

Surgical management and outcomes of severe gastrointestinal injuries due to corrosive ingestion

Amit Javed, Sujoy Pal, Elan Kumaran Krishnan, Peush Sahni, Tushar Kanti Chattopadhyay

Amit Javed, Sujoy Pal, Elan Kumaran Krishnan, Peush Sahni, Tushar Kanti Chattopadhyay, Department of Gastrointestinal Surgery and Liver Transplantation, All India Institute of Medical Sciences, New Delhi 110029, India

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Correspondence to: Sujoy Pal, MS, MCh, Department of Gastrointestinal Surgery and Liver Transplantation, 1st Floor, P.C Block, All India Institute of Medical Sciences, Ansari Nagar, New Delhi 110029, India. sujoypal@hotmail.com

Telephone: +91-11-26594879 Fax: +91-11-26588663

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Abstract

AIM: To report our experience in the surgical management of severe injuries of the gastrointestinal tract due to corrosive ingestion.

METHODS: A retrospective review of patients who underwent emergency surgery for severe gastrointestinal injuries following corrosive ingestion between 1983 and 2010 was carried out. Data was extracted from a prospectively maintained esophageal disease database. Severe corrosive injuries were defined as full thickness necrosis with perforation of the esophagus or the stomach (with or without involvement of the adjacent viscera) with resultant mediastinitis or peritonitis.

RESULTS: Between 1983 and 2010, 209 patients with corrosive injury of the esophagus were managed. Of these, 13 (6.2%) patients underwent emergency surgery for severe corrosive injury. The median age of the patients was 22 years and the median interval between ingestion of the corrosive substance and surgery was 24 h. The surgical procedures done included esophago-gastrectomy alone ($n = 6$), esophagogastrectomy with

duodenectomy ($n = 4$), esophagogastrectomy with pancreaticoduodenectomy ($n = 1$), esophagogastrectomy with splenectomy ($n = 1$) and distal gastrectomy with duodenectomy ($n = 1$). Two patients died in the postoperative period and one after discharge awaiting the second surgery. The factors significantly predictive of mortality following such an injury included renal failure at the time of initial presentation, presence of metabolic acidosis, delay of more than 24 h between corrosive ingestion and surgery, and corrosive induced adjacent organ injury (pancreatic) ($P < 0.001, 0.02, 0.005$ and 0.015 respectively). Ten patients underwent subsequent surgery for restoration of the alimentary tract continuity with a colonic pull-up ($n = 8$) and gastrojejunostomy ($n = 1$). In one patient, the attempted colon pull-up failed due to extensive scarring of the mesocolon. The median follow up (following restoration of continuity of the gastrointestinal tract) was 36.5 mo. One patient developed dysphagia due to a stricture at the anastomotic site, which was successfully managed by dilatation. Another patient developed severe aspiration, necessitating laryngeal inlet closure and permanent tracheostomy, and 3 patients complained of occasional regurgitation.

CONCLUSION: Management of severe corrosive injury involves prompt resuscitation and urgent surgical debridement. Although the subsequent restoration of continuity may be complicated and may not always be possible, long term outcomes are acceptable in the majority.

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Key words: Caustics; Esophagus; Esophageal stenosis; Dysphagia

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INTRODUCTION

Corrosive injury of the esophagus and stomach is a cause of major morbidity and is usually seen in the younger age group. Full thickness esophagogastric necrosis is a severe form of injury associated with considerable morbidity and mortality^[1-5]. It may occur due to ingestion of a large amount or highly concentrated corrosive substance. The injury may extend to involve adjacent viscera such as the duodenum, small intestine, colon, pancreas and gall bladder. Although there are studies describing the short and long term outcomes of definitive reconstruction for established corrosive strictures of the esophagus^[6,7], there is limited literature on the early and long term outcomes of patients managed in an emergency setting for corrosive-induced acute esophagogastric and/or adjacent organ necrosis. Ours is a high volume surgical center for the management of esophageal diseases in India. We aimed to analyze our experience in managing patients with severe gastrointestinal injuries following corrosive ingestion who presented with perforation of the esophagus and/or the stomach (with or without involvement of the adjacent viscera) to try and ascertain the risk factors for mortality, as well as the short and long term outcomes following surgical management.

