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A CROSS-SECTIONAL STUDY TO COMPARE HEART RATE VARIABILITY IN PATIENTS OF OBSESSIVE-COMPULSIVE DISORDER AND HEALTHY CONTROLS

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ABSTRACT

Background. Obsessive-compulsive disorder has been increasingly linked to autonomic nervous system dysregulation, which may confer elevated cardiovascular risk. Heart rate variability is a non-invasive marker of sympathovagal balance and autonomic flexibility. However, comprehensive heart rate variability assessment incorporating nonlinear indices in young, drug-naïve obsessive-compulsive disorder patients remains limited.
Aim. To compare time-domain, frequency-domain, and nonlinear heart rate variability parameters between patients with obsessive-compulsive disorder and healthy controls.
Materials and methods. The present cross-sectional comparative study included 80 participants aged 20–30 years: 40 newly diagnosed obsessive-compulsive disorder patients and 40 age- and sex-matched healthy controls. Heart rate variability was assessed using a 5-minute resting electrocardiography recording under standardized conditions.
Results. Patients with obsessive-compulsive disorder demonstrated a significant reduction in heart rate variability compared with healthy controls. Time-domain heart rate variability parameters were significantly lower in the obsessive-compulsive disorder group, indicating reduced parasympathetic cardiac modulation. In the frequency domain, total power and high-frequency normalized units were significantly decreased in obsessive-compulsive disorder patients, whereas low-frequency power, very-low-frequency power, and the low frequency/high frequency ratio did not show statistically significant differences between the two groups. Nonlinear heart rate variability analysis revealed a significant reduction in standard deviation 2, reflecting impaired long-term heart rate variability dynamics, while the standard deviation 1/standard deviation 2 ratio remained preserved.
Conclusion. Patients with obsessive-compulsive disorder demonstrate significant autonomic imbalance characterized by parasympathetic withdrawal, reduced overall heart rate variability, and diminished autonomic flexibility. These findings support impaired cardiovascular autonomic regulation as a consistent physiological feature of obsessive-compulsive disorder and highlight the potential role of heart rate variability assessment in early cardiovascular risk stratification and integrative psychiatric evaluation.

Key words: *obsessive-compulsive disorder, heart rate variability, autonomic dysfunction, parasympathetic activity, sympathovagal balance*

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ВАРИАБЕЛЬНОСТЬ СЕРДЕЧНОГО РИТМА У ПАЦИЕНТОВ С ОБСЕССИВНО-КОМПУЛЬСИВНЫМ РАССТРОЙСТВОМ И ЗДОРОВЫХ КОНТРОЛЬНЫХ ЛИЦ: ПОПЕРЕЧНОЕ ИССЛЕДОВАНИЕ

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АННОТАЦИЯ

Актуальность. Обсессивно-компульсивное расстройство всё чаще связывают с дисрегуляцией вегетативной нервной системы, что может повышать риск сердечно-сосудистых заболеваний. Вариабельность сердечного ритма является неинвазивным маркером вегетативной нервной системы. Однако комплексная оценка вариабельности сердечного ритма у больных с обсессивно-компульсивным расстройством, не принимавших лекарства, остаётся ограниченной.

Цель. Сравнить параметры вариабельности сердечного ритма во временной, частотной и нелинейной областях у пациентов с обсессивно-компульсивным расстройством и здоровых контрольных лиц.

Материалы и методы. Обследованы 80 человек в возрасте 20–30 лет: 40 пациентов с обсессивно-компульсивным расстройством и 40 здоровых лиц. Вариабельность сердечного ритма оценивалась с помощью 5-минутной записи электрокардиографии в состоянии покоя в стандартизированных условиях.

