

## Predictability of outcome of caustic ingestion by esophagogastroduodenoscopy in children

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### Abstract

**AIM:** To assess the necessity of esophagogastroduodenoscopy (EGD) to predict the outcome of caustic ingestion in children.

**METHODS:** The study included 206 children who underwent EGD because of ingestion of caustic substances between January 2005 and August 2010. Retrospective analysis of data of the patients was performed.

**RESULTS:** The male/female ratio was 1.6 and mean age was  $38.1 \pm 28.8$  mo. The caustic substances were acidic in 72 (34.9%) cases, alkaline in 56 (27.2%), liquid household bleach in 62 (30.1%), and unknown in 16 (7.8%). Fifty-seven (27.7%) patients were symptom-free. Significant clinical findings were observed in 149 (72.3%) patients. Upper gastrointestinal endoscopy findings of esophageal injury were grade 0 in 86 (41.7%) patients, grade 1 in 49 (23.8%), grade 2a in 42 (20.4%), grade 2b in 28 (13.6%), and grade 3a in 1 (0.5%) patient. 35 patients with grade 2a, 2b, and 3a injuries underwent esophageal dilation at second

week of ingestion. Esophageal stricture, which necessitated a regular dilation program developed in 13 of the aforementioned 35 patients. There is no statistically significant difference in the rate of development of esophageal stricture between the patients who ingested acidic (15.3%) and alkaline (8.9%) substances ( $P = 0.32$ ). Severe gastric injury was detected in 38 (18.5%) patients. The rate of development of gastric injury was significantly higher in the acidic group (14%) than in the alkaline group (2.9%) ( $P = 0.001$ ). Out of 149 patients with clinical findings, 49 (32.9%) patients had no esophageal injury and 117 (78.5%) patients had no gastric lesion. Esophageal and severe gastric injuries were detected in 20 (35.1%) and 8 (14%) of patients with no clinical findings respectively. Pyloric stenosis developed in 6 patients. Pyloric obstruction improved with balloon dilation in 2 patients. Mean hospitalization time were  $1.2 \pm 0.5$  d for grade 0 and  $2.3 \pm 5$  d for grade 1 and  $6.3 \pm 6.2$  d for grade 2a and  $15.8 \pm 18.6$  d for grade 2b. It was significantly longer for patients with grade 2a and 2b injuries ( $P = 0.000$ ).

**CONCLUSION:** Endoscopy is an effective technique for determining the presence of esophageal and gastric damage and to avoid unnecessary treatment in patients with no or mild injury.

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**Key words:** Endoscopy; Caustic; Injury; Esophagus; Stomach

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## INTRODUCTION

Corrosive ingestion is an important social and medical problem due to associated early and long-term complications, including bleeding, perforation, systemic complications (renal insufficiency, hepatic dysfunction, and diffuse intravascular coagulation), esophageal stricture, fistula, gastric outlet obstruction, and cancer<sup>[1-4]</sup>. Corrosive injury may also lead to economic hardship due to medical costs and psychosocial problems in affected children, including behavioral and educational, as well as domestic problems<sup>[5]</sup>. Although the use of child proof packages or containers is increasing, caustic ingestion is still an important problem in children because of uncontrolled and cheaper cleaners which have been introduced through common uncontrolled markets in developing countries<sup>[6,7]</sup>.

Several studies<sup>[8,9]</sup> indicate that clinical signs are not always helpful in predicting the degree of injury and subsequent stricture formation. esophagogastroduodenoscopy (EGD) is the most effective method for establishing the severity of injury and treatment planning. However the reported studies<sup>[8-10]</sup> that investigated the role of endoscopy in caustic ingestion focused especially on esophageal injury. There are several studies with limited number of patients which emphasizes the gastric findings with detailed findings and results of caustic injury. The aim of the present study is to determine significance and necessity of the EGD to predict the esophageal and gastric outcome of caustic ingestion and its effect on planning the treatment strategies in children.

## MATERIALS AND METHODS

The study included 206 children that underwent EGD in a single institution because of accidental caustic substance ingestion between January 2005 and August 2010. We didn't perform EGD in patients with questionable history of ingestion if they were asymptomatic and had no oropharyngeal finding. Age and gender of the patients, chemical properties of the caustic substances, clinical findings, endoscopic findings, treatment modalities, feeding methods, and long-term complications were analyzed retrospectively. Hematemesis, oropharyngeal fibrinous lesions, severe mucosal edema, vomiting, drooling, oropharyngeal hyperemia and respiratory distress were considered positive clinical findings.

