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A Common Toxicologic Emergency: Caustic and Corrosive Ingestions in Children Presenting to the Emergency Department

Sık Karşılaşılan bir Toksikolojik Acil: Çocuk Acil Servise Başvuran Korozif ve Kostik Madde Alan Çocuklar

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Abstract

Introduction: Accidental ingestion of cleaning substances poses a risk to children all over the world and in our country. In this study, we aimed to investigate the causes of this condition and the clinical problems caused by such serious consequences.

Methods: This study was designed as an observational, descriptive, retrospective study. The data were obtained from the hospital electronic medical records. In addition to the demographics, the type of poisoning, presenting complaints, diagnostic tests, medications, treatments and outcomes (results of esophagoscopy and follow-up) were also investigated. The cases were divided into two groups: patients who underwent esophagoscopy and were kept under observation and those kept under observation without esophagoscopy. Patients who underwent esophagoscopy were further divided into two groups as 'histopathological examination with normal findings ' and 'histopathological examination with abnormal findings. Hemogram, biochemical parameters and C-reactive protein levels were recorded. The cases with missing or inaccessible data were excluded from the study. The study was approved by the local ethics committee. The SPSS 22.0 program was used for the analysis of the data.

Results: Four thousand three hundred forty five had a diagnosis of poisoning and 295 were exposed to corrosive substances. The most common poisoning agent was bleach (23.7%). Of the patients, 132 (57.9%) underwent only clinical follow-up and 96 (42.1%) underwent esophagoscopy with clinical follow-up. The occurrence rate of esophageal strictures was significantly higher in patients ingesting degreasers ($p<0.05$). There was a significant relationship between elevated platelet count and amylase level and presence of esophageal pathologies ($p<0.05$).

Conclusion: Exposure to corrosive substances is a common problem during childhood. It was observed that ingestion of degreasers

Öz

Giriş: Tüm dünyada ve ülkemizde temizlik maddelerinin kazara alımı çocukluk çağı için risk oluşturmaktadır. Bu çalışmada böylesine ciddi sonuçları olan bu patolojinin etkenlerini ve yol açtığı klinik sorunları incelemeyi amaçladık.

Yöntemler: Bu çalışma gözlemsel, tanımlayıcı, geriye dönük bir çalışma olarak planlandı. Veriler hastane elektronik tıbbi kayıtlarından elde edildi. Demografik yapıya ek olarak, şikayetler, tanı testleri, maruz kalınan ajanlar, tedaviler ve sonuçlar (özefagoskopi durumu ve takip süresi) ile ilgili bilgiler elde edildi. Başlangıçta, olgular iki gruba ayrıldı, bunlardan biri "izlem ile birlikte özefagoskopi uygulananlar", diğeri ise "sadece izlenenler" idi. İkinci olarak, özefagoskopi yapılan olgular "normal sonuçlanan histopatolojik inceleme" ve "anormal sonuçlanan histopatolojik inceleme" olmak üzere iki gruba ayrıldı. Tüm hastaların laboratuvar testlerinde hemogram, biyokimyasal parametreler ve C-reaktif protein düzeyleri kaydedildi. Eksik veya erişilemeyen verileri olan hastalar çalışma dışı bırakıldı. Çalışma yerel etik kurul tarafından onaylandı. Verilerin analizinde SPSS 22.0 programı kullanıldı.

Bulgular: Dört bin üç yüz kırk beş hasta zehirlenme tanısı ile izlenmiş, zehirlenme tanısı alanların 295'inin korozif maddeye bağlı olduğu görülmüştür. Verilerine tam ulaşılamayan hastalar çalışma dışı bırakılmış ve çalışmamıza 122 erkek (%53,5) ve 106 kız (%46,5) toplam 228 olgu alınmıştır. En sık karşılaşılan kimyasal ajan çamaşır suyu (%23,7) olarak tespit edilmiştir. Olguların 132'sine (%57,9) sadece takip yapılırken, 96'ine (%42,1) beraberinde özefagoskopi yapılmıştır. Hastaların almış oldukları maddeler ile izlem ve özefagoskopi yapılma durumları arasında herhangi bir ilişki saptanmamıştır ($p>0,05$). Ancak yağ çözücü alımlarında istatistiksel olarak daha fazla özefagus striktürü görülmüştür ($p<0,05$).

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Abstract

increased the risk of esophageal stricture formation. Elevated platelet count and amylase level were found to be predictive of esophageal injury.