MATERIALS AND METHODS

We extracted information on patients who between 1983 and 2010 underwent emergency surgery for severe gastrointestinal injuries due to corrosive ingestion from a prospectively maintained esophageal diseases database. Patients who underwent elective surgery for established strictures^[6] or those who underwent emergency surgery for iatrogenic perforation of caustic strictures were excluded from this analysis. For the purpose of this study, we defined severe corrosive gastrointestinal injury as full thickness necrosis and perforation of the esophagus or stomach (with or without involvement of the adjacent viscera), with resultant mediastinitis or peritonitis. Categorical data were analyzed by Chi-square test using SPSS version 17.

Initial management and emergency surgical procedure

All patients with severe corrosive gastrointestinal injuries were admitted to the intensive care unit (ICU), resuscitated and started on broad spectrum parenteral antibiotics. The preoperative assessment included hematological, biochemical and blood gas analysis and X-rays of the chest and abdomen. A CT scan (chest and abdomen) was

done if there was a doubt in diagnosis and the patient was hemodynamically stable.

All surgical explorations were done through a midline incision and any devitalized/necrotic tissues were thoroughly debrided. If required, an esophagectomy was done through the transhiatal route. A decompressive tube duodenostomy was carried out if the injury extended to the first part of the duodenum or if the duodenal stump was unhealthy or edematous. All patients had a feeding jejunostomy for postoperative alimentation.

Postoperative period and follow up

Postoperatively, all patients were managed in an ICU. They continued on parenteral antibiotics and received feeds through the feeding jejunostomy catheter. All patients underwent psychiatric counseling after recovery. The patients were maintained on alimentary feeds through the jejunostomy tube while awaiting definitive reconstructive surgery (most commonly a colonic pull-up). In case of a colonic pull-up, the marginal arcade along the colon was preserved. An attempt was made to preserve the arcade at the site of the distal colonic transection. The right colon conduit was based on the ascending branch of the left colic artery and the left colon conduit was based on the left branch of the middle colic artery. Adequate vascularization of the colonic conduits was confirmed by occluding the mesocolic vessels planned for division by application of fine bulldog vascular clamps for several minutes and observing the color of the conduit and pulsations in the marginal arcade.

Following the colonic pull-up, patients were advised to eat small and frequent meals (instead of the standard 3 meals) and avoid liquids during and immediately after meals. They were also instructed to maintain an erect posture following meals and head end elevation (approximately 30 degrees) during sleep. All patients were followed up regularly as out-patients.

RESULTS

Between 1983 and 2010, 209 patients with corrosive injury of the esophagus were managed in the Department of Gastrointestinal Surgery at the All India Institute of Medical Sciences, New Delhi. Of these, 13 (6.2%) patients underwent emergency surgery for severe corrosive gastrointestinal injury. There were 6 men and the median age of the patients was 22 (range 15-40) years. All patients had ingested a liquid corrosive with a suicidal intent. Eight patients had ingested acid, 4 an alkali and 1 did not know the nature of the ingested corrosive. Two patients required a tracheostomy for respiratory distress due to laryngeal edema. Three patients were hypotensive, 4 had severe metabolic acidosis and 2 had renal failure. The median interval between ingestion of the corrosive and surgery was 24 (range 12-72) h.

All patients were explored through a midline vertical incision. Twelve of the 13 patients had full thickness necrosis with gangrene of the entire esophagus and stom-

Table 1 Surgical procedures carried out for severe corrosive injuries

Patient	Organs injured	Surgery done	Mortality	Subsequent surgery	Result
1	Esophagus, stomach, spleen	Esophagogastrectomy with splenectomy	No	Colon pull-up	Successful
2	Esophagus, stomach, duodenum	Esophagogastrectomy with duodenectomy	No	Colon pull-up	Successful
3	Esophagus, stomach, duodenum	Esophagogastrectomy with duodenectomy	No	Colon pull-up	Successful
4	Esophagus, stomach	Esophagogastrectomy	No	Colon pull-up (failed)	Failed
5	Esophagus, stomach	Esophagogastrectomy	No	Colon pull-up	Successful
6	Esophagus, stomach	Esophagogastrectomy	No	Colon pull-up	Successful
7	Esophagus, stomach, duodenum, pancreas	Esophagogastrectomy with pancreaticoduodenectomy	Yes	No (mortality)	-
8	Esophagus, stomach	Esophagogastrectomy	No	No (mortality)	-
9	Esophagus, stomach, duodenum	Esophagogastrectomy with duodenectomy	No	Colon pull-up	Successful
10	Esophagus, stomach, duodenum	Esophagogastrectomy with duodenectomy	Yes	No (mortality)	-
11	Esophagus, stomach	Esophagogastrectomy	No	Colon pull-up	Successful
12	Esophagus, stomach	Esophagogastrectomy	No	Colon pull-up	Successful
13	Stomach, duodenum	Distal gastrectomy with duodenectomy and ampullojejunostomy	No	Gastrojejunostomy	Successful

