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Original Research

Assessment of Autonomic Dysfunction and Heart Rate Variability in Patients with Chronic Obstructive Pulmonary Disease Visiting a Tertiary Care Center in Southern Bihar

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) is a systemic disorder associated not only with pulmonary impairment but also with significant extrapulmonary manifestations. Autonomic nervous system dysfunction, reflected by alterations in heart rate variability (HRV), has emerged as an important contributor to cardiovascular morbidity and mortality in COPD patients. Reduced HRV indicates sympathovagal imbalance and has been linked to disease severity and poor outcomes.

Objectives: To assess autonomic dysfunction and heart rate variability parameters in patients with COPD attending a tertiary care center in southern Bihar.

Materials and Methods: This prospective observational study was conducted over 12 months at Narayan Medical College and Hospital, Jamuhar. A total of 108 diagnosed COPD patients were enrolled. Autonomic function was assessed using standard cardiovascular reflex tests and HRV analysis derived from resting electrocardiogram recordings. Statistical analysis was performed using appropriate parametric and non-parametric tests, with $p < 0.05$ considered statistically significant.

Results: COPD patients demonstrated significant reduction in time-domain and frequency-domain HRV parameters, indicating autonomic dysfunction with predominant sympathetic activity. HRV parameters showed a significant association with disease severity.

Conclusion: Autonomic dysfunction is prevalent among COPD patients and is reflected by reduced HRV parameters. Early identification of autonomic impairment may help in risk stratification and improved management of COPD patients.

Keywords: Chronic obstructive pulmonary disease, autonomic dysfunction, heart rate variability, sympathetic activity

Introduction

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide and is characterized by persistent airflow limitation and chronic inflammatory response of the airways and lungs [1]. In addition to respiratory

involvement, COPD is increasingly recognized as a systemic disease affecting multiple organs, including the cardiovascular and autonomic nervous systems [2].

Autonomic nervous system imbalance plays a crucial role in cardiovascular regulation. Heart rate variability (HRV) is a non-invasive measure of autonomic modulation of cardiac function and reflects the balance between sympathetic and parasympathetic activity [3]. Reduced HRV has been associated with increased cardiovascular risk and mortality in various chronic diseases [4].

Several studies have demonstrated altered autonomic function in COPD patients, attributed to chronic hypoxia, systemic inflammation, oxidative stress, and hypercapnia [5–7]. These factors lead to enhanced sympathetic activity and reduced parasympathetic tone, which may contribute to arrhythmias, sudden cardiac death, and poor prognosis [8].

Despite growing evidence, data on autonomic dysfunction and HRV among COPD patients in the Indian population, particularly from eastern India, remain limited. Understanding the pattern of autonomic involvement may help in early identification of high-risk patients [9–12].

Therefore, the present study was undertaken to assess autonomic dysfunction and heart rate variability in patients with COPD attending a tertiary care center in southern Bihar.

Materials and Methods

Study Design

Prospective observational study.

Study Place

Narayan Medical College and Hospital, Jamuhar, Bihar.

Study Duration

12 months.

Sample Size

108 patients.

Inclusion Criteria

- Diagnosed cases of COPD based on GOLD criteria
- Age ≥ 40 years
- Clinically stable patients

Exclusion Criteria

- Known cardiac disease
- Diabetes mellitus
- Hypertension
- Neurological disorders
- Patients on drugs affecting autonomic function

Assessment of Autonomic Function

Autonomic function was assessed using:

- Resting heart rate and blood pressure
- Heart rate response to deep breathing
- Valsalva maneuver

Heart Rate Variability Analysis

Five-minute resting ECG recordings were used to calculate HRV parameters:

- **Time-domain:** SDNN, RMSSD
- **Frequency-domain:** LF, HF, LF/HF ratio

Disease severity was classified according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria.

Statistical Analysis

Data were analyzed using SPSS software. Continuous variables were expressed as mean ± SD. Comparison between variables was performed using appropriate parametric tests. Correlation between heart rate variability parameters and disease severity was assessed using Pearson's correlation coefficient. A p-value < 0.05 was considered statistically significant.

Results

A total of 108 patients diagnosed with chronic obstructive pulmonary disease were included in the study. All participants

completed autonomic function testing and heart rate variability analysis.

Demographic Characteristics

The mean age of the study population was 59.8 ± 8.6 years. Males constituted the majority of the participants (72.2%). A history of smoking was present in 77.8% of patients. The demographic profile of the study population is summarized in **Table 1**.

Table 1: Demographic characteristics of COPD patients (n = 108)

Variable	Value
Mean age (years)	59.8 ± 8.6
Male	78 (72.2%)
Female	30 (27.8%)
Smoking history	84 (77.8%)

Time-Domain Heart Rate Variability Parameters

Analysis of time-domain HRV parameters revealed a significant reduction in overall heart rate variability among COPD patients. The mean SDNN was 78.4 ± 18.6 ms, and the mean RMSSD was 21.3 ± 7.9 ms, indicating reduced parasympathetic activity. These findings are presented in **Table 2**.

