

# Corrosive esophagitis in children: a 30-year review

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## Abstract

Caustic ingestion with resultant corrosive esophagitis in the pediatric population comprises a heterogeneous group in terms of offending agent, location of burn and the degree of damage. Consequently, the treatment of these injuries has also varied over the years and the optimal management remains controversial. Another area of concern that is seldom reported in the otolaryngology literature is the socioeconomic impact of such injuries both on the child and on the family. We report a 30-year retrospective review of aerodigestive tract caustic injuries at The Hospital for Sick Children. Eighty patients were identified with an age range from 1 month to 16 years. Early and late complications are reviewed including 23 patients (29%) that developed medical complications and 16 patients (20%) that developed severe esophageal strictures. Five of these children required repeat prograde dilatation, while 11 children required gastrostomy and stringing with subsequent retrograde dilatation. All the 11 children required esophageal replacement surgery. The economic and social consequences to the child and family were also noted with particular attention to hospital costs, parental absenteeism from work, and the need for job relocation. A partial cost analysis using a child with a severe injury is presented as an example. Psychological aspects such as attempted murder, jail terms and attempted suicides are also documented. We also present an analysis of those children requiring esophageal replacement surgery, and examine the possible role of esophageal stents in recalcitrant strictures. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

*Keywords:* Corrosive esophagitis; Caustic ingestion; Esophageal replacement

## 1. Introduction

Caustic burns of the aerodigestive tract present the otolaryngologist with immediate and occasionally very long-term management problems. They are, fortunately, relatively rare injuries with an estimated incidence of 5000–15 000 cases per

year in the US [13]. Caustic ingestion in the pediatric population comprises a heterogeneous group in terms of offending agent, location of burn and the degree of damage. Consequently, the treatment of these injuries has also varied over the years and the optimal management remains controversial. Another area of concern that is seldom reported in the otolaryngology literature is the socioeconomic impact of such injuries both on the child and on the family.

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We report a 30-year experience with aerodigestive tract caustic injuries at the Hospital for Sick Children (HSC) in Toronto, Ontario, Canada. Specifically, we report on some of the social, psychological, and economic implications of these accidents on the child and immediate family during long term follow-up. Further, we present an analysis of those children requiring esophageal replacement surgery, and examine the possible role of esophageal stents in recalcitrant strictures.

## 2. Methods

All the new cases of caustic burns admitted between 1965 and 1995 at HSC were obtained from medical records. This excluded any minor ingestion that had been dealt with as an outpatient. Parameters examined included the year of admission, age, sex, caustic agent, degree and site of burn. Investigation with esophagoscopy was noted for timing and extent of examination whether to or beyond the level of the initial mucosal injury. Injuries were classified based on initial endoscopic findings and classified according to the method of Cardona and Daly [2].

The use of barium swallow was also noted. Management with antibiotics, steroids, and dilatation were noted. Early and late complications were reviewed including those that required esophageal replacement surgery. The economic consequences in terms of hospital costs, absenteeism from work and the need for job relocation was assessed. Social consequences of stress on the family including separation, divorce, and death were measured. Finally, the psychological aspects of the problem, including attempted murder, jail terms and attempted suicides with depression were evaluated.

## 3. Results

Eighty patients were identified over the 30-year period. Ages ranged from 1 month to 16 years. Sixty-three of the patients (78%) were between the ages of 1 and 3 years. The offending substance was an alkali in 56 children (70%). The most

common agent was Drano drain cleaner (29 patients). Various acids comprised only 11% of the cases (nine patients). An additional 15 cases (19%) involved Lysol, bleaching compounds, or other agents.

The degree of mucosal injury was first or second degree in 46 individuals (58%). More extensive second-degree burns were documented in 21 patients (26%) and an additional 13 patients (16%) were diagnosed with third degree burns. The more extensive mucosal injuries were often associated with multiple sites of involvement throughout the aerodigestive tract. In 54% (43 patients) the burns were confined to the oral cavity. Twelve injuries (15%) extended from the oral cavity to include the hypopharynx. In four additional patients (5%) the hypopharynx and larynx were primarily involved with no evidence of oral cavity injury. Twenty-one children (26%) had evidence of esophageal injury. There was only one case of documented gastric injury.

