



Caustic Esophageal Injuries, GER Strictures and Postoperative Strictures

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Introduction

Caustic Ingestion

In the pediatric population, caustic ingestions are mostly accidental, but there are also reported cases of child abuse or suicide attempts [1]. According to the American Association of Poison Control centers (AAPCC), approximately 50% of the 2.1 million toxic exposures in the United States were in children 5 years or younger [2]. The most common presenting symptoms following caustic ingestion are drooling, dysphagia, abdominal pain, and vomiting [3–5].

Household cleaning products may contain strong alkaline ($\text{pH} > 11$) or acidic ($\text{pH} < 3$) substances with the capacity to cause significant tissue damage along the oropharynx and esophagus when ingested [6, 7]. Alkaline products include bleach, lye (in oven and drain cleaners), detergents, hair straighteners/relaxers, and button disk batteries. The chemicals in these cleaning products include sodium phosphate, sodium carbonate, and ammonia. Acidic products include toilet bowl and swimming pool cleaners, and rust removers [6]. The mechanism of damage to the esophageal mucosa from alkaline substances is local absorption and liquefactive necrosis which may extend “full thickness” from the mucosa to the serosa. Resultant vascular thrombosis reduces tissue perfusion and leads to fibrotic scar tissue. Although these patients are at risk of developing full-thickness perforation, it is not often clinically observed. In contrast, ingestion of acidic substances leads to coagulation necrosis which may not penetrate all the tissue layers and may even protect against

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deeper tissue damage. Within a month, these children may develop strictures from scar formation which may be further exacerbated by gastroesophageal reflux [7, 8] (Fig. 8.1).

In the acute setting, children receive supportive care and are evaluated for hemodynamic stability, respiratory distress, or perforation. Subsequently, endoscopy is performed in stable, symptomatic patients or when the identified ingested substance is high-risk for esophageal injury. The extent of esophageal injury can be classified using the Zargar et al. grading scale (Table 8.1) [9].

The severity esophageal injury may also predict late-term complications and therefore direct subsequent management. The risk of stricture increases to 71.4% for Grade IIb injuries and 100% for grade III injuries, otherwise the risk of stricture ranges from 0% to 5% [9]. The mainstay of treatment for strictures is to perform serial endoscopic dilations. There have been many esophageal dilatation techniques utilized for strictures ranging from blunt bougienage (Maloney™, Tucker™, Savary™, or Filiform™ dilators) to the most commonly utilized pneumatic balloon dilators (PBD). For some patients, conservative management does not alleviate symptoms associated with strictures. Esophageal replacement is therefore indicated in patients refractory to improvement from serial dilations after 3–6 months or has a long-segment stricture, or the stricture is not amenable to segmental resection [8].

Fig. 8.1 Esophagram in patient after lye ingestion showing long proximal esophageal stricture

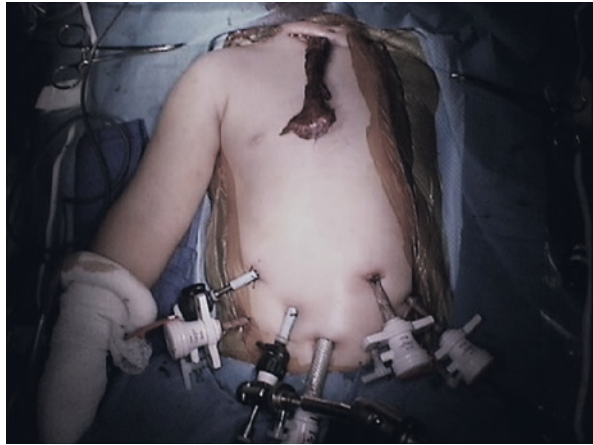


Table 8.1 Zargar et al. grading scale for esophageal injury

Staging	Extent of esophageal injury on endoscopy
Grade 0	No injury, normal mucosa
Grade I	Mucosal erythema and edema
Grade II	Friability, erosions, ulcerations, hemorrhages, exudate, blisters
IIa	Superficial non-circumferential
IIb	Deep or circumferential
Grade III	
IIIa	Multiple scattered ulcerations with patchy necrosis
IIIb	Extensive necrosis

Modified from Zargar et al. [9]

Fig. 8.2 External view of laparoscopic ports during minimally invasive gastric pull up



For segmental strictures, most respond to serial dilatations. Thus, the need for persistent dilations, or refractory and/or long strictures are the main indications for which esophagectomy with replacement should be considered. Figures 8.2, 8.3, and 8.4 depict images from a thoracoscopic esophagectomy, laparoscopic gastric transposition in a child following severe esophageal stricture from lye (caustic) ingestion.