Keywords: Pediatric emergency, corrosive, caustic, esophagoscopy

Öz

Sonuç: Çocukluk çağında korozif maddelere maruziyet sık görülen bir sorundur. Yağ çözücü alımının özafagusta striktür oluşma riskini arttırdığı görülmüştür. Acil serviste alınan tetkiklerden trombosit ve amilaz yüksekliği özafagusta hasar oluşumunu öngörmede etkisi olduğu tespit edilmiştir.

Anahtar Kelimeler: Çocuk acil, koroziv, kostik, özefagoskopi

Introduction

Accidental exposure to cleaning agents remains a serious problem for childhood throughout the world and especially in developing countries. Most cleaning materials contain corrosive or caustic substances. Caustic means burning or corroding organic tissue by chemical action, typically due to strong acid or alkaline properties. The major caustic agents are household bleaches and oven and drain cleaners which contain sodium hydroxide (NaOH), potassium hydroxide, hydrochloric acid, and nitric acid.[1,2] The resulting damage varies according to the type of substance, concentration, amount taken and duration of exposure.[1,2] Alkalis and acids produce tissue injury by different mechanisms; alkaline agents tend to cause esophageal injury via liquefactive necrosis if the pH is above 11.5-12.5, however, acids or corrosive agents tend to cause esophageal injury via coagulation necrosis if the pH is less than 2.

Poisoning with corrosive substances is common in childhood. 80% of all cases are child victims. The remaining group consists of adults who are exposed to large amounts of corrosive substances for suicidal purposes. This situation is more dangerous. Low socioeconomic status and low educational level increase the incidence of poisoning with corrosive agents.[3,4]

Although the actual frequency of such a serious health problem is not known, there are publications reporting the incidence rate of pediatric cases of 5-518 per 100.000 per year.[5,6] More than 40.000 child accidental poisonings are reported annually in the UK.[7] In the United States alone, the economic burden related with corrosive and caustic substance exposure in 2009 was recorded as $ 22.9 million.[8]

As a result, caustic poisoning is a condition that causes widespread, serious morbidity and high cost of treatment. We aimed to draw attention to poisoning with domestic cleaning agents, which is a preventable health problem with very simple precautions and family education, and to determine the current situation in our region.

Materials and Methods

This study was designed as an observational, descriptive, retrospective study. All patients, who were admitted to the pediatric emergency department (PED) in a tertiary health center due to ingestion of cleaning and corrosive caustic substances between January 2011 and December 2016, were included in this study. The data were obtained from the hospital automation system. In addition to the demographic information of the cases, the amount of substances, complaints, examination findings, treatments and the results were examined.

We determined the contents of caustic and corrosive substances. The cases are divided into two groups: patients who underwent esophagoscopy and were kept under observation and those kept under observation without esophagoscopy. Patients who underwent esophagoscopy were further divided into two subgroups: histopathological examination with normal findings and histopathological examination with abnormal findings. Hemogram, biochemical parameters and c-reactive protein (CRP) levels were recorded.

Of corrosive and caustic substances included in this study, degreaser agents contain NaOH and potassium hydroxide (KOH), bleaches contain sodium hypochlorite, surface cleaners and dishwasher rinse aids contain acetic acid and citric acid, descalers contain hydrochloric acid (HCl) and clog removers contain sodium bicarbonate.

Our approach to cases with caustic and/or corrosive substance intake is based on the clinical condition of the patient. If the patient suffers from difficulty swallowing, esophagoscopy is planned to determine the level of burn. When stricture formation is developed, surgical intervention is performed. If difficulty with swallowing liquid foods is not observed, the patient is monitored for at least six hours in PED. The cases with missing or inaccessible data were excluded from the study. The study was approved by the local ethics committee.

Statistical Analysis

Mean, standard deviation, median, minimum, maximum, frequency and rate values were used in the descriptive statistics of the data. The distribution of the variables was analyzed

by the Kolmogorov-Smirnov test. The Mann-Whitney U test was used in the analysis of independent quantitative data. The chi-square test was used in the analysis of independent qualitative data. Fisher's exact test was used when chi-square test assumptions were not met. The SPSS 22.0 program was used in the analysis of the data.

Results

In this period, 932.645 patients presented to the pediatric emergency department; 4345 (46.5%) of them were followed up with poisoning diagnosis and 295 (6.8%) of poisonings were related to corrosive substances. Patients whose data were not fully accessible were excluded from the final analysis. Finally, a total of 228 patients [122 (53.5%) boys] were enrolled. The mean age of the patients in the study group was 27±24.9 months (Table 1). The majority of the cases were intoxication related with exposure to non-branded bleaches detected in 54 cases (23.7%) and degreasers in 32 cases (14%) (Table 1).

