Original research

Surgical treatment of caustic esophageal strictures in adults

Ali Harlak [a,*], Taner Yigit [a], Kagan Coskun [a], Tahir Ozer [a], Oner Mentes [a], Bulent Gülec [b], Orhan Kozak [a]

[a] Gülhane Military Medical Academy, Gulhane Medical School, Department of General Surgery, GATA Genel Cerrahi AD., Etlik, Ankara 06018, Turkey
[b] Gülhane Military Medical Academy, Department of General Surgery, Haydarpasa, Istanbul, Turkey

ARTICLE INFO

ABSTRACT

Background and aims: Caustic esophageal injury is a rare clinical condition in adult patients. Although dilatation, or the conservative approach, is the primary treatment method, some patients require surgical intervention. Because of the rarity of such cases, standard surgical treatment algorithms cannot be utilized. In this article, we present our surgical experience and discuss the challenges in the surgical management of corrosive injury of the esophagus in adults.
Methods: A retrospective review was conducted of 28 patients who suffered from a corrosive esophageal injury between 1996 and 2011. Patient demographics, history of corrosive material ingestion, preoperative findings, treatment strategy, operative technique, postoperative course, requirements for further treatment, and the current status of the patients were investigated.
Results: All patients underwent a transhiatal esophagectomy in addition to a gastric pull-up with a cervical esophagogastrostomy. The mean follow-up time was 62 (12–140) months. One patient developed a deep surgical infection; anastomotic stenosis was noted and treated with dilatation in 13 patients. The mean time period between the operation and the first dilatation for 12 patients was 81 (45–161) days. The mean dilatation count for the patients was 3 (1–10).
Conclusion: Although it comes with high anastomotic stenosis rates, transhiatal esophagectomy and gastric pull-up with cervical anastomosis is a safe procedure, which can be performed for the treatment of corrosive esophageal stricture.

1. Introduction

Ingestion of caustic liquid materials frequently causes corrosive esophagitis and esophageal stricture. The majority of these cases do not require surgical intervention.[1–3] The type and quantity of the ingested corrosive material, the duration of the mucosal injury, and the effectiveness of the first aid are the key markers for esophageal stricture development.[4,5] Conservative treatment is not generally successful for esophageal strictures initiated by a third degree burn.[2,3] The literature on corrosive material ingestion concentrates primarily on incidents occurring in children. As for adult cases, the available literature data is extremely limited, including only small patient groups and typically focused on medical treatment. The literature regarding available surgical treatment emphasizes colonic transposition as the main reconstruction method after esophagectomy.[6,7] Recent literature data reveals that surgeons rarely prefer esophagogastroplasty for reconstruction. Excluding suicides, ingesting corrosive material is generally accidental for adult patients.[3] Esophagectomy is one of the main surgical procedures used in general surgery for a benign pathology. Unfortunately, there is neither enough information nor a consensus regarding the treatment of corrosive esophagitis.

In this study, utilizing our collected retrospective data, we examine surgical management and outcomes in adult patients with caustic esophageal stricture.

2. Methods

Between 1996 and 2011, surgically-treated patients with esophageal stenosis caused by the ingestion of a caustic material were enrolled in this study. To verify collected information and determine the patients' health status after the surgical treatment ended, a patient questionnaire was completed according to data collected from the patients' medical charts, face-to-face interviews, and telephone contact. Each patient's demographic data, time and reason of ingestion, type and amount of ingested material, time interval between ingestion and first aid, and type of first aid were collected and recorded.

Endoscopy and upper gastrointestinal barium radiograms were used preoperatively to study the grade and localization of esophageal damage and stricture. In order to screen for anatomical changes of the esophagus and the effects of the

surgical therapy, endoscopies were performed at different times postoperatively—according to patients' medical status and surgical outcomes. Symptoms between post-ingestion and surgery were classified as early (first week), moderate (two to six weeks), and late (six weeks to surgery). Dysphagia for liquid and solid foods, weight loss, and dietary changes for all patients were recorded during the time periods mentioned above.

The following detailed descriptive data were collected and used for interpretation of the effects of surgery on treatment: first aid administered, medical treatment, endoscopic dilatation attempts in the presurgical period, surgical technique, time interval between surgery and dilatation if performed, stent usage, postoperative hospital stay, early surgical complications, postsurgical complaints, anastomotic stenosis development rates and its treatment, and recent patient health status.

