Effect of a Single Session of Bergamot Orange Aromatherapy on Cardiac Autonomic Function among Patients with Depression

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ABSTRACT

BACKGROUND
Depression is becoming a major health concern in recent times, and nearly 350 million people suffer from depression. Reduced cardiovagal tone in patients with depression is well documented and contributes to higher cardiac morbidity and mortality.

OBJECTIVES
To investigate the effect of single session Bergamot orange essential oil aromatherapy on the cardiac autonomic function using Heart Rate Variability (HRV) among depression patients.

METHODS
The study included 80 patients (45 male, 35 female; age range 35 – 65, mean 44.92 ± 12.5) with HAMD (Hamilton Rating Scale for Depression) score of above 20. They were randomly allocated to either the Intervention group (Aromatherapy exposure group) (n = 40) or the Placebo control group (Water exposure group) (n = 40) in a 1:1 ratio. Bergamot essential oil was given as aromatherapy for 10 minutes. Blood pressure and cardiac autonomic nervous system parameters using Heart Rate Variability (HRV) were recorded 5 minutes before, immediately after applying the aroma inhalation, at 10 min and 30 min of a recovery period.

RESULT
Following the aromatherapy for 10 minutes, the systolic (SBP; p = 0.04), diastolic blood pressure (DBP; p = 0.05), and heart rate (HR;p = 0.04) decreased and HRV variables such as RMSSD (p = 0.01), and HF (n.u) (p = 0.05) significantly increased at 10 min and 30 min of recovery periods compared to controls.

CONCLUSION
The result suggests that 10-minutes aromatherapy with Bergamot essential oil seems to drive cardiac autonomic function towards parasympathetic domination. However, the long term use of Bergamot oil on the autonomic function balance among patients with depression has to be studied further**.**

KEYWORDS

Inhalation, Aromatherapy, Bergamot orange essential oil, HRV, Depression

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INTRODUCTION

Depression could be a life-threatening mood disorder marked by recurrent feelings of depression and impact individuals' quality of life due to impairment, pain, and high risk of self-harm.[1,2] Depression has become a major health concern in recent times, and nearly 350 million people suffer from the condition, while one million commit suicide every year.[3,4] By 2030 it is estimated that major depressive disorder will become the largest cause of disability-lived years of life.[5,6] The global incidence of depression has significantly increased and lays a high economic burden.[7,8] The widespread physical symptoms identified by patients include feelings of remorse, depression, worthlessness and desperation, failure to enjoy pleasure, changes in patterns of appetite and sleep, loss of energy, impaired attention and memory, motor retardation, exhaustion, and repeated ideation of suicide and death.[9,10] Validated techniques are available to detect symptoms of depression.[11] One of the most commonly used assessment is the Hamilton Depression Rating Scale that provides a clinical and self-reported evaluation.[12] First-line of therapy for major depressive disorder currently includes monoamine oxidase inhibitors, tricyclic antidepressants, serotonin-norepinephrine, and selective serotonin reuptake inhibitors.[13,14]

Despite the broad range of medications available, several patients could not achieve total recovery or suffer from adverse effects such as nausea, anxiety, weight gain, and sexual dysfunction. Increasing number of patients, therefore resort to alternate therapeutic modalities such as psychotherapy, counselling, exercise, self-help advice, and complementary and alternative medicine (CAM).[15]

Aromatherapy is one such CAM therapy chosen by patients with depressive symptoms. Aromatherapy is a cheap and non-invasive approach involving the controlled use of aroma oils for therapeutic and preventive purposes. It is widely used to treat depression, anxiety, certain cognitive disorders, insomnia, and stress-related disorders.[16]

Autonomic function (ANS), demonstrated through heart rate variability (HRV) is well documented to be compromised among patients with depression.[17] HRV is a measure of heart rate interval (beat-to-beat variations) and has been developed as a non-invasive method for assessing autonomic cardiac function. Recently, the magnitude of the depression has also verified the implementation of the different HRV indices.[9] Reduced HRV has been associated with extreme depression, and symptoms score.[17] Previous studies reported that aromatherapy intervention improves the HRV indices and sympathy-vagal balance.[18] To our knowledge, there is paucity of literature for the impact of aromatherapy on cardiac autonomic function among the patients with depression. The current study aims to find the impact of immediate effect of aromatherapy in patients with depression using Bergamot orange essential oil on HRV.