Other Indications for Esophageal Replacement for Children

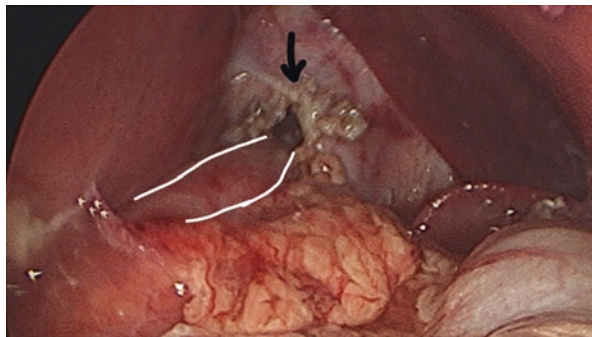
End-Stage Esophagus

Gastroesophageal reflux disease (GERD) is the pathologic retrograde movement of gastric contents into the esophagus causing symptoms such as heartburn and dysphagia and other complications, specifically strictures. Initial management includes lifestyle modifications and medical therapies. Current guidelines recommend anti-reflux surgery for children with GERD and (1) life-threatening complications of GERD, (2) symptoms refractory to optimal therapy, (3) chronic conditions (e.g., neurologically impairment), and (4) the need for chronic pharmacotherapy for symptom control. The laparoscopic Nissen fundoplication is the most commonly

Fig. 8.3 Remnant strictured esophagus and stomach pulled out via cervical incision prior to gastric pull-up



Fig. 8.4 Final laparoscopic view of gastric conduit (white lines) pulled up via widened hiatus (black arrow) prior to attached conduit to the hiatus



performed anti-reflux operation. In the pediatric population, the success rate is reported around 86% [10]. However, in the small subgroup of patients for which a fundoplication is ineffective, esophageal replacement might be indicated [11]. The indications for esophageal replacement in children with gastroesophageal reflux would include children with severe esophageal dysmotility for which initial fundoplication or revisional fundoplication would make subsequent esophageal replacement more difficult (especially for gastric transposition). Since the results of fundoplication in children with esophageal dysmotility is poor, post-pyloric feeding versus would be preferred management instead of fundoplication and esophageal replacement for failed feeding advancement and continued GERD.

Post-esophageal Surgery Strictures

Tracheoesophageal fistula with esophageal atresia (TEF-EA) occurs with an incidence of 1 in 4500 births. Primary surgical repair by performing a primary end-to-end- anastomosis of esophageal segments and removal of the fistula, through either open or minimally invasive techniques, is the basis of management [12]. TEF-EA can also be repaired with esophageal replacement, especially in patients with long

gap esophageal atresia [13, 14]. Currently, the most commonly reported complication is the development of a postoperative anastomotic stricture (AS) in approximately a third of survivors. An identified risk factor for developing AS includes long gap esophageal atresia [15–18]. As with strictures of other etiologies, the first-line treatment is endoscopic dilation. For patients who experience recurrent or persistent strictures, endoscopic medical therapy with steroids or mitomycin C may be utilized. Esophageal stenting has been described but would not be a long-term solution for stricture management [19].

Surgical intervention is reserved for scenarios when the AS is refractory to all the conservative therapies. Surgical options include stricture resection with direct anastomosis or esophageal replacement [18, 20]. Of note, interposition grafting is an extremely rare option specifically for the treatment of AS. There have only been a few reports in the literature [21]. Thus, the indications for esophageal replacement for postoperative anastomotic strictures include:

- Short-segment strictures following EA-TEF repair associated with chronic or recurrent TEF
- Long-segment strictures refractory to dilatation therapy or segmental resection
- Any stricture refractory to dilation but associated with severe esophageal dysmotility

Esophageal Replacement Conduits

The native esophagus remains the ideal conduit between the oropharynx and stomach and should be preserved when possible. However, when various insults to the esophageal tissue lead to permanent scar formation and strictures, despite attempts at conservative measures, esophageal replacement to reestablish upper gastrointestinal anatomy and function should be considered. The three most commonly performed operations for esophageal replacement are colonic interposition, gastric pull-up or transposition, and jejunal interposition. Each technique has shown to be effective but has been associated with significant morbidity and sometimes mortality. Other sections of this book will describe the operative techniques and reported outcomes/complications.

Summary

Of the operative techniques for esophageal replacement, each brings a risk of complications such as graft loss, anastomotic leaks, or strictures. Often the decision to perform a specific technique will be predicated upon surgeon experience as well as patient factors. Overall, the outcomes of esophageal replacement operations have been good such that any potential risks should be balanced against the benefits of an enhanced quality of life.

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