The same surgical team, using the same surgical techniques, performed all the operations. Patients were prepared and draped to expose the left neck, chest, and abdomen. An upper midline laparotomy incision was made. Gastric mobilization was performed preserving the right gastric artery and the right gastroepiploic arcade. A Kocher's maneuver was added after gastric mobilization. The lower portion of the esophagus was mobilized through the esophageal hiatus and continued with blunt mobilization into the upper mediastinal space (Fig. 1). The upper portion of the esophageal mobilization was started after a cervical incision was created and the distal cervical esophagus encircled. This allowed circular bimanual mobilization of the entire esophagus. The anterior border of the sternocleidomastoid muscle was retracted laterally, and the cervical prevertebral space was accessed medial to the carotid sheath contents. A Babcock clamp was used to grasp the distal cervical esophagus. The esophagus was then encircled by finger dissection. Finally, all esophageal attachments were removed and the esophagus completely mobilized. The esophago-gastric junction was subsequently divided with a GIA stapler and both the esophageal and the gastric fundic end were attached to a gastric tube's distal and proximal tip. Next, using a cervical neck incision, the intrathoracic esophagus and the gastric cardia were pulled out through the mediastinum. Just after the cervical esophagus was divided and the distal esophagus excised, a two-layered, inverted, hand-sewn anastomosis was performed between the cervical esophagus and the stomach. An intraoperative chest tube was applied as needed. Even though bilateral vagotomy is inevitable for esophagectomy, we did not perform any pyloromyotomy in this series and any problem related to gastric emptying has not occurred. Fig. 2 illustrates esophageal damage caused by caustic liquid material ingestion in a resected specimen. Fig. 3 shows postoperative incision scars on the neck and upper abdomen.

For our study, statistical analyses were conducted utilizing Chi-square and Student's *t*-tests.

Fig. 2. Esophageal damage caused by caustic liquid material ingestion.

3. Results

Between 1996 and 2011, 33 patients with a caustic liquid ingestion history were treated in the general surgery department of our hospital. Two patients who were operated on in 1996 were excluded due to insufficient data and a lack of contact with them. One patient with mental retardation and corrosive esophageal and gastric stricture underwent esophagectomy, gastrectomy, and colon transposition in 2007. He died after a suicide attempt during postoperative courses. Two patients were given an Ivor-Lewis esophagectomy because of a perforation and mediastinitis history, which was treated with medical intervention as prior therapy. Five patients were excluded from the study due to the use of different operation types and/or the loss of medical data. In the end, 28 patients were enrolled in the study. Only one patient was female, the others were male. The mean age was 22.1 (20–29).

The type and acid/alkaline nature of the ingested corrosive agents are listed in Table 1. While 26 patients ingested caustic liquid
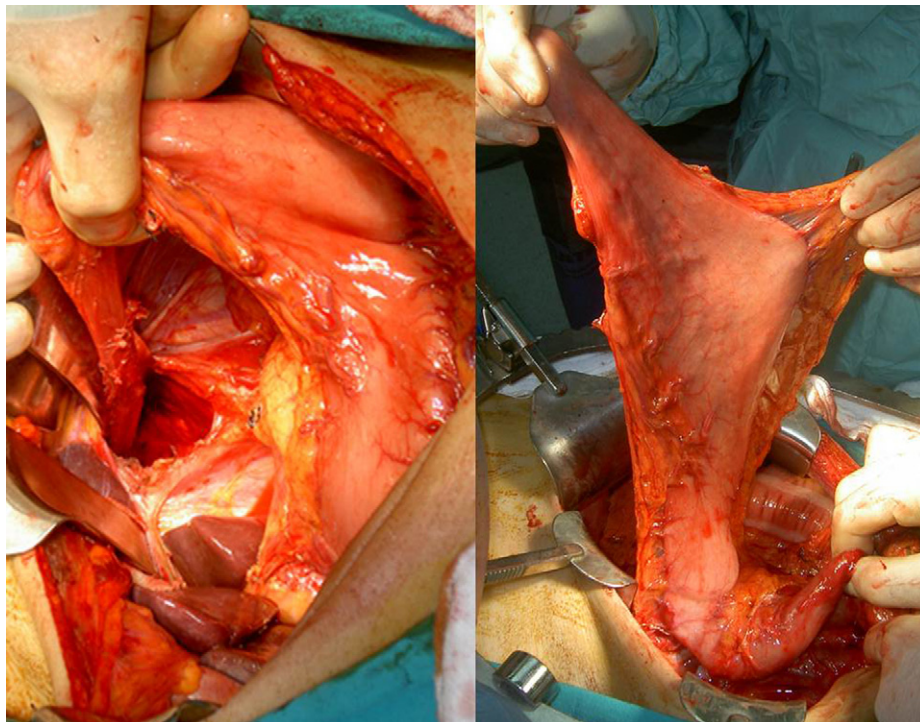

