Diagnostic Efficacy of Platelet-Related Parameters in Peritoneal Dialysis Patients with Comorbid Anxiety and Depression: Postprint

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Date: 2023-06-15T00:00:00+00:00

Abstract

Abstract Objective: To analyze the relationship between the incidence of anxiety and depression and platelet-related parameters in peritoneal dialysis (PD) patients, and the diagnostic efficacy of platelet-related parameters for anxiety-depression status in PD patients. Methods: A total of 245 PD patients from the First Affiliated Hospital of Hebei North University between September 2022 and February 2023 were selected. The Generalized Anxiety Disorder-7 (GAD-7) (7-time Generalized Anxiety Disorder Scale) and Patient Health Questionnaire-9 (PHQ-9) (Patient Heslth Questionnaire–9) were used to evaluate anxiety and depression status, respectively. Platelet count (PLT), mean platelet volume (MPV), and platelet distribution width (PDW) were taken as primary observation variables, while patient age, gender, education level, marital status, employment status, dialysis duration, body mass index (BMI), blood urea nitrogen (BUN), creatinine (Cr), glomerular filtration rate (GFR), and creatinine clearance rate (Ccr) served as covariates. Statistical analysis was performed using IBM SPSS 26.0. Results: In this study, the incidence of anxiety among PD patients was 15.9%, and the incidence of depression was 38.0%. After grouping, MPV, PDW, and dialysis duration showed significant differences between the two groups ($P<0.05$). Correlation analysis indicated that these differences were significantly correlated with the concomitant anxiety-depression state in PD patients. Binary logistic regression suggested that MPV and PDW were independent risk factors for anxiety-depression status in PD patients. The receiver operator characteristic curve,ROC indicated MPV for anxiety (AUC=0.750), MPV for depression (AUC=0.80), PDW for anxiety (AUC=0.732), PDW for depression (AUC=0.780). Conclusion: MPV and PDW demonstrate high diagnostic efficacy for anxiety-depression status in PD patients and can serve as objective reference indicators for anxiety-depression status in PD patients.

Full Text

Preamble

Diagnostic Efficacy of Platelet-Related Parameters for Anxiety and Depressive States in Peritoneal Dialysis Patients

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Funding: Hebei Provincial Technology Innovation Guidance Project (20477750D); Hebei Provincial Medical Science Research Project Plan for 2020 (20200542)

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Abstract

Objective: To analyze the relationship between the incidence of anxiety and depression and platelet-related parameters in peritoneal dialysis (PD) patients, and to evaluate the diagnostic efficacy of these parameters for anxiety-depressive states in PD patients.

Methods: A total of 245 PD patients from the First Affiliated Hospital of Hebei North University were enrolled between September 2022 and February 2023. Anxiety and depression were assessed using the Generalized Anxiety Disorder-7 (GAD-7) scale and Patient Health Questionnaire-9 (PHQ-9), respectively. Platelet count (PLT), mean platelet volume (MPV), and platelet distribution width (PDW) served as primary observation variables, while age, gender, education level, marital status, employment status, dialysis vintage, body mass index (BMI), blood urea nitrogen (BUN), creatinine (Cr), glomerular filtration rate (GFR), and creatinine clearance rate (Ccr) were included as covariates. Statistical analysis was performed using IBM SPSS 26.0.

Results: The prevalence of anxiety and depression in PD patients was 15.9% and 38.0%, respectively. After grouping, MPV, PDW, and dialysis vintage showed significant differences between groups ($P<0.05$). Correlation analysis revealed significant associations between these parameters and anxiety-depressive states in PD patients. Binary logistic regression identified MPV and PDW as independent risk factors for anxiety-depressive states in PD patients. Receiver operating characteristic (ROC) curve analysis demonstrated the following AUC

values: MPV for anxiety (AUC=0.750), MPV for depression (AUC=0.80), PDW for anxiety (AUC=0.732), and PDW for depression (AUC=0.780).

Conclusion: MPV and PDW exhibit high diagnostic efficacy for anxiety-depressive states in PD patients and may serve as objective laboratory reference indicators for early identification of these conditions.

Keywords: peritoneal dialysis; anxiety; depression; mean platelet volume; platelet distribution width; combined diagnostic efficacy; ROC curve

Introduction

Chronic kidney disease (CKD) has emerged as a global public health concern with increasing incidence worldwide. By the end of 2018, approximately 86,264 patients were receiving peritoneal dialysis (PD) in China. While PD therapy can improve quality of life and prolong survival in CKD patients, various complications and physical symptoms frequently trigger anxiety and depressive states. The prevalence of anxiety and depression among CKD patients is substantially higher than in the general population, with a meta-analysis by Suetonia Palmer et al. indicating that CKD patients have a five-fold increased risk. Moreover, the incidence of anxiety and depression rises progressively with declining kidney function. Depressive symptoms represent an independent predictor of adverse clinical outcomes in CKD patients, and early detection and treatment can enhance treatment compliance.

