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Changes in mean platelet volume in the course of upper gastrointestinal bleeding

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Abstract

In this study, we retrospectively evaluated patients with upper gastrointestinal bleeding (UGB) who were followed up at our center over a 3 year period and aimed to determine the factors affecting mean platelet volume (MPV) in patients with UGB, temporal changes in MPV during UGB, and the relationship between MPV values and the severity of UGB. Patients and methods: A total of 170 patients who were hospitalized between January 2010 and December 2013 with a diagnosis of UGB, completed a 72-hour follow up, and had a baseline blood count performed within 6 months were evaluated retrospectively. Demographic, clinical, and laboratory data, along with MPV values at baseline, on admission, and at 4 hours, 1 day, 2 days, 3 days, and discharge, were evaluated. Number Cruncher Statistical System (NCSS) 2007 was used for statistical analyses. Results: Women and patients with comorbid diseases had higher baseline MPV values; this effect disappeared after admission for UGB and reappeared at discharge. MPV values were lowest at the start of the bleeding and significantly increased during the course of UGB. Baseline MPV and MPV at discharge values were similar. There was no statistically significant relationship between any MPV measurement and transfusion amount. Conclusion: The effects of gender and comorbid diseases were negated by the presence of UGB and returned after UGB was controlled. MPV levels exhibited temporal changes during the course of UGB, indicating that MPV can be used as a marker; however, no statistical relationship was found between temporal MPV values and transfusion amount, a marker for UGB severity.

Keywords: Mean platelet volume, upper gastrointestinal bleeding, blood transfusion

Introduction

Upper gastrointestinal bleeding (UGB) is a common medical emergency worldwide; it is one of the most common causes of hospitalization for digestive tract diseases [1,2]. UGB is defined as bleeding into the gastrointestinal lumen from anywhere above the Treitz ligament, which includes the esophagus, stomach, and proximal duodenum [3]. Typically, patients with UGB present with symptoms such as hematemesis, melena, hematochezia, or anemia. The underlying pathologies of UGB are diverse, and some may be life-threatening lesions, such as peptic ulcer, or bleeding esophageal varices [4]. Although the prognosis of UGB is generally considered fair and most UGB stops spontaneously, severe UGB has a poor prognosis and a mortality between 20% and 39%. Therefore, the early identification of high-risk patients allows appropriate and timely interventions that may decrease morbidity and mortality [5].

Platelets are anucleate, disc-shaped cells that help maintain the integrity of blood vessels by ensuring adequate hemostasis. In addition to platelet count, another widely studied platelet parameter is mean platelet volume (MPV), which measures the average size of platelets. Increased MPV values have been associated with bleeding disorders, as well as sepsis and inflammatory disorders [6–10]. Increased MPV values have also been associated with shorter bleeding times. Therefore, it is suggested that MPV can be used to indicate the severity of UGB, especially in cases with severe bleeding [11]. Although MPV has been used to predict the prognosis of some diseases, few studies have evaluated the relationship between MPV and UGB severity [12–14].

In this study, we retrospectively evaluated patients with UGB who were followed up at our center over a 3 year period and aimed to i) identify the factors affecting MPV in patients with UGB, ii) examine the temporal changes in MPV during UGB, and iii) clarify the relationship between MPV values and the severity of UGB.

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Material and Methods

This retrospective study was carried out in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. Ethical approval was obtained from (censored) Hospital Ethics committee (192/14.10.2013).

Patients who were hospitalized in the Internal Medicine ward of Fatih Sultan Mehmet Training and Research Hospital with a diagnosis of UGB and met the inclusion criteria were evaluated retrospectively over a 3 year period. The in-house rule for the management of UGB was to routinely hospitalize patients for at least 72 hours unless they withdrew consent for treatment. Patients with established UGB confirmed with upper GI endoscopy, who had completed at least a 72-hour follow up, and who had a previous complete blood count within 6 months at our institution were included. The exclusion criteria were i) a known malignant disease (n=4), ii) concomitant (but not previous) coronary or cerebrovascular event, sepsis, or trauma (n=5), or iii) incomplete medical records (n=4). A total of 183 patients were considered, and 13 patients were excluded, leaving 170 for the final analysis of the data.