One hundred thirty two of the cases (57.89%) were only followed up and 96 (42.10%) underwent esophagoscopy. The mean age of the follow-up group was 29.2±27.2 months and the esophagoscopy group was 23.9±20.8 months (p=0.001) (Table 2). There were no differences between follow-up and esophagoscopy groups in terms of white blood cell (WBC) count, platelet count, serum CRP levels and serum amylase levels. Hemoglobin levels were significantly lower in the group undergoing esophagoscopy (p=0.01) (Table 2). Esophagoscopy was performed in 42.7% of the boys and 41.5% of the girls in the study group (p=0.002). There was no significant relationship between the substances and the follow-up and esophagoscopy status (p=0.14) (Table 2). When the duration of hospitalization was examined, the mean duration in the follow-up group and the esophagoscopy group was 55.35±27.16 hours and 68.17±11.70 hours (p=0.001), respectively (Table 2).

Table 1. Demographic characteristics of study group and pathology results from esophagoscopy

Age (month) (mean ± SD minimum/ maximum)	27.0±24.9 (4.0/121.0)	
	n	**%**
Gender		
Female	106	46.5
Male	122	53.5
Ingested substance		
Non-branded bleaches	54	23.7
Degreaser	32	14.0
Branded bleaches	22	9.6
Descaling detergent	22	9.6
Dish washer polisher	19	8.3
Surface cleaner	20	8.8
Drain opener detergent	9	3.9
Muriatic acid	8	3.5
Others[1]	42	18.4
Pathologic results in esophagoscopy		
Normal	50	50.0
Burned	38	38.0
Hyperemia	2	2.0
Stricture	10	10.0

[1]Other ingested substances: stain remover, dishwasher detergent, battery, powder detergent, hair dye color opener, SD: Standart deviation

Subgroup analysis was performed for esophagoscopy group based on their histopathological reports. When all pathological findings (hyperemic appearance, any degree burn, and stricture formation) were evaluated together, it was determined that ingestion of degreasers caused more damage (p=0.01) (Table 3). When the laboratory parameters and the histopathological findings of esophagoscopy were evaluated, platelet count and amylase level were significantly higher in the group with pathology (p=0.01 and p=0.02, respectively) (Table 3) When we evaluated 38 cases in whom esophageal burns were detected at the end of the esophagoscopic evaluation, it was found that 8 patients had esophageal burn due to exposure to non-branded bleaches, 7 - to dishwasher polisher aid, 6 - to branded bleach, 4 - surface cleaner, 4 - descaling detergent, and 9 patients had burn due to exposure to muriatic acid, stain removers, dishwasher salt, or drain openers (Table 4). The pathological results of the exposure to the substances are shown in Figure 1.

All cases were accidental ingestion of chemical substances. No patient needed pediatric intensive care. There was also no mortality.

Discussion

Exposure to corrosive and caustic substances in children is both serious health and economical problem worldwide.[8] While most cases are seen as accidental exposure under the age of four, the frequency of suicidal intake during adolescence is considerable, which can lead to more serious complications.[8] In our study, the mean age was 27 months, similar to the literature. In most studies, the male-to-female ratio was found to be high, and 53.5% of the cases were male in our study group.

The degree of damage is closely related to the type, concentration and pH of the chemical substance exposed. It has been reported that 17.2% of patients were admitted to pediatric emergency departments between 1990 and 2006 in the United States due to acid/alkali intake, 8% due to

exposure to ammonia compounds and 3.7% due to exposure to bleaches.[9] Similarly in our study, bleach-containing sodium hypochlorite, which is a strong alkali, was the most common agent (23.7%) while oil solvents containing KOH were the second (14%) and dishwashing detergents containing trisodium phosphate, descaling agents containing HCl and hypochloric acid were the third most common cause.

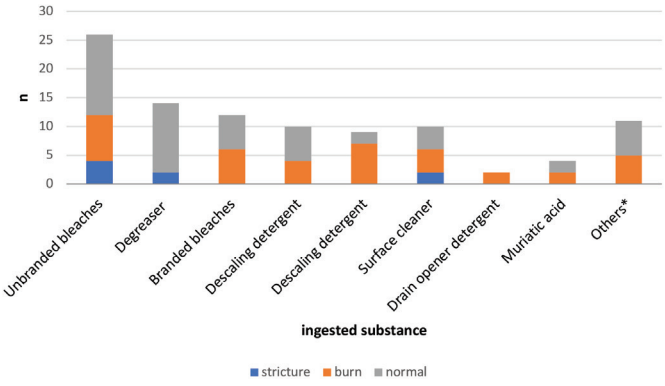

Figure 1. Demonstration of pathological findings related with the substances

In their study, Kucuk et al.[10] stated that the most serious burns were with oil solvents and that the severity of injury increased with non-branded and unlabeled ones. In a multicenter study conducted by Betalli et al.[11] in Italy, caustic soda (NaOH) was the most irritant substance and 73% of patients needed gastrostomy. In our study, when all the results were evaluated in terms of burn and stricture formation, KOH was found to be the most destructive substance.