Esophagoscopy was performed in 35 cases (44%). Endoscopy was performed within 24 h of the injury in seven cases, between 1 and 3 days in 15 cases, and between 4 and 7 days in eight cases. The remaining five cases had esophagoscopy performed greater than 7 days after the initial injury. There were no reported cases of perforation secondary to endoscopic examination irrespective of time interval relative to the initial injury. Complete esophagoscopy to the level of the lower esophageal sphincter was performed in 27 children (77%). In the other eight cases the esophagoscopy was terminated at the level of the most proximal circumferential injury. Ten severe injuries (extensive second degree and third degree burns) had complete esophagoscopy while in six patients the procedure was stopped at the level of the most proximal burn. Complete endoscopy was performed on 19 children with first or more limited second-degree injuries.

A barium swallow was performed on 13 children (16%), and ten of these studies were performed more than 2 weeks after the initial injury. Five of the cases involved only superficial first-degree burns as documented by previous endoscopy.

Antibiotics and systemic steroids were used in only 18 cases (22%): nine of these patients had

Table 1  
Patients requiring esophageal replacement surgery (gastric tube)

Case	Age at surgery (years)	Pneumo thorax	Neck anastomotic leak	Further surgery	Other complications	Number of dilatations after surgery	Length of follow-up (years)	Swallowing status at most recent follow-up
1	3	No	Yes	Resection of stricture	Wound infection	2	1	Poor
2	5.5	Yes	No			6	12	Good
3	17	No	No			2	11	Excellent
4	5	No	Yes			2	4	Excellent
5	3	No	Yes	Arytenoidectomy for bilateral vocal cord paralysis	Tracheotomy dependent	7	21	Poor
6	16	Yes	Yes	Resection of stricture	Lethal GI bleed	0	0.17	Died
7	4	No	Yes	Repair of persistent leak	Left phrenic nerve injury	5	20	Excellent
8	12	No	Yes	Repair of persistent leak	Wound infection	8	19	Excellent
9	7	Yes	Yes			6	16	Excellent
10	14	No	Yes			0	12	Excellent
11	7	No	Yes			5	2	Good

first degree burns, five children who received steroids had second degree injuries, while four patients had third degree burns.

#### 4. Complications

Twenty-three patients (29%) developed medical complications as a result of the caustic ingestion. There was, however, no direct mortality related to the initial injury. There was one episode each of chemical pneumonitis, atelectasis, aspiration pneumonia, and dysphagia with associated gastroesophageal reflux disease. One patient, after receiving systemic steroids, developed a gastric ulcer with associated hemorrhage. This was controlled with conservative measures and did not require surgical intervention. Nineteen (24%) of the 23 children suffered severe medical complications requiring further intervention. Three patients required anti-reflux surgical procedures after being followed for 6 months without response to medical therapy. The remaining 16 patients developed severe esophageal strictures. Five patients required repeat prograde dilatation, while 11 children required gastrostomy and stringing with subsequent retrograde dilatation. Typically, these children required dilatation procedures every 2–4 weeks. Although the frequency of dilatation would decrease over the first 6–12 months, the majority of these children continued to require dilatation procedures even 15 years after their initial injury. The 11 children (14%) that required gastrostomies eventually required esophageal replacement procedures (Table 1). All underwent gastric tube conduit reconstruction with anastomosis to the cervical esophagus. The time from initial injury to esophageal replacement ranged from 12 months to 14 years (mean 5 years). Table 1 summarizes the results of these 11 patients. Ten patients were followed from 1 to 30 years with one patient lost to follow-up after 1 year. One patient (Case 6, Table 1) died 2 months after the replacement surgery secondary to massive gastroesophageal hemorrhage. Another child (Case 7, Table 1) was noted to have a left vocal cord paralysis at the time of the caustic injury. The patient sustained a right recurrent laryngeal nerve

injury during esophageal replacement surgery necessitating tracheotomy. The patient remains tracheotomy dependent. All the ten patients learned to swallow and eat with minimal aspiration. Only one patient (Case 11, Table 1) requires tube feed supplement.

