






# Comparison of Clinical Observation and Upper GI Endoscopy in Corrosive Substances Ingestion: A Randomized Controlled Trial

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## Abstract

**Objectives** Oral intake of corrosive substances is a significant cause of morbidity and sometimes mortality in childhood. Early evaluation is essential in determining the course of possible damage. This study aimed to compare early endoscopic evaluation and clinical observation methods in patients with corrosive substance ingestion.

**Materials and Methods** Seventy-five patients with corrosive substance ingestion were hospitalized in a tertiary pediatric surgery clinic between January 2019 and December 2020. They were enrolled in a prospective randomized controlled manner, 35 of whom were in the endoscopy group and 40 in the clinical observation group, and their data were collected after obtaining consent from their families.

**Results** It was observed that the most common chemical agents in hospitalized patients with a history of corrosive substance intake were dish polishers and sink openers, and contact with strong alkaline substances was the most common case. Endoscopic evaluation increased the total cost compared with clinical observation but decreased the nil per os (nothing by mouth) duration, the number of drugs they took, and the inpatient duration ( $p < 0.05$ ). Neither the presentation symptoms nor physical examination findings were to the pH level of the corrosive substance ingested ( $p > 0.05$ ).

**Conclusions** Endoscopic evaluation could be a choice for reducing the length of hospital stay, drug doses, and the nil per os period, but it increases the total cost. Since no cases with significant esophageal damage were detected in our clinic at the time of this study, the results should be supported by larger series.

## Keywords

- ▶ corrosive structures
- ▶ caustic
- ▶ caustic injury
- ▶ children
- ▶ esophagoscopy

## Introduction

Corrosive substance ingestion (CSI) is a significant public health issue with tissue damage and associated morbidities. Especially in the pediatric age group, accidentally ingested corrosive substances could cause remarkable damage to mucosal or more profound layers of the lips, mouth, or

esophagus, and in severe cases, the outcome could be mortal.<sup>1,2</sup>

Corrosive substances include chemical structures that cause tissue damage by contact.<sup>3</sup> Especially the acidic or alkaline chemical compounds widely used in house cleaning have corrosive effects on human tissue.<sup>4,5</sup> Chemical

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substance contact in pediatric ages, especially in the first 6 years of life, is usually a result of curiosity, attractive packaging, and the tendency to identify substances orally.<sup>6-8</sup> Studies from several clinics in different countries reported a wide range (15–87.8%) of esophageal burns in children with CSI.<sup>6-13</sup> Once esophageal damage occurs, the patients need special care and repeated hospital admissions for esophageal dilations or alternative feeding procedures, increasing health care costs and decreasing quality of life.<sup>10,14,15</sup>

The optimal evaluation method has yet to be determined, probably because most clinics follow different algorithms to handle the problem.<sup>3,6,7,12,16-19</sup>

Patients with a history or suspicion of CSI are hospitalized and evaluated with endoscopy or clinical observation. Also, their sociodemographic data, the symptoms from presentation to end of the follow-up period, the characteristics of the chemical substance, and the total cost were noted down, and the primary aim was to evaluate the results of both groups to determine the optimal approach regarding the nil per os (NPO) period and costs.

## Methods

The study was performed in adherence to the current form of the Declaration of Helsinki. Ethical committee approval was granted by Health Sciences University Ankara Keçiören Clinical Research Ethical Committee, with the IRB number 2012-KAEK-15/2076. Between January 2019 and December 2020, 84 patients were hospitalized at the Pediatric Surgery Clinic at Health Sciences University Dr. Sami Ulus Maternity and Children's Hospital. Randomization was obtained using a simple random numbers table. The method of choice was determined before the patient's admission to the hospital according to the table, and the study is an open-label trial. During admission, the parents were informed about the study, related methods, and complications. Nine patients were excluded from the study because their parents did not provide consent for their participation.

Patients aged between 0 and 18 years who ingested a corrosive substance within the last 24 hours with parental approval for participating in the study and without previous esophageal intervention were included in the study. The patients with a history of previous intervention to the esophagus and whose parents refused participation were excluded.

