RESEARCH ARTICLE

Corrosive Ingestion in Children: Clinical, Laboratory and Endoscopic Findings

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ABSTRACT

Background and aim: Caustic substance ingestion usually occurs accidental in children or voluntary in suicidal adolescents. The tissue damage depends on type of corrosive chemicals, location of injury, duration, and amount. Endoscopy still remains as a reliable and gold standard procedure to evaluate the tissue injury. Thus, we aimed to compare the clinical, laboratory and gastroscopic findings of children presented with corrosive substance ingestion in relation with the ingested corrosive substance type in our study.

Material and Method: One hundred forty-one children and adolescents (62 female, 79 male) presented with caustic substance ingestion history within 24 hours, were evaluated retrospectively. Patients' demographic characteristics, ingested type and form (acid or base) of corrosive chemicals, gastroscopic findings, laboratory results were recorded and compared.

Results: The mean age was significantly higher in female patients (3,60±3,81) than male patients (2,27±2,89) (p=0,000). Caustic substance ingestion prevalence (69.5%) was peaked in the 0-3 age group. Of the patients 84,4% presented with no symptom. Bleacher was the most common corrosive substance (31.9%), followed by rinse aid (16.3%) and other substances (14.9%). 65,2% of caustic substance ingestions were caused by alkaline substances, and 18,4% by acidic agents. According to the gastroscopy findings underlying pathology was detected in 31,9% (n=45) of the cases. The stage I corrosive esophagitis was the most common pathology with a rate of %51,1. There were no statistically significant differences found according to the ingested form of corrosive agents [acid (34,6%) vs. base (27,2%)] between the patients with negative and positive baseline gastroscopy findings. But the mean value of neutrophile/lymphocyte ratio was statistically higher in the cases with ingested alkaline corrosive agents (0,96±0,80) than patients with ingested acidic corrosive agents (0,85±1,06) (p=0,016).

Conclusions: The findings of the present study suggest that elevated the neutrophil-lymphocyte ratio would improve diagnostic accuracy in cases with caustic substance ingestion. Therefore, widely available, simple, minimally invasive, and cost-effective hematological parameters suggest potential clinical benefits in cases with caustic injury. Furthermore, since ingestion of caustic agents is simply preventable issue in children, appropriate public education programs should provide by governments.

Keywords: Corrosive ingestion; Caustic injury; Corrosive agents; Pediatric Gastroscopy; Pediatric emergency.

Introduction

Caustic substance ingestion are represent major medical issue worldwide, particularly in preschool children. Caustic substance ingestion usually occurs accidental in children, but may present voluntary mostly in adolescents.[1] The annual incidence of caustic substance ingestion is 15.8 cases per 100,000 individuals in the United States.[2] However the corrosive ingestions are often seen in the developing countries.[3] The clinical manifestations and tissue damage in caustic substance ingestions depends on varied factors such as exposed form of corrosive chemicals, location of injury, duration of the contact, and ingested amount of caustic substance.[4]

Numerous numbers of toxic substances are available in market and particularly at home with inappropriate storage conditions. Ingestion of corrosive agents with strong alkali (pH > 12) or acid (pH < 2) associated with morbidity and mortality by injuries in the lips, oral cavity, oropharynx, oesophagus, upper airways, stomach and gastrointestinal tract.[5] There is no significant difference between them in terms of damage caused by acid and alkali substances. [6] Ingestions of corrosive substances may lead no symptoms to adverse outcomes such as acute and chronic complications, disability, sequelaes, death and long-term care-management requirements. Esophageal lesions were documented in 18 to 46% of all caustic substance ingestions in children.[4, 5, 7]

Considering the asymptomatic children particularly in oesophageal and oropharyngeal lesions, researchers highlighted that endoscopic evaluation of upper gastrointestinal tract mucosa should be performed immediatly in all children with caustic substance ingestion in order to detect severity of tissue damage.[8] However, patients should be under observation for 48 hours and endoscopy should be performed within 48 hours, early endoscopy (< 12 hours) may underestimate the tissue damage.[9] In our study, we aimed to compare the clinical, laboratory and gastroscopic findings of children presented with corrosive substance ingestion in relation with the ingested corrosive substance type.

