

# Increased mean platelet volume in patients with panic disorder

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**Objective:** The relationship between platelet activation and psychiatric disorders has been shown in previous work. Mean platelet volume (MPV) is a measure of platelet size and a good indicator of platelet activity, which increases in cardiovascular diseases (CVDs). It is known that anxiety is a considerable factor in the etiology of mortality in CVDs. The aim of the present study was to investigate any probable difference in the MPV of patients with panic disorder (PD).

**Methods:** Sixty-one drug-free patients, aged 18–65 years and diagnosed with PD according to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*, were included in the study, along with 63 healthy age- and sex-matched volunteers. The body mass index (BMI) was calculated and MPV measured for each subject.

**Results:** The MPV was found to be higher in the PD group compared to the control group ( $P=0.004$ ). There were no significant differences between the two groups in terms of platelet count or BMI.

**Conclusion:** Alterations in platelet activity may be a reflection of abnormal 5-hydroxytryptamine (5-HT) 1A receptor function in the central nervous system of subjects with a diagnosis of PD. These findings may elucidate the relationship between CVDs and PD. The findings of the present study suggest that MPV is increased in PD patients.

**Keywords:** mean platelet volume, panic disorder, anxiety

## Introduction

Platelets may reflect biochemical changes in the brain under different psychiatric conditions.<sup>1</sup> The mean platelet volume (MPV), the measure of platelet size, is considered to be a determinant of platelet function. Increased MPV is thought to be closely associated with cardiovascular diseases (CVDs), mainly acute myocardial infarction (MI),<sup>2</sup> ischemic heart diseases,<sup>3</sup> and congestive heart failure.<sup>4</sup> In addition, it has been proposed that for congestive heart failure patients who are admitted into hospital, MPV on admission is an independent predictor of mortality and 6-month mortality.<sup>4</sup> MPV has been suggested to be an independent risk factor for atherosclerotic disease.<sup>5</sup>

Peripheral platelet models are widely used as indicators of central serotonin (5-HT) metabolism, as they reflect central serotonergic function.<sup>1</sup> Serotonin is an important factor in the pathophysiology of anxiety disorders and plays pivotal roles in the vascular system in the regulation of vascular tone and platelet aggregation.<sup>6</sup> Platelets contain serotonin (5-HT) receptors such as 5-HT 2A, 5-HT 3, and a 5-HT transporter (5-HTT) in their membranes.<sup>7,8</sup> Experimental studies have shown that 5-HT-potentiated procoagulant responses of platelets enhance thrombogenesis on damaged vascular surfaces. These effects are modulated by selective serotonin reuptake inhibitors (SSRIs), which are commonly used in the treatment of PD.<sup>9,10</sup> Furthermore, several studies have reported decreased platelet activity after treatment for depression, especially with SSRIs.<sup>11,12</sup> Several serotonin transporter (5-HTT) abnormalities have been detected in

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panic disorder (PD), although results concerning the synaptic serotonin state are still inconsistent.<sup>13,14</sup> It has been reported that a hyperserotonergic state resulting from impaired 5-HTT function can cause an anxiety or fear response by stimulating the amygdala.<sup>15</sup> Conversely, serotonergic agents are known to relieve panic symptoms.<sup>16</sup>

Although a close relationship between ischemic heart disease and anxiety disorders has been proposed, only one study has reported a relationship between MPV and PD in the literature.<sup>17</sup> In the present study, it was hypothesized that patients with PD have higher MPV levels compared to healthy subjects. The aim of this nonrandomized case–control study was to investigate a possible relationship between MPV levels and PD.

## Methods

### Subjects

Seventy-nine consecutive outpatients, aged 18–65 years, of Research and Training Hospital Outpatient Psychiatry Clinic, School of Medicine, Mustafa Kemal University, had been diagnosed with PD (with or without agoraphobia) according to the fourth edition of *Diagnostic and Statistical Manual of Mental Disorders IV-text revision* (DSM-IV-TR) over a 6-month period. Of these patients, 61 (32 women and 29 men) patients agreed to participate in the study (Table 1). The control group included 63 physically and mentally healthy age- and sex-matched volunteers (32 men and 31 women). The flow-chart of the patient selection process is shown in Figure 1.

