sort of physical or mental stress, and were also advised to avoid taking any sedatives. The patient was advised to take light breakfast in the morning without tea and coffee.

All the examinations were done in the Autonomic Nerve Function Test Laboratory in the Department of Physiology, BSMMU. For the purpose of HRV recording, the subject was given bed rest for 15-20 minutes, after which 5 minutes ECG recording was carried out for HRV by polyrite D machine.

After completion of baseline HRV recording, the patients performed regular brisk walking for 3 months. For this purpose the patient were trained for brisk walking at a rate of 130 steps per minute for 30 to 45 minutes, for 3 to 5 days in a week for a period of 3 months duration. This exercise intervention was not applied to the control group¹⁹.

The frequency domain measures such as total power, HF power, LF power, LF norm and HF norm were analyzed before exercise and similarly after 3 months of physical exercise. ANOVA, independent t-test and paired t-test were used as applicable.

Table-I
Pre-exercise and post exercise frequency domain measures of HRV in different groups (n=105)

Groups		Total power (ms ²)	LF power (ms ²)	HF power (ms ²)	LF norm (nu)	HF norm (nu)
Control	No exercise					
	Pre	2622.2±61.3	714.5±16.4	530.01±20.5	56.8±1.5	34.7±1.3
	Post	2625.9± 60.9	715.3±24.8	532.2±19.5	58.75±2.2	36.24±1.56
IBS -D	Exercise					
	Pre	1827±114.6**	861.9±57.1*	369.9±44.3*	66.7±2.4**	28.5±1.9*
	Post	2595±110.4 ♦♦	749.6±39.4	471.9±30.2 ♦	63.9±1.97	32.8±1.0 ♦
IBS -C	Exercise					
	Pre	1745.2±136 **	835.2±39.1	275.2±31.5*	70.7±1.78 **	27.4±2.2 *
	Post	2566±104 ♦♦	755.1±38.8	464±31.0 ♦♦	68.4±31.0	30.8±1.5 ♦
IBS -A	Exercise					
	Pre	2075.9±143.4**	844.7±33.0*	282.3±23.4**	72.3±2.9***	27.7±1.6*
	Post	2562±148.7 ♦	745.4±52.0	488.1±39.3 ♦♦	68.2±1.32	31.3±1.04 ♦

Values are means ±SE, Statistical analysis were performed by independent t sample t-test and paired t -test.

Control – apparently healthy

IBS-C = Constipation predominant IBS

*** p< 0.010, ** p < 0.01 & * p < 0.05

●●● p< 0.001, ●● p< 0.01 & ● p< 0.05

♣♣♣ p<0.001, ♣♣ p< 0.01 & ♣ p<0.05

n = number of subjects

IBS-D = Diarrhoea Predominant IBS

IBS-A = Altered bowel habit type IBS

= Significant difference control versus IBS

= Significant difference among the IBS groups

= Significant differences pre versus post exercise

Results :

The pre-exercise mean values of systolic blood pressure (SBP), diastolic blood pressure (DBP) and pulse rate (PR) were found to be significantly higher in all IBS patients compared to control.(Table I)

Pre-exercise mean values of total power, HF power and HF norm were higher (p<0.05), on the other hand, mean values of LF power and LF norm were lower (p<0.05) all IBS groups than those of the control. No significant differences of these parameters were observed within subgroups of IBS patients. (Table II)

Post exercise mean values of LF power and LF norm were lower (p>0.05) in all IBS patients. In contrast, total power, HF power and HF norm were significantly increased in all IBS patients compared to their values in corresponding pre-exercise IBS groups.

Table-II

General Characteristics in different groups (n=105)

Parameters	Control	IBS-D	IBS-C	IBS-A
Age	32±1.26	32±1.36	29±1.36	32 ±1.37
BMI	22.8±0.29	22.2±0.48	21.8±0.43	22.3±0.44
SBP	114±1.55	120±1.63 *	120±1.96 *	120±1.79 *
DBP	71±1.25	75±1.59 *	77±1.66 *	76±1.24 *
PR	74±0.96	86±1.64 **	84±1.23 **	86±1.48 **

Values in means ±SE. For Diarrhoea predominant Irritable bowel syndrome (IBS-D), Constipation predominant Irritable bowel syndrome (IBS-C) & altered bowel habit type of Irritable bowel syndrome. *** p value < 0.001, ** p < 0.01 & p < 0.05, * = Significant difference versus control.

Discussion:

This prospective interventional study shows that moderate physical exercise improves the autonomic nerve function and possibly decrease the symptoms in patients with irritable bowel syndrome analyzed by heart rate variability (HRV).

Total power, LF power, HF power, LF norm and HF norm were all measured by Power spectral analysis method. The pre-exercise values of total power, HF power and HF norm were decreased and LF power and LF norm increased in all IBS patients compared to those of control. All the findings in baseline HRV indicate sympathetic predominance and sympathetic over activity seen in IBS patients.

The post exercise values of these parameters changed in significant manner especially total power, HF power and HF norm. These findings are consistent with the findings from other studies conducted to observe the effect of physical activity in healthy subjects⁷⁻⁸.

The differences in mean total power, HF power, HF norm, LF power and LF norm among all IBS subgroups were statistically non-significant in both pre and post exercise period. In the present study, moderate physical exercise lowered sympathetic and increased parasympathetic activities as indicated by changes in values of the HRV measures in post exercise period. This is in consistent with various investigators who proposed that moderate physical exercise is associated with either increased vagal tone or decreased sympathetic modulation of heart rate in both healthy and diseased conditions²¹⁻²².

Physical exercise reduces the stress by influencing brain plasticity¹ which results in higher parasympathetic activity and improvement in cardiovagal baroreflex sensitivity. Also both acetylcholine and choline-acetyl transferase content in cardiac tissue may be increased, thereby parasympathetic nervous activity⁸. In addition, physical exercise also might promote adjustments in cardiovascular control sites via either neural remodeling or endogenous factors like nitric oxide and angiotensin II. These adaptations might cause decrease in sympathetic and increase in vagal component in cardiac control to improve cardiac autonomic balance²³⁻²⁴.

Conclusion:

This study conclude that male patients with all the three subgroups of IBS have noticeably decreased parasympathetic with increased sympathetic activities and moderate physical exercise increased cardiac parasympathetic activity with decreased cardiac sympathetic activity.

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