Investigation of Mortality after Corrosive Ingestion: A Prospective Study

Roohollah Yeganeh[1*], Hasan Peyvandi[1], Mohammad Mohajeri[2], Reza Bashtar[2], Mohammad Bashashati[2], and Mina Ahmadi[3]

[1] *Department of Surgery, Loqman-Hakim Hospital, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

[2] *Department of Gastroenterology and Surgery, Loqman-Hakim Hospital, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

[3] *Resident of Community Medicine, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

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Abstract- Ingested corrosive substances produce different injuries, ranging from minor gastro esophageal burns to death, depending on the agent type, amount, concentration, and duration of substance exposure. The purpose of this study was to investigate the outcomes and different causes of mortality in patients ingesting caustic substances. In a prospective study, between April 1999 and January 2006, a total of 1260 patients with a history of caustic agent ingestion were admitted to Loqman-Hakim hospital emergency ward. Patients who died despite our management were included in this study. Mortality rate was stratified as early (during the primary hospitalization) and delayed (after discharge from the hospital) based on the etiologies. Sixty-two patients died during follow up. Among patients who died, mean arrival time to the hospital was 12 hours from exposure, ranging from 30 minutes to 120 hours. Aspiration and airway obstruction were the leading causes of mortality accounting for 25 patients' death. Twenty-seven of them underwent surgical intervention, among whom 21 deaths occurred after early operations and 6 deaths after delayed reconstructive surgery. In cases of caustic ingestion, early admission and airway protection besides surgical intervention, if indicated, can reduce the mortality rate.

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Key words: Caustic ingestion, mortality, acid ingestion, alkaline ingestion

Introduction

Given several efforts have been made on reducing corrosive properties of caustic liquids and educating the public about their danger, caustic agent ingestion remains a serious and devastating clinical problem (1). According to the annual report of the American Association of Poison Control, there were 124962 cases of human exposure to cleaning substances including acids and alkalis in 2004. Twenty-five of these cases resulted in death (2).

Caustic agents produce damage to the gastrointestinal tract, ranging from minor burns to situations in which corrosive lesions extend beyond the esophagus and the stomach to the duodenum, the jejunum, or the adjacent thoracoabdominal organs with high rates of complications and death (3). The severity of lesions produced by caustic substances on tissue depends on the type, amount and concentration of the caustic substance ingested, as well as on the time of contact with the mucosa. Other following complications are esophagitis, esophageal stenosis and progression to cancer, fistulas, perforations, stomach lesions and brain abscesses (4) Adults more frequently ingest caustic substances intentionally without expulsion resulting in greater and more extensive injury (5, 6).

Although there are many reports regarding corrosive agents ingestion, reported data on resulting mortalities and relevant causes are scarce. The objective of the present study was to investigate the causes of mortality observed in 62 patients admitted to our hospital who perished due to caustic ingestion.

Patients and Methods

In a prospective study, between April 1999 and January 2006, a total of 1260 patients with a history of caustic agent ingestion were admitted to Loqman-hakim

[*] **Corresponding Author:** Roohollah Yegane
Department of Surgery, Loqman Hakim Medical Center, Kamali St, Tehran, Iran
Tel: + 98 21 55419390, 912 1081073, Fax: +98 21 55416170
E-mail: Yeganeh.r@gmail.com, Yeganeh33_r@ Yahoo.com

Table 1. Types of caustic agents responsible for death in 62 patients

Caustic chemicals	agent		frequency
Acids	arsenic-based	depilatory agent	20
	sulfuric acid	Nondiluted acid	12
		Automobile batteries	3
	choloridric acid		12
	potassium permanganate		2
Alkaline	sodium hydroxide	Drain cleaners	11
		detergents	1
	sodium hypochlorite	bleaches	1
	total		62

hospital emergency ward. Sixty-two patients who died despite our management were included in this study. It is worth mentioning that our center is the only existing center for management of poisoned patients. Endoscopic examination was not performed on patients who had unstable homodynamic, airway edema, or acute abdominal signs until complete management. Patients who had acute abdominal sign underwent emergent surgery without performing endoscopy.

Mortality rate was stratified as early and delayed based on etiology. Early mortality was defined as the mortality related to airway obstruction, aspiration pneumonia, sepsis, and Multiorgan system failure (MOSF), extensive gastrointestinal gangrene, gastrointestinal bleeding, and co-morbid diseases (cardiac disease, etc) during the first admission. Delayed mortality was defined as the mortality relating to reconstructive surgery complications, delayed aspiration pneumonia, gastrointestinal perforation (peritonitis), and other causes related to caustic ingestion which occurred after discharging from the hospital.