ach. These 12 patients also had extension of the injury across the pylorus involving the first part of the duodenum (4), spleen (1) and second part of the duodenum/head of the pancreas (1). The thirteenth patient had full thickness necrosis of the distal stomach and the whole of the duodenum (until the fourth part with an exposed ampulla draining bile and pancreatic juice). In all patients, there was contamination of the mediastinal and peritoneal cavity with foul smelling, dirty hemorrhagic fluid. All patients underwent thorough debridement of all the necrotic tissues. The surgical procedures carried out are listed in Table 1. All patients had an esophagectomy through the transhiatal route, an end cervical esophagostomy and feeding jejunostomy. The patient where the injury had extended to involve the duodenum/head of the pancreas underwent an esophagogastrectomy with a pancreaticoduodenectomy. In the 13th patient, the esophagus was spared; the distal stomach and the first and second part of the duodenum were completely necrotic and the ampulla was seen with bile draining from it. Esophagectomy was not done and this patient underwent a distal gastrectomy, removal of the necrotic duodenum, anastomosis of the margins of the ampulla to a Roux-en-Y loop of jejunum (ampullojejunostomy), tube cholecystostomy, tube gastrostomy (for diversion) and feeding jejunostomy. A thorough peritoneal lavage was carried out in all the patients and mediastinal lavage (through the dilated hiatus) with placement of intercostal drains in the 12 patients who underwent an esophagectomy. The median duration of the emergency surgical procedure was 5 (3.5-8) h and the median blood loss was 700 (400-1000) mL.

The median ICU stay following surgery was 16 (6-30) d. Postoperative complications included leak from the duodenal stump (*n* = 4), pancreaticojejunal anastomotic leak (*n* = 1), prolonged ventilatory support (*n* = 6) and chest infection (*n* = 8). Two patients (15.4%) died in the postoperative period (one due to sepsis following leak from the pancreaticojejunostomy and the other due to sepsis and persistent renal failure). Another patient died 3 wk after discharge from the hospital while waiting for restoration of bowel continuity. Renal failure and meta-

Table 2 Factors predicting mortality following severe corrosive injuries

Factor	No mortality	Mortality	P value
Interval between corrosive ingestion and surgery			
Less than 24 h	10	0	0.005
More than 24 h	1	2	
Metabolic acidosis at initial presentation			
No	9	0	0.021
Yes	2	2	
Renal failure at initial presentation			
No	11	0	0.000
Yes	0	2	
Associated organ injury			
No splenic injury	10	2	0.657
Splenic injury	1	0	
No duodenal injury	7	0	0.097
Duodenal injury	4	2	
No pancreatic injury	11	1	0.015
Pancreatic injury	0	1	

χ^2 test used for categorical data using SPSS version 17.

bolic acidosis at the time of initial presentation, delay of more than 24 h between ingestion of the corrosive and surgery, and associated adjacent organ injury (pancreas) were found to suggest an association with mortality (*P* < 0.001, 0.02, 0.005, and 0.015, respectively; Table 2).

Ten patients underwent subsequent surgery for reconstruction of the alimentary tract. One patient who developed a stricture of the hypopharynx with scarred pyriform sinuses underwent pharyngeal reconstruction with a sternomastoid flap prior to the definitive reconstruction. A colonic pull-up was attempted in 9 patients and one patient (13th patient) underwent a gastrojejunostomy alone. In one patient, the attempted colonic pull-up failed due to extensive scarring of the mesocolon which resulted in injury to the mesocolic vascular arcade during mobilization.

