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Original Article

Predictive value of platelet lymphocyte ratio in carbon monoxide poisoning

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Abstract

Aim: Carbon monoxide (CO) poisoning has serious mortality and morbidity among patients who are admitted to the Emergency Department (ED) due to poisoning. Tissue hypoxia and cellular damage, caused by CO poisoning can trigger systemic inflammation. To investigate the relationship between CO poisoning and inflammation, the patient's Complete Blood Cell (CBC) parameters were compared with carboxyhemoglobin (COHb) levels and outcome.

Materials and Methods: Patients who presented with CO poisoning to ED between 01 September 2014 and 01 January 2019 were analyzed. Demographic characteristics (age, gender), laboratory parameters including blood gas analysis, CBC counts, and outcomes of patients were recorded. Inflammatory scores like Neutrophil to Lymphocyte Ratio (NLR), Lymphocyte to Monocyte Ratio (LMR), and Platelet to Lymphocyte Ratio (PLR) were calculated. Patients were divided into 4 groups according to COHb levels as non-toxic, mild, moderate, and severe exposure (<10%, 10-20%, 20-30%, >30%, respectively).

Results: A statistically significant difference was detected between groups regarding lymphocyte level, LMR, and PLR when groups were compared with regard to laboratory values and scores (p values were 0.026, 0.041, and 0.002, respectively). PLR was negatively correlated with COHb level (coefficient -0.212, Sig. 0.017). White blood cell and monocyte levels were found significantly different between patients who were discharged and who received hyperbaric oxygen therapy.

Conclusion: CBC parameters may be useful for the clinicians in CO poisoning as in many pathologies due to being rapid, inexpensive, and easily available.

Keywords: Carbon monoxıde; Emergency Department; platelet lymphocyte ratio; poisoning

INTRODUCTION

Carbon monoxide (CO) is a colorless, odorless gas, and a cause of serious mortality and morbidity among patients who are admitted to the Emergency Department (ED) due to poisoning. Approximately 50.000 ED admittance and an estimated 1,000 to 2,000 deaths per year due to CO poisoning were reported in the United States (1). CO poisoning is diagnosed by high levels of carboxyhemoglobin (COHb) in blood gas analysis in addition to clinical suspicion. The levels of COHb above 2% in nonsmokers and 10% in smokers are defined as "abnormal" (1). Although the clinical correlation between the COHb level and the symptoms has not been demonstrated, it is accepted that high COHb levels inform the severity of the intoxication (2).

It has been shown that tissue hypoxia and cellular damage, caused by CO poisoning can trigger systemic inflammation and this inflammatory response is related to serious complications of CO poisoning (3-5). As an easy and fast measurable indicator of systemic inflammation, the use of Complete Blood Cell (CBC) count parameters and some of the scores obtained from these parameters has been increasing in recent years (4-7). However, there is still not enough evidence in the literature for the routine use of these laboratory tests in CO poisoning.

In this study, the relationship between COHb levels and CBC parameters was investigated in patients with CO poisoning, and thereby it was aimed to provide data to the literature about the role of routine laboratory tests in CO poisoning.

MATERIALS and METHODS

This retrospective study was performed at a tertiary academic hospital with an annual 50.000 ED admittance. Ethical approval was obtained from the local ethic committee (27/11/2019, 262). Patients who presented to ED with a history of exposure to CO and level of COHb above 2% between 01 September 2014 and 01 January 2019 were analyzed. Written informed consent was not necessary because no patient data has been included in the

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manuscript. Demographic characteristics (age, gender), laboratory parameters including blood gas analysis, CBC counts, and outcomes of patients were recorded. Patients who had a pregnancy, history of acute or chronic liver and renal disease, chronic hematological disease, history of malignancy, acute or chronic inflammatory disease, autoimmune disease, drug use affecting CBC counts, and level of COHb lower than 2% were excluded. To investigate the relationship between COHb levels and CBC parameters, patients were divided into 4 groups according to COHb levels as non-toxic, mild, moderate, and severe exposure (<10%, 10-20%, 20-30%, >30%, respectively).

Statistical Analyses

Statistical analyses were done with the SPSS software version 20.0 for Windows. Inflammatory scores like neutrophil to lymphocyte ratio (NLR), lymphocyte to monocyte ratio (LMR), and platelet to lymphocyte ratio (PLR) were calculated by using the compute variable property of the SPSS program. The Kolmogorov-Smirnov test was used to verify the normality of the distribution of continuous variables. Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as percentages. To compare continuous variables, the One-Way ANOVA test or Kruskal-Wallis test, or Mann-Whitney U test was used when appropriate and Spearman Rho Test was used to investigate correlation. Categorical variables were compared with the chi-square test. A p-value of <0.05 was considered as statistically significant (2-tailed test).