Результаты. У пациентов с обсессивно-компульсивным расстройством наблюдалось значительное снижение вариабельности сердечного ритма по сравнению со здоровыми пациентами. Параметры вариабельности сердечного ритма во временной области были значительно ниже в группе пациентов с обсессивно-компульсивным расстройством, что указывает на снижение парасимпатической модуляции сердечной деятельности. В частотной области общая мощность и нормированные единицы высокочастотного диапазона были значительно снижены у пациентов с обсессивно-компульсивным расстройством, в то время как мощность низкочастотного диапазона, мощность очень низкочастотного диапазона и отношение низких и высоких частот не показали статистически значимых различий между двумя группами. Нелинейный анализ вариабельности сердечного ритма выявил значительное снижение стандартного отклонения 2, отражающее нарушение динамики вариабельности сердечного ритма в долгосрочной перспективе, в то время как отношение стандартных отклонений 1 и 2 оставалось стабильным.

Заключение. Пациенты с обсессивно-компульсивным расстройством демонстрируют значительный вегетативный дисбаланс со снижением парасимпатической активности и общей вариабельности сердечного ритма, уменьшением вегетативной гибкости, что подтверждает важную роль вегетативной регуляции при обсессивно-компульсивных расстройствах, подчеркивает потенциальную роль оценки вариабельности сердечного ритма в ранней стратификации сердечно-сосудистого риска и комплексной психиатрической оценке.

Ключевые слова: *обсессивно-компульсивное расстройство, вариабельность сердечного ритма, вегетативная дисфункция, парасимпатическая активность, симпатовагальный баланс*

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INTRODUCTION

The autonomic nervous system (ANS), a neural network contributing to genesis, maintenance and regulation of varied organ system homeostatic physiological dynamics, influences and modulates several essential physiological axes, namely, heart rate, blood pressure, respiration, digestion, reproduction, and other homeostatic input and output processes [1, 2].

The fine-tuned interplay between the sympathetic nervous system and parasympathetic nervous system is critically relevant for physiological homeostasis maintenance, inclusive of cardiorespiratory function and an interference of this delicately pitched equilibrium leads to autonomic dysfunction, associated with varied disorders, both physiological and psychological, including cardiovascular diseases (CVD), arrhythmias, hypertension and antecedent cardiovascular events and neuro-psychiatric complications, implicating a primal role of autonomic system dynamics, excessive sympathetic activity at the expense of reduced and compromised parasympathetic output, in genesis of pathological conditions affecting the cardiovascular system [3–5].

Obsessive-compulsive disorder (OCD) is a chronic psychiatric condition characterized by the presence of obsessions and compulsions. OCD is classified as an anxiety disorder in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), and is characterized by significant distress or impairment in social, occupational, or other important areas of functioning due to the persistence of obsessions and compulsions [6, 7].

Globally, OCD impacts an estimated 2–3 % of individuals over their lifetime, while annual prevalence rates range from 1.1 to 1.6 % [8, 9].

Neurobiologically, OCD reflects dysregulation of cortico-striato-thalamo-cortical circuits, aberrant prefrontal inhibitory control, and hyperactivity of limbic and hypothalamic regions – mechanisms closely tied to autonomic output. Studies demonstrate that individuals with OCD commonly show elevated sympathetic activity, reduced parasympathetic tone, and impaired vagal regulation [10–12].

Heart rate variability (HRV) as an important tool to evaluate autonomic functions, provide valuable insights into the interplay between the sympathetic and parasympathetic branches of the autonomic system and can help identify early signs of autonomic dysfunction, which may increase cardiovascular risk [13, 14].

Despite growing evidence linking OCD with autonomic dysfunction, gaps persist. Many studies have assessed only limited HRV parameters, used heterogeneous age groups, or failed to include nonlinear measures. A comprehensive autonomic evaluation in young drug-free OCD patients is clinically relevant because reduced HRV may predispose these patients to cardiovascular risk early in life.

The present study aims to fill this gap by performing detailed HRV assessment – time-domain, frequency-domain, and nonlinear measures – in young adults with OCD compared to healthy controls.