Ethical approval for this study was obtained from the local ethics committee in accordance with the Helsinki Declaration. All patients provided written informed consent to participate in this research. Patients were excluded if they were pregnant or breastfeeding or if they had hypertension or metabolic or blood disease, a history of chronic medical drug intake in the previous 2 months, or chronic cardiac and respiratory disease. Patients with any type of comorbid

psychiatric disorder were excluded. Subjects who had conditions that could affect MPV were also excluded. Body mass index (BMI) was calculated for all subjects.

### Blood sampling

Approximately 10 mL of blood was obtained from the front of the left arm after a 12-hour fasting period, and the first 2 mL of blood, which was used for the full blood count, was drawn into a vacutainer tube containing 0.04 mL of 7.5% ethylenediaminetetraacetic acid (EDTA, tripotassium salt). The remainder of the blood was drawn into a vacutainer tube without anticoagulant. Total cholesterol, triglyceride, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, albumin, aspartate transaminase (AST), and alanine transaminase (ALT) were determined using standard methods.

To minimize the potential interference of EDTA in relation to MPV, all blood samples were analyzed 60 minutes after venipuncture. MPV and platelet count were measured using a Cell-Dyn 3500 (Abbott Laboratories, Abbott Park, Chicago, IL, USA) device. After obtaining the blood samples, MPV and platelet counts were measured. Levels of 150,000–400,000 per mm<sup>3</sup> of blood were accepted as the normal range for platelet counts and 6.9–11.0 fL (femtoliter, a metric unit of volume equal to 10<sup>-15</sup> L) was used for MPV. All samples were analyzed daily at the Mustafa Kemal University Central Laboratory.

### Statistics

SPSS program v15 (SPSS Inc, Chicago, IL, USA) was used for statistical analysis of data. The Kolmogorov–Smirnov test and the two-tailed independent samples *t*-test were used to compare the groups. Continuous variables are presented as mean ± standard deviation. A *P*-value <0.05 was considered statistically significant.

### Results

The mean age was 23.51±5.37 years in the study group and 26.62±4.23 years in the control group. There was no difference between the two groups in terms of mean age (*P*>0.05).

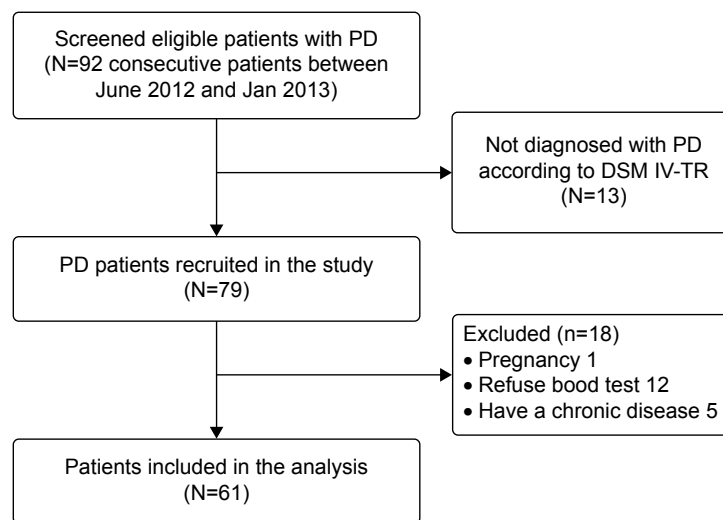
The MPV of the PD group (10.12±0.32 fL) was significantly higher than that of the control (8.27±0.91 fL; *P*=0.004). The mean BMI was 24.31±2.19 kg/m<sup>2</sup> in the study group and 23.67±3.43 kg/m<sup>2</sup> in the control group. There was no statistically significant difference between the two groups (Table 1).

