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Impact of Slow breathing exercise on heart rate variability in male Type 2 diabetes mellitus

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Abstract

Background: Reduced heart rate variability (HRV) with cardiac autonomic nerve dysfunction has been found in Type 2 Diabetes Mellitus (T2DM) patients. Yoga based slow breathing exercise (SBE) improved this autonomic functions in healthy subjects. **Objectives:** To assess the effect of SBE on cardiac autonomic nerve function(CANF) by power spectral analysis of HRV in patients with T2DM. **Methods:** This prospective interventional study was carried on 30 male diagnosed T2DM patients aged 45-55 years with disease duration 5-10 years enrolled from Out Patient Department of Endocrinology, Bangabandhu Sheikh Mujib Medical University, Dhaka. They performed SBE for 30 minutes twice daily for 3 months. Thirty apparently healthy age, BMI matched male who did not undergo any type of exercise were included as control. To assess the cardiac autonomic nerve function, power spectral analysis of HRV of all patients were done before and after 3 months of SBE. HRV data were recorded by polyrite D (RMS India). For statistical analysis, independent sample and paired sample t-test were used. **Results:** The pre-intervention values of Low frequency (LF) normalized unit(nu) and Low frequency/High frequency(LF/HF) ratio were significantly ($p<0.001$) higher and the values of LF power, HF power, HF normalized unit (HF nu) were significantly ($p<0.001$) lower in all diabetic patients compared to control. The post-intervention values of LF power, HF power, HF nu increased significantly ($p<0.001$) and the LF nu, LF/HF ratio decreased significantly ($p<0.001$)compared to their pre-intervention values in T2DM. There were no significant differences between the post intervention values of LF nu, HF nu and LF/HF ratio in T2DM and the control. **Conclusion:** Impaired cardiac autonomic nerve function was significantly improved by SBE in T2DM.

Key words: type 2 diabetes mellitus, heart rate variability, slow breathing exercise.

Introduction

The diabetic neuropathies are heterogeneous disorder, affecting autonomic nervous system (ANS)[1]. Diabetic autonomic neuropathy (DAN) includes manifestations in the peripheral components of the ANS and thus affect the cardiovascular system[2]. Impairment of autonomic nerve function occurs much earlier in diabetic patients[3]. Cardiac Autonomic Neuropathy(CAN) is the clinically important form of DAN[1] which is associated with reduced HRV[2]. HRV has been suggested as one of the diagnostic test which is accurate, non-invasive and generally reproducible technique for CAN[4-5]. In frequency domain method, Power Spectral Density (PSD) analyzes the information of total power which distributes as a function of frequency. Measurement of low frequency (LF) and high frequency (HF) component in normalized unit (n.u) represent the relative value of each power component. The vagal activity is a major contributor to the HF component. The LF component is an indicator of sympathetic activity. LF/HF ratio is considered as a mirror of sympatho-vagal balance[6].

Yoga based breathing exercise is a stress reliever in T2DM patients[7]. In 2001, a group of researcher reported combined beneficial effects of yoga with the conventional medication on metabolic status in T2DM[8]. Some investigators reported that requirement of oral

hypoglycemic agent and HbA1c level were decreased in patients who were practicing yoga[9-10].

Some researchers reported about improved cardiac autonomic activity after yoga practice in healthy people[11-12]. It was found that breathing exercise also had some good effects in some diseases like asthma and hypertension[11, 13]. On the other hand, some investigators reported about non significant change in cardiac autonomic function after breathing exercise in healthy subject [14].

On the basis of these conflicting reports, this study was designed to observe the effect of SBE on CANF by power spectral analysis of HRV in type 2 diabetes mellitus patients.

Methods

This prospective interventional study was done in the department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka from March'15 to February'16. The protocol of this study was approved by Institutional Review Board of BSMMU. Diagnosed thirty (30) male patients with T2DM aged from 45-50 years with fasting blood glucose 5.9-8.9 mmol/l were recruited by purposive sampling from OPD, Endocrinology, BSMMU. All patients were under treatment with oral anti-hyperglycaemic drugs and lifestyle management (diet and exercise).

T2DM patients underwent slow breathing exercise (SBE) for 3 months after collecting base line.

HRV and other data. Age and BMI matched thirty male healthy controls were taken by personal contact. Both patients and healthy subjects were free from history of chronic illness such as renal & heart diseases, neurological, psychological and thyroid disorders and smoking. They also did not practicing any type of exercise including yoga.

The goal, benefit and detailed procedure of the study were explained and informed written consent was taken from all the subjects. A detailed medical and family history were taken. A thorough clinical examination of all subjects was done and all information was recorded in a prefixed questionnaire. To prepare for HRV data recording the subjects were advised to take their meal by 9.00 pm at previous night with sound sleep and avoid any physical or mental stress and sedative. They were also advised to take light breakfast without tea and coffee in the examination morning.All the examinations were done in the Autonomic Nerve Function Test Laboratory in the department of Physiology, BSMMU. Heart rate variability (HRV) recording was done by RMS Polyrite D machine. The subjects were allowed to take rest for at least 5 minutes in calm and silent environment before recording. Then ECG recording was taken in supine position for minimum 5 minutes. After recording HRV parameters, the steps of SBE were explained to the patients. Seven (7) consecutive days training on SBE was given to them. Alternate nostril

breathing[11], a type of SBE was performed by the patients for three (3) months. Controls were not under any kind of exercise. Data were analyzed before and after SBE and then compared with control. For statistical analysis, independent sample t test and paired sample t test were done by SPSS version 20.

