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The Relationship of Blood Parameters with the Severity of Carbon Monoxide Poisoning

Karbon Monoksit Zehirlenme Şiddeti ile Kan Parametrelerinin İlişkisi

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Abstract

Introduction: Carbon monoxide (CO) poisoning is one of the most common poisonings worldwide. Many studies have investigated the relationship between predictive parameters and CO poisoning severity. We aimed to investigate the relationship between blood parameter values with poor outcome in CO poisoning, and CO values measured in blood.

Material and Method: This is a retrospective study. Patients who had CO levels ≥10% in their blood gas were included in the study. Patients were divided into 2 groups as those who required hyperbaric oxygen and those who do not. Demographic data such as age, gender of the patients, as well as CO levels in the blood gases of the patients, hemoglobin, leukocyte, neutrophil, platelet counts of the blood count, and MPV and PDW values were recorded. Also, creatinine, troponin, CRP, ALT values were recorded as well.

Results: The study was conducted with 110 patients. The mean age of the patients was 46.80±18.18 years. When the parameters were examined, the median WBC count of patients with patients who required HBO therapy was 8.73 [7.54-11.83], and the median WBC count of patients who did not require HBO therapy was 8.01 [6.96-9.72] (p=0.038). The median lymphocyte count of patients who required HBO therapy was determined as 2.73 [1.85-3.36], and this value was found to be higher than patients who did not require HBO therapy (p=0.026).

Conclusion: WBC and lymphocyte counts are higher in CO poisoning patients who required hyperbaric oxygen therapy. But these two values were not found to be independent risk factors in predicting hyperbaric oxygen therapy.

Keywords: Poisoning, carbon monoxide, oxygen, lymphocyte, leukocytes

Öz

Giriş: Karbon monoksit (CO) zehirlenmesi dünya çapında en yaygın zehirlenmelerden biridir. CO zehirlenmesi ile zehirlenme şiddetini tahmin edecek parametreleri araştırmak için birçok çalışma bulunmaktadır. Bu çalışmada kan parametre değerleri ile kanda ölçülen CO değerleri ve zehirlenmenin sonlanımı arasındaki ilişkiyi araştırmayı amaçladık.

Gereç ve Yöntem: Çalışmamız retrospektif bir çalışmadır. Kan gazında CO düzeyi ≥%10 olan hastalar çalışmaya dahil edildi. Hastalar hiperbarik oksijen ihtiyacı olanlar ve olmayanlar olarak 2 gruba ayrıldı. Hastaların yaş, cinsiyet gibi demografik verileri ile kan gazlarındaki CO düzeyleri, hemoglobin, lökosit, nötrofil, kan sayımı trombosit sayıları, MPV ve PDW değerleri kaydedildi. Ayrıca kreatinin, troponin, CRP, ALT değerleri de kaydedildi.

Bulgular: Çalışmaya 110 hasta dahil edildi Hastaların yaş ortalaması 46,80±18,18 idi. Parametreler incelendiğinde HBO tedavisi gereken hastaların WBC sayımı ortancası 8,73 [7,54-11,83], HBO tedavisi gerektirmeyen hastaların WBC sayısı ortancası 8,01 [6,96-9,72] (p=0,038) idi. Benzer şekilde HBO tedavisi gereken hastaların lenfosit sayısı ortancası 2,73 [1,85-3.36] olarak belirlendi ve bu değer HBO tedavisi gerektirmeyen hastalara göre daha yüksek bulundu (p=0,026).

Sonuç: Hiperbarik oksijen tedavisi gerektiren CO zehirlenmesi olgularında WBC ve lenfosit sayıları daha yüksektir. Ancak bu iki değer hiperbarik oksijen tedavisini öngörmede bağımsız risk faktörleri değillerdir.

Anahtar Kelimeler: Zehirlenme, karbonmonoksit, oksijen, lenfosit, lökosit

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INTRODUCTION

Carbon monoxide (CO) poisoning is one of the most common poisonings worldwide. Intoxication may cause only mild symptoms such as headache or nausea, or it may progress with a severe course that causes mortality.[1] CO binds to hemoglobin with greater affinity than oxygen and caused impaired use and utilization of oxygen by tissues. Also, it causes delayed neurological sequelae with concomitant lipid peroxidation.[2] Clinicians' suspicion is required for diagnosis, especially in mild cases, together with clinical symptoms and signs. The CO level measured in the blood is the most used method in the diagnosis.[3] There are many studies that have investigated the relationship between predictive parameters and CO poisoning severity.[1,4] The relationship between lymphocyte, neutrophil, troponin, and mean platelet volume with the severity of the poisoning has been demonstrated.[5,6] In addition, it has been shown that the neutrophil-lymphocyte ratio may be effective in predicting major cardiac adverse events in severe carbon monoxide poisoning.[7]

In our study, we aimed to investigate the relationship between blood parameter values with poor outcome in CO poisoning, and CO values measured in blood.

