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Factors Predicting the Hospital Mortality of Patients with Corrosive Gastrointestinal Injuries Receiving Esophagogastrectomy in the Acute Stage

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Abstract

Objectives The aim of this study was to identify the preoperative factors that affect the survival of patients who undergo esophagogastrectomy after corrosive ingestion, using analysis of their physiological condition, associated diseases, physical examination, and laboratory data.

Methods Between January 1995 and December 2005, 71 consecutive patients who underwent esophagogastrectomy for corrosive ingestion injuries were retrospectively reviewed. Of them, 41 survived and 30 (42.3%) died during the perioperative period. Logistic regression analyses were used to model markers for postoperative mortality, including descriptive data, clinical symptoms/signs, and laboratory data.

Results There were 35 males and 36 females included in the study, with an average age of 54.7 ± 14.9 years. After adjustments in the logistic regression model, age of over 65 years $(p = 0.021)$, presence of gross hematuria $(p = 0.016)$, twofold level of serum AST $(p = 0.012)$, blood pH level below 7.2 $(p = 0.017)$, and deficit of blood base over 16 $(p = 0.007)$ were found to be independent risk factors for patient mortality.

Conclusions We consider age over 65 years, preoperative pH < 7.2, base deficit >16, twofold level of serum AST, and presence of gross hematuria to be the important factors predicting postoperative hospital mortality in patients presenting with corrosive ingestion injuries who require emergency surgery.

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Introduction

The phenomenon of accidentally swallowing or intentionally ingesting caustic liquid (either acidic or alkaline) is not unusual worldwide. The most commonly discussed issue in the literature with respect to this topic concerns the operative indications, i.e., suitable timing for surgical intervention [1, 2]. However, very few studies have analyzed the preoperative factors that could predict the hospital mortality of patients who undergo esophagogastrectomy in the acute stage.

The aim of the present study was to identify the preoperative factors affecting these patients' survival by analyzing their physiological condition, associated diseases, physical examination, and laboratory data.

Materials and methods

Between January 1995 and December 2005, all patients with corrosive gastrointestinal injuries treated in a single tertiary-care institution were retrospectively reviewed. During the 11-year period, 537 patients with caustic

injuries were admitted. Of them, 73 adult patients (13.6%) who had emergency operations were included. Patients treated conservatively or in a preterminal state without the exemption of salvage operations were excluded. A comparison of the 73 complete follow-up patients with those who were not included showed no significant differences in age, gender, and BMI ($p = 0.112$, 0.662, and 0.623). Their general condition, associated diseases, physical examinations, laboratory data, and operative findings were reviewed and analyzed.

These patients were confirmed, through clinical examinations and statements of their families, as having accidentally swallowed or intentionally ingested corrosive (acidic or alkaline) agents. Physical examinations, chest radiography, and laboratory examinations, including arterial blood gas, complete blood count and biochemistry, were routinely performed.

Primary corrections, including fluid supply and acid–base balance, were administered at the emergency department. A nasogastric tube was inserted for acidic injuries of less than 2 h, for drainage only, not lavage [1, 3]. For those suspected of alkali ingestion or sustaining acidic injuries for more than 2 h, blind placement of a nasogastric tube was avoided because of the high risk of perforation. Antibiotics were routinely administered. Esophagogastroduodenoscopy (EGD) was accomplished within 12 h in almost all cases, except for those patients with peritoneal signs, in shock, and having conditions needing emergency surgery [4–10]. Under local anesthesia, the EGD evaluation was always performed by the first two authors, the senior thoracic surgeons. Evaluations descended through grade 1 or 2 injuries until the level at which grade 3 was confirmed. During EGD evaluation, esophagogastric injuries were modified and classified as follows: grade 0 = normal; grade 1 = edema and hyperemia of the mucosa; grade 2 = superficial localized ulceration, friability and blisters; and grade 3 = circumferential ulceration or multiple and deep ulcerations and areas of extensive necrosis [11, 12]. The indications for surgery were as follows: (1) presence of peritoneal signs or free air, (2) grade 3 corrosive injuries in EGD [13], (3) intractable acid–base imbalance after medical resuscitation, (4) indications of shock upon arrival at the emergency department, and (5) presence of gross hematuria. The relative indications for surgery were a persistent heart rate of greater than 110 min^{-1} and cardinal indications such as shock or acidosis being borderline or clinically worsening after medical resuscitation.