Endoscopic evaluation was performed under direct vision after an initial inspection of the hypopharynx. During endoscopy, air insufflations and retroflexion were carefully performed to avoid iatrogenic damage. In the majority of patients, endoscopy was performed without sedation to minimize the risk of aspiration. Mucosal damage was graded as follows; Grade 0: no endoscopic damage; grade 1: edema, erythema, and/or exudates, grade 2: moderate ulceration and or hemorrhage, and grade 3: extensive ulceration and/or hemorrhage (7).

Age, gender, type of ingested agent, admission time to hospital, aim of ingestion, physical examination findings, types of surgical approach, and length of hospital stay were evaluated. SPSS 11.5 for windows (New Jersey, USA) was used to analyze the collected data.

Results

Mortality occurred among 62 patients with caustic injury (4.9 %). The group consisted of 42 men (67.7 %) and 20 women (32.3 %) with a mean age of 47.8±19.95, ranging from 15-107 years. Caustic ingestion intent was suicidal in 54(87.1 %) and accidental in 8(12.9 %). The types of ingested material are shown in table 1.

Mean arrival time to the emergency ward was 12 hours after exposure (ranging from 30 min to 60 hours); 43 (69.4 %) patients within 2 to 24 hours, 12 (19.3 %) between 24 and 48 hours thereafter, and 7 (11.3 %) after 48 hours of ingestion. The mean duration of hospital stay was 5 days (ranging from 1 to 65 days).

The results of mortality evaluation as defined are presented in table 3.

In physical examination, the most frequent complaint was dysphagia presented in 84% of patients including stage I, II and III in 3 percent, 25% and 56% of patients, respectively. Other signs and symptoms from the most frequent to the least frequent were oral burns (70%), nausea and vomiting (58%), abdominal pain (55%), dyspnea (51%), stridor (49%) and hoarseness (49%), abdominal tenderness (49%), abnormal pulmonary sounds (43%), abdominal distention (10%) and signs of mediastinitis in 1% of patients. In medical history, 17 (28.3%) of patients had prior psychiatric problems and 12(20%) were suffering from cardiopulmonary problems.

Endoscopic evaluation was performed in 15 patients (25%), among which it revealed grade I, II and III in 2 (3.3%), 7 (11.7%) and 6 (10%) patients, respectively.

Table 2. Type of Surgery in 62 patients who died from caustic ingestion

surgery	type	number
Early operation	lapatomy, gasterotomy, posterior gastric wall biopsy and jejunostomy	2
	lapatomy,gasterotomy, posterior gastric wall biopsy, jejunostomy and intraluminal esophageal stent	7
	lapatomy, esophagogasterectomy,jejunostomy and cervical esogh-agostomy	9
	laparatomy and 2nd look operation 36 hour later	3
Delayed operation	reconstructive surgery (gastric pull up) through retrosternum	1
	reconstructive surgery (gastric pull up) through posterior mediastinum	2
	reconstructive surgery(colon interposition) through retrosternum	1
	reconstructive surgery (colon interposition) through posterior mediastinum	2

Twenty-seven (43.5%) patients underwent surgical intervention (Table 2). Twenty-one patients died after early operations and 6 patients died after performing delayed reconstructive surgery.

Discussion

In Iran, many strange ways are recently used in suicide attempts (8-10). Corrosive agents including acids, alkaline and depilatory agents account for 5% of suicides and accidental poisonings in our center (11). Another report from this center reported mortalities caused by corrosive agents equal to 7.2 % (12).

Arevalo-Silva et al showed that the severity of damages in caustic ingestion depended on the type of ingested substance, which varied depending on ethnicity (13). Although alkaline materials are the most frequently ingested caustic agent in western countries, easy accessibility of acidic substances makes them as the most frequently ingested substance in countries like India and Turkey (1, 14, 15). To our knowledge, acids are the most common ingested caustic agent in our region.