MATERIAL AND METHOD

Study Design

Our study was planned as a retrospective study. The study was conducted after the approval of the Karabük University Non-Interventional Clinical Researches Ethics Committee (Decision No:2022/820) and the data obtained using the hospital information system were anonymized and statistical analysis and interpretations were made in a blind manner.

Selection of Participants

Patients who applied to the emergency department with the suspicion of CO poisoning and had CO levels ≥ %10 in their blood gas were included in the study. Patients with CO levels <10, lack of data to be collected in the study, patients who were pregnant or under the age of 18 at the time of application were excluded from the study. Patients were divided into 2 groups as those who required hyperbaric oxygen (HBO) and those who do not. Patients with CO level ≥ %25, patients with ischemic chest pain or ECG changes or troponin positivity at presentation, patients with syncope, loss of consciousness, and abnormal neuropsychiatric disorders at presentation were defined as patients who required HBO.

Data Collection

Demographic data such as age, gender of the patients, as well as CO levels in the blood gases of the patients, hemoglobin (Hb), leukocyte, neutrophil, platelet counts of the blood count, and MPV and PDW values were recorded. Also, creatinine, troponin, CRP, ALT values were recorded as well.

Outcome

To investigate the relationship of platelet count, MPV, and PDW values with the course of the disease and relation of CO levels.

Statical Analysis

Statistical analysis was performed using the IBM SPSS Statistics 22 (IBM SPSS, Turkey) package program. In summarizing the data, descriptive statistics were tabulated for continuous variables as mean ± standard deviation or median and quartile width, depending on the distribution. Categorical variables were summarized as numbers and percentages. The normality test of numerical variables was checked with the Shapiro Wilks test, histogram, and Q-Q plot graphs. Comparison of the quantitative data, if they fit the normal distribution, Student's T-test was evaluated. If it did not fit the normal distribution, the Mann-Whitney U test was used. Correlation analyzes were used to investigate the relationships of continuous data. Logistic regression analysis was used to determine independent parameters affecting hyperbaric oxygen treatment. The chi-square test was used to compare the qualitative data and the significance was determined as $p<0.05$ during the tests.

RESULTS

The study was conducted with 140 patients. 30 patients were excluded from the study due to the lack of laboratory data. In our study, which was investigated on 110 patient data in total, 67 (60.9%) of the patients were women. It was determined that 45 (40.9%) of the patients included in the study received hyperbaric oxygen therapy. The mean age of the patients was 46.80±18.18 years. All demographic data and laboratory parameters of all patients are summarized in **Table 1**.

Table 1. Demographic data and laboratory parameters of the patients

Gender	
Female n (%)	67 (60.9%)
Male n (%)	43 (39.1%)
HBO therapy	
Yes n (%)	45 (40.9%)
No n (%)	65 (59.1%)
Age (year)	46.80±18.18
CO (%)	23.46±11.69
PLT (109/L)	243.40±73.55
PDW	16.23±0.49
Hgb (g/dL)	13.53±1.87
MPV (fL)	9.96±1.27
WBC (109/L)	8.14 [7.18-10.05]
Lymphocyte (109/L)	2.43 [1.68-3.10]
Neutrophil (109/L)	5.23 [4.11-6.88]
Troponin (ng/ml)	0.001 [0.001-0.013]
Creatinine (mg/dl)	0.77±0.28
ALT (u/L)	18.00 [13.00-27.00]
CRP (mg/L)	3.20 [1.30-6.12]

When the demographic data and laboratory parameters of patients who required HBO therapy or were not examined, the median WBC value of patients with patients who required HBO therapy was 8.73 [IQ 25-75, 7.54-11.83], and the median WBC count of patients who did not require HBO therapy was 8.01 [IQ 25-75, 6.96-9.72]. The median WBC count of patients who required HBO therapy was higher than those who did not (p=0.038). Similarly, the median lymphocyte count of patients who required HBO therapy was determined as 2.73 [IQ 25-75, 1.85-3.36], and this value was found to be higher than patients who did not require HBO therapy (p=0.026). PLT, PDW, and MPV values of patients with and without HBO indication were not statistically different from each other (p=0.218, p=0.983, and p=0.592, respectively). Other demographic data and laboratory parameters are summarized in **Table 2**.