Seventy-five patients' data were evaluated. Thirty-five were in the endoscopy (E) group, and 40 were in the clinical observation (CO) group. The informed consent form and the questionnaire were explained to the parents, and their approval to participate in the study was obtained.

**CO group:** The patients followed NPO with intravenous (IV) fluid, empiric antibiotics, and antireflux medication. If oropharyngeal lesions were presented, oral care was applied. Oral feeding was started on the asymptomatic patients in a 24-hour follow-up period, and then they were discharged. They were followed up as outpatients for a year, and after

3 weeks from discharge, an esophagogram was planned for the patients who became symptomatic during this period.

**E group:** The patients were hospitalized, and after a 6-hour period of NPO, an esophagoscopy evaluation was made, and patients without any damage to the esophagus were fed 2 hours after the procedure and discharged. They were also followed up as outpatients for a year.

The dysphagia evaluation of the patients was made by using the *Mellow–Pinkas scoring system*.<sup>20</sup> The esophageal damage in the E group was evaluated using the endoscopic *Zargar classification system*.<sup>21</sup>

## Sample Size and Statistical Analysis

Considering our previous results, five patients each were used to calculate the sample size. A two-sided sample size calculation with 80% power and a significance level of 0.05 suggest that 68 patients should be included. Considering the possible loss of patients, a total of 80 patients, 40 for each group, were planned to be included. All data were analyzed using IBM Statistical Package for the Social Sciences Statistics (SPSS) for Windows version 20 (IBM Corp., United States). Randomization was done using the simple random numbers table. Categorical data were expressed using frequency and percentage, while continuous data were represented using mean and standard deviation. The normality of the data distribution was assessed using the Shapiro–Wilk test and histograms. For a comparison of the categorical variables between the two groups, the chi-squared test was used, and in the cases where the chi-squared test assumptions were not met, Fisher's exact test was employed. If the continuous data met the assumption of normal distribution, the *t*-test was used for comparisons; otherwise, the Mann–Whitney *U* test was utilized.

## Results

Eighty-four patients were consulted from the emergency department to the pediatric surgery clinic with the prediagnosis of proven or suspected CSI in 24 months. Twenty-nine patients were hospitalized due to the suspicion of CSI, while the others had a proven CSI history. Nine of these patients' parents rejected collaborating in the study, so their data were excluded. A random number table was used to randomize the remaining 75 patients. Patient demographics are listed in ► **Table 1**.

Forty patients (53.3%) were categorized in the CO group and 35 patients (46.7%) in the E group. Forty-four of 75 patients (58.7%) were males, and 31 (41.3%) were females. The mean age in the E group was  $24.94 \pm 21.82$  months; in the CO group, it was  $28.80 \pm 23.30$  months. There was no significant difference between the E and CO groups using demographic variables ( $p > 0.05$ ).

The most frequently ingested substance was dishwasher polisher (38.6%) in both groups. It was followed by drain opener (21.3%), anti-scale (13.3%), and fat solvent (8%; ► **Table 2**).

The presented symptoms are dysphagia, drooling, oropharyngeal lesions, vomiting, and positive physical

**Table 1** Patient demographics

	E (n = 35)	CO (n = 40)	p
Age (mo), mean ± SD	24.94 ± 21.82	28.80 ± 23.30	0.234 <sup>a</sup>
Gender	M: 21; F: 14	M: 23; F: 17	
<b>Siblings</b>			
None	14 (40.0%)	16 (40.0%)	1.000 <sup>b</sup>
1 or more	21 (60.0%)	24 (60.0%)	
<b>Parental education level</b>			
Under-college	23 (66.7%)	27 (67.5%)	0.870 <sup>b</sup>
College and upper	12 (34.3%)	13 (32.5%)	

<sup>a</sup>Mann-Whitney *U* test.<sup>b</sup>Chi-squared test.**Table 2** The distribution of the ingested substance in groups E and CO

	E (n = 35)	CO (n = 40)
Dishwasher polisher	12 (34.3%)	17 (42.5%)
Drain opener	6 (17.1%)	10 (25%)
Anti-scale	6 (17.1%)	4 (10%)
Fat solvent	4 (11.4%)	2 (5%)
Detergent pod	3 (8.6%)	1 (2.5%)
Ultra-dens bleach	0	3 (7.5%)
Others	4 (10%)	3 (7.5%)

examination findings of the respiratory system. The most common symptom was vomiting (30.6%), followed by drooling (14.6%) and respiratory symptoms (7.9%).