Fig. 1. Transhiatal dissection of esophagus and gastric mobilization.

Fig. 3. Postoperative incision scars.

accidently, two patients ingested it on purpose with the intention of committing suicide. All of the patients, including the ones who attempted suicide, described the amount of the ingested material as one or two swallows.

All of the patients, except one, were admitted to the local hospital on the same day as the ingestion of the corrosive material. One patient arrived the day after ingesting it. Only six patients were given an endoscopy in the first week. Two of them were reported as having Grade-2 esophagitis and the other four had Grade-3 esophagitis. The stomachs of the patients from

these groups could be visualized due to the early endoscopy, which reported them as having mucosal erythema in the stomach. All patients were given an upper gastrointestinal system endoscopy at different times after the ingestion. The endoscopy attempts failed in six patients due to a complete stenosis of the esophagus. Because of the limitations of the endoscopic visualization of the gastric structures, the availability of the stomach for gastric pull-up was evaluated by barium study in patients who could tolerate liquid ingestion and/or computerized tomography during the presurgical period and palpation and inspection findings of the stomach during the intraoperative period. According to these criteria, no patient was classified as unsuitable for gastric pull-up.

Endoscopy, upper gastrointestinal system barium study, operative and pathological findings revealed that six patients had stenosis on the middle third of the esophagus, eight patients had stenosis on the distal third of the esophagus, and fourteen patients had stenosis between the middle third and distal third of the esophagus. The mean stenotic segment length was measured as 5.2 (2.9–9.3) cm.

It was noted that there were no esophageal perforations due to corrosive material ingestion. Esophageal perforation was noted in seven patients due to attempts at endoscopic dilatation. Four of these seven patients were operated on within 24 h after the diagnosis was made. Three other patients were initially managed with medical therapy. These three patients, who were also given an Ivor-Lewis esophagectomy, were excluded from the study.

While six patients suffered from oral mucosal lesions within ten days after ingestion, none of them resulted in permanent intracavitary lesions and they were treated with medical therapy.

Dysphagia to solid foods developed in 2–10 (mean 5.5) days and dysphagia to liquid foods developed in 5–18 (mean 11) days. Nine patients suffered from a complete obstruction of the esophagus, which even prevents the swallowing of saliva. Fifteen patients suffered from excessive weight loss.

All patients received at least one dilatation therapy during the preoperative period. Nine patients with complete esophageal stenosis received only one esophageal dilatation attempt, which was unsuccessful. All of these patients were treated with surgical intervention without insisting on dilatation. As for the remaining patient population, esophageal dilatation was given as follows: five patients—two times, three patients—three times, four patients—four times, five patients—five times, one patient—six times, and one patient—fourteen times.

All patients received a transhiatal esophagectomy and a cervical esophagogastrostomy. The mean time between the ingestion of the caustic material to surgery was 159 (median 82 and range 21–510) days. Nine patients received a bilateral and five patients a left chest tube placement. The rest of the patients did not need a chest tube. The mean hospital stay was 16 (range 9–31) days. Deep surgical site infection with evisceration in a patient was the only major early postoperative complication. There was no anastomotic leakage during the postoperative period.