Materials and Methods

SAMPLE
This study was performed with the Institutional Review Board protocol approval date 06//07/2020 and number 2020/14 in Istanbul Bakirkoy Dr Sadi Konuk Training and Research Hospital, between 01 April 2017- 01 April 2020. In this study 141 children and adolescents, aged between 0-16 years, presented with caustic substance ingestion history within 24 hours, were evaluated retrospectively. Exclusion criteria for present study were presence of any known esophageal, gastric, and duodenal diseases. Patients' demographic characteristics, ingested type and form (acid or base) of corrosive chemicals, gastroscopic findings, laboratory results were recorded and evaluated.

CORROSIVE AGENTS
1. Bleacher (alkaline)
2. Oil solvent (alkaline)
3. Drain opener (alkaline)
4. Laundry detergent (alkaline)
5. Laundry conditioner (acidic)
6. Dishwasher detergent (alkaline)
7. Rinse aid (acidic)
8. Hydrochloric acid (acidic)
9. Naphthalene
10. Cleaner (Aspirin) (alkaline)
11. Others

MEASURES
Cell blood count analysis was performed on patients' venous blood samples. Haematological parameters were analysed using a haematology analyser (Cell-Dyne 3700, Abbott, Abbott Park, IL, USA).

STATISTICAL ANALYSIS
All the data were analysed with SPSS (Statistical Package for the Social Sciences) software for Windows (v21.0; IBM, Armonk, NY, USA). Individual and aggregate data were summarized using descriptive statistics including mean, standart deviations, medians (min-max), frequency distributions and percentages. Normality of data distribution was verified by Kolmogorov-Smirnov test. Comparison of the variables with normal distribution was made with Student t test. The variables which were not normally distributed, the Mann Whitney and Kruskal Wallis tests were conducted to compare between groups. Evaluation of categorical variables was performed by Chi-Square test. P-Values of <0.05 were considered statistically significant.

Results

The 141 children with caustic substance ingestion history included in this study were; 62 (44,0%) female, 79 (56,0%) male, and the mean age was 2,85±3,38 years (Ranged=0-17) during application in our sample group. In addition, the mean age was significantly higher in female patients (3,60±3,81) than male patients (2,27±2,89) (p=0,000) (Table 1). It was also observed that prevalence of the cases (69.5%, n=98) were peaked in the 0-3 age group, and followed by the 3-6 age group with the rate of 18.4% (n = 26) (Figure 1).

Table 1. The mean age and gender analysis of the cases.

	n (%)	Age (Month) (Mean±SD)	P-value
Male	79 (%56,0)	2,27±2,89	
Female	62 (%44,0)	3,60±3,81	0,000*
Total	**141 (%100)**	**2,85±3,38**	

SD=Standart deviation.

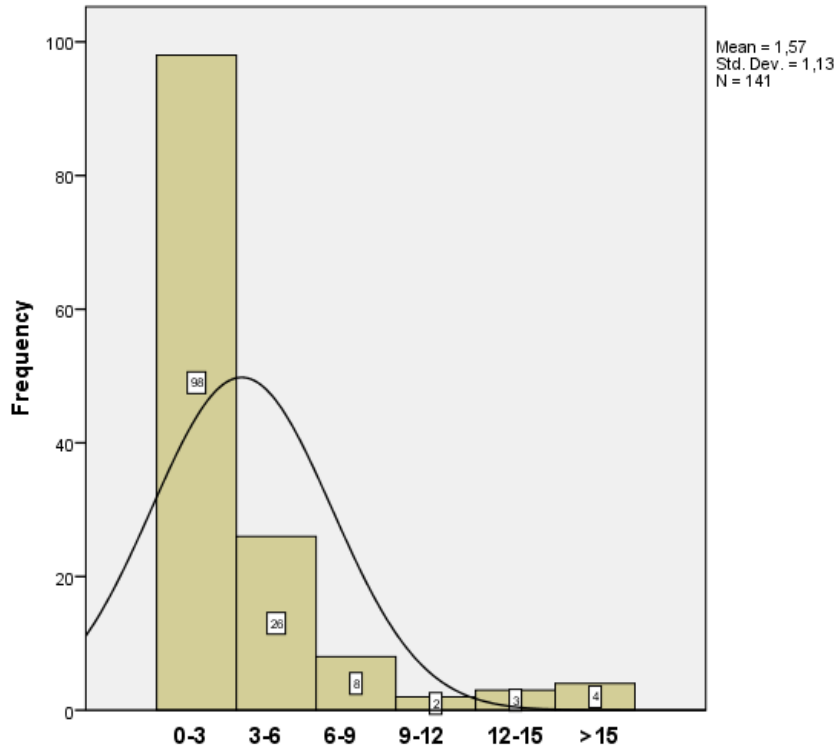*** = p<0.05 statistically significant.**

