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Effect of slow breathing exercise on heart rate variability: A non linear analysis in female major depressive disorder patients

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Abstract

Background: Major depressive disorder (MDD) is a mental health problem, associated with cardiac autonomic dysfunction. Cardiac autonomic function (CANF) can be assessed by non linear analysis of heart rate variability (HRV), a simple non-invasive software based analytical method. Yoga based slow breathing exercise (SBE) has role to improve autonomic dysfunction in some disease condition. **Objective:** To observe the effect of SBE on non linear measures of HRV in newly diagnosed female MDD patients. **Methods:** The quasi-experimental study was conducted in 2023 on sixty (60) newly diagnosed female MDD patients of 20-40 years aged, collected from the Department of Psychiatry, Bangabandhu Sheikh Mujib Medical University (BSMMU). Among them 30 were assigned with SBE and remaining 30 patients without SBE were followed up after 90 days. Both patient groups received conventional treatment during this period. Thirty apparently healthy female subjects with similar age & BMI were included as control for comparison and they did not perform breathing exercise. Data were taken at baseline and after 90 days in all the subjects. CANF was assessed by analysing non linear (poincare plot) of

HRV by using ECG based data acquisition device, Power lab 8/35. Data were expressed as mean±SD. For statistical analysis, ANOVA followed by post hoc Bonferroni test and paired sample "t" test were used. **Results:** At baseline pulse rate and BP were significantly lower in both group of MDD patients compared to control. The pre-intervention values of standard deviation of short term RR interval variability (SD1), standard deviation of long term RR interval variability (SD2) and ratio of short term and long term RR interval variability (SD1/SD2) were found significantly ($p< 0.001$) lower in MDD patients compared to healthy control. Following 90 days of SBE, significant ($p< 0.001$, $p< 0.05$) rise of these poincare plot parameters was noted in MDD patients whereas no significant changes of these parameters were observed in patients without SBE after 90 days of follow-up. Moreover, the pulse BP almost reached control level though the non linear parameters were still below control level after 3 months of SBE. **Conclusion:** Autonomic dysfunction occured in MDD patients SBE can improve cardiac autonomic dysfunction and sympathovagal balance in female MDD patients.

Key words: Poincare plot HRV, major depressive disorder, slow breathing exercise.

Introduction

MDD is a common mental health issue which has become one of the leading causes of ill health and functional disability around the world. People of all ages and about 3.8% of global population suffer from depression. Among them 5% people are adult. Women are more affected than men.[1]

MDD has been featured as depressed mood, loss of interest in work and decreased energy. Patients suffering from depression are prone to develop cardiovascular disease and cardiac mortality. Depressed patients exhibited four times mortality rate within six months of acute myocardial infarction (MI) compared to the non-depressed one.[2-4] Autonomic imbalance characterized by sympathetic predominance was found in MDD patients.[3,5,6] Studies suggested that cardiovascular disease in patients with mood disorder may result from the autonomic dysfunction.[7]

HRV measures the beat to beat temporal changes in heart rate which represents the central autonomic modulation over CANF.[4,8] Non-linear methods are emerging and potentially effective tool for HRV assessment.[9] Non-linear HRV can be geometrically presented by Poincare plot from where variability in heart rate can be visually identified. It is quantified by measuring SD1, SD2 and SD1/SD2 components. SD1 is the standard deviation of the poincare plot,which is a perpendicular to the line of identity and it measures short term variability. SD2 is the standard deviation of the poincare plot along the line of identity and measures long term variability. SD1 represents parasympathetic tone whereas sympathetic status is represented by SD2. SD1/SD2 reflects proportion of short term and long term variability and evaluates sympathovagal balance.[10,11]

Antidepressant drugs are commonly used for treatment of MDD patients. Antidepressant drug could not improve autonomic dysfunction in these patients.[12,13]

Different types of SBE has been successful for alleviating depressive symptoms.[14-16] SBE also improves CANF by increasing vagal tone or decreasing sympathetic discharge in some disease condition and also in normal healthy person.[17-20] But it's effect on non-linear HRV in depressive patients has not known. Therefore, this study aimed to investigate the effect of SBE on CANF by assessing poincare plot of non linear method of HRV in MDD patients.

Methods

Study design and setting

This quasi-experimental study was carried out at the Department of Physiology, BSMMU, Shahbag, Dhaka, in the year 2023 to observe the effect of SBE on cardiac autonomic function in MDD patients by analyzing HRV.

Participants

For this study, 60 newly diagnosed female MDD patients, aged 20-40 years and 30 apparently healthy female subjects with similar age & BMI were included as control for comparison. The patients were selected from the Out Patient Department of Psychiatry, BSMMU being diagnosed with Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V) criteria by psychiatrist. Among the sixty MDD patients, 30 were assigned with SBE and remaining 30 patients without SBE followed up after 90 days. Both patient groups received treatment with antidepressant drug (selective serotonin reuptake inhibitor and serotonin-norepinephrine reuptake inhibitor) during this period. Control group was selected via personal contact and was not assigned for SBE. Data were taken at baseline and after 90 days in all the subjects.