#### 5. Economic impact

Table 2 summarizes the approximate average medical costs for a child with a severe (advanced second or third degree injury) esophageal caustic burn. A typical case of a 21-month-old male infant is used as the example case. This child required continued therapy until he was 7.5 years of age. Costs are based on HSC charges in 1996 and are reported in Canadian dollars. Only direct medical costs covered by government insurance could be calculated from the medical chart. Indirect costs, for example, those relating to parental lost income or lodging for parents during hospitalization could not be determined by chart review.

#### 6. Psychosocial impact

The psychosocial implications of these injuries uncovered during the chart review are shown in Table 3 and were quite astonishing. Fifty percent of the effected children developed behavioral or educational problems. Almost one quarter of the families (22.5%) developed domestic problems.

Table 2

Economic impact during the treatment of a child with caustic induced esophageal stricture (average case of a 21-month-old followed for 7.5 years. Costs based on 1996 Hospital for Sick Children prices in Canadian \$)

Item	Cost (\$)
Hospital stay: 112 days	139 440
Number of general anesthetics: 29 (Esophagoscopy with dilatation: 27 Gastrostomy tube procedures: 2)	3726
Parental travel: 29 trips	29 000
Total cost	172 166

Table 3  
Psychosocial factors associated with children and families after caustic ingestion injury

Problem (some examples)	Number
Educational delinquency: (25 delayed 1 or more grades and 7 drop-outs from school)	32
Family break-up or relocation: (two mothers left to become nuns, three parents abandoned families, five parents with loss of employment)	18
Antisocial behaviour: (six run-aways, one attempted suicide, one child with multiple criminal incarcerations)	8

These problems developed despite early consultation and intervention from the departments of psychiatry, social work, as well as the hospital chaplaincy.

## 7. Discussion

A variety of agents, whether oxidizing, reducing, corrosive or desiccant may be responsible for the burns encountered in caustic ingestion injury. The two major groups are alkali and acids with the latter being much less common. In addition to agent pH, the extent of mucosal damage is influenced by three factors: (1) the quantity of substance ingested; (2) the physical state of the agent and (3) the duration of exposure [10]. Substances in a solid form usually produce a localized burn while those in a liquid form produce a more diffuse injury pattern. Damage tends to occur in areas of natural stagnation or pooling; corresponding to the known regions of anatomic narrowing within the esophagus (cricopharyngeus), as well as areas of external compression on the esophagus (aortic arch, the left mainstem bronchus, and hiatal region) [13,17].

The pathophysiology of the mucosal injury is dependent on the type of agent ingested. Acid produces coagulation necrosis with the depth of penetration limited by the eschar formation [5,18]. Alkaline causes liquefaction necrosis. Because there is no protective eschar in alkali burns the depth of penetration is usually much greater than

with acid injuries [1,2,18]. Tissue degeneration during the first 24–48 h is aggravated by bacterial invasion. Fibroblast proliferation within the wound is followed by collagen deposition over the first week. The burn area is weakest between days 7 and 21 because of sloughing of necrotic tissue and new collagen formation. As noted by Key, if the damage is not circumferential then the likelihood of stricture formation is remote [11]. Strictures typically manifest between 4 and 6 weeks after the initial injury.

