

Comparison of Platelet Mass Index with Total Oxidant/Antioxidant Levels in Intensive Care Unit Patients

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Background: One of the key mechanisms affecting mortality and morbidity in intensive care unit (ICU) patients is oxidative stress and the accompanying antioxidant defense system. The Platelet Mass Index (PMI) has been proposed as a novel parameter associated with both disease severity and inflammation. This study sought to explore the association between platelet mass index (PMI) and the levels of total oxidant status (TOS), total antioxidant status (TAS), and oxidative stress index (OSI) in patients admitted to the intensive care unit.

Methods: This prospective study included 152 ICU-hospitalized patients and 60 healthy controls. Blood samples were analyzed to determine TOS, TAS, procalcitonin (PCT), ferritin, C-reactive protein (CRP), mean platelet volume (MPV), white blood cell count, and platelet count (PLT). Platelet mass index (PMI) was calculated using PLT and MPV values, while OSI was calculated using TOS and TAS results.

Results: Among ICU patients, PMI, CRP, TOS, and OSI levels were elevated, whereas PLT and TAS levels were reduced compared with the control group. No significant clinical correlation was observed between PMI and the other measured variables.

Conclusion: PMI may serve as a simple, readily calculable biomarker reflecting oxidative stress levels in ICU patients. PMI can serve as a supportive parameter for evaluating oxidative stress in intensive care practice.

Keywords: Platelet mass index, total oxidant status, total antioxidant status, oxidative stress index

Introduction

Oxidative stress, resulting from an imbalance between the production of reactive oxygen species (ROS) and the antioxidant defense mechanisms, plays an essential role in the pathogenesis of many critical illnesses (1). The total oxidant status (TOS) and total antioxidant

status (TAS) are commonly used biochemical parameters to evaluate oxidative stress levels. The oxidative stress index (OSI), calculated as the ratio of TOS to TAS, provides a comprehensive reflection of the oxidative balance in the organism (2, 3). Increased OSI

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levels indicate excessive oxidative burden and reduced antioxidant capacity (4).

Platelets are not only essential for hemostasis, but also actively participate in inflammation and oxidative processes (5). The mean platelet volume (MPV) is an indicator of platelet size and activation status (6). Larger platelets are metabolically more active and more prone to release inflammatory and oxidative mediators (5). Oxidative stress can enhance platelet reactivity by reducing nitric oxide bioavailability, while activated platelets can generate ROS, further amplifying oxidative damage (7).

Several clinical studies have demonstrated a relationship between oxidative stress markers and platelet indices. Elevated MPV levels have been associated with increased TOS and OSI, and decreased TAS levels in various inflammatory and metabolic disorders (8). In critically ill patients, TOS and OSI values are reported to be significantly higher, whereas TAS levels are markedly reduced, indicating severe oxidative imbalance (9, 10).

Taken together, these findings suggest a complex interplay between oxidative stress and platelet activation. Evaluating TAS, TOS, OSI, and MPV together may provide valuable insights into the oxidative and inflammatory status of intensive care unit (ICU) patients.

Materials and Methods

Study design

Ethical approval for this study was obtained from the Harran University Clinical Research Ethics Committee (12.04.2021-HRÜ/21.08.20). The study included 152 patients admitted to the intensive care units of S.B. Şanlıurfa Mehmet Akif İnan Training and Research Hospital after January 2022. Additionally, a control group of 60 healthy volunteers, matched for age and gender, was enrolled. Patients who had received prior antioxidant therapy or had a history of cancer were excluded.

TOS and TAS were measured as described by Erel et al. (2). OSI was calculated from TOS and TAS. Procalcitonin (PCT), ferritin, and C-reactive protein (CRP) were analyzed automatically using the Roche Cobas 6000 c system. White blood cell count (WBC), platelet count (PLT), and mean platelet volume (MPV) were measured automatically using a Sysmex XN1000 (Sysmex Inc., Japan). The platelet mass index (PMI) was calculated using PLT and MPV values ($PMI = PLT \times MPV$) (11).