Thirteen (46.4%) patients developed anastomotic stenosis during the late postoperative period. The mean time for anastomotic stenosis development was 84 (range 45–161) days with 12 patients. One patient's anastomotic stenosis developed eleven years after the initial surgery. All patients with anastomotic stenosis received at least one dilatation therapy. The mean dilatation count for each patient was 3 (range 1–10). The time between consecutive dilatations was longer than it was previously. Dilatation therapy successfully cured the esophageal stenosis in all patients and they are still symptom free on postoperative follow up. The mean patient follow-up time was 62 (range 12–140) months.

Table 1
Ingested corrosive agents.

Ingested material	pH	Number of patient
Bleach	Alkaline	14
Floor cleansing detergent	Alkaline	3
Lime remover	Acid	4
Dish washer detergent	Alkaline	1
Car battery acid	Acid	2
Liquid pipe cleaner	Alkaline	1
Hydrochloric acid	Acid	3

4. Discussion

Severe complications, including life-threatening injuries, may occur after ingestion of corrosive fluids. Stricture formation remains the main long-term complication. Over 90% of patients with third-degree burns and 15–30% of patients with second-degree burns develop strictures.[2,4,8] Along with strictures and perforation, tracheoesophageal, gastrocolic and aortoenteric fistula, and severe hemorrhage secondary to gastric involvement have been reported.[8–10]

The literature revealed that only a few adult patients have undergone a surgical operation for caustic esophageal burn.[1–3] Therefore, the best surgical management of severe corrosive esophageal stricture is still being debated.

Because the cases with Grade-1 and Grade-2 esophageal burn might be treated at smaller hospitals, it was difficult to estimate the real incidence of corrosive material ingestion in this study. Naharci et al. reported that 58 patients with corrosive injury were admitted: 30 (51.7%) of those patients developed stricture of the esophagus, and only 8 (13.8%) were given surgical intervention in a five-year period.[1]

While the majority of patients with a caustic injury of the esophagus are treated without complications,[4,5,11] esophageal stricture may occur in a small number of these patients.[3,4] Dilatation is usually helpful in such patients; many of them tolerate it quite well and remain symptom free.[1,4] When dilatation therapy is ineffective, stricture may cause permanent dysphagia, which sometimes leaves the patient unable to swallow his or her saliva. In those cases, surgery is inevitable.[1,11,12]

There were at least two dilatation attempts for each patient; however, one patient underwent 14 dilatations before surgery. Potential side effects occurring with unsuccessful and insisted dilatation include not only the failure of the therapy but additional clinical problems such as perforation. In this case series, four patients were operated on under emergency conditions because of the esophageal perforation. Insistence on dilatation therapy may also cause delay in surgical therapy, which can result in increased postoperative morbidity due to the patient's deteriorated nutritional intake.

The extent of the injury and stricture formation depend primarily on the type [acid or alkaline], level of acidity [pH], duration of exposure on mucosa, quantity of the ingested agent, and the physical state of the patient.[4,5] The literature indicates that these patients usually ingest alkaline liquids.[3,5,8] There are two main explanations for this. First, the majority of the corrosive agents in daily use are made of alkaline materials. Second, a large number of patients who have ingested acidic liquids do not require medical intervention or are treated in small medical centers as outpatients. The medical literature indicates that alkaline agents usually cause more damage to the mucosal surfaces than acidic substances because the inflammation invades more deeply with the continuous release of OH after coming into contact with protein.[13] The data collected from this study also supports this conclusion.

Children are the main patient population of caustic liquid ingestion. They usually ingest caustic materials mistakenly —frequently when these liquids are stored in daily-use containers rather than their original packaging.[14] One might expect that ingestion of such materials would be minimal in the adult population. However, except for two patients who ingested caustic liquid in a suicide attempt, the other 26 patients (this number includes excluded five patients) in our series ingested these chemicals accidentally. Except for suicide attempts, patients usually ingested caustic liquids with only one or two swallows, which prevented them from incurring extensive tissue damage.

In this study, esophageal damage was primarily concentrated on the middle and 1/3 distal esophagus with a mean length of 5.2 cm.

The reason why esophageal injury frequently affects the distal part of the esophagus may be explained by lower esophageal sphincter activity, esophageal motor function, and anatomical specifications. On the other hand, this location provides the surgeon easier access for dissection and safe anastomosis to the proximal esophagus, which is usually unaffected by injury.