Table 3. Major mortality causes for 62 died patients with caustic ingestion

mortality	etiology	Non operated patients (n=35)		Operated patients (n=27)	
		acid	alkaline	acid	alkaline
early	Airway obstruction & Aspiration pneumonia	14	4	4	3
	Extensive gastrointestinal gangrene	-	-	3	2
	sepsis and MOSF*	3	-	5	-
	Gastrointestinal bleeding	-	1	1	2
	Co morbid diseases (cardiac disease, etc)	1	-	1	-
	Systemic toxicity	10†	-	-	-
delayed	Reconstructive surgery complication	-	-	3	1
	Delayed aspiration	-	2	-	-
	Gastrointestinal perforation (peritonitis)	-	-	-	1
	Co morbid diseases (cardiac disease, etc)	-	-	-	1
Total		28	7	17	10

* Multi organ system failure

†all patients ingested depilatory agent, 3 with comobrbid conditions

According to the present study, the most frequently used corrosive agent leading to death was arsenic-based depilatory agent called `Vajebi`. When we reviewed patients' database in our center, it became clear that mortalities due to this agent decreased from 22% in 1998 to 5.7% in 2003. Our research showed that it was due to alterations in chemical contents (16). Our analysis showed that it was a mixture of approximately 65% calcium bicarbonate ($Ca(HCO_3)_2$), 25% arsenic sulfide (As2S3), and 10% clay and moisture. When dissolved in water, As2S3 produces arsenous and arsenic acid. $Ca(HCO_3)_2$, arsenous acid and arsenic acid are corrosive components with acidic pH ,which damage the digestive tract following ingestion (17), while the arsenic component causes systemic arsenic poisoning, which led to death among 10 of our patients.

Our study revealed that successful suicide attempt was seen more in males than females with probably more amounts of corrosive agent used in males. Although most of the patients admitted to our center aged between 13 and 40 years, our studied patients were older which might be associated to their serious suicidal intention which led them to choose a more harmful method.

Considering the severity of lesions after caustic ingestion, patients' survival is closely related to the delay between ingestion and surgical treatment (18). Our patients' mortality revealed that a great number of patients died due to airway damage and instability at the early phase of management which points out the necessity of stabilization in order to reduce mortality in emergency settings.

We found acids the most frequent cause of mortality among our patients. Larynx and respiratory airways are among the major visceral organs of the body affected by the ingested caustic agents. It may cause airway obstruction and/or aspiration pneumonia. Aspiration pneumonia rarely occurs in patients with suicide intent who are conscious, and its occurrence is mainly due to alkaline ingestion. Aspiration due to acid ingestion is less likely than alkaline ingestion, and it greatly increases mortality (19). Therefore, the first step in the management of patients with corrosive injury is to maintain airway patency and hemodynamic stability. In patients presenting with apnea and stridor, intubation should be performed because of the possible development of edema (20). Alkali compared to acids, cause more laryngeal or tracheobronchial sequellae, which may decrease threshold for choking or cause dyspnea (19, 21). These patients are prone to delayed aspiration during the chronic stage of the corrosive injury. It occurred in 2 of our patients and caused repetitive episodes of admission due to aspiration pneumonia. We recommend laryngectomy and permanent tracheostomy for such patients, however further studies are necessary.

Gastrointestinal bleeding can occur after caustic injury to gastrointestinal mucosa. Two of our patients presented with aortoesophageal fistula which was confirmed after autopsy.

Endosopy should be done in every patient with patent airway and hemodynamic stability in order to determine the severity of lesion (20). In our study, endoscopic examination was performed in only 15 (24.2 %) patients. Endoscopy could not be done in patients with airway and hemodynamic instability and in patients with acute abdominal signs who underwent emergent surgery.

Extensive gastrointestinal gangrene is the untreatable and inevitable complication of caustic ingestion. It is related to the type, amount, and concentration of ingested substance (3-6). Massive intestinal necrosis is a reasonable indication for extensive abdominal surgery after caustic ingestion (3). According to our guidelines, we perform extensive resection when the gangrenous tissue is limited to the second part of the duodenum because these patients will most likely die. Our patients with extensive gastrointestinal gangrene, presented with abdominal organs gangrene extended to large intestine and their abdomens were full of sludge.

Most of our patients who died were those who underwent early surgical intervention. Although early extended surgical intervention is recommended in these patients (3), it may manifest with more mortalities not related restrictively to operation, but to more severe injury, co-morbid conditions and respiratory problems.

Late mortalities after surgical interventions seem to be less common. The candidate patients for late reconstructive surgeries are elective and stable, with complete preoperative preparation. However, this operation is major and may cause decompensation with high rates of complications. In conclusion, given the high mortality rate relating to caustic ingestion, it is of great importance to keep in mind that a great number of deaths occur in the acute phase of treatment; therefore, precise attention in emergency room to early admission to the hospital, supportive therapy in terms of airway protection, and early surgery, if indicated, can reduce the mortality rate.

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