Ampicillin with sulbactam and ranitidine were routinely administered to all patients before EGD. EGD was performed in all patients under general anesthesia by a fiberoptic Pentax LH-150PC (Japan) endoscope. Endoscopy was performed within 48 h of initial injury. Endoscopic findings were graded by using a modification of the method of Di Costanza which was used by

Poley *et al*<sup>[4]</sup> as grade 0: normal; grade 1: mucosal edema and hyperemia; grade 2a: hemorrhagic, bullous mucosa, exudates, fibrinous membranes, or superficial ulceration; grade 2b: circumferential ulceration in addition to grade 2a; grade 3: scattered small necrotic areas, and black or brown mucosa. Grade 2a, 2b, and 3 were defined as severe lesions. Gastric injury was classified as normal (normal mucosal appearance, edematous or hyperemic mucosa) or severe (exudates, fibrinous membrane, superficial ulceration, scattered small necrotic area and hemorrhagic, black or brown mucosa).

Intravenous antibiotics and H<sub>2</sub> (histamin-2) receptor blocker were discontinued in patients with grade-0 and grade-1 injuries. Patients with grade-0 and grade-1 esophageal injury without severe gastric injury were fed orally and discharged after endoscopy. Gastric decompression and medical treatment which included steroid, intravenous antibiotics (ampicillin-sulbactam, netilmicin, and metronidazol) and H<sub>2</sub> receptor blocker were given in patients with grade 2 and 3 injuries or severe gastric injury. All patients who had grade-2 or 3 esophageal injury without severe gastric injury were fed *via* nasogastric tube after endoscopy. Enteral nutrition was not started and total parenteral nutrition (TPN) was given in patients who had severe gastric injury which was characterized with mucosal necrosis. A repeat endoscopy was performed for the reevaluation of the esophageal and gastric injury, and to start dilation within 7-13 d after caustic ingestion in patients with high suspicion about development of esophageal stricture and grade 2 or higher injury. Oral nutrition was initiated after detection of esophageal and gastric amelioration during the repeat endoscopy. Barium meal studies were performed in all patients with severe esophageal or gastric injuries at the end of the third week of ingestion to determine if esophageal or pyloric stricture was present. Dilation management was started in patients with esophageal or pyloric stricture.

### Statistical analysis

Statistical analysis was performed using SPSS v.11.5 software. Data were analyzed using descriptive statistical methods. Differences between groups were analyzed using the chi square test for categorical variables and Mann Whitney-U for continuous variables.  $P < 0.05$  was considered statistically significant.

## RESULTS

The male/female ratio was 129/77 and mean age was  $38.1 \pm 28.8$  mo (range: 4 mo-15 years). The caustic substances were acidic in 72 (34.9%) patients, alkaline in 56 (27.2%), liquid household bleach in 62 (30.1%), and unknown substance in 16 (7.8%) patients. Fifty-seven patients (27.7%) were symptom-free on admission. Positive clinical findings were observed in 149 (72.3%) patients. The median time of presentation was 1 h (range 10 min-7 d) and mean time of endoscopy was  $1.56 \pm 1.39$  d (range: 1-10 d). Endoscopy was performed within 48 h of injury

**Table 1** Endoscopic findings of the patients number based on ingested caustic substance *n* (%)

Esophageal grade	Acidic	Alkaline	Liquid household bleach	Unknown content	Total
Grade 0	14	18	44	10	86 (41.7)
Grade 1	11	20	15	3	49 (23.8)
Grade 2a	25	12	2	3	42 (20.4)
Grade 2b	21	6	1	0	28 (13.6)
Grade 3a	1	0	0	0	1 (0.5)
	72 (34.9)	56 (27.2)	62 (30.1)	16 (7.8)	206 (100)

**Table 2** Esophageal stricture in relation to esophageal injury *n* (%)

Grade of esophageal injury	Stricture rate
Grade-0	0 (0)
Grade-1	0 (0)
Grade 2a	6 (37.5)
Grade 2b	9 (56.25)
Grade 3	1 (6.25)
Total	16 (100)

in 185 (89.8%) patients and was performed after 48 h in 21 (10.2%) patients because of late presentation. Esophageal findings according to the type of ingested substance are summarized in Table 1. One hundred and thirty-three patients with no or grade 1 esophageal injury were fed and discharged after endoscopy. Two patients who had grade 1 esophageal injury were hospitalized for 21 d and 30 d respectively because of severe gastric injury.