Statistical Analysis

Statistical analyses were conducted using GraphPad Prism version 8.0.0 for Windows (GraphPad Software, San Diego, CA, USA, www.graphpad.com). Data normality was evaluated with the Kolmogorov-Smirnov test. Comparisons between groups were performed using Fisher's exact test and the unpaired t-test. Pearson's correlation coefficient was used to assess relationships between variables, with a p-value <0.05 considered statistically significant.

Results

There were no significant differences between the patient and control groups in age or gender (Table 1). Compared with the control group, patients had higher PMI, CRP, TOS, and OSI, whereas PLT and TAS were lower (Table 1; Figures 1 and 2). No significant correlation was found between PMI and any of the parameters measured in this study (Table 2).

Discussion

According to this study, oxidative stress levels are elevated in intensive care patients, whereas antioxidant capacity is reduced. In these patients, platelet (PLT) counts are low, whereas the platelet mass index (PMI) is high. No significant changes were observed in mean platelet volume (MPV) values. However, no significant correlation was found between PLT or its subparameters and oxidative stress

Table 1. Comparison of MPV, TOS, TAS, and OSI values between ICU patients and the healthy control group

Variables	Control	Patient	p value
Age (years)	59.6±15.8	63.6±21.3	0.15*
Gender (n)	<i>Male</i> 29	86	0.28**
	<i>Female</i> 31	66	
PLT (x10 ³ /μL)	315.8±74.6	219.7±105.1	<0.0001*
MPV (fl)	10.25±0.9	10.62±1.1	0.105*
PMI	3141±787.4	2360±1038	0.0003*
WBC (x10 ³ /μL)	9.0±7.6	11.3±6.5	0.11*
CRP (mg/L)	5.4±14.9	86.6±90.0	<0.0001*
PCT (ng/L)	5.3±27.2	5.6±19.5	0.95*
TOS (μmol H ₂ O ₂ Eqv/L)	9.0±5.8	12.8±7.4	0.009*
TAS (mmol Trolox Eqv/L)	2.66±0.9	1.58±0.7	<0.0001*
OSI (AU)	550.8±413.7	1052±1062	0.01*

* Unpaired t test; **Fisher's exact test; AU: Arbitrary units; PLT; Platelet; MPV: Mean Platelet Volume; PMI: Platelet Mass Index; WBC: White Blood Cell; CRP: C-Reactive Protein; PCT: Procalcitonin; TOS: total oxidant status; TAS: total antioxidant status; OSI: oxidative stress index

Table 2. Pearson correlation analysis R-score

	PLT	MPV	PMI	TAS	TOS	OSI	PCT	CRP	WBC
PLT	1.00								
MPV	-0.34	1.00							
PMI	0.98	-0.16	1.00						
TAS	0.04	0.03	0.03	1.00					
TOS	-0.02	-0.04	0.00	-0.11	1.00				
OSI	0.03	0.00	0.07	-0.54	0.69	1.00			
PCT	-0.21	-0.05	-0.12	-0.04	0.10	0.09	1.00		
CRP	-0.28	0.14	-0.15	-0.14	-0.03	0.07	0.29	1.00	
WBC	-0.03	0.00	0.04	-0.13	0.12	0.14	0.13	0.33	1.00

PLT; Platelet; MPV: Mean Platelet Volume; PMI: Platelet Mass Index; WBC: White Blood Cell; CRP: C-Reactive Protein; PCT: Procalcitonin; TOS: total oxidant status; TAS: total antioxidant status; OSI: oxidative stress index

markers. Our findings suggest that high PMI values may be associated with increased oxidative stress and impaired antioxidant defense. This supports, albeit to a limited extent, the existing literature on the relationship between PMI, inflammation, and oxidative stress.

Oxidative stress leads to cellular damage and dysfunction by activating inflammatory mediators and modifying proteins, lipids, and nucleic acids (12). This process is particularly pronounced in intensive care patients, predisposing them to multiple organ and system dysfunction. Studies conducted in intensive care patients reported significantly elevated TOS levels and reduced TAS levels (13). These findings indicate that in critically ill patients, the oxidant load is increased and the antioxidant defense mechanisms are insufficient to counterbalance this burden (13).

