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Mean platelet volume and platelet distribution width as mortality predictors in intensive care unit

Yoğun bakım ünitesinde ortalama platelet hacmi ve platelet dağılım hacminin mortaliteye etkisi

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ÖZ

Giriş ve Amaç: Bu çalışmada genel yoğun bakım ünitesi (YBÜ)'ndeki hasta popülasyonunda, MPV (ortalama platelet hacmi) ve PDW (platelet dağılım hacmi) parametrelerinin mortalite ile olan ilişkisini değerlendirmeyi amaçladık.

Gereç ve Yöntem: Genel YBÜ'de yatan 284 hasta retrospektif olarak analiz edildi. Hastaların ilk yatışlarında MPV ve PDW değerleri, ölmeden veya taburcu edilmeden önceki son MPV ve PDW değerleri, yoğun bakımda yatış süreleri ve yaşları kaydedildi.

Bulgular: Hayatta kalan hasta grubunda MPV ve PDW'nin ilk ve son değerleri arasında istatistiksel olarak anlamlı fark yoktu. Benzer şekilde, ölen hasta grubunda PDW değerleri değişmedi ($p>0,05$). Ancak ölen hasta grubunda son MPV değerleri ilk MPV değerlerinden istatistiksel olarak anlamlı fark oluşturacak şekilde yüksekti ($p<0,05$). Bu çalışmada mortalite ile ilişkili hastaların yaş, yoğun bakımda kalış süreleri, MPV ve PDW değerleri karşılaştırıldığında en önemli faktörün MPV değerinde yükselme olduğu bulundu.

Sonuç: Bu çalışma, yoğun bakım hastalarında MPV artışının mortalite ile yakından ilişkili olabileceğini göstermiştir.

Anahtar Kelimeler: MPV, PDW, mortalite, yoğun bakım ünitesi

ABSTRACT

Background and **Aim:** This study aimed to determine the mean platelet volume (MPV) and platelet distribution width (PDW) values of intensive care patients, and show the relationship between these parameters and mortality.

Material and Method: In the present study, 284 patients who were hospitalized in the intensive care unit were retrospectively analyzed. MPV and PDW values of the patients when they first hospitalized, their last MPV and PDW values before they died or were discharged, their ages and duration of ICU period were recorded.

Results: There was no statistically significant difference between the first and last values of MPV and PDW in the surviving patient group. Similarly, PDW values did not change in the group of patients who died ($p> 0.05$). However, the last MPV values were significantly higher in the deceased patient group than the first MPV values ($p <0.05$). In this study, when the age, length of stay in the intensive care unit, MPV and PDW values were compared, the most important factor was found to be an increase in MPV.

Conclusion: This study showed that MPV increase in intensive care patients may be closely related to mortality.

Keywords: MPV, PDW, mortality, intensive care unit

INTRODUCTION

In addition to preservation of hemostasis, platelets have many important functions such as healing wounds, regulating inflammations, angiogenesis, tumor growth and metastasis and fetal vascular remodeling (1,2). Complete blood count parameters including platelet indices are routinely used for diagnostic purposes in laboratories, and obtaining results immediately is clinically a major advantage (3). As a result of complete blood count, the mean platelet volume (MPV) and the mean platelet distribution width (PDW) values, which are among the indicators of platelet morphology and proliferation, are found (4).

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Mean platelet volume value ranges between 7.2 and 11.7 fL in a healthy person (5). Various cytokines such as thrombopoietin and interleukin-6 play an important role in the increase of platelet volume (6). Increased platelet activation increases the rate of production of new platelets occurring in the bone marrow, thus the proportion of more active and large young cells in the blood increases. As a result, the increase in platelet activation leads to an increase in MPV (7). While MPV increases, the number of platelets decreases; therefore, the mass ratio of platelets in the blood remains in a certain balance (8).

Increased MPV values were found to be associated with several diseases such as coronary artery diseases (9), hypertension, diabetes mellitus (10), and acute pancreatitis (11). However, MPV values were found to be low in some diseases such as rheumatoid arthritis and Familial Mediterranean Fever (FMF) (10).