Several studies have indicated that the clinical manifestations of caustic ingestion injuries are poor predictors of the extent or depth of esophageal injury [4,8,13,18]. Crain and coworkers found that only 33% of those patients with evidence of oral cavity burns actually had esophageal burns [4]. Gandreault's group reviewed 373 cases of caustic ingestion and found that 12% of children with second degree esophageal injuries had no significant esophageal or abdominal complaints [8]. Although no attempt was made to associate presenting symptoms and symptoms with clinical findings in the present study, we did note that in the four cases with isolated hypopharyngeal and laryngeal injuries no oral cavity involvement was seen. There was a trend, however, in the degree of oral mucosal injury; the more extensive burns were associated with a higher rate of multiple site involvement.

Medical management of caustic ingestion includes antibiotics, steroids, and H<sub>2</sub> blockers. Antibiotics have been shown to markedly reduce the incidence of stricture formation [11]. The role of steroids remains controversial. In Oakes and coworkers review of the literature, they found 14 studies with an aggregate of greater than 2000 patients treated with steroids. There was no measurable benefit of the use of steroids when compared with those patients who did not receive systemic steroids [12]. Others recommend systemic steroids in second-degree injuries if they are given within the first 48 h after the injury. Their use is, however, contraindicated in the presence of third degree burns because of the potential increased risk of perforation [15,18]. In our series one of the four patients with third degree injuries that received systemic steroids developed complications,

and the use of systemic steroids had no measurable benefit when compared with similar patients with either first or second degree burns that did not receive these medications.

Secondary damage due to reflux may play a significant role in stricture formation. H<sub>2</sub> antagonists and antacids should be considered in the management of these injuries [13]. Some patients will ultimately require anti-reflux procedures as did three children in the present study.

The use of endoscopy has become the cornerstone in the investigation of these injuries. Controversy still remains, though, as to when to perform endoscopy and whether one should risk potential perforation by advancing the instruments beyond the level of the most proximal damage. Holinger advocated endoscopy within 48 h of injury for mild to moderate injuries with systemic symptoms [9]. Alternatively, Borja advocated waiting 10–14 days prior to endoscopic assessment [1]. The trend over the past 15 years has been to delay initial endoscopy for 24 h to allow the full extent of the damage to manifest [3,6,16,18]. These authors also recommend endoscopic evaluation within 4 days of the injury before the esophageal wall begins to weaken substantially. At HSC, it is interesting to note that 14 of the 35 endoscopies were performed outside this time frame. Eight cases were actually performed between days 4 and 7-post injury without sequelae. If it is elected to perform esophagoscopy termination at the level of the most proximal circumferential burn is also now the accepted regimen. In ten of our earlier cases complete esophagoscopy was performed despite the presence of a severe proximal injury without sequelae. These findings strengthen the position of those who advocate complete esophagoscopy in all cases of suspected severe injury [3,6,16]. These authors stress the high mortality associated with full thickness necrosis of the lower esophagus and stomach necessitating early recognition and intervention. Contrast studies are not helpful early, as they tend to underestimate the extent of damage. Only 16% of our patients underwent a barium swallow study. The majority of these studies were done in the follow-up period after endoscopy had confirmed a less severe injury. Contrast studies

are of greater value in those cases of moderate burns to allow assessment of dynamic esophageal function and to assess results following a dilatation.

The primary treatment for caustic esophageal strictures remains dilatation; whether retrograde or prograde [15,17]. The optimal frequency and time of such procedures is not well established and is largely individualized. The time interval between procedures is based on the effects of previous dilatations and symptomatology. Results of barium studies did not appear of use in determining further dilatation procedures or the extent of dilatation required.

The timing of and type of esophageal replacement that becomes necessary is debatable. At HSC, the average time from injury to such replacement (with a gastric tube) was 5 years with good (not excellent) results. The majority of the replacement problems are related to the esophago-gastric tube anastomosis [22].