Increased production of reactive oxygen species (ROS) intensifies the inflammatory response and accelerates tissue damage. Ayala et al. (4) reported that increased ROS production in peripheral lymphocytes of intensive care patients is associated with long-term mortality. Similarly, rapid declines in antioxidant molecules have been linked to poor prognosis (14). In a study by Çakırca et al. (15), TAS levels were also reduced in intensive care patients. A high OSI reflects both an increased oxidant load and decreased antioxidant capacity, indicating the severity of oxidative stress (13).

The relationship between inflammation and PMI has also been demonstrated in studies of inflammatory bowel disease; PMI has been reported to correlate more strongly with disease activity than platelet count or MPV, independent of these variables (16). Low PMI values have also been associated with adverse prognostic features, including increased mortality (17). However, the number of studies

directly comparing PMI with oxidative stress markers is quite limited.

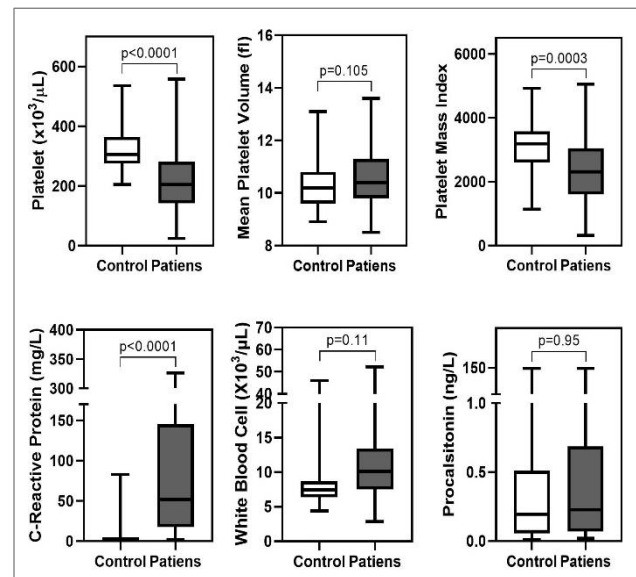


Figure 1. Comparison of PLT, MPV, PMI, CRP, WBC, and PCT values in the ICU and Control groups

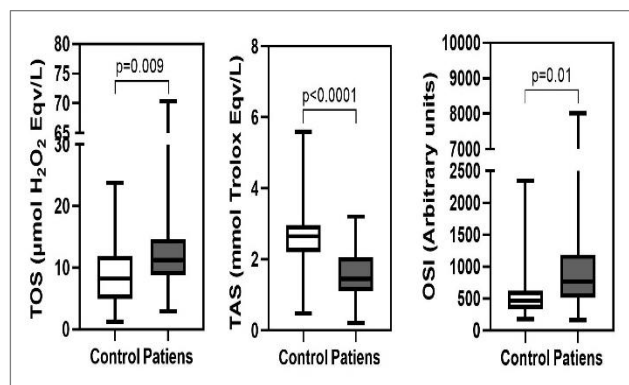


Figure 2. Comparison of TOS, TAS, and OSI values in the ICU and control groups

In this study, elevated CRP, OSI, and PMI levels, along with reduced TAS levels, indicate increased systemic inflammation, oxidative stress, and platelet activation. CRP reflects the acute-phase response of systemic inflammation and is associated with poor prognosis and multiple organ dysfunction in intensive care patients (18, 19). The increase in OSI supports the notion that inflammation and oxidative stress mutually reinforce each other, thereby exacerbating tissue damage (4). However, no

correlation was found between CRP, OSI, and PMI. This suggests inflammatory, oxidative, and hemostatic responses do not always proceed in parallel. These mechanisms may be influenced differently depending on disease etiology, the patient's metabolic status, and treatment response (20). Furthermore, low TAS supports the notion that the antioxidant defense system is insufficient to counteract the increased oxidative stress in critically ill patients (4).

Conclusion

In conclusion, the findings of elevated PMI, TOS, and OSI, along with reduced TAS levels, in intensive care patients indicate increased oxidative stress and impaired antioxidant defense. However, the lack of correlation among these parameters suggests that independent mechanisms may influence oxidative stress and platelet activation. These results highlight the complex interplay between inflammation, oxidative stress, and hemostatic response in critically ill patients. Prospective studies with larger sample sizes are needed to determine the prognostic value of these biomarkers more clearly.

Conflict of Interest

The authors declare no conflict of interest.

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