MATERIALS AND METHODS

The present study was a cross-sectional, comparative study conducted at the Department of Physiology, in collaboration with Department of Psychiatry at S.M.S. Medical College and Attached Hospitals, Jaipur (Rajasthan) from March 2024 to May 2025 after obtaining the desired approval from Institutional Research Review Board (IRRB) and Ethics Committee of the Institution. A total of 80 study participants were recruited within the age group of 20–30 years of either sex after obtaining the written informed consent in which 40 were newly diagnosed patients with obsessive compulsive disorder as cases and 40 were healthy controls. The procedure was explained to all before commencing any test and a detailed history was recorded.

Inclusion criteria. Newly diagnosed patients with obsessive-compulsive disorder, aged 20–30 years of either sex as cases, age matched healthy volunteers of either sex as controls, and participants given written informed consent were included in the present study.

Exclusion criteria. Subjects who have any psychiatric disorder other than OCD, history and/or symptoms of any cardiovascular or pulmonary disease or any disease affecting cardiovascular function, individuals on medications which are known to affect cardiovascular function and subjects who have history of smoking and alcoholism were excluded from the present study.

METHODOLOGY

All the subjects were instructed to abstain from coffee, nicotine, alcohol 24 hours and food 2 hours before undergoing examinations. The procedure of the test was explained to all the subjects before conducting the tests. All the subjects were given 10 minutes rest in supine position, so that subjects may acclimatize themselves to experimental and environmental conditions.

Heart rate variability (HRV) data were collected by recording a standard three-lead electrocardiogram (ECG) using a PowerLab system (AD Instruments) at a sampling rate of 1000 Hz. Each participant rested in the supine position for 10 minutes, followed by a 5-minute recording period under spontaneous breathing in a quiet, temperature-controlled room maintained at 24 ± 1 °C. Participants were instructed to keep their eyes closed, remain silent, and minimize body movements to avoid artifacts. The HRV analysis was performed in compliance with the Task Force recommendations (1996) [15] using LabChart HRV Analysis Module (AD Instruments). Three analysis domains were utilized:

- **Time-domain measures:** SDNN (standard deviation of NN intervals); RMSSD (root mean square of suc-

cessive differences), and pNN50 (percentage of NN intervals differing by more than 50 ms), reflecting overall and parasympathetic variability.

• **Frequency-domain measures:** power spectral density was calculated using fast Fourier transform (FFT) for Total Power, VLF (very low frequency), LF (low frequency), HF (high frequency), and LF/HF ratio.

• **Nonlinear analysis:** Poincare plot analysis was applied to assess the complexity of RR interval dynamics for SD1, SD2 and SD1/SD2 ratio.

Statistical analysis

The collected data was analysed using the statistical package for social sciences (SPSS) version 27 and Microsoft Excel 2021. The normality of the data was assessed using the Shapiro – Wilk test. The data were not normally distributed hence parameters were described as the median and interquartile range. Mann – Whitney U-test was applied for testing the significance of the difference between OCD patients and healthy controls. P-value of <0.05 was taken as statistically significant.

RESULTS

Time domain measures (Table 1) revealed a consistent and significant reduction in heart rate variability (HRV) among OCD patients, indicative of autonomic dysregulation. The SDNN, a global measure of HRV reflecting both sympathetic and parasympathetic activity, was significantly lower in the OCD group [38.68 ms (IQR: 27.44–54.47)] compared to controls [57.01 ms (IQR: 45.37–65.59); $p < 0.001$].

Similarly, RMSSD, which specifically reflects short-term parasympathetic modulation, was reduced in OCD participants [31.75 ms (IQR: 22.12–41.70)] versus controls [40.66 ms (IQR: 33.53–51.99); $p < 0.001$].

Moreover, the percentage of NN intervals differing by more than 50 ms (pNN50) was markedly lower in the OCD group [11.68 % (IQR: 4.93–23.74)] than in the control group [22.32 % (IQR: 16.39–27.19); $p = 0.001$], further confirming diminished vagal activity and compromised beat-to-beat variability in individuals with OCD.

Frequency-domain measures (Table 2) also demonstrated reduced autonomic flexibility in OCD. The total power, representing overall autonomic input, was significantly lower in OCD patients [1372.05 ms^2 (IQR: 831.72–2459.12)] compared to healthy controls [2087.00 ms^2 (IQR: 1117.25–2806.75); $p = 0.026$].