Figure 1. Distribution of the cases according to age groups.

While 84,4% (n=119) of the patients presented with no symptom; 15 (10,6%) patients applied with vomiting, 2 (1,4%) patients applied with rash on the lips, 1 (0,7%) patient with sore throat, 1 (0,7%) patient with dyspnea, 1 (0,7%) patient with fever, and 1 (0,7%) patient with hoarseness. All patients were exposed to corrosive substances in their homes; bleacher was the most common corrosive substance (n=45) with a rate of 31.9%, followed by rinse aid (16.3%, n=23) and other substances (14.9%, n=21) (Table 2).

Table 2. Distribution of corrosive substances exposed in cases.

Corrosive Agents	n	%
Bleacher	45	31.9
Oil solvent (alkaline)	12	8,5
Drain opener (alkaline)	12	8,5
Laundry detergent (alkaline)	8	5,7
Laundry conditioner (acidic)	2	1,4
Dishwasher detergent (alkaline)	12	8,5
Rinse aid (acidic)	23	16,3
Hydrochloric acid (acidic)	1	,7
Naphthalene	2	1,4
Cleaner (Aspirin) (alkaline)	3	2,1
Others	21	14,9

In our study 65,2% of caustic substance ingestions were caused by alkaline substances, 18,4% by acidic substances, and 16,3% were caused by other agents. There were no statistically significant differences found according to the ingested form [acid (34,6%) vs. base (27,2%)] of corrosive agents between the patients with negative and positive baseline gastroscopy findings (p=0.459).

Pharyngeal hyperemia was reported in 24 (17.0%) cases, while no oral findings were found in 117 (83,0%) patients during baseline physical examination. According to the gastroscopy findings which performed at the time of diagnosis; no underlying pathology was detected in 68,1%

(n=96) of the cases. The stage I corrosive esophagitis was the most common pathology with a rate of %51,1 (n=23); followed by stage I corrosive gastritis (17,8 %, n=8) and stage I corrosive esophagitis + stage I corrosive gastritis (15,6%, n=7). Of the patients 55,3% (n=78) were received no treatment. The sodium alginate was the most common treatment protocol with the rate of 27,0 % (n=17) and followed by Proton pump inhibitor-Domperidon treatment protocol 17,5% (n=11) (Table 3). All patients with positive gastroscopy findings (n=45) and 18,8% of the patients (n=18) with negative gastroscopy findings were received treatment.

Table 3. Treatment protocols and frequencies.

Treatment	n	%
Sodium alginate	17	27,0
Domperidon- Sodium alginate	9	14,3
Domperidon- Sodium alginate -Proton pump inhibitor	4	6,3
Proton pump inhibitor - Sucralfate	6	9,5
Proton pump inhibitor - Domperidon	11	17,5
Proton pump inhibitor - Domperidon- Sucralfate	11	17,5
Proton pump inhibitor - Domperidon- Sucralfate	5	7,9

Gastroscopy was not performed in 96.5% (n=136) of the patients after treatment. In the remaining 5 patients (3,5%); 1 had negative underlying pathology, 1 patient was detected as pangastritis, 1 patient was stage I corrosive esophagitis, 1 patient was stage 2 corrosive esophagitis and in 1 patient stage 3 corrosive esophagitis reported.