Previous studies have linked anxiety and depression to neuroinflammatory responses, serotonin dysregulation, and deficiency of brain-derived neurotrophic factor (BDNF). Notably, BDNF is stored in platelets and released into circulation upon platelet activation, where it regulates neuronal and glial development and protects cognitive and neurological function. Platelet membranes contain serotonin receptors, and activated platelets secrete pro-inflammatory cytokines, anti-inflammatory factors, and various bioactive substances. The storage and release of these substances are closely related to platelet activity, while platelet parameters such as MPV and PDW serve as reliable indicators of platelet activation and function. This study aims to evaluate the prevalence of anxiety and depression among PD patients at our institution, analyze the correlation between platelet-related parameters and these conditions, and assess their predictive and diagnostic efficacy for anxiety-depressive states in PD patients. By introducing these correlations into clinical practice, we seek to provide objective laboratory markers for early identification of anxiety-depressive states in CKD patients, enabling timely intervention and improving diagnostic efficiency.

Methods

1.1 Study Population

We enrolled PD patients undergoing regular follow-up at the peritoneal dialysis clinic of the First Affiliated Hospital of Hebei North University between September 2022 and February 2023. Inclusion criteria were: (1) diagnosis of CKD according to established criteria; (2) age >18 years with dialysis vintage >6 months; (3) stable condition for 2 months without hospitalization, trauma, or surgery; (4) treatment with conventional glucose-based lactate-buffered dialysate (Ultrabag, Baxter Healthcare, Guangzhou, China) using continuous ambulatory peritoneal dialysis (CAPD); (5) ability to understand and complete questionnaires; and (6) capacity to provide informed consent. Exclusion criteria included: (1) history of psychiatric disorders or family history thereof; (2) organic brain injury; (3) hematological disorders or acute infection; (4) immune system diseases such as thrombocytopenic purpura; (5) blood transfusion within 3 months; (6) current use of psychiatric medications, sedative-hypnotics, hormones, or anticoagulants; and (7) communication barriers or inability to comprehend questionnaires. This cross-sectional study complied with the Declaration of Helsinki and was approved by the Ethics Committee of the First Affiliated Hospital of Hebei North University, with written informed consent obtained from all participants.

1.2 Data Collection and Assessment

We collected demographic and clinical data including age, gender, education level, marital status, employment status, BMI, BUN, Cr, GFR, Ccr, PLT, MPV, and PDW. Anxiety was assessed using the GAD-7 scale, which has demonstrated excellent reliability with 89% sensitivity and 82% specificity for detecting anxiety disorders. Depression was evaluated using the PHQ-9 scale, a validated instrument for measuring depression severity with 88% sensitivity and 88% specificity. For this study, we integrated the GAD-7 and PHQ-9 into a single questionnaire while preserving the original content. Trained research staff administered the questionnaires using standardized instructions in private settings without family members present. Completed questionnaires were reviewed by two investigators and scored according to the criteria shown in . Blood samples were collected after 12-hour fasting on the following day, drawn into EDTA tubes, and analyzed within 2 hours at the central laboratory of our hospital using a multi-parameter platelet function analyzer (PL-12, Jiangsu, China).

1.3 Observation Indicators

We retrieved patient demographics and laboratory values from electronic medical records. GFR was estimated using the 4-variable MDRD formula, and Ccr was calculated using the Cockcroft-Gault formula. Based on GAD-7 scores, patients were divided into anxiety (n=39) and non-anxiety groups (n=206). Based on PHQ-9 scores, patients were categorized into depression (n=93) and

non-depression groups (n=152). The primary objective was to examine associations between anxiety-depressive states and the aforementioned variables, and to evaluate their diagnostic efficacy for PD patients with comorbid anxiety and depression.

1.4 Statistical Analysis

All analyses were performed using IBM SPSS 26.0. Normality was assessed using the Kolmogorov-Smirnov test. Normally distributed continuous variables were expressed as mean±SD, non-normally distributed continuous variables as median (P25, P75), and categorical variables as n(%). Intergroup comparisons were conducted using independent samples t-test for normally distributed variables with homogeneity of variance, and Mann-Whitney U test for non-normally distributed variables. Point-biserial correlation analysis examined associations between variables and anxiety-depressive states. Binary logistic regression analysis identified independent risk factors among variables showing statistical significance. Receiver operating characteristic (ROC) curves assessed diagnostic efficacy, with cutoff values determined by Youden's index. All tests were two-tailed with significance set at α=0.05. Figures were generated using GraphPad Prism 9.0.

Results

2.1.1 Anxiety Group Characteristics

Among 245 valid cases (124 males [50.6%], 121 females [49.4%]; mean age $55.24\$\pm0.81years), the prevalence of anxiety was 15.9\^{}\{2\}\$=5.232,$ P=0.022), though the contingency coefficient of 0.145 suggested a weak relationship. Detailed data are presented in .