After esophagectomy, the best way to reestablish intestinal continuity is by colonic repositioning or gastric pull-up. Lesser anatomical changes and a single anastomosis requirement are the advantages of gastric pull-up. Our experience demonstrated that caustic liquid ingestion does not usually result in anatomical alteration in gastric structures and does not result in gastric perforation. Nevertheless, before surgery, it is important to examine the gastric anatomy by a contrasted X-ray study or other means (i.e., CT, endoscopy) to make sure the stomach is available for pull-up. Additionally, if the stomach is judged as ready for pull-up, the final decision should be given on surgery. Esophagectomy can be performed via a transhiatal or transthoracic approach. The transhiatal approach is advantageous since it is not necessary to use a thoracic incision.[11,12]

We performed a transhiatal esophagectomy on all of our patients without any serious complications. Transhiatal esophagectomy is also advantageous for the general surgeon because esophageal dissection is done via the anatomical planes where the general surgeon is very knowledgeable and familiar. Additionally, thoracotomy, which enables accurate lymphadenectomy, is not necessary for patients with a caustic injury of the esophagus because the pathology is not a malignant process.

Pleural injury is the most common intraoperative complication of the transhiatal esophagectomy.[11,12] It is commonly caused by a blunt dissection of the thoracic esophagus. Pleural integrity should be visually checked intraoperatively and an air bubble test performed via filling the operation field with water. Thoracic tube drainage should be used if any pleural tearing is present or suspected. In this study, 14 patients were judged as not having any pleural damage and thoracic drainage was not used. Five of the 14 patients received left thoracic tube drainage and nine received bilateral thoracic tube drainage.

Anastomotic leakage is one of the significant potential early postoperative complications of esophagogastrostomy. Orringer et al. reported a 13% rate of anastomotic leakage in their study.[11] Although only a limited number of patients develop this complication, patients having leakage always face a high risk for serious infection. Clinical conditions can range between fistula formations and sepsis in patients with anastomotic leakage. Treatment also ranges between conservative managemenand an operative approach.[11]

One major late postoperative complication of the esophagogastrostomy is anastomotic stenosis on the esophagogastrostomy line. Honkoop et al. reported the rate of anastomotic stenosis as 42% in patients given an esophagogastrostomy for various reasons.[15] In order to prevent stenotic complications, various attempts can be used such as oblique and hand sewn noncontinuous anastomosis. Four of the patients in this study had a laparoscopic endoscopic stapler applied vertically to the posterior anastomotic wall in order to make the anastomosis wider. This attempt failed to prevent all four patients from anastomotic stenosis. Although intraoperative efforts seem to prevent patients from developing stenosis, it is obvious that many of them are still less effective and stenosis may develop despite taking all available protective measures. Dilatation therapy is still one of the major treatment modalities for postoperative stenosis just as it is for primary stenosis. Bougie dilatation is an effective, safe, but relatively invasive method for the treatment of anastomotic strictures.[15] While self-expandable stent application to the stenotic segment of the esophagus is recommended as an alternative

method, stand migration is a major complication of this procedure.[16]

Colonic transposition changes the gastrointestinal anatomy more than gastric pull-up because it comes with increased morbidity and mortality.[17] Therefore, colonic transposition should be performed only on certain patients whose stomach is not suitable for reconstruction. Yararbai et al. reported two cases of graft necrosis in 34 patients with colonic transposition.[6] In another study, including 82 patients who underwent colonic transposition, six deaths were reported due to two cases of graft necrosis, two cases of aspiration pneumonia, one case of bacterial peritonitis due to abdominal anastomotic leakage, and one disseminated intravascular coagulopathy.[18] Knezević et al. reported a series, including 336 patients with colonic transposition and early postoperative complications, which included anastomotic leakage, colonic necrosis, and hemo-pneumothorax. They reported an early postoperative complication rate of 26.49%. Furthermore, the authors declared that cervical anastomotic stricture, peptic colonic ulceration, bowel obstruction, and thoracic outlet compression were the late postoperative complications with an overall rate of 14%.[17]

5. Conclusion

Although it comes with high anastomotic stenosis rates, transhiatal esophagectomy and gastric pull-up with cervical anastomosis are safe procedures for the treatment of corrosive esophageal stricture.

Ethical approval
None declared.

