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Original Article

Hematological Inflammatory Markers Are Associated with Parkinson's Disease Severity

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Abstract

Background: Parkinson's disease (PD) is a progressive neurodegenerative disorder with increasing prevalence in Sub-Saharan Africa. Hematological biomarkers, reflecting systemic inflammation, may predict disease severity.

Objective: This study evaluates their prognostic potential in PD patients from Southwest Nigeria.

Methods: A hospital-based, cross-sectional study was conducted, involving 70 PD patients stratified into severe (stages 3–5, n=10) and non-severe (stages 1–2, n=60) groups using the Hoehn and Yahr (H&Y) scale, and 70 age- and sex-matched controls. Hematological parameters (white blood cell, red cell, platelet indices, and ratios) were analyzed using t-tests, binary logistic regression, and Receiver Operating Characteristic (ROC) curve analysis. A p-value < 0.05 was considered significant.

Results: Severe PD was observed in 14% of patients, with 76% being male. Compared to controls, PD patients had lower red blood cell counts (P=0.045), haemoglobin (P=0.014), and higher red cell distribution width-standard deviation (RDW-SD, P<0.001). Independent predictors of severity included age (P=0.010), gender (P=0.003), red blood cell count (P=0.002), haemoglobin (P=0.003), haematocrit (P=0.007), RDW-SD (P=0.001), and plateletcrit (PCT, P<0.001). ROC analysis showed excellent predictive accuracy for RDW-SD (AUC=0.959) and PCT (AUC=1.000).

Conclusion: RDW-SD and PCT are robust biomarkers for PD severity, highlighting the role of systemic inflammation. These findings support their integration into PD management and warrant further longitudinal studies.

Keywords: Parkinson's disease, hematological biomarkers, RDW-SD, PCT, inflammation, severity

Introduction

There has been increasing burden of PD in the last two decades.(Alabi et al., 2019; A. A. Ojagbemi et al., 2013; Ojo et al., 2021; Otubogun et al., 2020). Observed prevalence of PD ranges from 7/100,000 in Ethiopia to 67/100,000 in Nigeria. The most recent community based study reported a mean age at onset of 69.4 years.(A. Ojagbemi, 2013; Ojo et al., 2020; Zesiewicz, 2019) PD are the most common movement disorders and are generally perceived to have lower prevalence and incidence in Sub-Saharan Africa (SSA) because of the relative youthfulness of the SSA population, under-recognition, paucity of published reports, and cultural perception of neurologic disorders generally as being part of normal ageing. (Ojo et al., 2020, 2021)

Parkinson's disease (PD) is marked by α-synuclein accumulation and chronic neuroinflammation, contributing to neuronal loss. Inflammatory processes involve microglial activation, cytokine release, and gut microbiota changes.(Eo et al., 2024) Several anti-inflammatory agents have shown neuroprotective effects in PD models. Key inflammatory biomarkers such as NLRP3, NF-κB, α-synuclein, chemokines, and VEGFA play roles in immune regulation and disease progression. Blood-based ratios like NLR, NHR, RDW-SD, PLT, and MHR, along with cytokines (e.g., IL-6, TNF-α, hsCRP), offer promise for early detection, monitoring, and targeted therapy in PD.(Li et al., 2024a)

Reliable biomarkers are needed to improve early diagnosis, monitor disease progression, and evaluate treatment response in Parkinson's disease (PD), as current methods are limited by cost and accessibility. Indices derived from full blood count (FBC) parameters such as the red cell distribution width to platelet (RDW-/PLT), neutrophil to lymphocyte ratio (NLR), neutrophil to high-density lipoprotein ratio (NHR), and monocyte to high-density lipoprotein ratio (MHR) are emerging as valuable, cost-effective tools for assessing disease severity and progression(Kwak et al., 2024; Muñoz-Delgado, Macías-García, et al., 2023). These biomarkers indicate systemic inflammation, which plays a crucial role in various chronic conditions, including neurodegenerative diseases like PD(Muñoz-Delgado, Labrador-Espinosa, et al., 2023). However, there is a significant lack of knowledge about the usefulness of these hematological markers in prognosticating and differentiating the severity of PD (Li et al., 2024b). This study attempts to assess the relationship between hematological biomarkers, their prognostic potential, and the severity of PD. Incorporating these indices into the care of PD patients could notably improve monitoring, ultimately aiding the development of new, personalized therapeutic strategies.

Materials and Methods

2.1 Study Design

This hospital-based, descriptive, cross-sectional study was conducted at a tertiary healthcare institution serving as the principal referral centre for the state and neighbouring regions. Ethical approval was obtained from the Health Research Ethics Committee (HREC) (Ref No: OOUTH/HREC/275/2019AP). Informed consent was secured from all participants, with confidentiality maintained and the option to withdraw without affecting medical care.

2,2 Selection and Description of Participants

The study included 70 PD patients and 70 healthy controls, matched for age and sex. PD diagnosis was confirmed using the National Institutes of Health (NIH) Parkinson Disease Clinical Data Elements, requiring bradykinesia plus at least one of rest tremor, rigidity, or postural instability (11).

Supportive criteria included asymmetric onset, positive response to dopaminergic therapy, and exclusion of alternative parkinsonism causes. Exclusion criteria included atypical parkinsonism or comorbidities affecting hematological parameters. PD patients were stratified into severe (stages 3–5, n=10) and non-severe (stages 1–2, n=60) groups using the Hoehn and Yahr (H&Y) scale (Li et al., 2024b).

2.3 Data Collection

An interviewer-based questionnaire collected socio-demographic details (age, gender, education, occupation), clinical history (age of onset, symptom duration, side of onset), symptom types (tremor, rigidity, bradykinesia, postural instability), medication usage, and medical records reviewed by a neurologist. Hematological parameters were obtained from full blood counts.

