

# The white blood cell count can predict severe injury caused by caustic ingestion

## Beyaz kan hücre sayısı kostik alımı nedeniyle oluşan ciddi yaralanmayı öngörebilir

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### ABSTRACT

**Objective:** It is unclear whether esophagogastroduodenoscopy (EGD) should be performed early on in patients receiving caustic substances. In this study, the relationship between white blood cell (WBC) counts and patients with early EGD and upper gastrointestinal system injuries was investigated.

**Method:** Patients who applied for urgent care because of caustic substance ingestion between January 2011 and December 2014 were retrospectively investigated. The esophageal, gastric and duodenal injuries were graded according to the method of Zargar. Zargar grade 0 and 1 injuries were defined as low scores and others were defined as high scores (Grade 2a to 3b injuries). The WBC counts in these patients have been studied.

**Results:** 173 of 242 patients were excluded from the research. Our research was conducted with 69 patients. The most common caustic agent ingested was alkaline (66.7%). The number and severity of duodenal injuries was less than those of esophagus and stomach. Sensitivity and specificity values for patients with WBC count  $\geq 11.95$  K/ $\mu$ L were found to be 64% and 91%, respectively.

**Conclusion:** Higher white blood cell counts in patients with caustic exposure can be an important predictor of the severity of injury and the need for early esophagogastroduodenoscopy.

**Keywords:** Caustic substance, esophagogastroduodenoscopy, Zargar score, white blood cell count

### ÖZ

**Amaç:** Kostik madde alan hastaların hangilerine erken dönemde özofagogastroduodenoskopi yapılması gerektiđi net deđildir. Bu çalışmada, beyaz kan hücre sayısı ile erken dönem özofagogastroduodenoskopi gereksinimi olabilecek hastalar ve üst gastrointestinal sistem yaralanmaları arasındaki ilişki araştırıldı.

**Yöntem:** Ocak 2011 ile aralık 2014 tarihleri arasında kostik madde alımı nedeni ile acil servise başvuran hastalar geriye dönük araştırıldı. Özafagus, mide ve duodenumdaki yaralanmalar Zargar metoduna göre derecelendirildi. Zargar yaralanma derecesi 0 ve 1 olanlar düşük skorlu deđerleri ise yüksek skorlu olarak tanımlandı (2a-3b yaralanmalar). Bu hastalardaki beyaz kan hücresi sayısı incelendi.

**Bulgular:** Çalışmamız 69 hasta ile yapıldı. En sık alınan kostik madde alkalın (%66,7) idi. Duodenal yaralanma sayısı ve şiddeti özafagus ve mideye göre daha azdı. Çalışmamızda, beyaz kan hücre sayısı  $\geq 11,95$  K/ $\mu$ L olan hastalar için sensitivite ve spesifite deđerleri sırasıyla %64 ve %91 idi.

**Sonuç:** Kostik madde maruziyeti olan hastalarda yüksek beyaz kan hücre sayısı yaralanmanın şiddetini ve erken özofagogastroduodenoskopi gerekliliđini öngörmesi açısından önemli bir bulgu olabilir.

**Anahtar kelimeler:** Kostik madde, özofagogastroduodenoskopi, Zargar skoru, beyaz kan hücre sayısı

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## INTRODUCTION

Caustic substance intake, whether alkaline or acidic, can cause serious morbidity and sometimes mortality<sup>(1,2)</sup>. The absence of a strong association between symptoms and the severity of the lesion can compromise the management of patients with caustic exposure<sup>(3)</sup>. Due to the high tissue penetration rates of both strong acidic and alkaline agents, it is not much of an importance which agent the patient is exposed to<sup>(4)</sup>. However, the pathophysiology of the destruction caused by acidic and alkaline agents in the gastrointestinal wall differs from each other<sup>(1,5)</sup>.

In these patients esophagogastroduodenoscopy (EGD) is the gold standard diagnostic tool in determining the location, extent and severity of the injury<sup>(3)</sup>. It is known that the severity of endoscopically detected injury correlates with clinical outcome<sup>(6-10)</sup>. However, EGD may cause complications such as gastrointestinal perforation and bleeding<sup>(9,11)</sup>. In addition to these, EGD is not often applicable under emergency conditions. Therefore, it is important to determine the clues regarding which patient will undergo EGD in emergency practice.

In this study, the relationship between upper gastrointestinal system injury caused by caustic ingestion and white blood cell (WBC) count was investigated.

## MATERIAL and METHODS

This retrospective study was conducted between January 2011 and December 2014 in an urban tertiary emergency department (ED) that has approximately 180,000 visits annually. The study was approved by the local ethics committee.

The data for all patients aged 18 years and older who were referred to ED because of ingestion of a caustic substance were retrospectively scanned from the patient files and the hospital automation system. Patients were excluded from the study for the following reasons: refusal of treatment (n=65), missing EGD results (n=69 p), and WBC data on admission

(n=34), pregnancy (n=3), EGD delayed 24 hours after admission (n=2) and presence of an immunosuppressive disease (hematologic, cancer, etc.).