Most patients ingested strong alkaline substances (46.6%) in both groups. Fifty-two patients (69.3%) ingested strong or weak alkaline substances, 19 patients (25.3%) ingested strong or weak acids, and 4 (5.3%) patients ingested neutral substances.

The relation between symptoms and physical examination findings at presentation to the hospital and pH levels of the ingested chemical substance was not statistically significant ( $p > 0.05$ ; ►Table 3).

Eighteen of the 75 patients (24%) ingested a chemical substance from a different nonspecific container (e.g., plastic bottle, glass), and 57 patients (76%) ingested it from the original package of the substance. All of the patients (100%) ingested the chemical substance unintentionally. The endoscopic findings of the patients are listed ►Table 4.

In all patients, NPO and inpatient duration in the CO group were longer than those in the E group ( $p < 0.001$  vs. 0.013). Histamine 2 receptor blocker (H2RB) drug dose count and IV antibiotic dose count given to the patients in the CO group were higher than that those given to the patients in the E group ( $p = 0.002$  vs.  $< 0.001$ ). The total cost was higher in the E group than in the CO group ( $p = 0.045$ ). Asymptomatic patients were evaluated in a separate column. In asymptomatic patients, the NPO duration of the patients in the CO group was longer than that in the patients in the E group ( $p = 0.005$ ). The inpatient duration of the patients in the CO and E groups was not statistically different ( $p = 0.013$ ). The H2RB drug dose count given to the patients in the CO and E groups was not statistically different ( $p = 0.055$ ). IV antibiotics dose count given to the patients in the CO group was higher than the dose given to the patients in the E group ( $p = 0.012$ ). Total cost was not statistically different between the two groups ( $p = 0.130$ ; ►Table 5).

The initial symptoms in 74 patients regressed in the follow-up period. Only one patient in the E group developed esophageal stricture and was diagnosed with an esophagogram during the follow-up. He was the only patient who

**Table 3** Symptoms and examination findings at presentation and pH level relation

pH <sup>a</sup>	Strong acid (n = 8)	Weak acid (n = 12)	Neutral (n = 4)	Weak alkaline (n = 17)	Strong alkaline (n = 34)	p <sup>b</sup>
<b>At presentation</b>						
Symptoms present	4 (50.0%)	6 (50.0%)	0 (0.0%)	5 (29.4%)	17 (50.0%)	0.250
No symptoms	4 (50.0%)	6 (50.0%)	4 (100.0%)	12 (70.6%)	17 (50.0%)	
PE findings present	3 (37.5%)	5 (41.7%)	0 (0.0%)	3 (17.6%)	14 (41.2%)	0.262
No PE findings	5 (62.5%)	7 (58.3%)	4 (100.0%)	14 (82.4%)	20 (58.8%)	

Abbreviation: PE, physical examination.

<sup>a</sup>pH levels were evaluated with pH indicator strips.<sup>b</sup>Chi-squared test.