Operative procedure

All patients were operated on by the same surgical team. They were placed in the supine position and given general anesthesia with tracheal intubation. Small median laparotomy was performed to confirm the injuries to the intra-abdominal organs. The incision was then extended up to the xiphoid and down to just above the umbilicus if resection was to be carried out. Any soiling and dirty ascites were sucked out if present. The extent of injury was confirmed through serosal involvement. Total esophagogastrectomy was performed. At the same time or just after the abdominal procedure, a left oblique cervical incision along the anterior margin of sternocleidomastoid muscle was made. The cervical esophagus was dissected and transected. The distal end was closed tightly. The esophagectomy was performed transhiatally. The proximal stump was always taken out at the wound as a cervical esophagostomy and a drain was placed separately. After the resection, the entire peritoneal cavity was washed with about 10,000 ml of normal saline under empiric judgment. Abdominal drains were placed over the posterior mediastinum, neck splenic fossa and foramen of Winslow under empiric decision. Witzel jejunostomy was performed routinely. The patient was sent to the intensive care unit for postoperative care. Postoperative chest radiography was taken to rule out the presence of pneumothorax. The patient was weaned off the ventilator and the endotracheal tube was removed as soon as possible. Nutrition was given through the jejunostomy tube after the patient regained bowel movement. The patient was discharged after achieving stable vital signs, regular jejunostomy feeding, and normal bowel movement.

Data collection and statistical analysis

Before beginning our analysis, the available literature was reviewed to identify factors thought to be important for patient survival [14–16]. Since there are few studies in the literature on this matter, we remained focused on whether arterial blood gases, including base excess and pH, could be used as a rapid and useful indicator and prognosis for the injury. Case patients were analyzed for their descriptive variables by reviewing the medical charts. Student t tests and χ^2 tests were used to compare continuous and categorical descriptive variables, respectively, between surviving and expired patients. Univariate and multivariate logistic regression analyses were used to examine the relationships between the relative risks and clinical outcomes. Potential confounders such as age, gender, medical history, clinical symptoms/signs, and laboratory data were adjusted in all multivariate analyses. Results were expressed as a mean with standard deviation or odds ratios (OR) and 95% confidence interval (CI) where appropriate. A p value of less than 0.05 denoted statistical significance. SPSS for Windows v12.0 (SPSS, Inc., Chicago, IL) was used for all statistics.

Results

Of the 73 patients, the data for two patients were incomplete and the records of 71 patients were enrolled. There were 35 males and 36 females with an average age of 54.7 ± 14.9 years. Ten patients who were initially excluded from surgery ultimately worsened and required surgery. Seven patients had significant respiratory complications due to aspiration injury and required emergency intubation and ventilation support. Three patients experienced postoperative leakage of the duodenal stump and required long-term drainage. Of the 71 patients, 41 survived and 30 (42.3%) died during the perioperative period (Table 1). The mean age of those who died (67.8 ± 10.3 years) was significantly greater ($p < 0.001$) than that of those who survived (45.2 ± 16.3 years). Between the two groups, gender, presence of gross hematuria, and initial mean blood pressure, heart rate, and serum leukocyte counts were not significantly different ($p = 0.705$, 0.118, 0.483, 0.745, and 0.751, respectively). Furthermore, there were significantly fewer survivors with diabetes, hypertension, and/or peritoneal signs ($p = 0.001$, 0.002, and 0.006, respectively). Serum creatinine, AST, ALT, and deficit of blood base were also lower in survivors ($p = 0.009$, 0.002, 0.007, and <0.001, respectively). The blood pH levels were significantly lower in patients who died ($p = 0.001$).