According to the evaluation of laboratory findings at the time of diagnosis; the mean values of neutrophile was $4,63\pm2,66$ x10^9/L, and lymphocyte was $6,06\pm2,71$ x10^9/L in our study. There were no statistically significant differences

found according to the neutrophile and lymphocyte results between the patients with negative and positive gastroscopy findings (p> 0.05). In addition, there were also no statistically significant differences found according to the neutrophile/lymphocyte ratio between the patients with negative ($0,94\pm0,82$) and positive gastroscopy findings ($1,06\pm1,11$) (p=0.998) (Table 4). But the mean value of neutrophile/lymphocyte ratio was statistically higher in the cases with ingested alkaline corrosive agents ($0,96\pm0,80$) than patients with ingested acidic corrosive agents ($0,85\pm1,06$) (p=0,016).

Table 4. The comprasion of laboratory findings, clinical characteristics and gastroscopy results.

| | Clinical Variables | Gastroscopy | | p-value |
		Negative	Positive	
Gender n (%)	Female	41 (%42,7)	21 (%46,7)	0,659
	Male	55 (%57,3)	24 (%53,3)	
Oral symptom n (%)	Absent	79 (%82,3)	38 (%84,4)	0,751
	Pharyngeal Hyperemia	17 (%17,7)	7 (%15,6)	
Age (Mean±SD)	-	2,76±3,45	3,04±3,26	0,328
Neutrophile/Lymphocyte ratio (Mean±SD)	-	0,94±0,82	1,06±1,11	0,998
Neutrophile (x10^9/L) (Mean±SD)	-	4,48±2,35	4,93±3,22	0,696
Lymphocyte (x10^9/L) (Mean±SD)	-	6,03±2,67	6,12±2,82	0,872

*= p<0.05 statistically significant.

Discussion

Corrosive substance ingestion more frequently documented in children aged below 5 years, furthermore it was highlighted that prevalance of caustic substance ingestion peaks at 2 years of age.[2] De Jong AL et al. documented incidence of caustic substance ingestion peaked between 1-3 years of age (78%, n=63) in a study consisting of 80 children (age ranged=1 month - 16 years) whose data gathered during the 30-year period.[10] Supportively in our study, the mean age was 2,85±3,38 years and prevalence of the cases (69.5%) were peaked in the 0-3 age group.

In a study 70% of caustic substance ingestions were reported to be caused by alkaline substances, 11% by acidic substances, and the most common agent was documented as Drano drain cleaner.[10] Additionally, in a meta-analysis consisting of 64 articles related to caustic ingestion in children Rafeey M. et al. reported that the bleaches and cleaners are the most frequent corrosive chemicals.[2] Similarly Karaman I. et al. reported 75% alkali corrosive substance, 18% acid substance and 5% other substance in their study conducted with 968 children presented with caustic substance ingestion during the 22-year period.[11] Researchers also noted bleach as the most frequently ingested corrosive agent.[11] In a study conducted by Kayaalp, it was determined that the most frequently consumed agent was oil dissolver with a very high rate of 66%.[12] In accordance with published data, in our study 65,2% of caustic substance ingestions were caused by alkaline substances, 18,4% by acidic substances, and the bleacher was the most common (31.9%) corrosive agents.