**Table 4** Endoscopy findings of the patients in the E group

Grade	Asymptomatic (n = 18)	Symptomatic (1 or more symptoms), n = 17
0	11 (61.1%)	12 (70.5%)
1	4 (22.2%)	3 (17.6%)
2	3 (16.6%)	1 (5.8%)
3	0 (0%)	1 (5.8%)

**Table 5** Comparison of different variables in the E and CO groups at follow-up

	All patients			Asymptomatic patients		
	E (n = 35)	CO (n = 40)		E (n = 18)	CO (n = 25)	
	Mean ± SD	Mean ± SD	p <sup>a</sup>	Mean ± SD	Mean ± SD	p <sup>a</sup>
NPO duration (h)	21 ± 18.8	29.2 ± 12.7	< 0.001 <sup>b</sup>	19.4 ± 14	26.64 ± 10.2	0.005 <sup>b</sup>
Inpatient duration (h)	32.3 ± 26.5	35.6 ± 17.7	0.013 <sup>b</sup>	27.4 ± 16.7	31.40 ± 12	0.096
H2RB doses count	2.3 ± 2.2	2.9 ± 1.5	0.002 <sup>b</sup>	1.9 ± 1.3	2.52 ± 0.8	0.055
IV antibiotic doses	4.2 ± 4.8	5.8 ± 2.7	< 0.001 <sup>b</sup>	3.4 ± 3	5.12 ± 1.9	0.012 <sup>b</sup>
Cost (₺)	474.1 ± 235	375.1 ± 160	0.045 <sup>b</sup>	450.3 ± 221	347.92 ± 113	0.130

Abbreviations: H2RB, histamine 2 receptor blocker; IV, intravenous; NPO, nil per os; SD, standard deviation; ₺: Turkish lira.

<sup>a</sup>Mann–Whitney *U* test.

<sup>b</sup>*p* < 0.05.

needed esophageal dilatation. This patient had ingested a quarter glass of liquid dishwasher polisher, whose pH level was 11 (strong alkaline). The initial symptoms were drooling and dysphagia. The patient had three esophageal dilatations during the 12-month follow-up. No other patient in either group needed esophageal dilatation.

## Discussion

Corrosive esophagitis and esophageal strictures related to CSI are common and important public health issues, especially in developing or undeveloped countries.

The study aimed to evaluate the total cost for the patients with CSI whether they underwent endoscopy or were managed conservatively as inpatients. Studies in English literature suggest that performing routine endoscopy for CSI patients is a more expensive method than clinical observation.<sup>22,23</sup> Besides that, Abbas et al, in a large series of 21,682 patients with CSI, reported that early endoscopic evaluation decreases the cost of late endoscopic evaluation.<sup>22</sup> This study reports a similar result without evaluating the timing of the endoscopy; endoscopic evaluation increases the total cost of clinical observation for CSI patients (E: ₺474.11 ± 235.45; CO: ₺375.13 ± 160.18; *p* = 0.045).

It was reported that early endoscopic evaluation in CSI patients with mild or no esophageal burn decreases the NPO period.<sup>24,25</sup> The results of this study are consistent with the results reported in the literature (E: 21.03 ± 18.77 hours; CO: 29.20 ± 12.66 hours; *p* < 0.001).

Rafeey et al in 2016 in a series of 9,888 patients and Abbas et al in 2017 found early endoscopic evaluation to decrease the inpatient duration by revealing the presence or absence

of the damage so that the clinician could determine the appropriate approach sooner.<sup>22,25</sup> Nevertheless, the Drooling, Reluctance, Oropharynx, Others, Leukocytosis (*DROOL scoring system*) presented by Uygun et al advocated clinical evaluation and laboratory tests to evaluate the possible esophageal damage with 100% sensitivity and 96.6% specificity without performing esophagoscopy.<sup>26</sup> This study found that esophagoscopy led to earlier diagnosis of esophageal injury, enabling patient to be fed and discharged sooner.

Data on contact with chemicals worldwide are generally collected in national poison information and follow-up centers of countries. Considering that not all countries report these data regularly, it is not possible to determine the total exposure to corrosive substances worldwide and how many of them are in children. The 2018 report created by the National Poison Data System (NPDS) in the United States reported that children's most commonly ingested chemicals are those used in household cleaning.<sup>14</sup> Among the substances most frequently contacted by children in the patients included in our study, the most common ones were dishwasher polish, sink opener, descaling agent, and degreaser. Our research observed that the corrosive substance was drunk from its original packaging in 76% of the cases.