The median follow up after restoring continuity of the alimentary tract was 36.5 (8-60) mo. All patients were able to eat a standard Indian diet, consisting of cooked vegetables, boiled rice, lentils/pulses, hand cooked bread,

yoghurt and fruits. All the patients gained weight. There were no leaks at the cervical esophagocolic anastomosis. Dysphagia due to stricture of the anastomosis occurred in one patient and was successfully managed with endoscopic dilatation. This patient was subsequently started on a self-dilatation program and did not require further endoscopic dilatations. Three patients complained of aspiration on swallowing. In one patient, the aspiration was incapacitating and necessitated closure of the laryngeal inlet and a permanent tracheostomy. Three patients complained of symptoms of regurgitation which were managed with dietary advice and the use of prokinetics.

DISCUSSION

Full thickness esophagogastric necrosis due to corrosive ingestion is at the extreme end of the spectrum of injury to the alimentary tract. Such extensive injury is usually seen following ingestion of a large amount of a concentrated corrosive substance, especially with a suicidal intent, as occurred in most of our patients. Usually the injury is limited to the esophagus and stomach. The relative sparing of the duodenum may be due to pyloric spasm caused by the irritant corrosive or the alkaline pH of the duodenum. These injuries also result in metabolic abnormalities such as severe acidosis and dehydration. Loss of the gut mucosal barrier coupled with peritoneal and mediastinal contamination results in severe sepsis.

Management of these patients involves urgent resuscitation with correction of fluid and electrolyte and acid-base abnormalities, administration of broad spectrum antibiotics and immediate surgical exploration. In a comparative study of 27 patients, the mortality rates for patients undergoing surgery or supportive treatment were 67% and 100%, respectively^[8]. The aim of surgery in these patients is to remove all the non-viable tissue and do a thorough peritoneal and mediastinal drainage. There are only a few studies on the management and outcome of severe esophagogastric injuries due to ingestion of a corrosive. In a review by Cattani *et al*^[1], 2 of 9 such patients died in the immediate postoperative period, with another 3 deaths in the initial few months following the surgical resection. In another review on the outcome of gastric perforation following corrosive ingestion, all patients with gastric necrosis and perforation died, whereas those with only perforation (which were repaired primarily) survived^[3].

A significantly higher mortality has been reported in patients in whom a thoracoabdominal approach was used for esophageal resection following severe corrosive injuries. Lai *et al*^[8] reported a significantly higher mortality in patients in whom a thoracoabdominal approach was used for esophageal resection following severe corrosive injuries. In their series, 18 patients underwent emergency operations. The overall mortality following surgery was 66.7%. Four patients died after undergoing esophagectomy with resection of the stomach using the thoracoabdominal method. Only three of the eight

patients who had esophageal stripping along with resection of the stomach through the abdomen died (37.5%). The authors concluded that when using the surgical approach, resection of the stomach with stripping of the esophagus is superior to the thoracoabdominal method. In our study, 2 patients died in the immediate postoperative period and another while awaiting the reconstructive procedure. Considering the magnitude of injury and the extent of initial resection, the perioperative death rate was relatively low. The factors that may have resulted in a better outcome in these patients included aggressive resuscitation followed by immediate surgical intervention (which in turn may have prevented extension of injury to the adjacent organs), radical removal of all necrotic tissue, resection of the esophagus *via* the transhiatal route and maintenance of postoperative nutrition by jejunostomy feeds. Resection of the esophagus *via* the transhiatal route in these patients was facilitated by the corrosive-induced periesophageal edema reducing the morbidity of the procedure.

Two patients had transmural necrosis of the second part of the duodenum and one of them had associated necrosis of the head of the pancreas. The latter patient underwent a pancreaticoduodenectomy with a pancreaticojejunostomy and hepaticojejunostomy. This patient had a leak from the pancreaticojejunal anastomosis and died of sepsis. Pancreaticoduodenectomy along with an esophagogastrectomy is a formidable procedure in these critically ill patients. The pancreas is soft, friable and inflamed and, in the presence of peritoneal sepsis and underlying hypotension, is likely to leak. Munoz-Bongrand *et al*^[2] in their experience of pancreaticoduodenectomy for corrosive injury advocated blocking the pancreatic duct by injecting a polymer and staple closure of the pancreatic stump. However, the procedure was complicated by development of necrotic hemorrhagic pancreatitis. The other patient (sloughed out duodenum without involvement of the pancreatic head; 13th patient) was managed by debridement of the necrosed duodenum and doing an ampullojejunostomy. To the best of our knowledge, such a procedure has not been previously described in the literature for severe corrosive injuries of the duodenum. Contemplating a pancreaticoduodenectomy in this patient was considered hazardous in view of marked inflammation in the area. The patient had a controlled bile leak in the postoperative period which gradually stopped. He subsequently underwent a gastrojejunostomy and had a good outcome.