In a study by Rigo et al.[12] to predict mortality due to caustic substance intake in adults, a WBC higher than 20.000/mm^3, serum CRP levels higher than normal, strong acid substance intake, and profound gastric ulcer with necrotic area were found to increase mortality. Since we do not have mortal outcome, we cannot evaluate these parameters, and we observed that CRP and WBC had no value in predicting esophageal burn or stricture. Similarly, in a study conducted by Kaya et al.[13] including 134 patients poisoned with corrosive substances who underwent esophagoscopy, it was reported that patients with high-grade esophageal injury had higher WBC compared to those with low-grade esophageal injury,

Table 2. Comparison of the two groups; follow-up only and esophagoscopy and follow-up

	Observation only group (n=132)	Esophagoscopy and observation group (n=96)	Total	p
Age (month) mean ± SD	29.2±27.2	23.9±20.8		**0.001**^{t}
Gender (n/%)				
Male	7/57.3%	52/42.7%	122/100%	**0.002**$^{\chi 2}$
Female	62/58.5%	44/41.5%	106/100%	
	Mean ± SD	**Mean ± SD**		
Laboratory values				
WBC1 (/mm^3)	11.300±4.100	10.900±2.970		0.93^m
Neutrophil (/mm^3)	4.700±2.400	4.900±3.000		0.78^t
Hemoglobin g/dL	11.9±1.1	11.4±1.4		0.01^t
Platelet (/mm^3)	315.100±110.0009	336.600±100.400		0.34^t
Amilase (U/L)	52.8±31.6	60.4±21.8		0.37^t
CRP^2 (mg/dL)	2.0±0.2	2.42±0.5		0.45^t
	N/%	**N/%**	**(N/100)**	
Ingested substance				0.14^t
Non-branded bleaches	30/55.55	24/44.45	54 (100)	
Degreaser	20/62.5	12/37.5	32 (100)	
Branded bleaches	10/45.45	12/54.54	22 (100)	
Descaling detergent	12/54.54%	10/45.46	22 (100)	
Dishwasher polisher	10/52.62	9/47.38	19 (100)	
Surface cleaner	10/50	10/50	20 (100)	
Drain opener detergent	7/77.77%	2/22.23	9 (100)	
Muriatic acid	4/50	4/50	8 (100)	
Others^3	29/69.05	13/30.95	42 (100)	
Duration of follow-up (hours) mean ± SD	55.35±27.16	68.17±11.70		**0.001**^{t}

^{1}WBC: White Blood Cell, ^{2}CRP: C-Reactive protein mg/dl, ^{3}Other ingested substances: Stain remover, dishwasher detergent, battery, powder detergent, hair dye color opener, ^{m}Mann-Whitney U test, ^{t}Student's t-test χ^2Chi-square test, SD: Standart deviation

Table 3. The distribution of demographic, clinic and laboratory data and exposed substances according to the presence of pathology in the histopathological results of the cases undergoing esophagoscopy

	Histopathological examination with normal findings (Mean ± SD) (n=50)		Histopathological examination with abnormal findings (Mean ± SD) (n=50)		p
Age (month)	22.0±14.7		30.3±31.2		0.96
Laboratory values					
WBC1 (/mm^3)	11.2±2.9		10.7±3.0		0.43
Neutrophil (/mm^3)	5.1±3.1		4.7±2.8		0.45
Hemoglobin g/dL	11.2±1.4		11.7±1.3		0.06
Platelet (/mm^3)	299.7±111.2		365.9±100.7		**0.01**
Amilase (U/L)	51.4±22.1		81.5±9.8		**0.02**
CRP[2] (mg/dL)	2.4±1.9		3±1.8		0.58
	(N)	**(%)**	**(N)**	**(%)**	**p**
Gender					
Male	26	52	28	56	0.69$^{\chi^2}$
Female	24	48	22	44	
Total	50	100	50	100	
Ingested substance					
Non-branded bleaches	14	28.0	12	24.0	0.82$^{\chi^2}$
Degreaser	12	24.0	2	4.0	**0.01**$^{\chi^2}$
Branded bleaches	6	12.0	6	12.0	1.00$^{\chi^2}$
Descaling detergent	4	8.0	6	12.0	0.74$^{\chi^2}$
Dishwasher polisher	4	8.0	6	12.0	0.74$^{\chi^2}$
Surface cleaner	2	4.0	7	14.0	0.17$^{\chi^2}$
Drain opener detergent	2	4.0	2	4.0	1.00$^{\chi^2}$
Muriatic acid	0	0.0	2	4.0	0.47$^{\chi^2}$
Others[3]	6	12.0	7	14.0	0.82$^{\chi^2}$
Total	50	100	50	100	
Duration of follow-up (hours)	67.00±13.97		70.56±7.12		**0.001**^{t}