There was no significant difference between groups in terms of total cholesterol, triglyceride, AST, ALT, albumin, hemoglobin, or hematocrit (*P*>0.05; Table 2).

**Table 1** Characteristics of PD and control groups

	PD group (n=61)	Control group (n=63)	P-value
Age	23.51±5.37	26.62±4.23	NS
MPV (fL)	10.12±0.32	8.27±0.91	0.004
PC (×10 <sup>9</sup> )	242.65±34.17	238.84±36.41	NS
BMI (kg/m <sup>2</sup> )	24.31±2.19	23.67±3.43	NS
Sex			
Male	29 (47.55%)	31 (49.20%)	NS
Female	32 (52.45%)	32 (50.80%)	NS

**Abbreviations:** BMI, body mass index; fL, femtoliter; MPV, mean platelet volume; NS, no significance; PC, platelet count; PD, panic disorder.



**Figure 1** The flowchart of patient selection process.

**Abbreviations:** DSM IV-TR, *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, text revision*; PD, panic disorder.

## Discussion

MPV has been defined as a decisive factor in platelet function. It has been shown that platelet size, measured as MPV, correlates with platelets' reactivity.<sup>3</sup> Previous researchers have claimed that large platelets that include compact granules are more enzymatically and metabolically active than other types.<sup>18</sup> Depression and anxiety disorders are important factors in the etiology of mortality in CVDs.<sup>19</sup> Anxiety disorders have been shown to increase the risk of MI<sup>20</sup> and CVD,<sup>21,22</sup> while the risk of cardiac mortality is increased twofold.<sup>23</sup> Higher anxiety symptom levels have been associated with increased risk for stroke independent of other risk factors.<sup>24</sup>

PD is one of the most frequent anxiety disorders. Some studies have demonstrated links between PD and CVD.<sup>25</sup> It was shown that patients with PD or phobic anxiety have an increased risk of CVD compared with control subjects.<sup>25,26</sup>

On a pathophysiological level, it has been hypothesized that stress-related conditions may affect several biological mechanisms that negatively influence cardiovascular functions.<sup>27</sup> It has been suggested that platelet activity is affected by emotional stress and that some coronary events such as MI may be triggered by these stressors.<sup>28</sup>

Quite a few studies have investigated MPV in psychiatric populations. Canan and Ataoglu<sup>12</sup> reported that MPV was found to be elevated in 15 patients with major depression. After 8 weeks of escitalopram treatment, it was shown that MPV levels were statistically significantly lower than baseline in 15 patients with major depression.<sup>12</sup> In a large population-based study, 289 patients with major depression were found to have increased MPV levels in comparison with control subjects.<sup>5</sup>

In the present study, we found increased MPV levels in patients with PD. Although a relationship between increased platelet activity and anxiety, depression, and post-MI depression has been reported on earlier, the relationship between anxiety and platelet functions has not been precisely proven.<sup>29</sup> In a recent study, it was reported that patients with anxiety disorder showed multiple changes in platelet parameters.<sup>30</sup> These changes originated from a decrease of the serotonin transporter in [3H]imipramine-binding sites of platelets and an increase in 5-HT 2A receptor-binding sites on the surface of platelets.<sup>31</sup> Abnormalities in 5-HT 1A receptor functions and alterations in 5-HTT levels and activity are described in platelets from patients affected by anxiety disorders.<sup>32,33</sup> Moreover, several reports have pointed toward decreased platelet activity after treatment with SSRIs

**Table 2** Laboratory parameters of PD and control groups

	PD group (n=61)	Control group (n=63)	P-value
Triglycerides (mg/dL)	132.83±29.23	129.47±67.63	0.12
AST (U/L)	23.83±5.53	23.15±3.41	0.25
ALT (U/L)	24.76±6.26	23.27±5.33	0.22
Albumin (g/dL)	4.27±1.23	4.09±1.46	0.17
Hb (g/dL)	15.12±3.03	15.45±2.59	0.14
Htc (%)	41.46±5.28	42.55±5.72	0.08
Total cholesterol (mg/dL)	178.47±29.22	175.25±34.17	0.09