Demographic and clinical data, including age, gender, time to admission from first symptoms, erythrocyte suspension transfusion amounts, and comorbidities (diabetes mellitus, hypertension, coronary artery disease, cerebrovascular disease, chronic renal or liver failure, and other comorbidities), were retrieved from medical records. The diagnosis of UGB was based on the presence of hematemesis, hematochezia, or melena and endoscopic confirmation of a focus of UGB. All included patients underwent a diagnostic workup for UGB within the hospitalization period. Complete blood count, biochemical tests, and Helicobacter pylori (H. pylori) rapid urease tests were performed with routine in-house commercial kits.

MPV values were measured with an automated blood count analyzer. Venous blood samples were collected into dipotassium ethylene-dinitro-tetraacetic acid (EDTA) tubes, and all inpatient samples were routinely tested within 20 minutes and reported within 60 minutes of blood drawing to comply with institutional quality standards. Temporal variations in MPV values were evaluated for each patient from admission to discharge (baseline, admission, 4 hours, 1 day, 2 days, 3 days, and discharge). Hemoglobin, albumin, blood urea nitrogen (BUN), creatinine values, and the relationship of these parameters with each other were investigated.

Statistical analysis

Number Cruncher Statistical System (NCSS) 2007 was used for statistical analyses. Frequency (%), mean (SD, standard deviation), and median (minimum–maximum) were used for descriptive statistics. Mann-Whitney-U and Kruskal-Wallis tests were used for comparisons of groups (2-group and >2 group comparisons, respectively). Wilcoxon-sign-rank and related-samples Friedman's two-way analysis of variance tests were used for related samples (2-group and >2 group comparisons, respectively). Spearman's correlation analysis was used to evaluate the relationships between parameters. A p value <0.05 was defined as the level of statistical significance.

Results

Demographic, clinical, and biochemical parameters of the study population

The demographic, clinical, and biochemical parameters of the study population on admission are presented in Table 1. Two-thirds of the patients were male, the median age of the patients was 67, and 38% of the study population had no other comorbid disease. Hypertension, coronary artery disease, and diabetes mellitus were the most prevalent comorbidities. Time to admission for the cases ranged from 1 to 120 hours, with a median of 18 hours. Etiological evaluations identified a duodenal ulcer in 35.9% (n=61) and peptic ulcer in 30.6% (n=52) of the cases. The erythrocyte suspension transfusion amounts varied between 0 and 10 units, with a median of 2 units. Four or more units of erythrocyte suspension was transfused in 25.3% (n=43) of the cases. H. pylori positivity was seen in 61.2% (n=104) of the cases (Table 1).

Table 1. Demographic, clinical and biochemical parameters of study population on admission

Age	Median (Range)	67 (18-92)
Gender	Male (n, %)	112 (65.9)
	Female (n, %)	58 (34.1)
Comorbidities	None (n, %)	65 (38.2)
	Hypertension (n, %)	25 (14.7)
	Coronary artery disease (n, %)	24 (14.1)
	Diabetes mellitus (n, %)	22 (12.9)
	Cerebrovascular disease (n, %)	13 (7.6)
	Chronic renal failure (n, %)	11 (6.5)
	Chronic liver disease (n, %)	5 (2.9)
	Other (n, %)	5 (2.9)
Time to admission	Hours (mean±SD)	30.3±29.3
Laboratory findings on admission	Hemoglobin (g/dL) (mean±SD)	9.08±2.52
	White blood cells (x10^9) (mean±SD)	11.8±5.4
	Platelet count (x10^9) (mean±SD)	274.9±113.1
	MPV (fL) (mean±SD)	7.95±1.04
	Blood urea nitrogen (mg/dL) (mean±SD)	43.1±27.7
	Creatinine (mg/dL) (mean±SD)	1.27±1.16
	Albumin (g/dL) (mean±SD)	3.39±2.27
UGB Etiology	Duodenal ulcer (n, %)	61 (35.9)
	Peptic ulcer (n, %)	52 (30.6)
	Gastritis (n, %)	44 (25.9)
	Esophageal varices (n, %)	7 (4.1)
	Gastric cancer (n, %)	4 (2.4)
	Other (n, %)	2 (1.2)
Transfusion amount	Median (Range)	2 (0-10)
Helicobacter Pylori test	Positive (n, %)	104 (61.2)