[1]WBC: White Blood Cell, [2]CRP: C-Reactive Protein mg/dL, [3]Other ingested substances: stain remover, dishwasher detergent, battery, powder detergent, hair dye color opener
^{t}Student's t-test, χ^2Chi-square test

Table 4. Histopathologic findings related with ingested substances

Ingested substance	Normal (N)	Stricture in esophagus (N)	Burn in esophagus (N)
Non-branded bleaches	14	4	8
Degreaser	12	2	-
Branded bleaches	6	-	6
Descaling detergent	6	-	4
Dishwasher polisher	2	-	7
Surface cleaner	4	2	4
Drain opener detergent	-	-	2
Muriatic acid	2	-	2
Others[1]	6	-	5
Total	52	8	38

[1]Other ingested substances: stain remover, dishwasher detergent, battery, powder detergent, hair dye color opener

however, WBC but did not have sufficient predictive value.[13] This may be due to the fact that adults in the study by Rigo et al. were exposed to more corrosive substances and that the patient group consisted of medically ill patients.[12] The reason for the lack of WBC elevation in our cases may be that all of the cases in our study group were accidentally exposed to a small amount of corrosive substances. Therefore, this small amount of corrosive substance may not have caused a systemic response as leukocytosis. It was observed that elevated platelet count and amylase level increased the possibility of tissue damage in patients presenting to emergency clinic immediately after exposure. This may be explained by the fact that platelet count is an acute phase reactant and amylase is secreted from the salivary glands and esophagus.

The gold standard technique for damage assessment is endoscopic assessment. With this examination, the esophagus

is evaluated visually and damage and stricture formation can be observed.[14-16] It is recommended to be done within the first 12-48 hours and not to exceed 96 hours.[17,18] Endoscopic dilatation is recommended 5-15 days after ingestion. According to the study by Kaya et al.[13], endoscopic pathologic findings were found in 12% of completely asymptomatic patients without lesions in the mouth. Therefore, indications for performing endoscopy are not clear. While some authors do not recommend endoscopy in patients who do not have a lesion in the oral cavity and can swallow saliva, others recommend it for all patients with spontaneous vomiting.[19-22] However, they agree to do it in all patients who attempted suicide.[23] In our study, patients with no oral lesions and no swallowing dysfunction were followed up without endoscopy. 132 of 228 cases included in our study (57.89%) were followed up only and 96 (42.10%) underwent endoscopy.

Study Limitations

Since it is a retrospective study, cognitive evaluation of the patients could not be performed and long-term results of the cases could not be reached. Prospective studies on this subject will analyze the situation more clearly.

Conclusion

In conclusion, involuntary use of corrosive-caustic substances and resultant pathological problems are quite common in childhood. Therefore, it is important to ensure that all products containing such substances, especially cleaning products, are equipped with locked mechanisms so that children cannot open them and are kept out of the reach of children. The importance of this matter should be emphasized in prospective randomized controlled trials with more patients.

Ethics

Ethics Committee Approval: İzmir Katip Çelebi University Rectorate Non-Interventional Clinical Research Ethics Committee was taken with the decision number 228 dated 04.10.2017.

Informed Consent: As this is a retrospective study, the information is received from the otomation system of the hospital. Therefore, there is no informed consent received from the cases individually.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: G.G., E.B., M.A., M.O.Ö., Design: G.G., E.B., M.A., M.O.Ö., Data Collection or Processing: G.G., E.B., M.A., M.O.Ö., Analysis or Interpretation: G.G., E.B., M.A., M.O.Ö., Literature Search: G.G., E.B., M.A., M.O.Ö., Writing: G.G., E.B., M.A., M.O.Ö.

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