Platelet distribution width shows the distribution of platelets in the blood. The closer the volumes of platelets are, the lower the PDW value is. PDW was found between 8.3 and 25.0 fL (12, 13) in the studies conducted with healthy individuals. PDW values allow observing the changes in the activity of platelets, their volumetric variability and evaluation of their morphological structure (14).

Intensive care units are the last places where patients with life-threatening risk are supported with basic life support and are tried to be returned to a healthy life. Therefore, it is very important to have an idea about the prognosis of the disease. Several scoring methods such as APACHE III, SAPS II, MPM II, MODS, LOD score (LODS) etc. (15) have been developed to evaluate the mortality risk of patients hospitalized in intensive care units (ICU). These methods are guides for the evaluation of some parameters such as the severity of the patients in the intensive care services, the level of the response to treatment, the process of treatment and the determination of the road map to be followed during the treatment process (16). Many studies have shown that these scoring systems have been very successful in predicting prognoses (17). Scoring systems are constantly updated; consequently, better results can be obtained in determining the prognosis.

The aim of this study was to determine MPV and PDW values of the patients in intensive care units and their relationship between mortality.

MATERIAL AND METHOD

The study included 284 patients aged between 18 and 101 years. MPV and PDW values of the patients who stayed in ICU 10 days or less were taken daily and those of the patients who stayed more than 10 days were taken weekly. MPV and PDW values that were obtained as a result of the first complete blood count taken from the moment when the patients were admitted to the intensive care unit were noted as MPV_{First} and PDW_{First}. The MPV and PDW values obtained in the last complete blood samples taken before the patients were discharged or they died were referred to as MPV_{Last} and PDW_{Last}. Patients' ages and duration of ICU period were also recorded and evaluated to determine their relationship with mortality.

Statistical Analyses

Statistical analyses were conducted using SPSS 24 program. Kolmogorov-Smirnov/Shapiro-Wilks tests were used whether the data were normally distributed. The mean and standard deviation values of the parameters with normal distribution were calculated. The first and last values of MPV and PDW were compared using dependent sample t test. Changes in MPV and PDW values depending on age and duration of stay in the ICU were analyzed using Pearson Correlation. Age, duration of ICU period, MPV_{First}, MPV_{Last}, PDW_{First} and PDW_{Last} values, which affect mortality, were compared using logistic regression analysis, and the results were shown using region of convergence (ROC). Data were evaluated with a 95% confidence interval, and $p<0.05$ was considered significant.

Ethical Declaration

After ethics committee approval (Decision no: 02/06), all patients were retrospectively determined using the central database of our hospital.

RESULTS

The data of 284 patients were obtained retrospectively. The 42.2% of the patient who survived was female and 57.8% was male. The 46.7% of the excitus patients was female and 53.3% of the patient was male. The average age of the patients who survived was 60.18 and average age of the excitus patients was 70.10 (**Table 1**).

Table 1. The mean and standard deviation values of demographical parameters (Age, sex and duration) of the patients who died and who survived.

		Survived 187					Died 107				
		Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max
Age		60,18	64,00	19,820	18	94	70,10	73,00	15,782	18	101
Duration		9,95	6,00	10,072	2	81	14,51	9,00	18,644	2	145
Sex	Female	79 (% 42,2)					50 (% 46,7)				
	Male	108 (% 57,8)					57 (% 53,3)				

SD: Standart deviation

The mean MPV_{First}, MPV_{Last}, PDW_{First} and PDW_{Last} values of the patients who died and who survived were evaluated separately (Table 2). MPV and PDW results of the patients who survived were: MPV_{First}=8.19 (1.07), MPV_{Last}= 8.35 (1.24), PDW_{First}=16.6 (1.29) and PDW_{Last} = 16.28 (1.43). MPV and PDW results of the patients who died at the end of intensive care process were: MPV_{First}= 8.45 (1.21), MPV_{Last}= 9.36 (1.47), PDW_{First} =16.33(1.36) and PDW_{Last} =16.46(1.73) When the patients were classified based on the fact that they died or survived, the mean values of all patients were as follows: MPV_{First} =8.29(1.13) MPV_{Last} =8.72(1,41) PDW_{First} =16.22(1.31) and PDW_{Last} =16.35(1.55) (**Table 2**).