MATERIALS AND METHODS

Participants

Inclusion and exclusion criteria: Current research included patients diagnosed with depressive disorder. The diagnostic criteria for depression according to Diagnostic and Statistical Manual of the American Psychiatric Association-IV-TR (DSM-IV-TR) Axis I disorders (SCID) was used for the screening. Additionally, the Hamilton Rating Scale for Depression (HAMD) was measured, and patients were included if the HAMD score exceeded 20.

Exclusion criteria: Patient with organic depressive disorder, alcohol abuse, history of any other psychiatric illness, any cardiac abnormality were excluded.

All selected patients had a record for anti-depressive medication; thus, it was not identified as a criterion for exclusion. Olfactory function checks on subjects were performed to ensure none had anosmia.

Allocation of subjects: The project was registered in Clinical Trials Registry-India (CTRI/2020/10/028213) before commencing. The subjects were recruited after getting informed consent and ethical clearance also obtained from institutional ethical committee (SMC/IEC/2020/03/037). Total of 124 patients screened, the outpatient department's (OPD) analysis included 80 patients who had met the inclusion criteria. A total of 80 patients (45 males, 35 females; age range 35 – 65, mean 44.92 ± 12.5 yrs) were assigned randomly into two groups, i.e., the Intervention group (Aroma exposure group) (n = 40) and placebo control group (Water exposure group) (n = 40) in a 1:1 ratio by simple randomization (lottery method). We estimated the sample size based on a power of 0.9, an effect size of 0.74, and an "α" of 0.01, from the previous report using G power software (19). Blinding was not possible among the participants as it was a aromatherapy intervention. However, the investigator who gave the intervention and assessed the HRV was blinded to both the group participants.

Intervention

Two forms of aroma stimulation were used in this experiment-Bergamot orange essential oil (BEO) and water as a control. 10 µl of BEO (Citrus bergamia; purchased from Aroma magic certified traders for the herbal products) or water were pipetted into a small cotton pad designed for a diffuser (Hervey Ultrasonic Aroma Diffuser, Lifestyle Int Pvt Ltd, india). Airflow from the diffuser was placed near the subject's nostril using the diffusers 15 cm long circular cylinder fitted with a 3 cm diameter perforated funnel for 10 min. For 10 minutes, each patient was inhaling the aroma. Exposure to aromatherapy with measuring points: at baseline (T1), immediately after aromatherapy (T2) and 10 min (T3) and 30 min (T4) after a recovery period. The distance of the aroma stimulus, dilution, duration was fixed to all the persons (Figure 1).

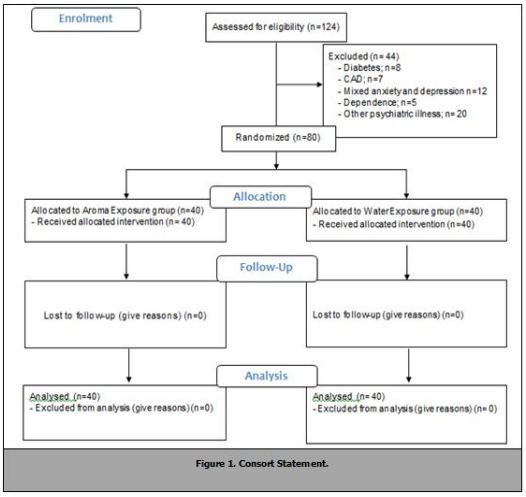

Figure 1. Consort Statement.

Blood Pressure and Heart Rate

Patients in both groups reported a day before the intervention and demonstrated the procedure to them. Supine brachial systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were obtained using semi-automated blood pressure monitor (Omron; HEM-7201) before the intervention. There were three consecutive measurements, and the mean values were used. Baseline BP and HR were assessed after 10 min of supine rest and replicated in 10 min and 30 min of recovery time immediately after aroma inhalation. They weren't allowed to move or rise from their supine position during the rehabilitation time.