A significant reduction was also seen in the high-frequency (HF) component [OCD: 48.51 nu (IQR: 39.25–56.84); control: 59.84 nu (IQR: 40.92–69.15); $p = 0.049$], which is predominantly mediated by parasympathetic input.

In contrast, there were no significant group differences in the very low frequency (VLF) component [OCD: 361.95 ms^2 (IQR: 146.86–492.21); control: 300.02 ms^2 (IQR: 171.40–462.73); $p = 1.000$] or the low-frequency (LF) component [OCD: 43.43 nu (IQR: 30.23–52.68); control: 35.96 nu (IQR: 29.84–46.20); $p = 0.167$].

The LF/HF ratio, often used as a marker of sympathovagal balance, showed a trend toward increase

TABLE 1

TIME-DOMAIN PARAMETERS OF HRV IN OCD PATIENTS VS. CONTROLS

Parameters	OCD		Control		*p*-value
	median	interquartile range	median	interquartile range	
SDNN, ms	38.68	27.44–54.47	57.01	45.37–65.59	0.00009*
RMSSD, ms	31.75	22.12–41.70	40.66	33.53–51.99	0.00039*
pNN50, %	11.68	4.93–23.74	22.32	16.39–27.19	0.00136*

TABLE 2

FREQUENCY-DOMAIN PARAMETERS OF HRV IN OCD PATIENTS VS. CONTROLS

Parameters	OCD		Control		*p*-value
	median	interquartile range	median	interquartile range	
Total _P, ms^2	1372.05	831.72–2459.12	2087.00	1117.25–2806.75	0.02561*
VLF, ms^2	361.95	146.86–492.21	300.02	171.40–462.73	1.00000
LF, nu	43.43	30.23–52.68	35.96	29.84–46.20	0.16692
HF, nu	48.51	39.25–56.84	59.84	40.92–69.15	0.04854*
LF/HF, %	0.79	0.58–1.07	0.71	0.45–0.91	0.09883

TABLE 3
NONLINEAR PARAMETERS IN OCD PATIENTS VS. CONTROLS

Parameters	OCD		CONTROL		p-value
	median	interquartile range	median	interquartile range	
SD1, ms	36.38	22.71–55.14	40.14	31.07–59.31	0.09883
SD2, ms	76.42	49.55–88.45	92.69	78.62–131.37	0.00056*
SD1/SD2	0.51	0.45–0.61	0.48	0.39–0.60	0.21204

in the OCD group but did not reach statistical significance [0.79 (0.58–1.07) vs. 0.71 (0.45–0.91); $p = 0.099$].

Nonlinear HRV parameters (Table 3), which provide insight into the complexity and self-similarity of heart rate dynamics, also showed alterations in OCD patients. SD2, which captures long-term HRV patterns, was significantly lower in the OCD group [76.42 ms (IQR: 49.55–88.45)] than in the control group [92.69 ms (IQR: 78.62–131.37); $p < 0.001$]. While SD1, reflecting short-term variability, was numerically lower in OCD [36.38 ms (IQR: 22.71–55.14)] compared to controls [40.14 ms (IQR: 31.07–59.31)], the difference was not statistically significant ($p = 0.099$). The SD1/SD2 ratio, a dimensionless index of HRV geometry, also did not differ significantly ($p = 0.212$), suggesting that while overall variability was reduced, the proportional contribution of short- and long-term components was preserved.

DISCUSSION

The present study demonstrated significantly reduced heart rate variability (HRV) in patients with OCD, characterized by decreased SDNN, RMSSD, pNN50, HF power, total power, and SD2 indices, indicating generalized parasympathetic withdrawal and impaired autonomic flexibility. These findings suggest that OCD is associated with sustained vagal inhibition rather than transient autonomic hyperarousal.