RESULTS

A total of 126 patients of whom 58 (46%) were male and 68 (54%) were female, were included in the study. The mean age and mean COHb level of the patients were 30,0 (±20,1) years and 16,3% (±10,4), respectively.

The vast majority of the patients (34,1%; n=43) were in the "non-toxic exposure" group. Mean age was significantly higher in the "severe exposure" group. No difference was detected between groups regarding gender distribution. When patient groups were compared according to laboratory values and scores; a significant difference was detected between groups regarding lymphocyte level, LMR, and PLR (Table 1). No difference was detected between groups according to the other laboratory tests and scores. Only PLR value was detected to show a negative correlation when the correlation between the values which showed significant difference and COHb level was analyzed (Table 2).

When patients were grouped according to the outcome, it was seen that none of the patients were lost in our hospital, 84 (66.7%) patients were discharged from ED while 42 (33.3%) were transferred to a Hyperbaric Oxygen (HBO) center. The comparison of these groups showed that WBC and monocyte levels were significantly different (Table 3).

Table 1. Comparison of demographic and laboratory data of patients grouped by COHb level

	COHb <10% Non-toxic	COHb 10-20% Mild exposure	COHb 20-30% Moderate exposure	COHb 30% Severe exposure	P value
Number of patients (%)	43 (34.1%)	34 (27%)	35 (27.8%)	14 (11.1%)	-
Mean Age (years)	25.7 (±19.0)	24.3 (±17.6)	35.3 (±20.6)	43.3 (±21.1)	**0.004**
Gender (M/F)	18/25	18/16	16/19	6/8	0.798
Hgb (mg/dl)	13.3 (±2.0)	13.5 (±1.7)	13,5 (±1.9)	13.3 (±2.1)	0.642
RDW	14.2 (±1.9)	14.2 (±1.3)	14,1 (±1.3)	14.4 (±1.5)	0.906
WBC	10.2 (±3.0)	10.2 (±3.2)	9.9 (±2.4)	11.8 (±2.9)	0.199
Neutrophile	6.9 (±2.6)	7.3 (±3.0)	6.5 (±2.4)	7.4 (±2.3)	0.723
Lymphocyte	2.4 (±1.4)	2.1 (±1.5)	2,6 (±1.3)	3.3 (±1.7)	**0.026**
Monocyte	0.6 (±0.2)	0.6 (±0.2)	0.5 (±0.2)	0.7 (±0.4)	0.338
Platelet	288 (±106)	264 (±84)	260 (±66)	227 (±59)	0.254
MPV	8.5 (±1.1)	8.5 (±1.0)	8.3 (±0.7)	8.7 (±0.9)	0.503
NRL	3.6 (±2.4)	5.1 (±4.0)	3.4 (±2.5)	3.4 (±3.3)	0.129
LMR	4.3 (±2.9)	3.6 (±2.2)	4.5 (±1.4)	4.6 (±2.1)	**0.041**
PLR	141.1 (±77.4)	163.1 (±82.7)	123.4 (±69.9)	88.2 (±51.5)	**0.002**

COHb: Carboxyhemoglobin, Hgb: Hemoglobin, RDW: Red Cell Distribution With, WBC: White Blood Cell, MPV: Mean Platelet Volume, NLR: Neutrophile to Lymphocyte Ratio, LMR: Lymphocyte to Monocyte Ratio, PLR: Platelet to Lymphocyte Ratio, M: Male, F: Female

Table 2. Correlation analysis of COHb and CBC parameters

			PLR	LYMP	LMR
Spearman's rho	COHb	Correlation Coefficient	**-0.212**	0.090	0.112
		Sig. (2-tailed)	**0.017**	0.318	0.211
		N	126	126	126

LMR: Lymphocyte to Monocyte Ratio, PLR: Platelet to Lymphocyte Ratio, Lymp: Lymphocyte, COHb: Carboxyhemoglobin