A repeat endoscopy and bouginage were performed within 7 d to 13 d after initial procedure in 35 patients with grade 2a and grade 2b esophageal injury and high suspicion about development of esophageal stricture. Esophageal stricture was detected in 16 patients with barium meal study. Thirteen of them needed more than 1 dilation. The correlation of degree of esophageal injury and stricture formation. The stricture rate was 15.3% (11 patients) and 8.9% (5 patients) among the patients with acidic and alkaline injuries, respectively (Table 2). No esophageal strictures developed in patients that ingested liquid household bleach or unknown caustic substances. Although 63.6% of patients who developed esophageal stricture ingested acidic substances, there is no statistically significant difference in the rate of development of esophageal stricture between the patients who ingested acidic and alkaline substances (*P* = 0.32).

Severe gastric injury was detected in 38 (18.4%) patients (Table 3). Gastroscopy could not be performed in 2 patients that ingested acidic substances because of severe esophageal edema. Gastric injury was more severe than esophageal injury in 7 (3.4%) patients. The rate of development of gastric injury was significantly higher in the acidic group than in the alkaline group (*P* = 0.001). Septicemia developed in four patients (1.9%) after oral feeding which was started after revealing the

normal esophageal appearance with partially improved initial severe gastric mucosal injury by control endoscopy. Pyloric stenosis developed in 6 patients. Five patients ingested acidic substances while one patient ingested liquid household bleach. Three of them had no clinical signs after ingestion. Endoscopy revealed grade 2a and grade 2b esophageal injuries in 2 and 4 of them, respectively. Severe gastric injuries, especially of the antral and pyloric areas, were observed in all 6 patients. Endoscopic balloon dilation of the pylorus was attempted in 4 of these patients and pyloric obstruction improved with dilation in 2 of them. One month following ingestion gastrojejunostomy and Heineke-Miculicz pyloroplasty were required in three and one remaining patients respectively.

Esophageal and gastric endoscopic findings according to clinical findings are summarized in Tables 4 and 5. The sensitivity and specificity of all clinical findings regarding severe esophageal injury were calculated as 80.6% and 32.8%, respectively. However sensitivity and specificity of all clinical findings regarding severe gastric injury were calculated as 75.7% and 29%, respectively. Tracheal injury was observed only in 1 patient. Duodenal injury was not detected in any of the patients. No complications related to endoscopy were observed in any of the patients.

TPN was required in 15 (7.3%) patients, of which 14 had severe gastric, antral or pyloric injury; six patients developed pyloric stenosis. One patient with esophageal injury without gastric injury required TPN because of enteral nutrition intolerance. Mean hospitalization time were 1.2 ± 0.5 d for grade 0 and 2.3 ± 5 d for grade 1 and 6.3 ± 6.2 d for grade 2a and 15.8 ± 18.6 d for grade 2b. It was significantly longer for patients with grade 2a and 2b injuries (*P* = 0.000).

## DISCUSSION

Extent of injury following caustic ingestion depends on amount, concentration and pH of substance and tissue contact time<sup>[8,11]</sup>. Alkaline injury caused liquefaction necrosis which results in deep penetration of tissue<sup>[11]</sup>. Alkaline injury appears mostly in esophagus. However acidic injury causes coagulation necrosis which limits deep penetration. Acidic substance rapidly transit to the stomach because of their low viscosity and specific gravity. This condition results gastric injury more than esophageal injury<sup>[11]</sup>.