The factors influencing postoperative mortality are given in Table 2. The risk factors for patient mortality in the univariate analysis included age between 45 and 65 years, age over 65 years, diabetes, hypertension, presence of peritoneal signs, serum creatinine over 1.5 mg/dl, serum AST > 84 U/L, serum ALT > 80 U/L, blood pH level below 7.2, and deficit of blood base over 16

($p = 0.005$, <0.001, 0.006, 0.005, 0.014, 0.019, 0.005, 0.009, 0.016, and 0.010, respectively). Patient mortality was independent of gender, presence of gross hematuria, abnormal vital signs, and abnormal leukocyte counts. After adjustments in the multivariate logistic regression model, age over 65 years, presence of gross hematuria, twofold level of serum AST, blood pH level below 7.2, and deficit of blood base over 16 were found to be independent risk factors for patient mortality ($p = 0.021$, 0.016, 0.012, 0.017, and 0.007, respectively), whereas diabetes, hypertension, presence of peritoneal signs, serum creatinine over 1.5 mg/dl, and twofold level of serum ALT were not significant after additional adjustment ($p = 0.153$, 0.331, 0.085, 0.675, and 0.625, respectively).

Of the patients who survived, esophageal replacement was successfully performed for 37 patients (from a total of 40) 6 months after the caustic injury. One 40-year-old female patient attempted suicide again 1 month after the caustic injury (and was successful), and the two remaining patients could not be located for follow-up. After reconstruction, four patients experienced mild cervical anastomotic leakage and conservative treatment was sufficient, while five patients had cervical anastomotic stricture for which bougination was required.

Discussion

The amount of corrosive agent swallowed and the time from the moment of ingestion until the patient's admittance into the emergency room were difficult to determine. The only way to know was to ask the patient during history taking, but the information would be mostly inaccurate. Over three-fourths of our patients suffered from major

Table 1 Descriptive variables and clinical features of the study patients

	Patients (N)		p value
	Expired (30)	Survivors (41)	
Gender (male/female)	14/16	21/20	0.705
Age (years)	67.8 ± 10.3	45.2 ± 16.3	<0.001
Diabetes (%)	33.3	2.4	<0.001
Hypertension (%)	36.7	7.3	0.002
Hematuria (%)	23.3	9.8	0.118
Peritoneal signs (%)	93.3	65.9	0.006
Mean blood pressure (mmHg)	105.5 ± 31.5	101.3 ± 18.5	0.483
Heart rate (bpm)	96.0 ± 26.9	94.0 ± 25.3	0.745
Leukocyte counts (mm^{-3})	17912.7 ± 8984.4	$18,609.3 \pm 9211.1$	0.751
Creatinine (mg/dl)	1.5 ± 0.9	1.1 ± 0.5	0.009
AST (U/L)	184.9 ± 261.3	47.6 ± 47.5	0.002
ALT (U/L)	106.0 ± 177.8	27.3 ± 27.7	0.007
Blood pH	7.16 ± 0.17	7.27 ± 0.10	0.001
Base deficit	14.2 ± 5.9	9.2 ± 5.0	<0.001

Student t test and χ^2 test were used to compare continuous and categorical descriptive variables, respectively, between surviving and expired patients

Table 2 Unadjusted and adjusted risk factors influencing mortality before operation