**Abbreviations:** ALT, alanine aminotransferase; AST, aspartate aminotransferase; Hb, hemoglobin; Htc, hematocrit; PD, panic disorder.

in patients with major depression.<sup>11,34</sup> It has been suggested that some mechanisms that lead to platelet abnormalities in major depression are altered intraplatelet concentrations of monoamines and catecholamines, altered platelet function by increased plasma concentrations of 5-HT and epinephrine, and altered platelet function by increased intraplatelet calcium mobilization.<sup>35</sup>

It is known that patients with anxiety, depression, or disruptive behavior disorder have increased catecholamine levels, sympathetic activity, and cortisol secretion.<sup>36</sup> Vizioli et al<sup>37</sup> have shown that increased sympathetic activity can also cause higher MPV values. On the basis of these reports, some investigators have postulated that the sympathoadrenal activation may stimulate platelets via 2-adrenoreceptor activation,<sup>38</sup> which in turn induces shape change and thereby increases MPV.<sup>39</sup> Anxiety and depressive disorders are also associated with increased inflammatory cytokine levels, endothelial dysfunction, and platelet reactivation. As in the central nervous system, plasma platelets play a role in serotonin synthesis, secretion, and reuptake.<sup>40</sup>

Serotonin not only has a pivotal role in the pathophysiology of depression and PD, but also participates in hemostasis by affecting platelet aggregation.<sup>6</sup> Serotonin 5-HT<sub>2A</sub> receptors and serotonin transporter receptors in platelets and the brain are encoded by the same gene.<sup>40</sup> It has been reported that patients with anxiety disorder have increased platelet reactivation related to serotonin.<sup>40</sup> Dysregulation of serotonin and increased adrenaline, which are crucial in the etiology of PD, induce platelet activation.<sup>30</sup> In one study, platelet 5-HT uptake maximal velocity ( $V_{max}$ ) and its associated affinity constant ( $K_m$ ) were found to be lower in PD patients than in normal control subjects.<sup>41</sup> In this study, Kang et al reported that patients with PD showed abnormalities in platelet 5-HTT function; furthermore, they found that after 12 weeks of paroxetine treatment, the  $K_m$  values of platelet serotonin transporters increased in parallel to clinical improvement. They speculated that impaired 5-HTT function might be related to the dysregulation of the autonomic nervous system in PD.<sup>41</sup>

In the literature, this is the second study to evaluate MPV levels in PD patients. Gul et al<sup>17</sup> investigated the correlation of levels of MPV in 37 PD patients; contrary to our findings, they found lower MPV levels in PD patients compared to the control group. They speculated that abnormal 5-HT metabolism, such as specific alterations of the 5-HT receptor functional state in platelets of PD patients, could lead to decreased MPV.<sup>17</sup> But they could not explain the exact mechanism of or reason for the decreased MPV in PD

patients. Moreover, their sample size was small (n=37), so it cannot be generalized to all PD patients.

As PD and depression share common pathophysiological mechanisms, they both are treated with similar drugs (SSRIs). Because a vast number of studies have reported increased MPV in patients with major depression, we believe that increased MPV levels can be expected in PD patients.

This study has some limitations. First, the sample size is relatively small, and to generalize these results, multicenter studies with more patients with PD are needed. Second, the study population was not screened for other conditions that have been reported to affect platelet activity, such as cigarette smoking and hypertension. Third, as panic attack severity is not measured by scales, the correlation between MPV and panic severity could not be evaluated.

## Conclusion

In our study, MPV levels of patients with PD were higher than those of control subjects. These findings may elucidate the relationship between CVDs and PD. The findings of the present study suggest that MPV is increased in PD patients. Better-designed and more advanced studies are necessary to determine the exact function of platelets and the importance of MPV in PD patients.

## Disclosure

The authors report no conflicts of interest in this work.

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