2.4 Statistical Analysis

Data were entered into Microsoft Excel for cleaning and analysed using IBM SPSS version 23. Normality was confirmed using the Shapiro-Wilk test, enabling parametric tests. Descriptive statistics were calculated for demographic and clinical variables. Group comparisons used Chi-square tests for categorical data and independent t-tests for continuous variables. Binary logistic regression identified predictors of PD severity, and ROC curve analysis evaluated diagnostic performance of significant hematological parameters. A p-value < 0.05 was considered significant.

Results

3.1 Comparison of Demographic and Hematological Parameters Between Cases and Controls

Among 70 PD patients, 14% (n=10) had severe PD, with 53 (75.7%) being male and 17 (24.3%) females based on biological sex. The mean age at onset was 69.4 years. Table 1 compares demographic and hematological parameters between PD patients and controls, showing significant differences in red blood cell count (RBC, P=0.045), haemoglobin (HGB, P=0.014), mean corpuscular volume (MCV, P=0.001), mean corpuscular haemoglobin (MCH, P<0.001), RDW-SD (P<0.001), platelet distribution width (PDW, P=0.002), platelet-to-lymphocyte ratio (PLR, P<0.001), and RDW-SD/PLT (P=0.003).

3.2 Demographic and Clinical Characteristics

Age Group: Patients aged >60 years had a higher prevalence of severe PD (100% vs. 38.3%, χ^2=13.081, P<0.001).

Gender: Females showed a higher proportion of severe PD (60% vs. 18.3%, χ^2=8.093, P=0.004).

3.3 Hematological Parameters

White Blood Cell Indices: Severe PD patients had higher total white blood cell counts (7.77±5.27 vs. 5.37±2.11 $\times 10^9$/L, P=0.013). No significant differences were found for neutrophils, lymphocytes, monocytes, eosinophils, or basophils.

Red Cell Indices: Severe PD patients had lower RBC (3.76±0.29 vs. 4.85±0.63 $\times 10^{12}$/L, P<0.001), HGB (10.71±1.80 vs. 12.38±1.34 g/dL, P=0.001), haematocrit (HCT, 32.64±4.65 vs. 37.32±4.40%, P=0.003), and higher RDW-SD (55.65±9.63 vs. 39.73±4.98 fL, P<0.001). MCV (P=0.001) and MCH (P=0.012) differed significantly.

Platelet Indices: Plateletcrit (PCT) was higher in severe PD (0.32±0.00 vs. 0.22±0.04%, P<0.001). No differences were found for platelet count (PLT), mean platelet volume (MPV), or PDW.

Ratios: NLR (1.92±1.52 vs. 1.12±0.97, *P*=0.031), RDW-CV/PLT (0.16±0.14 vs. 0.07±0.019, *P*<0.001), and RDW-SD/PLT (0.50±0.39 vs. 0.20±0.062, *P*<0.001) were higher in severe PD.

3.4 Regression Analysis

Independent predictors of severe PD included age (p=0.010), gender (p=0.003), RBC (p=0.002), HGB (*P*=0.003), HCT (*P*=0.007), RDW-SD (*P*=0.001), and PCT (*P*<0.001).

3.5 ROC Analysis

ROC results, which showed excellent predictive accuracy for RDW-SD (AUC=0.959), PCT (AUC=1.000), Age group (AUC=0.857), Gender (AUC=0.888).

Discussion

This study investigated the association between full blood count-derived hematological biomarkers and the severity of Parkinson's Disease (PD), with the goal of identifying accessible and cost-effective biomarkers. The results reveal that red cell distribution width-standard deviation (RDW-SD) and plateletcrit (PCT) are promising biomarkers of PD severity.

Participants with severe PD had lower red blood cell (RBC) counts, hemoglobin (HGB), and hematocrit (HCT), and significantly higher RDW-SD and PCT. RDW-SD and PCT had exceptionally high predictive power, with receiver operating characteristic (ROC) area under the curve (AUC) values of 0.959 and 1.000 respectively, suggesting their strong potential as biomarkers of disease severity.

Logistic regression confirmed that age group, gender, RBC, HGB, HCT, RDW-SD, and PCT were all independent predictors of disease severity ($p < 0.05$). Older age is associated with a higher likelihood of severe PD, and females, despite being fewer in number, had disproportionately higher severity rates(Gialluisi et al., 2024). The therapeutic implication of this study with regard to hormone will need to be fully explored. These findings suggest a systemic inflammatory profile and hematological dysregulation accompanying PD progression, which aligns with emerging evidence linking chronic inflammation to neurodegeneration(Ma et al., 2024).

These results are in agreement with existing literature highlighting the role of inflammation and oxidative stress in PD (Hartai et al., 2005; Kenangil et al., 2020). Prior studies have shown elevated RDW-SD values in patients with chronic inflammatory and neurodegenerative disorders, which supports our findings of higher RDW-SD in severe PD.

Similarly, the identification of PCT as a marker of total platelet volume as a significant predictor may reflect platelet activation and vascular changes, which have been implicated in PD related neuroinflammation. While the AUC of 1.000 for PCT may appear unusually high, it suggests near-perfect discriminatory ability.

Interestingly, while the neutrophil-to-lymphocyte ratio (NLR) trended higher in severe PD, it was not statistically significant in the regression model. This was unexpected given NLR's known relationship with systemic inflammation. The small sample size or confounding variables such as medication use and comorbidities may have influenced this result.

Conclusion

RDW-SD and PCT are promising, inflammation-related biomarkers for PD severity. Their integration into clinical practice could improve patient management in resource-limited settings. Further research is warranted to establish their longitudinal utility and therapeutic implications.

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