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CARDIAC AUTONOMIC MODULATION CHANGES IN MOOD DISORDERS: A COMPARATIVE STUDY

Psychiatry

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ABSTRACT

Mood disorders, such as depression and bipolar disorder, represent a major global health burden. Recent advancements in understanding the physiological underpinnings of mood disorders have highlighted the potential role of heart rate variability (HRV) as an indicator of autonomic nervous system (ANS) dysfunction. This study aims to explore the relationship between HRV and mood disorders, examining its potential as a biomarker for diagnosis and treatment efficacy. A total of 150 participants (75 diagnosed with major depressive disorder, 75 with bipolar disorder) and 50 age-matched healthy controls were assessed using both time-domain and frequency-domain HRV measurements. Results indicate significant differences in HRV between patients with mood disorders and healthy controls, with lower HRV observed in the disorder groups. These findings suggest HRV as a promising tool for understanding autonomic dysregulation in mood disorders.

KEYWORDS

INTRODUCTION

Mood disorders are psychiatric conditions characterized by persistent disturbances in emotional regulation, impacting approximately 10-20% of the global population. Major depressive disorder (MDD) and bipolar disorder (BD) are two prevalent mood disorders that not only impair mental health but are also associated with various somatic symptoms. One of the emerging physiological markers for these conditions is heart rate variability (HRV), which reflects the autonomic nervous system's ability to regulate cardiac function. Low HRV has been linked to an array of psychiatric disorders, including mood disorders, indicating potential dysregulation of the parasympathetic nervous system (PNS) and sympathetic nervous system (SNS).

This study seeks to provide deeper insight into the relationship between HRV and mood disorders, offering a comprehensive assessment through both time-domain and frequency-domain HRV measures, and testing the hypothesis that lower HRV correlates with the severity of mood disorders.

MATERIALS AND METHODS

This was a Cross-sectional, Observational study conducted in the Department of Psychiatry at Sri Venkateswara Medical College, Tirupathi, India. The study was approved by the Institutional Ethics Committee of Sri Venkateswara Medical College and Associated SVRRGG Hospital, Tirupathi (Approval Number: Lr.No.117/2019). A total of 150 participants were recruited from a psychiatric outpatient clinic. The sample consisted of 75 individuals diagnosed with major depressive disorder (MDD), and 75 individuals diagnosed with bipolar disorder (BD). A control group of 50 age-matched healthy individuals was also included. Participants were excluded if they had any major medical conditions, other psychiatric disorders, or were using substances (except prescribed medication). Informed consent was obtained from all participants.

Procedure

HRV of subjects was measured at rest with a digitalized polygraph, Bioharness Device. Participants were asked to lie down on a couch adjacent to the polygraph instrument, remain awake, and breathe normally.). Data was collected in a controlled environment, with participants instructed to refrain from caffeine or alcohol consumption for 12 hours prior to testing They were also asked to remove any metallic possessions that they might be wearing or carrying. ECG metallic electrodes were attached to the right arm, left arm and left leg. After five minutes of rest, ECG lead II was recorded for five minutes at a speed of 25 mm per second and voltage of 10 mm per mv to obtain short-term HRV. High and low filters were set at 99 and 0.1 Hz, respectively. Respiratory rate was obtained for all the participants. The ECG data were used for offline analysis of HRV.

Data Analysis

The ECG signals were analyzed offline after visual checking for any artefacts or ectopic beats. HRV was analyzed in the frequency domain (LF power, HF power, total power, and LF: HF ratio). Statistical Analysis was conducted using SPSS software.

Two types of HRV measurements were employed:

- **Time-Domain Measures:** Standard deviation of normal-to-normal intervals (SDNN) and Root Mean Square of Successive Differences (RMSSD).
- **Frequency- Domain Measures:** Low-frequency (LF) power (0.04-0.15 Hz) and high-frequency (HF) power (0.15-0.4 Hz), with the LF/HF ratio calculated as an index of autonomic balance.

Data Analysis

HRV data were analyzed using the Kubios HRV software (version 3.3). Descriptive statistics were employed to summarize the data. Comparisons between groups were conducted using one-way ANOVA, with post hoc tests to identify specific group differences. Pearson correlation coefficients were computed to assess the relationship between HRV measures and clinical symptoms (as measured by the Hamilton Depression Rating Scale for MDD and the Young Mania Rating Scale for BD).

RESULTS

Group	Age (mean ± SD)	Gender (M/F)	BMI (mean ± SD)	Medication use
MDD (n=75)	35.4 ± 10.2	35/40	26.1 ± 4.3	Antidepressants
BD (n=75)	32.1 ± 9.7	34/41	24.7 ± 3.8	Mood stabilizers, antipsychotics
Healthy controls (n=50)	34.0 ± 11.0	25/25	25.3 ± 3.5	None

Participant Demographics

Results: The demographic characteristics of the participants are summarized in table 1

HRV - Parameters

- **Time-domain measures:**
- MDD participants exhibited significantly lower SDNN (mean: 32.2 ms) and RMSSD (mean: 21.4 ms) compared to controls (SDNN: 56.3 ms, RMSSD: 41.7 ms).
- BD participants showed intermediate values for both SDNN (mean: 42.7 ms) and RMSSD (mean: 31.0 ms), but these were still lower than healthy controls.
- Statistical analysis revealed significant differences between MDD

and both BD and control groups ($p < 0.01$), and between BD and controls for RMSSD ($p < 0.05$).

- **Frequency-domain measures:**
- Both MDD and BD groups exhibited lower HF power compared to controls (MDD HF: 72.1 ms^2, BD HF: 84.4 ms^2, Control HF: 146.3 ms^2), while LF power was higher in BD (LF: 192.3 ms^2) compared to MDD (LF: 135.4 ms^2) and controls (LF: 127.8 ms^2).
- The LF/HF ratio was significantly higher in BD (LF/HF: 3.5) compared to MDD (LF/HF: 2.0) and controls (LF/HF: 1.1), indicating increased sympathetic dominance in BD.

Correlations With Clinical Scores

There was a significant negative correlation between HRV indices and clinical severity, particularly in MDD. Lower RMSSD and SDNN scores were correlated with higher depression scores ($r = -0.43$, $p < 0.01$), while the LF/HF ratio was positively correlated with manic symptoms in BD ($r = 0.39$, $p < 0.01$).

DISCUSSION

Our findings suggest a clear distinction in autonomic regulation between individuals with mood disorders and healthy controls. The significant reduction in HRV in both MDD and BD groups aligns with previous research highlighting autonomic dysregulation as a hallmark of these conditions. The reduced vagal tone, as reflected by the lower RMSSD and SDNN, supports the hypothesis of PNS dysfunction in mood disorders. Moreover, the elevated LF/HF ratio in BD suggests an overactive sympathetic nervous system, particularly during manic episodes.

These findings are consistent with the idea that autonomic imbalance may contribute to the pathophysiology of mood disorders, possibly through altered stress response mechanisms. Lower HRV has been proposed as an indicator of poor prognosis and may also serve as a valuable marker for evaluating treatment efficacy. Further research is needed to explore the mechanistic pathways linking HRV to mood disorder symptomatology and to examine whether HRV biofeedback could offer therapeutic benefits for patients.

CONCLUSION

The results of this study support the use of HRV as a potential biomarker for mood disorders, with lower HRV associated with depressive and manic symptom severity. This provides evidence of autonomic nervous system dysfunction in both MDD and BD, highlighting HRV as a promising tool for clinical assessment. Future studies should further explore HRV in longitudinal designs and assess its potential for use in personalized treatment strategies for mood disorders.

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