Table 2: Time-domain heart rate variability parameters

Parameter	Mean ± SD
SDNN (ms)	78.4 ± 18.6
RMSSD (ms)	21.3 ± 7.9

SDNN: Standard deviation of NN intervals; RMSSD: Root mean square of successive differences. Values indicate reduced overall heart rate variability and parasympathetic activity when compared with established normative reference values.

Frequency-Domain Heart Rate Variability Parameters

Frequency-domain analysis demonstrated autonomic imbalance with sympathetic predominance. The mean low-frequency (LF) power was 612.4 ± 210.6 ms², while the high-frequency (HF) power was 218.7 ± 96.4 ms². The mean LF/HF ratio was 2.9 ± 1.1, suggestive of increased sympathetic modulation. Frequency-domain HRV parameters are detailed in **Table 3**.

Table 3: Frequency-domain heart rate variability parameters

Parameter	Mean ± SD
LF (ms²)	612.4 ± 210.6
HF (ms²)	218.7 ± 96.4
LF/HF ratio	2.9 ± 1.1

LF: Low frequency; HF: High frequency. Increased LF/HF ratio reflects sympathetic predominance compared with normal reference ranges.

Correlation Between HRV and Disease Severity

A statistically significant association was observed between COPD severity and HRV parameters. Patients with more severe disease showed higher LF/HF ratios and lower SDNN values. The correlation between LF/HF ratio and disease severity was statistically significant ($p < 0.001$). This relationship is graphically illustrated in **Figure 1**.

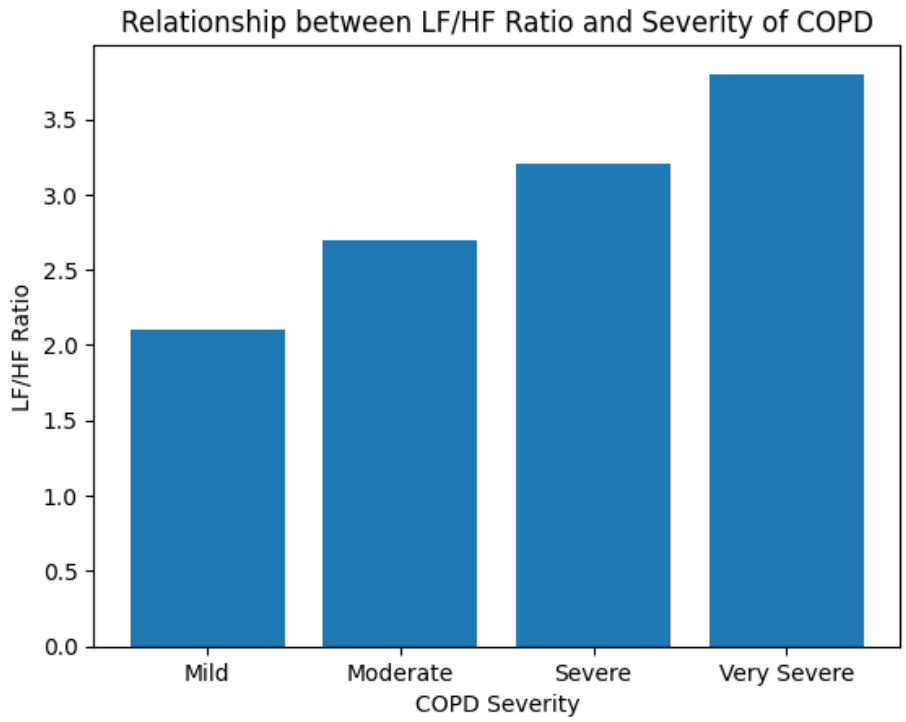

Figure 1: Relationship between LF/HF ratio and severity of chronic obstructive pulmonary disease showing progressive sympathetic predominance with increasing disease severity.

Discussion

The present study demonstrates significant autonomic dysfunction in COPD patients, as evidenced by reduced HRV parameters. These findings are consistent with previous studies reporting sympathovagal imbalance in COPD [13–15].

Chronic hypoxemia and systemic inflammation are proposed mechanisms leading to enhanced sympathetic activation and reduced parasympathetic modulation [16,17]. Reduced SDNN and RMSSD observed in the present study indicate diminished overall HRV and parasympathetic activity, respectively [18].

The increased LF/HF ratio suggests sympathetic predominance, which has been associated with higher cardiovascular risk and mortality [19]. Similar findings have been reported in studies evaluating HRV in moderate to severe COPD patients [20,21].

The significant correlation between HRV parameters and disease severity highlights the potential role of autonomic assessment as a prognostic marker in COPD [22]. Early identification of autonomic dysfunction may allow timely interventions, including pulmonary rehabilitation and optimization of therapy [23,24].

This study adds valuable regional data and reinforces the importance of assessing autonomic function in COPD patients, especially in resource-limited settings [25].

Conclusion

Autonomic dysfunction is common in COPD patients and is characterized by reduced heart rate variability with sympathetic dominance. HRV assessment may serve as a useful non-invasive tool for early detection of autonomic imbalance and may aid in risk stratification and management of COPD patients.

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