Table 2. The mean and standard deviation values of MPV and PDW of the patients who died and who survived

		Survived (mean±SD)	Died	Total
MVP	First	8.19 ±1.07	8.45 ±1.21	8.29 ±1.13
	Last	8.35 ±1.55	9.36 ±1.47	8,72 ±1.41
PDW	First	16.16±1.29	16.33±1.36	16.22±1.31
	Last	16.28±1.43	16.46±1.73	16.35±1.55

MPV: Mean platelet volume, PDW: Platelet distribution width, SD: Standart deviation

There was no statistically significant difference between MPV_{First} and MPV_{Last} values of the group of the patients who survived (p>0.05). Similarly, there was no statistically significant difference between their PDW_{First} and PDW_{Last} values (p>0.05). Also, there was no statistically significant difference between PDW_{First} and PDW_{Last} values of the group of the patients who died (p>0.05). However, there was a statistically significant difference between MPV_{First} and MPV_{Last} values of the group of the patients who died (p<0.05). Age, duration of ICU period, MPV and PDW values of the patients were compared in order to evaluate their effects on mortality. MPV_{Last} (p:0.000) was found to be the most significant key factor in mortality. This was followed by age (p:0.001) and duration (p: 0.007), respectively (**Table 3**).

Table 3. Correlation between mortality and sex, age, duration, MPVFirst, MPVLast, PDWFirst, PDWLast

Correlations							
	Sex	Age	Duration	MPV_{First}	MPV_{Last}	PDW_{First}	PDW_{Last}
Pearson Correlation (pr)	-0,043	0,251**	0,157**	0,110	0,342**	0,063	0,054
p	0,458	<0,001	0,007	0,060	0,000	0,283	0,357

MPV: Mean platelet volume, PDW: Platelet distribution width

The ROC used for the evaluation of the same parameters showed that MPV_{Last} was the most significant parameter. MPV values higher than 8.95 were suggested to be a valuable parameter when predicting mortality in ICU patient with a specificity of 74,9% and sensitivity of 63,6%. This was followed by age and duration of ICU period, respectively (**Table 4, Figure 1,2**).

Table 4. AUC and P values of the factors affecting mortality based on ROC

Parameter	AUC	p	Cut-Off	Specifity	Sensitivity
AGE	0.65281	<0,001*	>70,5	63,6	71,4
DURATION	0.56972	0.046*	>7,5	60,4	57,9
MPV_{First}	0.55463	0.119	-	-	-
MPV_{Last}	0.70388	<0,001*	>8,95	74,9	63,6
PDW_{First}	0.55118	0.144	-	-	-
PDW_{Last}	0.54625	0.186	-	-	-

MPV: Mean platelet volume, PDW: Platelet distribution width, AUC: Area under curve,*p<0.05

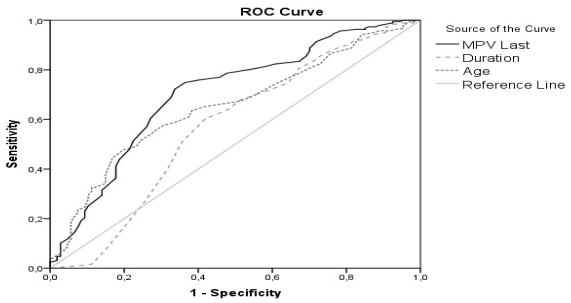

Figure 1. ROC of the factors affecting mortality. MPV: Mean platelet volume

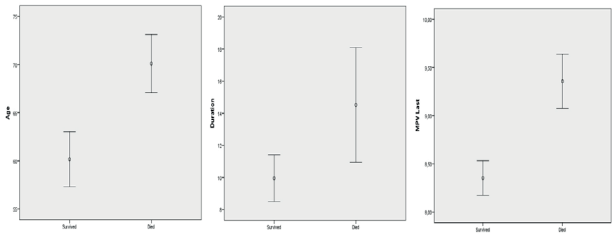

Figure 2. Age, Duration, MPV_{Last} values in Error bar graph. MPV: Mean platelet volume