Results

There were no significant differences in respect of age and BMI between patient & healthy control(Table I).The pre-exercise values of pulse rate, systolic blood pressure and diastolic blood pressure were found significantly higher in diabetic patients compared to those of control (Table I).Pre-exercise mean value of mean LF nu and LF/HF ratio were significantly ($p<0.001$) higher and pre-exercise values of mean LF power, HF power, HF nu were significantly ($p<0.001$) lower in T2DM than those of control. In addition, Post exercise mean values of LF power ($p< 0.001$), HF power ($p< 0.001$) and HF nu ($p< 0.01$) increased significantly and LF nu, LF/HF ratio ($p< 0.01$) decreased significantly after 3 months of slow breathing exercise in comparison to their pre-exercise values. Moreover, no statistical differences were observed between control and post exercise values of LF nu, HF nu and LF/HF ratio but post SBE values LF and HF power though significantly higher than their corresponding pre SBE value, still remained significantly lower than control value . (Table II)

Table I: General Characteristics in different groups at baseline (N=60)

Parameters	Control (n=30)	T2DM (n=30)
Age (years)	48.5±0.50 (45-55)	49.86±0.56 (45-55)
BMI (sq/m)	22.89±0.23 (19.4-25.9)	23.24±0.23 (20.2-24.8)
SBP (mm of Hg)	125.33±1.04 (120-140)	129.14±1.41** (110-140)
DB P(mm of Hg)	77±0.88 (70-85)	80.34±0.89* (70-90)
Pulse Rate (beat/min)	77.03±0.80 (68-84)	82.69± 0.84*** (68-88)

Data were expressed as Mean ± SE. Values in parentheses indicate ranges. For statistical analysis independent sample t test was done. (***= $p<0.001$, ** = $p< 0.01$ and * = $P < 0.05$)

Table II: The values of Frequency Domain measures of HRV in different groups (N=60)

Parameters	Control (n=30)	T2DM Pre- SBE (n=30)	T2DM Post- SBE (n=30)
LF power (m2/sec)	303.58 ± 38.93 (73.41-814.03)	38.23 ± 5.16*** (2.71-99.54)	129.54 ± 18.11###YYY (3.92-439.64)
HF power (m2/sec)	254.76 ± 31.57 (46.68-819.97)	19.31 ± 2.73*** (0.79-55.87)	103.47 ± 15.32###YYY (7.41-339.03)
LF norm (nu)	50.31 ± 3.22 (17.93-78.74)	67.86 ± 2.07*** (26.64-79.61)	55.72 ± 2.87## (32.87-78.38)
HF norm (nu)	49.70 ± 3.21 (21.26-82.07)	32.13 ± 2.07*** (20.39-73.36)	44.27 ± 2.87## (21.62-67.13)
LF/HF ratio	1.31 ± 0.17 (0.22-3.70)	2.38 ± 0.16*** (0.36-3.90)	1.58 ± 0.18## (0.49-3.63)

Data were expressed as Mean ± SE. Values in parentheses indicate ranges. Statistical analysis was done by Independent sample 't' test, Paired sample 't' test (*-T2DM(preSBE) vs control***-$p<0.001$, **-$p< 0.01$) ; (#- pre vs post SBE, ##- $p< 0.01$###= $p<0.001$);(Y- post SBE vs control; YYY- $p<0.001$)T2DM=Type 2 Diabetes mellitus, SBE- Slow breathing exercise.

Discussion

In this study, the baseline values of pulse rate, systolic blood pressure and diastolic blood pressure were significantly higher in diabetic patients in comparison to control. Slow breathing exercise for 3 months improved all these parameters towards parasympathetic predominance.

Higher values of pulse rate, systolic blood pressure, diastolic blood pressure, mean LF nu, LF/HF ratio and lower value of mean LF power, HF power, HFnu in diabetic patients represent autonomic imbalance towards sympathetic activity [15-19].

The mean value of LF power increased significantly after slow breathing exercise. But some other researchers found non significant changes in both healthy and diabetic patients group after breathing exercise [14, 22].The significant increase of post exercise mean value of HF power was observed in this study. But a group of researchers found significant decrease in this parameter in healthy subjects after breathing exercise [14]. Again another group found non significant changes after breathing exercise in diabetic patients with hypertension [20].

The post exercise value of mean LF nu was decreased significantly in this study which is consistent with findings of other researchers in healthy subjects after practicing yoga[21]. But some researchers found no significant change after breathing exercise in healthy subjects[14, 22].

The significant increase of post exercise value of mean HF nu and LF/HF ratio was observed in this study. A group of researchers also observed similar findings in both healthy subjects and diseased patients after practicing yoga[21,20-23]. But some researchers reported about no significant change after breathing exercise in both healthy subjects[14, 22].

From this study it is seen that slow breathing exercise improved cardiac autonomic nerve activity towards parasympathetic predominance in the diabetes mellitus patients which was indicated by significant change of post exercise values of mean LF nu, mean HF nu and LF/HF ratio in comparison to their pre-exercise value. Slow deep breathing exercise helps to increase concentration towards the breathing that decreases the stress of the subjects. This stress free condition might decreases sympathetic activity and increases parasympathetic activity [11]. In this way, SBE might shift autonomic nerve function activity away from sympathetic and towards parasympathetic dominance.

Yoga based slow breathing exercise might increases vagal activity which shift sympathovagal balance towards para-sympathetic activity [12, 21-22, 24-27]. SBE also increases baroreflex sensitivity[28-29].It has also been suggested that synchronization of neural tissues of both hypothalamus and brainstem because of generation of hyperpolarization current in fibroblast of lungs and decrease of adrenaline may be responsible for the changes in this study[28-30].

Conclusion

From this study, it can be concluded that autonomic nerve dysfunction in T2DM was improved by practicing yoga based SBE towards parasympathetic dominance.

Conflict of interest: None

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