Investigators have employed an array of techniques as a means to prevent or treat caustic esophageal strictures. The early insertion of stents was first proposed by Salzer in 1920 and later advocated by Fell and coworkers [7,14]. Early work fell into disfavor because it was found that the strictures soon reformed after the stent was removed. More recent work has once again brought the question of esophageal stenting for benign strictures to the forefront. Colon and Chang, as well as Estrera and coworkers have shown that the use of stents can decrease the frequency of stricture formation. Further, when strictures did develop after stent removal, the strictures were easier to dilate [3,6]. The use of a self-expanding esophageal stent for malignant strictures is well documented [19,20]. This technology is now being applied in both the animal models and in cases of recalcitrant benign strictures [21,22]. At HSC we have employed such stents in two children with benign strictures with promising results. In both cases, however, the strictures were associated with a tracheoesophageal fistula and not related to caustic ingestion. The stents were used in an effort to avoid esophageal replacement surgery. Figs. 1 and 2 demonstrate a stent in one of these children; a

6-year-old female with a repaired congenital esophageal atresia and tracheoesophageal fistula. She developed an esophageal stricture after surgical repair of her defect and has undergone over 90 general anesthetic procedures related to fistula repair, stricture dilatation and antireflux surgery. She required at least one prograde dilatation procedure every 4–6 weeks. The initial metal stent had been in position for 8 months and has been replaced on two occasions with a silastic stent after accumulation of excessive granulation tissue. Following esophageal stenting, she could not only swallow more efficiently, but required no interval dilatation procedures (follow-up 18 months).

Therefore, because of the possible complexity and long term economic and psychosocial havoc of such caustic ingestions, we propose the following management protocol:

1. If endoscopy is contemplated, it should be performed between 24 and 48 h after injury to fully evaluate the extent of injury. We concur with the work of Colon, Estrera, and Thompson that complete esophagoscopy (to level of the lower esophageal junction) is required.
2. Consider the use of prophylactic antibiotics in

all suspected second or third degree burns.

3. If esophageal replacement is indicated, then gastric tube replacement is the procedure of choice.
4. Although repeat dilatation, retrograde or prograde, is the treatment of choice in persistent esophageal strictures, stents may play an increasing role in recalcitrant cases.
5. We recommend early social service intervention and both individual and family counseling in all cases of severe (second or third degree burns) caustic ingestion injuries.

## 8. Conclusions

Serious pediatric aerodigestive caustic burns occur two to three times a year at HSC and most are due to alkali. Sixty percent are less serious injuries. Fifty percent are confined to the oral cavity. One-quarter develop complications up to and including esophageal replacement (7%). Stenting may offer some benefit. The long-term economic and psychosocial havoc on the child and his/her family can be ominous.

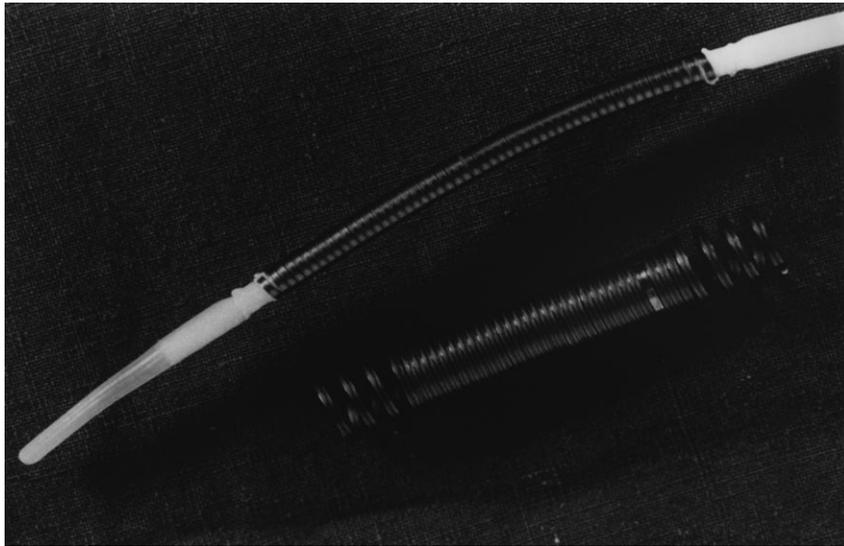


Fig. 1. Esophageal stent loaded on balloon catheter for placement within the esophageal stricture.