Table 2. Comparison of demographic data and laboratory values of patients with and without indication for HBO therapy

Value	HBO indication (+)	HBO indication (-)	p
Gender(female) n (%)	25 (64.6%)	42 (55.6%)	0.338χ
Age (year)	48.53±19.94	48.60±16.90	0.408*
CO (%)	33.75±7.79	16.33±8.05	<0.001
PLT (109/L)	253.82±82.02	236.20±66.77	0.218
PDW	16.23±0.48	16.23±0.50	0.983
Hgb (g/dL)	13.44±1.75	13.61±2.02	0.636
MPV (fL)	9.88±1.35	10.02±1.22	0.592
WBC (109/L)	8.73 [7.54-11.83]	8.01 [6.96-9.72]	0.038¥
Lymphocyte (10^9/L)	2.73 [1.85-3.36]	2.13 [1.40-2.86]	0.026
Neutrophil (10^9/L)	5.23 [4.01-8.73]	5.24 [4.12-6.12]	0.557
Troponin (ng/ml)	0.009 [0.001-0.310]	0.001 [0.001-0.100]	0.001
Creatinine (mg/dl)	0.81±0.26	0.74±0.30	0.183
ALT (u/L)	18.00 [14.00-25.50]	20.00 [12.50-27.00]	0.633
CRP (mg/L)	3.20 [1.44-6.15]	3.40 [1.25-6.05]	0.704

χChi-square test was performed, *Student's T-test was performed, ¥Mann Whitney-U test was performed

In the logistic regression analysis performed to determine the independent parameters for HBO treatment, lymphocyte and WBC counts were not found to be independent risk factors in the logistic regression analysis (**Table 3**).

Tablo 3. Logistic regression analysis for hyperbaric oxygen indication

	Wald	Odds ratio	95% C.I.	
WBC	2.543	1.238	0.952	1.611
Lymphocyte	1.175	0.728	0.410	1.293
Platelet	0.230	1.002	0.993	1.012
CO	23.815*	1.378	1.212	1.568

C.I.= confidence interval, Omnibus χ2 (4) = 87.39 p<0.001 R2 = 0.739 (Negelkerke)

DISCUSSION

In our study, the mean age of the patients presenting with CO poisoning was 46.80±18.18 years, which is similar to other studies in the literature.[8,9] In a study investigating troponin I elevation in CO poisoning, it was found that WBC count was higher in patients with troponin elevation than in patients without troponin elevation, but no difference was found between lymphocyte levels between these two groups.[10] Bagci et al. devided the patients presenting with CO poisoning into 2 groups mild-moderate and severe. According to the analyzes made in the study, there was no difference between the two groups in terms of MPV or platelet values, while the lymphocyte value was found to be higher in cases of severe poisoning.[11] In another study, patients were divided into 2 groups as those with and without severe CO poisoning, and WBC, lymphocyte, troponin, and MPV values were found to be higher in severe poisoning cases.[12] It was found that patients with high CO levels at admission had significantly higher troponin values in studies that examined patients with delayed neuropsychiatric sequelae after carbon monoxide poisoning.[13,14] Similarly, we found that WBC and lymphocyte counts, and troponin values were found to be higher in patients with an indication for HBO therapy than in patients without an indication for HBO therapy. Temrel et al. compared the laboratory values of the control group with a CO level of less than 10% and the patients with a CO level of more than 10% and found that WBC, neutrophil count, and MPV values were higher in the CO poisoning group, lymphocyte value was lower, and platelet value was not different in both groups.[15] Unlike our study, the reason for the higher MPV value and lymphocyte count being lower may be the study was conducted with a control group without CO poisoning cases. Similar to our study, Karaman et al. found that the WBC counts of the patients who required HBO therapy were significantly higher than those who do not require HBO therapy and the lymphocyte count increased with the increase in CO levels.[16]

In our study, when the parameters that could be used to determine the need for HBO therapy were examined, it was found that only the CO level was an independent factor in predicting the treatment. Similarly, Liao et al. determined that the CO value and Modified Poisoning Severity Score were independent factors for HBO therapy.[17]

Limitation

Our study is a single-center study and has relatively few patients. In the study, there was no data on the mortality of the patients. In addition, we did not investigate late neurophysiological sequela.

CONCLUSION

WBC and lymphocyte counts are higher in CO poisoning patients who required hyperbaric oxygen therapy, which we can define as serious. However, these two values were not found to be independent risk factors in predicting hyperbaric oxygen therapy.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was conducted after the approval of the Karabük University Non-Interventional Clinical Researches Ethics Committee (Decision No:2022/820).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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