Sampling

Purposive sampling was adopted to select the patients as well as control subjects.

Exclusion criteria

All these patients were free from severe depression, suicidal attempts, substance abuse, thyroid disorder, other psychiatric disease, illness affecting autonomic function, history of current medication.

Data collection procedure

Before examination and collection of blood sample all the subjects were thoroughly briefed about the aim, objectives and detail procedure of the study and then their informed written consent was taken. All the subjects were interviewed about their detail clinical history, thorough physical examinations with BMI and blood samples were collected to exclude exclusion criteria. The subjects were requested to report in the Noorzahan Begum Neurophysiology Research Lab At the Department of Physiology, BSMMU between 8.00 to11.00 a.m. for HRV recording. They were advised to have their meal by 9:00 pm on previous night, to remain free from any physical or mental stress, not to take any drugs affecting central nervous system and to have a restful sleep at night before the examination day. The subjects were advised to avoid tea or coffee at breakfast on the day of HRV data recording. The subjects were kept in complete bed rest in supine position for 30 minutes in a controlled temperature of 25°C, dim illumination and sound-proof environment of lab. During this period subject was advised not to talk, eat or drink and also not to perform physical or any mental activity, even sleep. Then ECG was recorded on lead II for 5 minutes by data acquisition device Power Lab 8/35 (AD instrument, Australia). HRV data was analyzed by Lab chart software.

Intervention

In this study the slow breathing exercise done by inhaling slowly then retaining the breath followed by exhaling slowly through alternate nostril keeping the opposite nostril closed[21]. Patients were trained with the steps of SBE until they were confident enough to perform it at home. they were instructed to exercise everyday in the morning and evening for 15-20 minutes in sitting position and keep the recordings in a diary. The diary with time schedules including the pictures and procedures of SBE in Bangla were also provided. Patients were monitored for breathing exercisethroughtelephoniccalls, What's-App group response for severaltimes inaweek and a few by frequent home visits. For compliance, all

the subjects were advised to come for follow up assessment after 90 days to the same Department.

Statistical analysis

Data were expressed as mean ± SD. For statistical analysis, ANOVA followed by post hoc Bonferroni test and paired sample "t" test were done by using SPSS-27 version. p value of < 0.05 was considered as statistically significant.

Results

In this study, all depressed patients and healthy control were matched by age and BMI (Table I). At baseline, mean pulse rate, SBP were found significantly ($p< 0.001$, $p<0.05$) higher, whereas SD1, SD2 and SD1/ SD2 were significantly ($p< 0.001$) lower in MDD patients compared to the healthy control. In addition, changes in these parameters were not significant between two groups of patients at baseline (Table II). after 90 days of SBE, mean pulse rate, SBP and DBP significantly ($p< 0.001$) decreased but SD1, SD2 and SD1/SD2 significantly ($p< 0.001$, $p< 0.05$) increased in MDD patients whereas after 90 days of follow up, MDD patients without SBE did not show significant changes in these parameters when compared to their baseline values. (Table III). Furthermore, pulse, SBP and DBP values were significantly lower and SD1, SD2 were significantly higher in SBE group compared to the non-SBE group at follow up (Table IV). Moreover, pulse BP were almost to the control level whereas SD1, SD2 and SD1/SD2 remained significantly lower than control after 90 days of follow up. Lack of significant change of these parameters between pre and post follow up in MDD patients without SBE but under conventional anti depressant drugs (Table III) demonstrate no effect of these treatment on CANF in MDD.

Discussion

In this study, higher resting pulse rate, SBP in newly diagnosed MDD patients compared to control indicating cardiac autonomic dysregulation in MDD patients, is consistent with other study[22,23].

Table I : Age and BMI in different groups (N=90)

Variables	SBE (n=30)	Non-SBE (n=30)	Control (n=30)
Age (Years)	28.33±5.16	27.10±4.98	28.73±3.86
BMI (Kg/m^2)	23.53±1.59	23.42±1.69	23.64±1.28

Data were expressed as Mean ± SD. Statistical analysis was done by One-way ANOVA followed by post-hoc Bonferroni test; BMI= Body Mass Index

Table II : Baseline values of pulse rate, SBP, DBP and poincare plot HRV measures in different groups (N=90)

Variables	SBE (n=30)	Non-SBE (n=30)	Control (n=30)
Pulse rate (beats/min)	83.73±7.43***	84.43±8.69***	71.20±5.38
SBP (mm of Hg)	117.00±7.72*	116.50±9.69*	110.50±10.28
DBP (mm of Hg)	76.33±6.69	76.83±7.13	73.33±7.69
SD1	15.44±7.14***	14.26±5.06***	43.26±9.81
SD2	40.31±6.71***	34.08±9.46***	74.09±15.78
SD1/SD2	0.389±0.18***	0.430±0.13***	0.599±0.13

Data were expressed as mean ± SD. Statistical analysis was done by One-way ANOVA followed by post-hoc Bonferroni test. SBP= Systolic blood pressure, DBP= Diastolic blood pressure, SD1= Standard deviation of short term RR interval variability, SD2= Standard deviation of long term RR interval variability, SD1/SD2 = Ratio of short term and long term RR interval variability. *depicts control baseline vs MDD baseline. $^{*}p<0.05$, $^{***}p<0.001$.