The pH value of the corrosive compounds can predict the location and degree of damage they may cause. For this reason, it is crucial to learn the chemical properties of the contacted substance to determine the appropriate management and follow-up path for patients exposed to chemical substances. Reports in the literature suggest that strong alkaline substances are the most frequently detected group associated with corrosive activity in the esophagus.<sup>25,27</sup>

Studies show that more signs of gastric outlet obstruction are seen with ingesting strongly acidic substances.<sup>28–30</sup> In our study, the highest number of patients (46.7%) were exposed to strong alkaline (pH 11) substances, followed by weak alkaline (pH 8–11) substances, which affected 22.7% of the patients.

In evaluating the patients at the time of admission to the hospital, there was no difference between the patients with acid or alkali contact in terms of symptoms or physical examination findings. The literature reports that tissue damage is frequently caused by strong acids and especially strong alkalis.<sup>12,31,32</sup> The absence of a relationship between pH value and symptoms and physical examination findings in this study may be due to the small number of patients or the fact that patients with a history of suspected CSI and patients with a proven record of drinking were not separated when patient data were collected. The most frequent symptom was vomiting (30.6%), thought to be the result of forced vomiting by parents.

It has been reported in different studies that substances with a pH value of less than 3 are associated with lesions that occur primarily at the gastric outlet and substances with a pH value above 11 are associated with lesions especially in the esophagus.<sup>27,30,32</sup> There are studies on the time until endoscopy and symptoms at the time of application in adults, but the first 24- to 48-hour period is considered the early period in time intervals.<sup>22</sup> In our study, the latest endoscopy was performed at the 26th hour in patients who underwent endoscopy, so no comparison with the literature could be made. In our study, the relationship between patients who underwent an endoscopy and time elapsed between the ingestion of corrosive substances and endoscopy, the presence of symptoms at the time of admission, or the pH value of the substance consumed by the patient and the damage levels determined as a result of endoscopy were evaluated, but no statistically significant result was obtained. To make this evaluation more accurate, a study with a more extensive patient series is needed.

Temiz et al<sup>33</sup> argued that early evaluation of patients with esophagoscopy after ingesting corrosive substances may prevent unnecessary medication. It has been reported that the use of drugs can be reduced with scales that can be used to evaluate possible esophageal damage in patients without endoscopy.<sup>26</sup> Our study found that the use of antibiotics and antacid treatment was lower in patients with no or very low-grade burns detected by endoscopy compared to those managed with clinical observation. This may be due to the initiation of empirical therapy in patients in the CO group.

Current guidelines recommend prioritizing clinical observation in patients who present with a history of corrosive substance intake but have no symptoms at the time of admission, no physical examination findings, and no significant findings in the examinations, and it is emphasized that the need for esophagogastroduodenoscopy (EGD) or endoscopy application is reduced.<sup>16,34,35</sup> Our study demonstrated that in patients with no symptoms the length of hospital stay

and time spent without oral administration could be reduced by early endoscopy. The use of drugs could be reduced, but the average cost of management of these patients also increases with the application of endoscopy. In addition, the fact that only 1 of the 75 patients had stenosis with EGD, and only this patient had dilatation, supports the use of endoscopic evaluation and extraction of EGD in selected cases rather than as a routine procedure.

In patients with findings suggestive of esophageal injury due to corrosive substance but do not have severe oropharyngeal-glottic edema, hemodynamic instability, and gastrointestinal system perforation, performing endoscopy to determine whether there is a lesion in the esophagus or stomach can facilitate earlier discharge from the hospital. However, in patients who do not have symptoms, physical examination findings, and laboratory findings at the time of admission, conservative monitoring without endoscopy, drug administration, and controlled close oral intake is the preferred method.

## Conclusions

Endoscopic evaluation of patients who present with CSI is a feasible method to evaluate the degree of damage. Especially in the asymptomatic patient group, endoscopic evaluation could provide an opportunity for earlier oral feeding and quicker discharge of the patients without increasing the total cost. Multicenter, more extensive series with randomized controlled trials are needed to support the findings.

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### Conflict of Interest

None declared.

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