The late complications of caustic ingestion are closely related to the depth and extent of the esophageal or gastric injuries. Several clinical approaches and treatment modalities were recommended in injured children<sup>[6,12-15]</sup>. However, to estimate the risk of stricture formation, to begin early and appropriate treatment, and to prevent unnecessary malnutrition and medication use, the presence of esophageal and gastric damage should be documented. Several diagnostic trials were conducted for this purpose and included radiocontrast esophagography, scintigraphy, and esophageal ultrasound; however, the usefulness and prognostic value of these methods remain

**Table 3** Gastroscopic findings according to caustic substance *n* (%)

	Substance				Total ( <i>n</i> = 206)
	Acidic ( <i>n</i> = 72 )	Alkaline ( <i>n</i> = 56)	Liquid household bleach ( <i>n</i> = 62 )	Unknown content ( <i>n</i> = 16)	
Severe gastric injury	29 (14)	6 (2.9)	2 (1)	1 (0.5)	38 (18.4)

**Table 4** Severity of esophageal lesions in relation to clinical findings *n* (%)

Clinical findings	Grade of esophageal injury				
	0	1	2a	2b	3
Normal ( <i>n</i> = 57) (27.7%)	37 (17.9)	9 (4.4)	9 (4.4)	2 (1)	0
Positive clinical findings ( <i>n</i> = 149) (72.3%)	49 (23.8)	40 (19.4)	33 (16)	26 (12.6)	1 (0.5)

**Table 5** Severity of gastric lesions in relation to clinical findings *n* (%)

Clinical findings	Gastric injury	
	Normal	Severe
Normal ( <i>n</i> = 57) (27.7%)	49 (23.7)	8 (3.9)
Positive clinical findings ( <i>n</i> = 149) (72.3%)	117 (56.8)	30 (14.6)

Gastroscopy could not be performed in 2 (1%) patients with positive clinical findings because of severe esophageal edema.

controversial<sup>[16,17]</sup>. The predictability of esophageal injury based on signs and symptoms, and the necessity of upper gastrointestinal endoscopy has been addressed in previous reports<sup>[1,2,4,8,9]</sup>. Although Gaudreault *et al*<sup>[9]</sup> considered vomiting, dysphagia, excessive salivation, abdominal pain, refusal to drink, and oropharyngeal burn specific clinical signs and symptoms of caustic injury, they observed severe esophageal burns in only 18%-33% of patients with these findings and concluded that clinical signs or symptoms cannot predict esophageal injury. Nonetheless, endoscopic evaluation was suggested as a mandatory intervention in symptomatic corrosive-injured patients, but it was not necessary for asymptomatic patients, especially those with a questionable history<sup>[3,18]</sup>. Lamireau *et al*<sup>[8]</sup> reported that vomiting, drooling, and oropharyngeal lesions were not predictors of esophageal injury; however, respiratory symptoms, hematemesis, or the presence of at least 3 symptoms were highly predictive of severe gastrointestinal injury, even though their sensitivity was low. However none of the authors stated the gastric injury in detail and its relation with symptoms and outcome of caustic injury.

We observed severe esophageal injury in 19.3% of our patients that did not have symptoms on the contrary 59.7% of the patients with positive clinical symptoms have no or grade 1 esophageal injury. Fifty percent of patients who developed pyloric stenosis did not have any clinical findings. We want to emphasize that clinical findings are not predictors of esophageal or gastric injury. Although sensitivity of clinical findings was relatively high; specificity of findings was low. Therefore these results support that the absence of any oropharyngeal lesion

does not rule out the severe esophageal or gastric injury.

Endoscopic evaluation is the most effective and widely used technique for establishing the severity of injury. The burned esophagus is weakest between the 7th and 21st d of injury<sup>[5]</sup>; the frequency of endoscopic complications such as fistulas, perforation, and bleeding usually increase in patients with high-grade injury during this period<sup>[5,5]</sup>. Early endoscopy is recommended, especially in the first 24-48 h<sup>[1,3,18]</sup>.

It is usually recommended to stop endoscopy at the first circumferential esophageal burn because of the risk of perforation beyond this point<sup>[19]</sup>; however; we think that this approach might cause a more severely burned esophagus or stomach to be missed. We observed severe gastric injury in 18.4% patients; gastric injury was more severe than esophageal injury in 3.4% of patients. We performed endoscopy after 48 h of injury in 10.2% of patients because of late presentation to the hospital. In contrary to the ordinary knowledge, we performed complete upper gastrointestinal endoscopy to reveal gastric injury even in patients in which severe esophageal injury was detected through endoscopy in all patients except two. However, there were no complications due to late or complete EGD.