UGB: Upper gastrointestinal bleeding, MPV: Mean platelet volume, SD: standart deviation

When male patients were compared with female patients, several significant differences between genders were identified. Female patients were 14 years older (p=0.001, Mann-Whitney-U test), and hemoglobin and thrombocyte levels were both lower in women(p=0.02 and 0.03, respectively, Mann-Whitney-U test). There were more female patients with diabetes (p=0.008 chi-square test), but there were no differences between men and women for the other comorbidities;H. pylori positivity was more frequent in men (p=0.01, chi-square test), and the etiology of UGB differed between genders: gastritis was more frequent in women,butduodenal ulcers were more frequent in men (p=0.003 and 0.001, respectively, chi-square test) (Table 2).

Table 2. Demographic, clinical and biochemical parameters of male and female patients

		Male (n=112)	Female (n=58)
Age ***	Median (Range)	61 (18-92)	75 (19-92)
Comorbidities	None (n, %)	48 (42.9%)	17 (29.3%)
	Hypertension (n, %)	15 (13.4%)	10 (17.2%)
	Coronary artery disease (n, %)	18 (16.1%)	6 (10.3%)
	Diabetes mellitus (n, %) **	9 (8%)	13 (22.4%)
	Cerebrovascular disease (n, %)	6 (5.4%)	7 (12.1%)
	Chronic renal failure (n, %)	8 (7.1%)	3 (5.2%)
	Chronic liver disease (n, %)	3 (2.7%)	2 (3.4%)
	Other (n, %)	5 (4.5%)	0 (0%)
Time to admission	Hours (mean±SD)	29.5±30.5	31.9±26.9
Laboratory findings on admission	Hemoglobin (g/dL) (mean±SD)*	9.41±2.5	8.45±2.44
	White blood cells (x10^9) (mean±SD)	12.1±5.5	11.1±5.1
	Platelet count (x10^9) (mean±SD)*	289.3±120.6	247.2±91.7
	MPV (fL) (mean±SD)	7.87±1.02	8.09±1.07
	Blood urea nitrogen (mg/dL) (mean±SD)	41.1±26.6	47±29.5
	Creatinine (mg/dL) (mean±SD)	1.3±1.24	1.2±1.0
	Albumin (g/dL) (mean±SD)	3.52±2.77	3.16±0.53
UGB Etiology	Duodenal ulcer (n, %) ***	54 (48.2%)	7 (12.1%)
	Peptic ulcer (n, %)	30 (26.8%)	22 (37.9%)
	Gastritis (n, %) **	21 (18.8%)	23 (39.7%)
	Esophageal varices (n, %)	4 (3.6%)	3 (5.2%)
	Gastric cancer (n, %)	2 (1.8%)	2 (3.4%)
	Other (n, %)	1 (0.9%)	1 (1.7%)
Transfusion amount	Median (Range)	2 (0-10)	2 (0-7)
Helicobacter Pylori test	Positive (n, %) **	76 (67.9%)	28 (48.3%)

UGB: upper gastrointestinal bleeding, MPV: mean platelet volume, SD: standard deviation. *p<0.05, ** p<0.01, *** p<0.001, Mann-Whitney U test for continuous and Chi square test for categorical variables.

Effect of several factors on MPV at baseline and during UGB

Both baseline and on admission MPV values had significant, moderately negative correlations with platelet count (R=-0.45, p=0.001 and R=-0.39, p=0.001, respectively). MPV values were found to be not correlated with age, time until application, percentage decrease in hemoglobin, transfusion amounts, creatinine, albumin, BUN, white blood cell count, or H. pylori infection.