Table III : Pre and post follow up values of pulse rate, SBP, DBP and poincare plot HRV measures in MDD patients (N=60)

Variables	SBE(n=30)		Non-SBE (n=30)	
	Pre	Post	Pre	Post
Pulse rate (beats/min)	83.73±7.43	75.70±4.75$^{\#\#\#}$	84.43±8.69	82.89±7.92
SBP(mm of Hg)	117.00±7.72	110.83±7.08$^{\#\#\#}$	116.50±9.69	116.00±10.20
DBP (mm of Hg)	76.33±6.69	71.33±5.86$^{\#\#\#}$	76.83±7.13	75.83±6.44
SD1	15.44±7.14	23.70±6.43$^{\#\#\#}$	14.26±5.06	15.50±5.42
SD2	40.31±6.71	53.31±11.19$^{\#\#\#}$	34.08±9.46	37.01±9.91
SD1/SD2	0.389±0.18	0.460±0.15$^{\#}$	0.430±0.13	0.427±0.12

Data were expressed as Mean ± SD. Statistical analysis was done by Paired sample t-test. SBP= Systolic blood pressure, DBP= Diastolic blood pressure, SD1= Standard deviation of short termRR interval variability, SD2= Standard deviation of long term RR interval variability, SD1/SD2 = Ratio of short term and long term RR interval variability. $^{\#}$depicts pre SBE vs post follow up SBE. $^{\#}p<0.05$, $^{\#\#\#}$ $p<0.001$

Table IV : Post follow up values of pulse rate, SBP, DBP and poincare plot HRV measures in different groups (N=90)

Variables	SBE (n=30)	NSBE (n=30)	Control (n=30)
Pulse rate (beats/min)	75.70±4.75$^{\$\$\$}$	82.89±7.92***	71.80±6.00
SBP (mm of Hg)	110.83±7.08$^{\$}$	116.00±10.20*	109.50±8.94
DBP (mm of Hg)	71.33±5.86$^{\$}$	75.83±6.44	72.50±5.84
SD1	23.70±6.43$^{***\$\$\$}$	15.50±5.42***	39.94±8.39
SD2	53.31±11.19$^{***\$\$\$}$	37.01±9.91***	73.01±14.6
SD1/SD2	0.460±0.15*	0.427±0.12***	0.562±0.13

Data were expressed as mean ± SD. Statistical analysis was done by One-way ANOVA followed by post-hoc Bonferroni test. SBP= Systolic blood pressure, DBP= Diastolic blood pressure, SD1= Standard deviation of short term RR interval variability, SD2= Standard deviation of long term RR interval variability, SD1/SD2 = Ratio of short term and long term RR interval variability. *depicts Control post follow up vs MDD post follow up, $^{*}p<0.05$, $^{***}p<0.001$. $^{\$}$depicts post follow up SBE vs post follow up non-SBE, $^{\$}p<0.05$, $^{\$\$\$}p<0.001$.

After performing SBE along with medication for 90 days, significant decrement of all these parameters compared to non-SBE group of MDD patients, suggesting the involvement of SBE for the improvement in cardiovascular autonomic dysregulation in MDD patients. Similar effect of SBE on cardiac autonomic dysfunction were reported in other disease condition.[19,24,25]

In this study, lower values of SD1, SD2 and SD1/SD2 at baseline in all newly diagnosed MDD patients indicate cardiac autonomic dysregulation in these patients, which is similar to others.[23] Again significant increment in these parameter after 90 days of performing SBE indicate significant improvement in both sympathetic and parasympathetic function in

MDD patients. But the improvement was not upto control level. This observation of improvement of autonomic dysfunction following SBE, is further supported by non-significant change in these parameters without SBE at follow up. Significant higher values of SD1 and SD2 at after 3 months in SBE group compared to the non-SBE group further confirmed the beneficial effect of SBE on CANF in female MDD patients. Although both group of patients were under anti-depressive medication, the results in patients without SBE after 90 days exclude the effect of anti-depressive drug on CANF in MDD. Some investigator observed similar effect of SBE on these parameters in other disease condition[19]. The exact mechanism of improvement of CANF from SBE is not well understood. It has been suggested that stretching of slowly adapting pulmonary receptor above tidal volume result in increased vagal discharge to nucleus tractus solitarius, which in turn strengthened the vagal center to send increased parasympathetic input to the SA node of heart. In this way SBE resets the central autonomic discharge and shifts the autonomic balance towards parasympathetic dominance.[26]

Conclusion

This study concludes that SBE was effective to improve cardiac autonomic dysfunction and sympathovagal balance in female MDD patients. Therefore it can be recommended, SBE to be used as adjunctive to medication in these patients to improve cardiac autonomic dysfunction.

Ethical clearance

Ethical clearance was approved by Institutional Review Board of BSMMU.

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