Funding
The authors declare that any sources of funding are used for current research.

Authors contribution
Ali Harlak: study design and writing.
Taner Yigit: study design and writing.
Kagan Coskun: data collection.
Tahir Ozer: data collection.
Oner Mentes: data analysis.
Bulent Gülec: data Collection, revision.
Orhan Kozak: study design and revision.

Conflict of interest
The authors declare that they have no conflict of interest.

References

1. Naharci IM, Tuzun A, Erdil A, Ates Y, Bagci S, Yamanel L, et al. Effectiveness of bougie dilation for the management of corrosive esophageal strictures. *Acta Gastroenterol Belg* 2006;**69**:372—6.
2. Ramasamy K, Gumaste VV. Corrosive ingestion in adults. *J Clin Gastroenterol* 2003;**37**:119—24.
3. Mamede RC, De Mello Filho FV. Treatment of caustic ingestion: an analysis of 239 cases. *Dis Esophagus* 2002;**15**:210—3.
4. Symbas PN, Vlasis SE, Hatcher Jr CR. Esophagitis secondary to ingestion of caustic material. *Ann Thorac Surg* 1983;**36**:73—7.
5. Bautista Casasnovas A, Estevez Martinez E, Varela Cives R, Villanueva Jeremias A, Tojo Sierra R, Cadranel S. Retrospective analysis of ingestion of caustic substances by children. Ten-year statistics in Galicia. *Eur J Pediatr* 1997;**156**:410—4.
6. Yararbai O, Osmanodlu H, Kaplan H, Tokat Y, Coker A, Korkut M, et al. Esophagocoloplasty in the management of postcorrosive strictures of the esophagus. *Hepatogastroenterology* 1998;**45**:59—64.
7. Zhou JH, Jiang YG, Wang RW, Lin YD, Gong TQ, Zhao YP, et al. Management of corrosive esophageal burns in 149 cases. *J Thorac Cardiovasc Surg* 2005;**130**:449—55.
8. Gumaste VV, Dave PB. Ingestion of corrosive substances by adults. *Am J Gastroenterol* 1992;**87**:1—5.
9. McAuley CE, Steed DL, Webster MW. Late sequelae of gastric acid injury. *Am J Surg* 1985;**149**:412—5.
10. Mamede RC, de Mello Filho FV. Ingestion of caustic substances and its complications. *Sao Paulo Med J* 2001;**119**:10—5.
11. Orringer MB, Marshall B, Iannettoni MD. Transhiatal esophagectomy for treatment of benign and malignant esophageal disease. *World J Surg* 2001;**25**:196—203.
12. Gupta NM, Gupta R. Transhiatal esophageal resection for corrosive injury. *Ann Surg* 2004;**239**:359—63.
13. Zargar SA, Kochhar R, Nagi B, Mehta S, Mehta SK. Ingestion of strong corrosive alkalis: spectrum of injury to upper gastrointestinal tract and natural history. *Am J Gastroenterol* 1992;**87**:337—41.
14. Gün F, Abbasoğlu L, Celik A, Salman ET. Early and late term management in caustic ingestion in children: a 16-year experience. *Acta Chir Belg* 2007;**107**:49—52.
15. Honkoop P, Siersema PD, Tilanus HW, Stassen LP, Hop WC, van Blankenstein M. Benign anastomotic strictures after transhiatal esophagectomy and cervical esophagogastrostomy: risk factors and management. *J Thorac Cardiovasc Surg* 1996;**111**:1141—8.
16. Barthel JS, Kelley ST, Klapmakn JB. Management of persistent gastroesophageal anastomotic strictures with removable self-expandable polyester silicon-covered [Polyflex] stents: an alternative to serial dilation. *Gastrointest Endosc* 2008;**67**:546—52.
17. Knezević JD, Radovanović NS, Simić AP, Kotarac MM, Skrobić OM, Konstantinović VD, et al. Colon interposition in the treatment of esophageal caustic strictures: 40 years of experience. *Dis Esophagus* 2007;**20**:530—4.
18. Deng B, Wang RW, Jiang YG, Gong TQ, Zhou JH, Lin YD, et al. Prevention and management of complications after colon interposition for corrosive esophageal burns. *Dis Esophagus* 2008;**21**:57—62.