Short Term HRV Estimation

The Task Force's advice on HRV was adopted for the monitoring of short term HRV. For this reason, an ECG analogue amplifier (AD Converter) was used to acquire limb lead II ECG at a rate of 8000 samples / second during supine rest (20). Raw R-R interval data was collected from the A-D converter and stored separately in the device. HRV analysis was performed using version 2.2 of the kubios HRV analysis software (Bio signal Research Community, Finland). The root means square of successive differences (RMSSD) represents the vagal tone in the time domain and is free from respiratory control and high frequency (HF) band which is frequently referred to as the respiratory band (0.15 and 0.40 Hz), representing the vagal tone were selected for the present study. We then recorded the ECG for 40 min continuously for the entire experimental period (from the baseline to after the inhalation).

Statistical Analysis

Data is given as Mean ± SD (standard deviation). One way ANOVA test followed by Tukey HSD (post hoc) test was used to compare the mean difference of intragroup changes using R statistical software version 3.2.1.

RESULTS

All registered participants successfully completed the study with no dropouts, and none of the participants reported any adverse effects. Table 1 summarizes the essential characteristics of the study participants in both groups; The HR increased immediately after (+ 16.8 ± 6.4 bpm) aroma therapy exposure (Table 2). HR decreased marginally at 10 min of recovery time (-4.8 ± 2.4 bpm) and significantly reduced at 30 min (-10.2 ± 4.6 bpm) compared with the baseline ($P<0.01$). SBP increased immediately after aromatherapy (10.4 ± 4.9 mmHg) and decreased (-2.4 ± 3.9 mmHg) at 10 minutes and (-8.6 ± 4.8 mmHg) 30 minutes after recovery ($p < 0.01$); similarly, DBP decreased immediately after aromatherapy (-3.8 ± 5.2 mmHg), while a significant reduction was observed at 10 min (-10.9 ± 6.4 mmHg) and 30 min (-14.2 ± 6.2 mmHg) of recovery time ($P < 0.05$). Changes in RMSSD (vagal tone) after aroma therapy were recorded (Figure 2), and after aroma therapy we observed a substantial increase immediately after aroma therapy, at 10 and 30 min recovery period ($P < 0.01$). The HF band (vagal tone) also significantly increased after aroma ($P < 0.05$) and the difference was observed at 10 min and 30 min of recovery period too.

Parameters	Control Group	Intervention group	P-value
Age (years)	45.78 ± 4.10	41.67 ± 6.90	0.9

Bodyweight (kg)	55.90 ± 15.67	56.45 ± 13.85	0.6
Body mass index (kg/m^2)	27.66 ± 5.98	29.12 ± 7.35	0.7
Systolic blood pressure (mm Hg)	135.37 ± 16.91	133.12±12.93	0.5
Diastolic blood pressure (mm Hg)	83.89 ± 14.70	85.38 ± 15.06	0.7
Resting HR (beats/min)	76.26 ± 11.30	79.33 ± 10.19	0.7

Table 1. Baseline Characteristics of the Patient Participated.

Variables	Intervention group		P-value		Control group		P-value	
	Δ at immediately after	Δ at 10 min	Δ at 30 min		Δ at immediately after	Δ at 10 min	Δ at 30 min	
HR bpm	+ 16.8 ± 6.4	-4.8 ± 2.4	-10.2 ± 4.6	0.04	+ 10.2 ± 5.2	+6.4 ± 3.2	+3.2 ± 1.2	0.05
SBP mm Hg	+ 10.4 ± 4.9	-2.4 ± 3.9	-8.6 ± 4.8	0.04	+5.8 ± 3.9	+6.6 ± 1.9	+3.3 ± 1.8	0.57
DBP mm Hg	-3.8 ± 5.2	-10.9 ± 6.4	-14.2 ± 6.2	0.05	+3.6 ± 4.8	+5.2 ± 2.4	+2.2 ± 3.9	0.13
SDNN	+12.8 ± 4.9	+19 0.7 ± 6.77	+10.2 ± 4.8	0.03	+4.5 ± 1.88	+6.7 ± 2.9	+3.2 ± 2.6	0.34
RMSSD	11.8 ± 5.8	22.8 8 ± 11.8	28.9 ± 8.1	0.01	4.6 ± 2.8	8.2 ± 3.1	5.1 ± 2.9	0.23
HF (n.u)	5.8±3.6	8.4 ± 2.6	14.3 ± 3.9	0.04	3.4 ± 1.9	4.7 ± 2.8	5.8 ± 3.5	0.12

Table 2. Changes in Resting Cardiovascular and Short Term HRV Parameters.