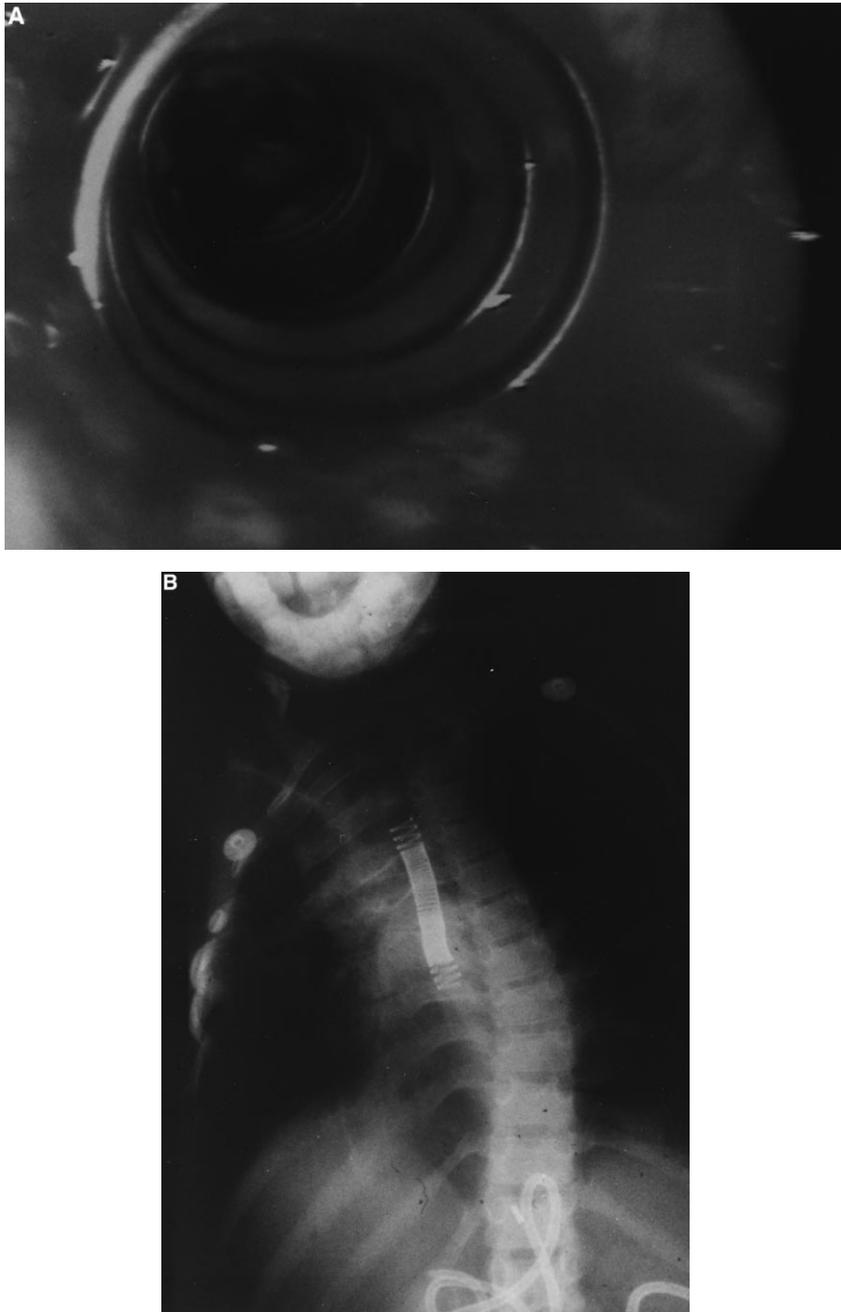


Fig. 2. (A) Esophageal stent positioned within the stricture. (B) Chest X-ray showing final position of stent.

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