Risk factors	Died (%)	Survivors (%)	Unadjusted OR (95% CI)	Unadjusted p value	Adjusted OR (95% CI)	Adjusted p value
Male gender	46.67	51.22	0.83 (0.32-2.14)	0.705	0.84 (0.79-8.92)	0.887
Age						
≤45 years	3.3	53.7	1		1	
45-65 years	43.3	31.7	22.00 (2.572-188.19)	0.005	41.88 (0.54-3240.01)	0.092
>65 years	53.3	14.6	58.67 (6.42–536.28)	<0.001	628.88 (2.61-151,351.70)	0.021
Diabetes	33.33	2.44	20.01 (2.39-167.44)	0.006	170.72 (0.15–195,829.18)	0.153
Hypertension	36.67	7.32	7.33 (1.83-29.42)	0.005	16.81 (0.06–5000.68)	0.331
Gross hematuria	23.33	9.76	2.82 (0.74-10.69)	0.128	108.23 (2.36–4698.85)	0.016
Peritoneal signs	93.33	65.85	7.26 (1.50-35.02)	0.014	886.35 (0.39–2,018,743.02)	0.085
MBP < 90 mmHg	33.33	17.07	2.43 (0.80-7.39)	0.118	0.04 (<0.01–2.75)	0.138
HR > 120 bpm	20	14.63	1.00 (0.99-1.02)	0.741	9.17 (0.22–374.30)	0.242
Leukocyte counts > 20,000 cells/mm³	30	41.46	0.61 (0.22-1.64)	0.324	0.02 (<0.01–0.89)	0.017
Creatinine > 1.5 mg/dl	33.33	9.76	4.62 (1.29-16.62)	0.019	0.44 (0.01–20.40)	0.675
AST > 84 U/L	36.36	7.32	7.33 (1.83-29.45)	0.005	1332.02 (4.95–358,180.12)	0.012
ALT > 80 U/L	30	2.44	17.14 (2.03-144.61)	0.009	40.28 (<0.01–107796443)	0.625
Blood pH < 7.20	50	21.95	3.56 (1.27-9.95)	0.016	65.73 (3.01–323.34)	0.017
Base deficit > 16	33.33	7.32	6.33 (1.56-25.67)	0.010	5072.83 (10.40–2,474,601.76)	0.007

MBP mean arterial blood pressure, *HR* heart rate, *AST* aminotransferase aspartate, *ALT* aminotransferase alanine, *OR* odds ratio, *CI* confidence interval

depression and the ingestion of caustic liquid was an attempt to commit suicide; thus, it is almost impossible for such psychiatric patients to admit how much they drank. Therefore, to correlate the severity of injuries and prognosis with the swallowed amount is inappropriate. In this study, this factor was completely ignored, although reports with this association included were found in the literature [11, 14, 15, 17].

Many studies that discuss the suitable timing of surgical intervention for patients with caustic gastrointestinal injuries were found in the literature [1, 12, 18]. The usual indications are peritoneal signs, grade 3 injuries on EGD [13], intractable metabolic acidosis, and shock [1, 3, 19, 20]. Some doctors have referred to peritoneal free air and pneumothorax on plain radiography as surgical indications [9]. However, of the 71 cases of corrosive gastrointestinal injuries in the present series, only two patients with perforated organs had peritoneal free air and one had pneumothorax. The cause for these situations could be that the gastric or the esophageal wall becomes gangrenous and sticky so that the intraluminal air cannot enter the peritoneal or the thoracic cavity, as in the case of a simple perforation, or it may be more or less due to the supine position of the patient during roentgenography. Therefore, free air is a very unreliable indication for surgery. Different from previous reports, the present study analyzes the

preoperative factors, predicting the mortality of patients who undergo resection at the acute stage using current, available, contemporary medical devices [17, 21]. These factors are the physical conditions, laboratory data, and image studies collected at the very moment of admittance into the emergency department (Table 1). The main goal of this study was to try to predict the risk of death of patients who undergo resection. We have to emphasize that all patients who were diagnosed for surgical intervention finally underwent esophagogastrectomy, i.e., no patients were found to have only partial thickness esophageal lesions (grade 2) in the resected specimens. During surgery, the degree of esophagogastric injury and the pathological examination of the resected specimen matched the preoperative staging. The patients treated conservatively or who were in a preterminal state were excluded from the study. Because of the serious surgical indications, this series had a higher mortality rate than other studies [22].

The adjusted p values show that diabetes and hypertension were not significant through univariate analysis. However, diabetes is known to affect healing and immunity clinically. Nonetheless, the perioperative control of blood sugar levels is the current approach in intensive care [23].

The male gender is considered to have a poorer prognosis [2]. However, this was not significant in our series.

Intentional ingestion (attempted suicide) is a factor of severe injury and associated with a higher rate of complications [24, 25]. Intentional ingestion may be more frequent in patients with respiratory injury and vice versa [26]. In our series, most of our patients drank the caustic liquid in a suicide attempt. The ratio of intentional ingestion to accidental swallowing was too great to be compared. Therefore, we did not take it into consideration.