The predictive value of early symptoms and physical examination findings in patients with caustic substance ingestion is still debated. Boskovic et al. documented no symptom in 65.9% of patients and positive clinical findings in 34.1% of their patients in a study consisting of 176 children presented with caustic substance ingestion.[13] They also reported no underlying pathology in 54% of the cases and 44.9% mild to severe corrosive injuries according to the gastroscopy outcomes. Researchers concluded that the presence or absence of any clinical signs and symptoms are not predictors of corrosive injuries, additionally they highlighted that endoscopy should perform as a mandatory technique in children with caustic substance ingestions.[13] As Doğan et al. revealed in their study, 61% of children with esophageal injury had no oral burn.[14] Similarly, Kucuk et al. documented superficial mucosal hyperemia and edema in 69 children in a study of 154 pediatric patients with caustic substance ingestion during 6

years period.[15] Researchers also reported positive endoscopy findings in 63 patients and 40 severe injuries.[15] Consistently, in our study, while 84,4% (n=119) of the patients presented with no symptom; pharyngeal hyperemia was reported in 17.0% of our cases. According to the gastroscopy findings underlying pathology was detected in 31,9% (n=45) of our cases. In addition, there were no statistically significant differences found according to the ingested form [acid (34,6%) vs. base (27,2%)] of corrosive agents between the patients with negative and positive baseline gastroscopy findings.

On the other hand, Sabzevari et al. most commonly reported esophageal lesions in 50 cases (grade 1 in 6 cases, grade 2a in 15 cases, grade 2b in 27cases), followed by gastric lesions in 34 cases via endoscopy in a study conducted with 54 children presented with caustic substance ingestion.[16] Similarly, Dehghani et al. documented esophageal injury (48.2%) as the most frequent gastroscopy finding, followed by gastric injury (14.6%) in their study conducted with 41 caustic substance ingestion-patients.[17] In accordance with published data, in our study the stage I corrosive esophagitis was the most common pathology with a rate of %51.1; followed by stage I corrosive gastritis (17,8 %) and stage I corrosive esophagitis + stage I corrosive gastritis (15,6%).

Hematological parameters have been associated with inflammatory processes and inflammation severity.[18] Recently leukocyte counts, neutrophil counts, the neutrophil-lymphocyte ratio, mean platelet volume (MPV), platelet distribution width (PDW) and white blood cell (WBC) has been evaluated as an inflammatory marker in several inflammatory diseases such as cardiovascular, cerebrovascular disorders, endometriosis, pulmoner disease and also in acute appendicitis.[19-22] Besides, there are limited number of published data evaluated inflammatory parameters in caustic injuries. Uyar, et al. significantly associated higher neutrophil-lymphocyte ratio with positive gastroscopy findings (35.3%) in a study of 190 patients (p=0.010). But no significantly relation reported between positive gastroscopy findings and white blood cell and C-reactive protein levels.[23] Similarly, Kaya et al. reported significantly higher mean WBC count in children with high-grade esophageal injury (p=0.000) in a study consisting of 134 children with caustic substance ingestion.[24] In another study of 210 patients Rigo et al. concluded that leukocytosis had prognostic and predictive value for mortality in patients with caustic substance ingestion.[25] Rezan et al. significantly associated higher neutrophil-lymphocyte ratio with increased

severity of caustic injury in a study of 133 patients.[26] Supportively, Siddique et al. reported a strong correlation between neutrophil / lymphocyte ratio and endoscopic grade of caustic injury in 148 patients.[27] Furthermore, Kim et al. documented that the neutrophil/lymphocyte ratio was significantly higher in complicated patients who had ingested alkali substances in a study consisting of 37 children with caustic substance ingestion.[28] In our study, although there were no statistically significant differences found according to the neutrophile, lymphocyte counts, and neutrophile/lymphocyte ratio between the patients with negative and positive gastroscopy findings; the mean value of neutrophile/lymphocyte ratio was statistically higher in the cases with ingested alkaline corrosive agents than patients with ingested acidic corrosive agents.

Conclusion

The findings of the present study suggest that elevated the neutrophil-lymphocyte ratio would improve diagnostic accuracy in cases with caustic substance ingestion. Therefore, widely available, simple, minimally invasive and cost-effective hematological parameters suggest potential clinical benefits in cases with caustic injury. In this respect, further researches should be perform with larger study groups to achieve more assuring results about predictive value of hematological parameters in corrosive ingestions. Furthermore, since ingestion of caustic agents is simply preventable issue in children, appropriate public education programs should provide by governments.

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