Gender had an effect on baseline MPV values (females 9.0±1.3 vs males 8.58±2.11, Mann-Whitney-U test, p=0.018) but had no effect on MPV values on admission (p=0.287). Similarly, patients with comorbid diseases had higher baseline MPV values (patients with comorbid diseases 8.96±1.56 vs 8.34±1.03, Mann-Whitney-U test, p=0.002), whereas comorbidity had no effect on MPV values on admission. Patients with diabetes mellitus had the most pronounced changes from baseline MPV values when compared to patients without any comorbidities (9.2±1.41 vs. 8.34±1.03, Mann-Whitney-U test, p=0.009). In general, MPV values were distributed similarly regarding etiology, except for patients with esophageal variceal bleeding. Both the baseline and on admission MPV values of patients with esophageal variceal bleeding were significantly higher than those of patients with other etiologies (baseline 9.74±1.74 vs. 8.68±1.4, Mann-Whitney-U test, p=0.05; on admission 8.71±0.94 vs. 7.92±1.02, Mann-Whitney-U test, p=0.03).

Moreover, at discharge, MPV values were affected by gender (females 9.07±1.26 vs males 8.54±1.21, Mann-Whitney-U test, p=0.03), and the effect of comorbid diseases on MPV reappeared as well (patients with comorbid disease 9.04±1.3 vs 8.52±1.06, Mann-Whitney-U test, p=0.007).

Changes of MPV values during UGB and at discharge

The temporal changes in MPV values are presented in Figure 1. MPV values were similar at baseline and at discharge (8.73±1.41 vs 8.84±1.24, respectively, p>0.05). Otherwise, at each time point, MPV was significantly different from the previousand followingvalues. A significant and visible trend was seen in MPV values, which was characterized by decreased levels during admission and normalization at discharge (related-samples Friedman's two-way analysis of variance tests, p=0.0001).

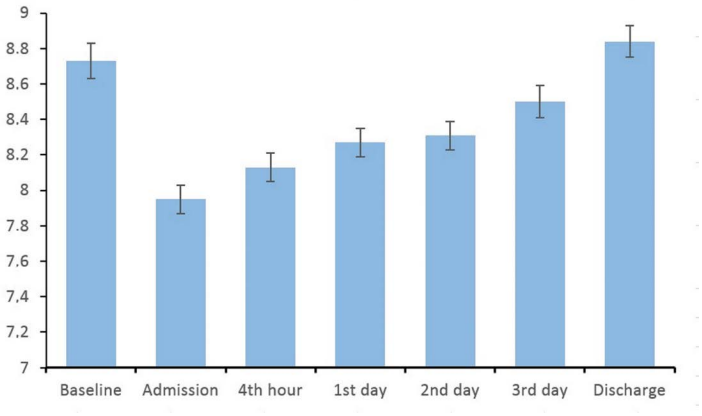

Figure 1. Temporal changes in MPV during UGB. All data are presented as the mean±S.E.M. MPV levels were similar at baseline and at discharge. MPV was the lowest on admission and exhibited an increasing trend during the course of UGB.

Relationship between MPV values and amounts of transfusion

There was no statistically significant relationship between MPV values (baseline, 0 hour, 4th hour, 1st day, 2nd day, 3rd day, and discharge) and the amount of transfused erythrocyte suspension (all p>0.05, Spearman's correlation) (Table 3). Additionally, all MPV values were similar between patients with 4 or more erythrocyte transfusions and patients with 3 or less (all p>0.05, Mann-Whitney-U test, data not shown).

Table 3. Relationship between transfusion amount and MPV.

	Transfusion amount and MPV	
	R coefficient	**P value**
Baseline	0.035	0.649
0-hour	-0.134	0.081
4th hour	-0.065	0.398
1st day	-0.099	0.197
2nd day	-0.102	0.186
3rd day	-0.123	0.110
Discharge	-0.001	0.986

MPV: Mean platelet volume

Discussion

Determining the severity of bleeding in patients admitted to the emergency department with UGB is critical for the follow-up and treatment of the patient. In the present study, we aimed to determine the factors affecting MPV in patients with UGB, the temporal changes in MPV during UGB, and whether MPV could predict the severity of UGB.