2.1.2 Depression Group Characteristics

The same cohort of 245 patients exhibited a depression prevalence of 38.0%. Mann-Whitney U tests identified significant differences between depression and non-depression groups in dialysis vintage (Z=-3.079, P=0.002), MPV (Z=-7.878, P<0.001), PDW (Z=-7.367, P<0.001), and PLT (Z=-2.77, P=0.006). Chi-square analysis revealed no significant associations between depression status and gender, marital status, education level, comorbidity type, or employment status. Complete data are shown in .

2.2.1 Anxiety Correlation Analysis

Point-biserial correlation analysis demonstrated significant positive correlations between anxiety and MPV (r=0.358, P<0.01), PDW (r=0.340, P<0.01), and a negative correlation with dialysis vintage (r=-0.141, P<0.05). Results are summarized in .

2.2.2 Depression Correlation Analysis

Significant correlations with depression were observed for PLT (r=-0.158, P<0.05), MPV (r=0.489, P<0.01), and PDW (r=0.477, P<0.01). These findings are detailed in .

2.3.1 Anxiety Group Regression Analysis

Binary logistic regression with anxiety status as the dependent variable and demographic/clinical factors as independent variables yielded a statistically significant model (^{2}=7.821, P=0.451) with 86.5% predictive accuracy. MPV (β=1.178, OR=3.249, 95%CI: 1.992-5.302, P<0.001) and PDW (β=0.533, OR=1.705, 95%CI: 1.348-2.155, P<0.001) emerged as independent risk factors for anxiety. Regression results are presented in .

2.3.2 Depression Group Regression Analysis

Similarly, logistic regression for depression status produced a significant model (^{2}=4.151, P=0.843) with 76.3% accuracy. MPV (β=1.752, OR=5.765, 95%CI: 3.434-9.677, P<0.001) and PDW (β=0.830, OR=2.294, 95%CI: 1.761-2.987, P<0.001) were identified as independent risk factors for depression. Complete results appear in .

2.4.1 Anxiety Diagnostic Efficacy

ROC analysis revealed an AUC of 0.750 (95%CI: 0.661-0.839) for MPV in predicting anxiety, with a cutoff value of 10.35 fL, sensitivity of 64.1%, and specificity of 78.2%. For PDW, the AUC was 0.732 (95%CI: 0.641-0.822), cutoff 11.45 fL, sensitivity 59.0%, and specificity 79.6%. The combined diagnostic model achieved an AUC of 0.859 (95%CI: 0.793-0.925). The ROC curve is shown in [Figure 1: see original paper].

2.4.2 Depression Diagnostic Efficacy

For depression, MPV demonstrated an AUC of 0.80 (95%CI: 0.740-0.859), cutoff 10.15 fL, sensitivity 63.4%, and specificity 84.2%. PDW showed an AUC of 0.78 (95%CI: 0.718-0.843), cutoff 10.85 fL, sensitivity 66.7%, and specificity 81.6%. The combined model yielded an AUC of 0.870 (95%CI: 0.826-0.915). The ROC curve is presented in [Figure 2: see original paper].

Discussion

Serotonin is synthesized from tryptophan in the gut via tryptophan hydroxylase, stored in platelet dense granules via serotonin transporters, and platelets serve as the primary transporters and largest storage pool of this key neurotransmitter in depression pathophysiology. MPV, a standard measure of

platelet size, is considered a reliable indicator of platelet activation. Our correlation analysis revealed significant positive associations between MPV, PDW, and anxiety-depressive states in PD patients, consistent with previous research. Balázs Fábián's study of autoimmune disease patients found MPV significantly correlated with depression (OR=2.003, p=0.012), while a large Italian cohort study of 12,732 healthy adults demonstrated a significant positive correlation between depressive symptoms and PDW. Mehmet Kokacya et al. reported that altered platelet activity could reflect abnormal serotonin 1A receptor function in panic disorder patients, and Fatih Canan's community-based study of 2,286 individuals identified mean MPV as a useful biomarker for psychiatric disorders, showing higher platelet activation in depressed patients. Furthermore, clinical and animal studies have confirmed that aspirin combined with antidepressants yields greater symptomatic improvement than antidepressant monotherapy, reinforcing the link between platelet parameters and depressive symptoms.

Our findings demonstrate that MPV and PDW are significantly positively correlated with depressive states in PD patients and exhibit high diagnostic predictive efficacy. Given the accessibility of these laboratory parameters, they may provide objective clinical guidance for early identification of adverse psychological states such as anxiety and depression in PD patients, thereby improving diagnostic timeliness. Although limited by its single-center, cross-sectional design and regional scope, our study establishes that MPV and PDW correlate positively with anxiety-depressive states in PD patients and offer high diagnostic efficacy. These results provide valuable evidence for early clinical diagnosis and create opportunities for early intervention in PD patients with comorbid depression.

In conclusion, MPV and PDW are positively correlated with anxiety-depressive states in PD patients and demonstrate high diagnostic efficacy. By leveraging readily available clinical laboratory data, our study identifies objective markers that can enhance nephrologists' ability to recognize anxiety-depressive states early in PD patients, improve healthcare-seeking behavior, and potentially mitigate the negative impact of these conditions on long-term prognosis.

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Note: Figure translations are in progress. See original paper for figures.