Table 3. Comparison of laboratory data of patients grouped by HBO requirement

	Discharged (n:84)	Transferred (n:42)	P-value
Age (years)	29.6 (±18.6)	30.9 (±23.1)	0.975
COHb	12.5 (±8.2)	23.9 (±10.2)	**<0.001**
Hgb	13.5 (±1.8)	13.3 (±2.0)	0.778
RDW	14.2 (±1.7)	14.2 (±1.2)	0.486
WBC	9.7 (±2.5)	11.4 (±3.2)	**0.009**
Neutrophile	6.5 (±2.4)	7.7 (±2.9)	0.060
Lymphocyte	2.3 (±1.3)	2.7 (±1.6)	0.394
Monocyte	0.5 (±0.2)	0.7 (±0.3)	**0.024**
Platelet	270 (±92)	260 (±74)	0.932
MPV	8.5 (±1.0)	8.4 (±0.8)	0.948
NLR	3.7 (±2.5)	4.4 (±3.9)	0.848
LMR	4.3 (±2.5)	4.1 (±1.9)	0.990
PLR	139.9 (±74.7)	128.1 (±80.6)	0.173

HBO: Hyperbaric Oxygen, Hgb: Hemoglobin, RDW: Red Cell Distribution With, WBC: White Blood Cell, MPV: Mean Platelet Volume, NLR: Neutrophile to Lymphocyte Ratio, LMR: Lymphocyte to Monocyte Ratio, PLR: Platelet to Lymphocyte Ratio

DISCUSSION

The present study has revealed that PLR value was correlated with COHb value and could be useful for the detection of the poisoning severity. Despite the presence of the studies in the literature investigating many CBC parameters and the ratios obtained from these values in CO poisoning, to the best of our knowledge, this is the first study that reveals a negative correlation between COHb and PLR.

Lee et al. have first investigated daily variations in CBC parameters in patients with CO poisoning in 1994 (8). The authors have found Hematocrit (Htc), WBC, Mean Platelet Volume (MPV) significantly high, and platelet count significantly low. Similarly, Karabacak et al. have shown that platelet and MPV values were significantly high in patients with CO poisoning compared to the control group (7). A significant difference was detected between the patients with different COHb levels despite the absence of a control group in our study. Also, a difference was found between the "non-toxic exposure" group and "severe exposure" group with regard to only PLR level (Table 1). No difference was found regarding the parameters in the abovementioned studies. It was suggested that this was resulted from the fact that all patients included in our study had CO exposure and the above-mentioned studies did not make a comparison according to COHb level. Besides, the detection of a negative correlation between PLR and COHb level indicates that PLR level is more reliable than the other parameters for estimation of poisoning severity (Table 2). Therefore, PLR value may be useful for the clinicians when blood gas tests are difficult to obtain in CO poisoning.

Our study has revealed that elevated WBC and monocyte values, as well as COHB level, could predict HBO therapy in the early period of CO poisoning. As a well-known parameter, COHB level is a good predictor of HBO therapy in CO poisoning. While HBO therapy is recommended at COHB levels above 25% in the guidelines (9), lower levels are also considered an indication in some centers (10). No studies could be encountered in the literature investigating the relationship between CBC parameters and HBO therapy. However, Moon et al. have reported that WBC, neutrophil, elevated NLR, and decreased lymphocyte, LMR at the time of admission could predict elevated troponin I in CO poisoning (4). These studies seem to support ours given that cardiac enzyme elevation is among the indications of HBO therapy. Also, PLR values were seen to be lower in the patients who required HBO therapy compared to those who were discharged however the difference was not statistically significant. Therefore, we consider that studies with a larger number of patients are required.

LIMITATIONS

The main limitations of our study are its retrospective design and relatively small patient number. Besides, the severity of CO poisoning is usually determined according to clinical symptoms in the literature however our study did not include physical examination findings due to being retrospective. Not reporting the duration between CO exposure and the time of admission to ED is another limitation.

CONCLUSION

Our study is valuable as it reveals the negative correlation between PLR and COHb level and it is the first study in literature investigating this relationship. PLR may be useful for the clinicians for estimation of poisoning severity when it is difficult and time-consuming to measure blood COHb level. Our study has also revealed that WBC and monocyte elevation at the time of admission could predict HBO therapy requirement. We consider that clinicians could benefit from these parameters when they had a dilemma for HBO therapy. CBC parameters could significantly help the clinicians in CO poisoning as in many other pathologies due to being fast, inexpensive,

and easily available. Studies with a detailed methodology and a larger number of patients are required to better understand these results.

Competing Interests: The authors declare that they have no competing interest.

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