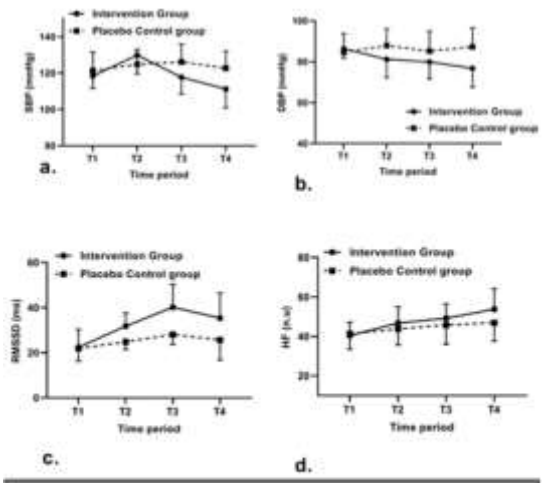

Figure 2. Changes in the SBP (a), DBP (b), RMSSD(c) and HF (d) between the intervention group and control group over time period.

DISCUSSION

After 10 min of a single aromatherapy session with Bergamot orange essential oil, we found a significant improvement in HRV indices among patients with depression in the intervention group. To our knowledge, this is the first study to examine the changes in ANS among depression patients caused by Bergamot orange essential oil. Using Bergamot orange aromatherapy significantly reduced blood pressure and improved HRV parameters indexed by SDNN, RMSSD, and HF power in patients with depression representing the state of parasympathetic domination.

The mechanism through which aroma therapy works is unique. The olfactory system of our body consists of olfactory mucous membrane situated in the upper part of nostrils. The odorant substances which are volatile can stimulate the olfactory receptors by binding on to the receptor proteins in the cilia. The odorant receptor complex activates adenyl cyclase thus forming cyclic AMP. The cAMP causes influx of sodium ions into the receptor cell and generation of receptor potential. As the firing level of receptor potential is achieved it produces action potential which transmitted to the olfactory bulb which connects directly to the limbic system of the brain.[21] The limbic system has a strong impact on the emotions, instinctive behaviors, motivation and memory in response to chemicals in the essential oil.[22] The olfactory impulses also reach the reticular activating system (RAS) of the brain to analyses the particular aroma and to integrate the emotions with already existing memories. The olfactory pathway projecting to hypothalamus activates the emotions, thus stimulating pituitary gland cascading responses. The odorant chemicals in the essential oil have provoked physiological, psychological and emotional responses that influence feelings and behaviour.[22] The observed

effects (of Bergamot orange aromatherapy) could be due to the high content of limonene, linalool, and linalyl acetate found in citrus fruits.[23] Earlier studies with BEO inhalation alone showed essential effects on the reduction of anxiety, depression, and blood pressure, and heart rate.[24] Interestingly, a study recorded that natural bergamot essential oil aromatherapy achieved only the marked reduction of stress level in teachers (elementary school) with different workloads.[25] They also found that age and BMI variables affected the aromatherapy performance. The variance and influences of age, gender, body weight, BMI, resting blood pressure, and heart rate have been assessed on these study findings, and no significant differences have been identified between the control and intervention group and further contribute to the possible effect of aromatherapy on the parameters examined above.

The observed effect on the control group's heart rate in the current study might be attributed to the psychological stimulation elicited during warm inhalation. Current study demonstrates that aromatherapy using Bergamot orange oil helps in improving cardiovagal health as shown in markers such as HRV, blood pressure and heart rate. Further studies with larger sample size with longer duration of Bergamot orange oil inhalation would help to further explore and validate the therapeutic effectiveness observed in our study.

CONCLUSION

The present study showed that the single session of Bergamot orange essential oil intervention enhanced the autonomic cardiac function towards parasympathetic dominance, and this effect persisted for 20 min of recovery time. This exploratory pilot research offers valuable information for future studies aimed at reducing depression among the patients.

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