The most frequent complication of corrosive substance ingestion is esophageal stricture. The rate of stricture formation is reported to be between 2% and 63%<sup>[5,6,9,13,20]</sup>. Baskin *et al*<sup>[20]</sup> reported that 4.7% of patients with grade 2a injury and 26% of those with grade 2b injury developed esophageal stricture. Huang *et al*<sup>[6]</sup> reported that all patients with grade 2 and 3 injury developed esophageal stricture. Overall, incidence of esophageal stricture was 7.8% in our study. Fourteen point three percent of our patients with grade 2a esophageal injury developed esophageal stricture. This rate was 32.1% and 100%, respectively, in patients with grade 2b and grade 3 esophageal injuries. We think that the partially low overall rate of esophageal stricture was related to the treatment strategies which were directed through the findings of EGD. Because we started early dilation within 7-13 d after initial procedure in patients who had grade 2 and 3 esophageal injury<sup>[3]</sup>. Therefore early dilation is suggested

to improve the outcome of esophageal injury and reduce the number of patients that develop esophageal stricture which was detected at the third week of ingestion.

We did not observe a significant statistical difference in the rate of development of esophageal injury between the acidic and alkaline ingestion groups in contrary to the literature, however esophageal and gastric injury occurred less frequently in the liquid household bleach and unknown content groups than in the acid and alkaline groups. Although 68.7% of the patients who developed esophageal stricture ingested acidic substances, there was no difference in the rate of stricture formation between the acidic and alkaline ingestion groups.

In the present study gastric injuries occurred with greater frequency in the acidic group than in the alkaline group [acidic (40.2%) *vs* alkaline (10.7%)]. Several studies<sup>[21-24]</sup> report that the overall incidence of gastric outlet obstruction is 5%-10% and that surgical correction is the preferred treatment modality in these patients. We observed gastric injury in 8.4% of our patients and gastric outlet obstruction occurred in 15.7% of them. Another advantage of EGD in patients with gastric injury is attempt of balloon dilation for pyloric stenosis.

We think that overlooking gastric injury distal to the upper circumferential esophageal injury is prevented by the gastroscopy which is completed even severe circumferential esophageal injury is detected. Also the widespread use of endoscopy and endoscopic dilation reduce the necessity for surgical procedures to treat corrosive-induced gastric outlet obstruction.

In conclusion, we think that endoscopy which is a mandatory and effective technique should be performed to prevent unnecessary hospitalization and medication use, to plan initial treatment and to predict the patients who are under the risk of developing esophageal stricture and/or gastric outlet obstruction. EGD can be performed without complications in experienced hands. Additionally EGD has advantages such as to establish treatment and follow-up strategies and improving the clinical outcome of the children with caustic ingestion.

## COMMENTS

### Background

Corrosive ingestion is still an important problem causing serious esophageal and gastric injuries which end up with esophageal strictures and pyloric obstruction in children. There are several studies with limited number of patients which emphasizes the gastric findings and results of caustic injury. Endoscopy is the most effective method for establishing the severity of injury.

### Research frontiers

There have been several studies which indicate that clinical signs are not always helpful in predicting the degree of injury and subsequent stricture formation of esophagus and pylorus. Endoscopy provides detailed information about the grade of corrosive injury thus helps to predict esophageal and gastric outcomes.

### Innovations and breakthroughs

The present retrospective study investigated the necessity of endoscopy to predict the outcome of caustic ingestion in children. This study suggests that endoscopy should be performed in all patients who experienced caustic ingestion except the patients with a questionable history and had no symptoms. Also severe gastric injury was observed in 18.4% patients and more severe than

esophageal injury in 3.4% of patients in this study. Therefore complete upper gastrointestinal endoscopy should be performed to prevent misdiagnosis.

### Applications

This article provides important data about significance and necessity of the endoscopy in patients with caustic ingestion. It is important to establish the severity, penetration and extent of injury to plan the treatment strategies in children with caustic ingestion.

### Terminology

Upper gastrointestinal endoscopy and esophagogastroduodenoscopy (EGD) are direct visual examination of mouth, esophagus, stomach and duodenum through an endoscope. Stricture is narrowing of the lumen. Total parenteral nutrition is defined as feeding of patient intravenously by bypassing of digestive system.

### Peer review

The manuscript is a reasonable retrospective review of 206 children who underwent EGD because of caustic ingestion. Severe gastric injury was noted in 18.5% and endoscopies proved safe even in the setting of severe esophageal injury.

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