On physical examination, the presence of peritoneal signs, mean blood pressure <90 mmHg, and heart rate >120 min^{-1} were not significant factors. These signs revealed that the injuries were severe, but, on the other hand, they could reflect the condition of the patient before operation, so that quicker response and treatment could be provided. Therefore, these three factors cannot predict the postoperative prognosis, although in certain studies [24] the development of peritoneal signs is a good indicator of the severity and extent of the injury and is an indicator that the corrosive injury is very advanced.

Another factor is age over 65. This shows that the younger the victim, the better the recovery. Some authors have stated that those over 50 years old had a high mortality rate [14]. The average age in the mortality group was 67.8 ± 10.3 years, which was significantly older than that of the survival group (45.2 ± 16.3 years) ($p < 0.001$). On multivariate analysis, being older than 65 years is significant. This may reveal that the younger the patient, the greater the tolerance of caustic injuries and that the older the patient, the more trauma suffered from the caustic liquid.

Some authors consider white blood cell count over 20,000 mm^{-3} at admission an independent predictor of death [20]. In this study we had the same result on multivariate analysis ($p = 0.015$), although it was of no statistical significance between the two groups.

The significance of creatinine level has never been studied. The level was significantly different between the two groups on univariate analysis ($p = 0.009$) and also on unadjusted risk factor analysis ($p = 0.019$). However, the adjusted p value was not significant ($p = 0.235$). This means that the underlying renal insufficiency is not related to mortality, which is somewhat the same as the nonsignificance of diabetes and hypertension. However, preventative or alerting signs to past history of diabetes mellitus or hypertension should still be kept in mind.

As for other studies [11], pH < 7.2 and base deficit above 16 meq/L were associated with a higher mortality rate. In our study, whether using univariate or multivariate analysis, the results were very definite and should be considered very significant factors. The results showed the significant role of the pH of the caustic substance in producing more severe injury, and this should be considered more important than the amount ingested.

The presence of gross hematuria is associated with the severity of the caustic injury. Kidney tubule dysfunction or acute oliguric kidney failure has been reported after ingestion of acetic acid at high concentrations [27–29].

Both ALT and AST are associated with liver cell injury; however, the levels of ALT and AST in this study are differently presented. On univariate analysis, both were significantly different between the survival and mortality groups. However, on multivariate analysis, only AST was statistically significant. We explain this as follows: AST is found in other organs, including muscles, kidney, and heart, in addition to the liver. High levels of AST result in multiple-organ damage. ALT is found primarily in the liver, and high ALT levels indicate liver damage. Massive noninflammatory periportal liver necrosis would occur following concentrated acetic acid ingestion [30]. The injuries can be predicted as being more generalized and severe when AST soars, which is consistent with our result.

Some studies have considered associating acid ingestion with higher mortality rates than alkaline ingestion [19]. In the present study, 56/71 (78%) of the patients had acidic injuries, 8% were alkaline, and the rest were unknown. It is inappropriate to compare the patients due to the discrepancy in the numbers. Also, besides the pH of the caustic substance, another more important factor to be considered is the amount of ingestion, which in many cases we were unable determine from the statements of the patients and their families. Actually, if the amount of ingested liquid is large, the difference in the severity of injuries between acid and alkaline becomes insignificant.

Many of our patients had depressive disorders and refused to communicate after sustaining injuries (suicide attempt), while others could not remember the actual amount. In other words, the amount that the doctors recorded would be mostly inaccurate. That is why we deliberately neglected the amount ingested, although in many studies this has been defined as an important factor.

Conclusions

This study directly analyzed the preoperative clinical conditions, underlying systemic diseases, physical examinations, and laboratory data of the adult patients who underwent emergency esophagogastrectomy in the acute injury stage. Age over 65 years, preoperative pH < 7.2, base deficit >16, twofold level of serum AST, and presence of gross hematuria were the important factors predicting postoperative hospital mortality. Certainly, it is multifactorially related and further large-scale studies are required.

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