Eight patients underwent a colonic pull-up for restoration of gastrointestinal continuity (Table 1). Reconstruction in these patients may be complicated by associated scarring of the hypopharynx, the lack of stomach as a conduit, peritoneal adhesions and scarring of the mesocolon. The colon was used as a conduit in all these patients as all patients had injury involving both the esophagus and the stomach and had undergone an esophagogastrectomy. The conduit is brought up to the neck through the sub-sternal route as the posterior mediastinal space gets oblit-

erated due to prior chemical injury and mediastinitis. The continuity is restored by an esophagocoloplasty and anastomosing the lower end of the colonic conduit to a Roux-en-Y limb of jejunum. Free jejunal interposition loops have also been described in the reconstructive surgery. The reported success rate following resection for cancers has been as high as 94.6%^[9]. They have also been used to salvage a failed colon interposition^[10]. The defect is reconstructed by interposition of a free jejunal graft using microvascular surgical techniques. Although such grafts may be effective for short segment interposition, they cannot be used to completely reconstruct a neo-esophagus. In one patient, there was extensive scarring of the mesocolon. This resulted in injury to the mesocolic vascular arcade during mobilization of the colon. The scarred small bowel mesentery and dense fibrosis in the neck prevented us from considering a free jejunal transposition. This patient has been maintained on jejunostomy feeds since. This was unfortunate but under the circumstances options were severely limited.

Eventually all the patients who underwent a successful reconstruction ($n = 9$) were able to eat a normal diet and gained weight. One patient who developed an anastomotic stricture was managed successfully by endoscopic dilatation and subsequently by self-dilatations with a Foley's catheter, as has been previously reported^[11].

Our results suggest an association of renal failure and metabolic acidosis at the time of initial presentation, delay of more than 24 h between ingestion of the corrosive and surgery, and associated adjacent organ injury (pancreas) with mortality. This conclusion may, however, be limited by the retrospective nature of our study, the small number of patients and because few deaths occurred in the present study.

In conclusion, corrosive-induced full thickness gastroesophageal necrosis is a serious problem that often portends a grave outcome. Management involves prompt recognition, resuscitation and urgent surgical debridement of the necrotic tissues. Although the subsequent restoration of continuity may be complicated and may not always be possible, long term outcomes are acceptable in the majority.

COMMENTS

Background

Full thickness necrosis of the esophagus and the stomach is a severe form of injury following corrosive ingestion. The injury can extend to involve adjacent organs such as the duodenum, small intestine, colon, pancreas and gall bladder. The present article describes the management and outcomes of patients with such severe gastrointestinal injuries following corrosive ingestion.

Research frontiers

Although there are studies describing the short and long term outcomes of definitive reconstruction for established corrosive strictures of the esophagus,

there is limited literature on the early and long term outcomes of patients managed in an emergency setting for corrosive-induced acute esophagogastric and/or adjacent organ necrosis.

Innovations and breakthroughs

A retrospective review of patients who underwent emergency surgery for severe gastrointestinal injuries following corrosive ingestion between 1983 and 2010 was carried out. Data was extracted from a prospectively maintained esophageal disease database. Severe corrosive injuries were defined as full thickness necrosis with perforation of the esophagus or the stomach (with or without involvement of the adjacent viscera) with resultant mediastinitis or peritonitis.

Applications

The present study highlights the importance of prompt recognition, resuscitation and urgent surgical debridement of the necrotic tissues following severe corrosive gastrointestinal injuries. It also shows that although the subsequent restoration of gastrointestinal continuity may be complicated and may not always be possible, long term outcomes are acceptable in the majority.

Peer review

This manuscript is derived from a prospectively collected data and designed as a retrospective analysis of patients undergoing emergency gastrointestinal surgery for severe injuries caused by the ingestion of corrosive agents. The authors highlight some factors as being associated with the increased risk of mortality. They also emphasize that once the perioperative period where complications are frequent is managed successfully, the long term results are satisfactory.

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