Herein, our findings indicate that MPV values were higher in female patients and in patients with diabetes mellitus during UGB. The effect of gender on MPV was also previously shown in acute appendicitis and acute ischemic stroke [15,16]. This finding may be attributable to gender differences, but further studies are required. Various studies have shown that MPV increases in acute coronary syndrome, diabetes mellitus, cerebrovascular events, preeclampsia, renal artery stenosis, hypercholesterolemia, smoking, and sepsis [6–10]. In this study, MPV was found to be significantly higher in patients with comorbidities, in accordance with the literature; however, MPV values were especially higher in patients with diabetes mellitus. It has also been previously reported that MPV was significantly higher in patients with complicated diabetes than in patients with uncomplicated diabetes or a non-diabetic control group [17]. Patients with esophageal variceal bleeding had higher MPV values at both baseline and on admission; this can be explained by the fact that esophageal varices result from increased portal hypertension, which in turn causes splenomegaly and reduced thrombocyte counts. The inverse relationship between thrombocyte count and MPV values is widely known [18].

We found temporal changes in MPV during the course of UGB. A significant and visible trend was seen in MPV, with decreased levels during admission and normalization at discharge. Interestingly, MPV values were similar at baseline and at discharge. Moreover, the effects of gender and comorbid diseases on MPV disappeared on admission for UGB and reappeared at discharge. These findings warrant further studies to clarify the temporal pattern of MPV during the course of UGB.

Conflicting results have been reported by studies that evaluated the relationship between MPV and bleeding severity. Akın et al. [12] reported no relation between MPV and bleeding severity in 97 patients with UGB. However, in another study conducted by Tanoğlu et al. [19], increased MPV levels were positively correlated with hospitalization time and the need for erythrocyte suspension transfusion. It was also stated that increased MPV levels in patients with UGB admitted to the emergency department may indicate the need for hospitalization and for transfusion. Makay et al. [13] studied the relationship between MPV and gastrointestinal bleeding in pediatric patients with Henoch-Schönlein purpura and found that MPV may be an indicator of gastrointestinal bleeding in Henoch-Schönlein purpura. Senel et al. [14] also reported that platelet indices (including MPV) can be used to predict gastrointestinal bleeding severity and prognosis. In this study, we compared the required amount of transfused erythrocytes as a measure of bleeding severity and MPV. However, we did not find a significant relationship between the amount transfused and MPV. These conflicting results may have been caused by differences in the patient populations, as well as pre-laboratory (blood collection, handling, and processing) and laboratory conditions, as mentioned previously [20].

Our study had several limitations. Because of the retrospective nature of this study, fewer parameters could be reliably used for the analyses. Additionally, regarding the patient characteristics, it is particularly important to assess the amount of bleeding with more accurate tools. In this study, we used transfusion amount as a proxy marker; thus, this is an important limitation, and future studies should utilize more objective parameters to determine the severity of bleeding. Furthermore, the lack of some crucial data that are known to be associated with UGB risk, such as tobacco and alcohol use, is another limitation of this study.

Our findings indicate that MPV was higher in female patients and patients with other comorbidities, especially diabetes mellitus. However, these effects were negated by the presence of UGB and returned after UGB was controlled. MPV levels exhibited temporal changes during the course of UGB, indicating that they can be used as a marker; however, we did not find any statistical relationship between temporal MPV values and transfusion amount, a marker for UGB severity. It would be beneficial to conduct further studies on the use of MPV as a parameter for bleeding severity with different markers for UGB severity, especially in patients with comorbidities.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
All authors declare no financial support.

Ethical approval
This retrospective study was carried out in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. Ethical approval was gained from (censored) Hospital Ethics committee (192/14.10.2013).

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