Hospital records of the patients were reviewed by two emergency medicine physicians and a gastroenterologist. The age, gender, WBC count on admission, type and quantity of caustic substance, reason of ingestion (accidental or suicidal intent) and patient's outcomes were recorded. Caustic substances were classified as acidic, alkaline and hydrocarbons. Esophagogastroduodenoscopy of patients were reviewed by a gastroenterologist in the endoscopy unit and the esophageal, gastric and duodenal injuries were graded according to the method of Zargar as follows: Grade 0, normal findings; Grade I, edema and hyperemia of the mucosa; Grade IIa, superficial localized ulceration, friability, and blister; Grade IIb, Grade IIa plus circumstantial ulceration; Grade IIIa, multiple ulceration, area of necrosis, brown-black, or grayish discoloration; and Grade IIIb, extensive necrosis<sup>(12)</sup>. Zargar Grade 0 and 1 injuries were defined as low scores and others were defined as high scores (Grade 2a to 3b injuries).

The WBC count was measured during the first hour of admission. The WBC count was determined using a hematological cell counter (LH 780 Analyzer, Beckman Coulter Inc., Miami, FL, USA). The expected WBC count in our laboratory ranged between 4.2-10.6 K/ $\mu$ L.

In the analysis of the data, SPSS 22 (version 22.0.0.0) was used. Quantitative data were expressed in terms of number of observations and percentages (%), qualitative data were expressed in terms of median, interquartile range (IQR), minimum (min), maximum (max) values. Mann-Whitney U test and Spearman correlation analysis were used for quantitative data.

Wilcoxon signed-rank test was used to compare the severity of Zargar injury scores between duodenum and esophagus and also duodenum and stomach. Receiver operating characteristic (ROC) analysis was used to determine WBC count for patients whose Zargar scores were Grade 2a and above. Threshold

values were obtained by ROC analysis. Odds ratio was calculated by using cross-tables and sensitivity and specificity were calculated by using standart formulas. All analyzes were performed at 95% confidence interval, and p values <0.05 were considered statistically significant.

**RESULTS**

The records of 242 caustic substance exposure patients were reviewed. A hundred and seventy-three patients were excluded. Thus, 69 patients were included in the study. Forty-nine percent (n=34) of the patients were males, with a median age of 42 years (IQR:29; min:18, max:86).

The most commonly ingested caustic agent was alkaline (66.7%) followed by acidic substances (17.4%) and hydrocarbons (15.9%). Most frequently accidental (79.7%) ingestion was detected. Although there was no difference between the amounts of intake between the two groups (accidental or not) (p=0.665), the rate of injury due to acidic ingestion was higher relative to the alkaline and hydrocarbon ingestion groups (p<0.001). In one of the 3 patients who had not undergone endoscopic duodenal examination, the stomach and esophagus were found to have Zargar Grade 2a lesions. In two patients, there were no injuries to the stomach and esophagus. Only one of 66 patients who underwent endoscopic duodenal examination was found to have Zargar Grade 2a lesions. Zargar 3b injuries were detected in the esophagus and stomach of this patient. The severity of duodenal injuries (mean:0.14±0.39, min:0, max:2) was lesser than that of gastric (mean:0.76±1.36,

min:0, max:5) and esophageal injuries (mean:0.87±1.29, min:0, max:5) (duodenum vs esophagus, p<0.001; duodenum vs stomach, p<0.001). The Zargar injury grades of the study patients are shown in Table 1.

Median WBC counts of the patients at the time of

**Table 2. The relationship between gender, substance, amount, reasons for taking, severity of injury, and white blood cell count.**

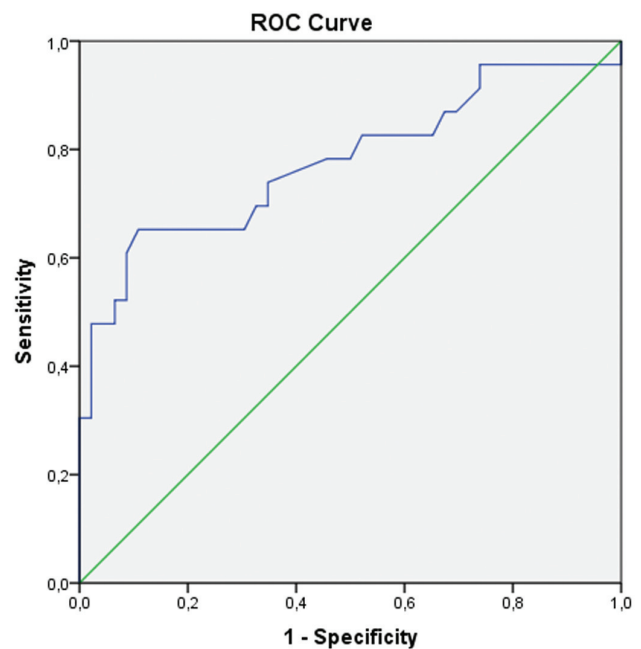
	White blood cell count median (IQR); K/ $\mu$ L	p
<b>Caustic substance</b>		
Acid (n=19)	11.4 (8.1)	0.407*
Alkali (n=46)	9.3 (3.8)	
Hydrocarbon (n=4)	9.4 (0.7)	
<b>Gender</b>		
Male (n=34)	9.3 (6.6)	0.746**
Female (n=35)	9.3 (3.7)	
<b>Reasons for taking</b>		
Accidental (n=55)	9.2 (3)	0.009**
Suicidal intent (n=9)	13.2 (9)	
Unknown (n=5)	15.5 (12)	
<b>Amount of substance</b>		
<100 ml (n=46)	9.3 (3.3)	0.012**
$\geq$ 100 ml (n=12)	13.9 (5.2)	
Unknown (n=11)	8.7 (7.7)	
<b>Zargar grade</b>		
High score (n=23)	13.9 (6.3)	<0.001**
Low score (n=46)	9.1 (3.1)	