The present findings parallel R. Hoehn-Saric et al. (1995) [16], who reported reduced psychophysiological responsiveness in OCD despite elevated subjective anxiety. While their work emphasized stress reactivity, the comprehensive HRV assessment in the present study confirms impaired autonomic adaptability in OCD. In contrast, B.R. Slaap et al. (2004) [17] reported preserved HRV, possibly due to reliance on limited short-term spectral measures. The inclusion of time-, frequency-, and nonlinear indices in the present study likely enhanced sensitivity to autonomic dysfunction.

The reduced HRV data observed is consistent with D.M. Davydov et al. (2007) [18] in major depression and K.J. Bär et al. (2007) [19] in schizophrenia, both demonstrating parasympathetic withdrawal with relative sympathetic dominance. These convergent findings suggest shared autonomic dysregulation and cardiovascular vulnerability across psychiatric disorders.

The results also align with the neurovisceral integration model proposed by J.F. Thayer et al. (2009) [20], which links reduced HRV to impaired prefrontal inhibitory control over autonomic and emotional systems. In this context, reduced HRV in OCD reflects diminished neurovisceral flexibility and impaired self-regulation, supporting reduced HRV as a core pathophysiological marker rather than an epiphenomenon.

Consistent with A. Pittig et al. (2013) [21] and the meta-analysis by J.A. Chalmers et al. (2014) [22], the present study demonstrated reduced HF-HRV across anxiety-related psychopathology, including OCD. Although A. Havnen et al. (2013) [23] did not find a direct association between HRV and OCD severity, their observation of reduced HF-HRV in relation to impaired cognitive inhibition supports a link between vagal tone and executive control, complementing the present findings.

Similar to present study autonomic impairment has been reported by H. Olbrich et al. (2022) [24] in unmedicated OCD patients and by M. Sandhya et al. (2022) [12], who demonstrated reductions across multiple HRV domains along with abnormal autonomic reactivity.

Finally, alignment with Z. Wang et al. (2023) [25] and F. Jüres et al. (2024) [26], who reported reduced HRV across emotional disorders and in first-degree relatives of OCD patients, respectively, suggests that diminished vagal tone may represent both a disease marker and a potential endophenotype for OCD. Collectively, these findings confirm that impaired parasympathetic modulation and autonomic inflexibility are consistent physiological features of OCD, with implications for cardiovascular risk stratification and targeted autonomic interventions.

CONCLUSION

The present study, in comparison with prior research, confirms that OCD is characterized by impaired cardiovascular autonomic function, including reduced parasympathetic modulation, sympathetic predominance, and diminished autonomic adaptability. While minor discrepancies exist due to methodological and demographic differences, the overall pattern is consistent with fin-

dings in other anxiety disorders. By systematically combining HRV and reflex-based measures in a homogeneous young adult cohort, the present study reinforces sympathovagal imbalance as a robust feature of OCD and highlights the value of cardiovascular autonomic testing as an objective adjunct in psychiatric assessment.

LIMITATIONS

The present study has several limitations, including a modest, age-restricted sample, single-centre design, cross-sectional approach, and potential confounding from prior medication or psychiatric comorbidities. Advanced autonomic assessment tools and lifestyle factors were also not fully incorporated, which may influence results. Future research should involve larger, multicentre, and longitudinal studies to clarify causal relationships and disorder-specific autonomic patterns, integrate advanced HRV and neuroimaging measures, and stratify for comorbidities. Such work could establish autonomic parameters as prognostic biomarkers and guide individualized therapy in OCD.

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Ethics approval

The study was approved by the local ethics committee. The approval and procedure for the protocol were obtained in accordance with the principles of the Helsinki Convention.

Conflict of interest

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Authors' contribution

The authors declare their authorship to be in compliance with the international ICMJE criteria.
Lokesh Kumar – conceptualization; methodology; investigation; data curation; formal analysis; visualization; writing – original draft; article administration.
Ashwani Verma – investigation; data curation.
Harsha Shree Sharma – investigation.
Amitabh Dube – conceptualization; methodology; writing – review and editing, supervision.

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Протокол исследования был одобрен локальным этическим комитетом. Одобрение и процедуру проведения протокола получали по принципам Хельсинкской конвенции.

Конфликт интересов

Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

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