DISCUSSION

Intensive care units are special units having the risk of mortality and where critical diseases are followed up and treated. The causes of admission to intensive care units vary. According to a study, the most common specific stay causes are: sepsis (8%), pneumonia (6.7%), exacerbation of COPD (chronic obstructive pulmonary disease) (5.8%), cerebrovascular accident (5.2%), gastrointestinal bleeding (4.5%), acute renal failure (3.5%) and meningitis (3.2%). In addition, the most common concomitant diseases are diabetes mellitus (DM) (17%), hypertension (HTN) (13%) and COPD (12%). There are many physiological and pathological factors affecting the mortality of inpatients as well as causes of hospitalization: nosocomial infections, underlying diseases, age, duration of ICU preiod, etc. (18). Some patients die before the underlying disease and factors that deteriorate the prognosis can be detected. Therefore, it is important to detect the patients immediately whose prognosis

is deteriorating. Thus, the probability of detecting the cause of the prognosis deteriorating immediately increases, and the process of treatment can be determined. For monitoring the prognosis, scoring systems, which are both practical and reliable, have been developed. These scoring systems were compared and more efficient ones were tried to be found (19, 20). Scoring systems have been updated and improved over time in order to find better ones (21).

Various studies investigating MPV have shown that the increase in MPV is related to many diseases (22, 23). However, there are limited studies investigating MPV values in the patient population in intensive care units and those investigating the relationship with prognosis. In addition, MPV values obtained in these studies are the samples resulted from the complete blood count results that were obtained while the patients were admitted to the intensive care unit (24). In our study, we compared both the values obtained from the blood samples taken during the first hospital admission and the MPV values obtained from final blood counts before the patients were discharged from the intensive care unit or before they died. Therefore, we have an opportunity to examine how MPV values changed based on the the fact that the patients survived or died during the stay period in the intensive care unit. Although many studies have shown that MPV is related to mortality, some others claim just contrary (25, 26, 27). We found in our study that while there was no significant difference between MPV levels taken during the first hospitalization and MPV_{Last} values of the patients who survived, there was a statistically significant increase in MPV_{Last} values of the patients who died.

In some studies, patients in intensive care units were examined and it was found that MPV and PDW values increased significantly in the groups of patients who died (24, 25). However, in our study, there was no significant change in PDW values in both groups of the patients who died and who survived.

There are many factors that affect mortality in intensive care units. One of the important factors that can be evaluated independently of the underlying disease is age. Another important factor is the duration of ICU period. Age and duration of ICU period were similar factors that affect mortality in our study. We compared these two parameters and relation between MPV-PDW values and mortality. Examining the effects of all these different factors on mortality, the most effective factor on mortality was found to be MPV_{Last}. This was followed by age, duration of ICU period and PDW_{First}, respectively.

CONCLUSION

We claim that the increase in MPV values may be associated with mortality in the patients who were admitted to the intensive care units. In addition, we hope MPV values that can be obtained through complete blood counts at regular intervals during the intensive care period will help determine the prognoses of patients, thus contributing health personnel to determine the road map to follow in the patient follow-up and to re-evaluate the treatment process. In order for MPV changes to be included in the scoring systems or to be used as a sign of poor prognosis, new large-scale studies including more patients and different sample groups are needed.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding this manuscript.

There is no financial disclosure for all author.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Authors' Contributions

Işın Gençay; Conceptualization, Investigation, Data Curation, Writing-original raft preparation, Ünase Büyükkoçak; Writing-Review and editing. Gökay Ateş; Investigation, Methodology, Osman Cağlayan: Statistical Evaluation.

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