\*Kruskal-wallis test

\*\*Mann-whitney U test

**Table 1. Zargar injury grades of the patients.**

Grade	Esophagus (n=69)	Stomach (n=67)	Duodenum (n=66)
0	42	43	58
1	6	12	7
2a	15	6	1
2b	2	1	-
3a	2	1	-
3b	2	-	-



**Figure 1. Receiver operating characteristic curve of white blood cell count for patients whose Zargar score is 2a and above.**

admission was 9.3 K/ $\mu$ L (IQR:4.9, min:5.7, max:33.3). The relationship between gender, amount, and type of the substance ingested, reasons for ingestion, severity of injury, and WBC counts are shown in Table 2.

There was a moderate correlation between WBC counts and maximum Zargar injury scores detected at stomach, esophagus and duodenum ( $p < 0.001$ ,  $r = 0.603$ ). In patients whose Zargar scores were Grade 2b and above, area under curve for WBC count was calculated as 0.78 (95% CI, 0.65-0.91) (Figure 1). Sensitivity, specificity and odds ratio for WBC count of  $\geq 11.95$  K/ $\mu$ L in patients with high Zargar scores (Grade 2a to 3b injuries) were 64%, 91% and 2.33 (95% CI, 1.39-3.91) respectively.

Sixty patients (87%) were hospitalized, in whom 6 patients (8.7%) were intensive care patients, and 2 patients (2.9%) exited. The deceased patients were both male, and aged 49 (acidic ingestion, WBC count=14.3 K/ $\mu$ L) and 60 years (alkaline ingestion, WBC count=33.3 K/ $\mu$ L), respectively. Both of the mortalities were due to gastrointestinal perforation.

## DISCUSSION

This was a retrospective cross-sectional study evaluating the correlation between WBC count during admission and severity of caustic injury defined by EGD results. Our hypothesis was that we could find a predictor for severity of injury in cases with caustic ingestions that could indicate a need for earlier EGD. In this study, we have found that WBC count is higher in patients with severe injuries than in those who are not seriously injured.

The severity of the injury resulting from the caustic ingestion is related to the type, quantity and concentration of the substance ingested<sup>(13)</sup>. It has been reported that there is no good correlation between laboratory test results and the severity of injury due to caustic ingestion<sup>(14)</sup>. However, Rigo et al.<sup>(3)</sup> reported that WBC count of  $\geq 20000$  cells/ $\text{mm}^3$  were an independent indicator for mortality in patients ingesting caustic agents. In another study, Havanond

emphasized the increase in WBC count (higher than bold value) in patients with high grade (Grades 2b and 3) injuries. In his study, Havanond has reported that the lesion may be severe if drooling saliva is present, and WBC count is higher than normal value after evaluation of the buccal mucosa<sup>(11)</sup>. In this study, we found that WBC count was statistically higher in patients with severe injuries than those who were not severely injured, but WC count was moderately correlated with the severity of the injury. We think that elevated WBC count is the result of ischemia, inflammation, edema and necrosis of tissue.

Although many studies suggest early EGD in symptomatic patients, the rules for performing early EGD on patients with caustic ingestion have not been clearly defined<sup>(13)</sup>. Some authors have reported that premature application of EGD is unnecessary for patients with accidental intake who do not display symptoms during admission because of the small amount of substance ingested<sup>(8)</sup>. White blood cell count is easily applicable, less invasive and cheap marker, even though it is weakly correlated with the severity of injury. In cases of caustic ingestion, high WBC levels should suggest serious injury, but the absence of leukocytosis is not enough to exclude injury alone. In this study, we found that the severity of injury was high in patients with WBC count  $\geq 11.95$  K/ $\mu$ L. For this reason, we think that it would be beneficial to use this parameter in predicting the severity of the injury of the patient and the need for EGD during the early period of exposure.

## Limitations

The inadequate number of patients included in the study and the small number of cases with serious injuries were the most important limitations of our study. In this study, admission symptoms and signs of patients were not evaluated. Since our study was retrospective, discrimination between causes of leukocytosis such as infection that might affect WBC count could not be made.

## CONCLUSION

High white blood cell count in patients admitted to ED after caustic ingestion may be an important finding in predicting the severity of the injury and the need for early esophagogastroduodenoscopy.

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